Flexi G4 AC
Workshop Manual

Part Number: 42056-00
Issue D – 26/06/2013

Produced by Narrow Aisle Ltd

When ordering spare parts for your Flexi Generation 4 forklift truck, check the truck specification supplied with your truck for the correct listing for variables, such as, chassis, mast or traction controller that are fitted.

Member Fork Truck Association

Issued by:
Narrow Aisle Limited, Great Western Way, Great Bridge, Tipton, West Midlands, DY4 7AH, United Kingdom.

BSI REGISTERED UKAS QUALITY MANAGEMENT
Certificate No. FM 33051

Contents

This Page is intentionally Left Blank

Introduction

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

About This Manual

The aim of this manual is to enable the maintenance and repair of Flexi Generation 4 trucks.

Manual Usage

Section Location

This manual is divided into the following Sections:

A. Introduction
B. Front axle assembly
C. Steering
D. Mast support assembly
E. Rear wheel assembly
F. Parking brake system
G. Hydraulic system
H. Pedal plate module
I. Chassis
J. Mast
K. Seat and covers
L. Electrical system

Section Contents

Each Section contains some or all of the following information:

Description - Brief description of the equipment covered in the section.

Operation - Where necessary, a brief description of the operation of the system is incorporated.

Maintenance - The routine servicing requirements by hours or period in use.

Specification - Tolerances, dimensions, tightening torque's, etc., applicable to the Section.

Special Tools - A list of special tools required with the operations for which they are used.

Overhaul - All overhaul operations applicable to the equipment contained in the Section.

Fault Diagnosis - Where necessary, a list of possible faults, with a logical list of suggested causes and remedies is incorporated in the Section.

Maintenance Operations

Narrow Aisle Ltd. Trucks are thoroughly examined, tested and lubricated before leaving the factory. However, regular maintenance and lubrication are necessary to ensure smooth running and long life. The maintenance operation contained in each section details the checks, adjustments and preventive maintenance necessary on the components contained in the specific section.

The recommended maintenance periods are for trucks operating in normal, clean operating conditions. For abnormal temperatures, dust contaminated areas, or moist conditions, etc., more frequent maintenance will be required.

CAUTION

Modification must not be carried out on the truck or its attachments in any way which may affect its operational performance, safety and stability as originally specified by the manufacturer.

Modifications which may be found necessary for application purposes must, for safety reasons, be made in agreement with **Narrow Aisle Ltd.**

Narrow Aisle Ltd. Trucks are built with quality components, the use of inferior spare parts could result in inadequate safety and poor reliability. We strongly recommend the use of genuine **Narrow Aisle Ltd**. spares. **Narrow Aisle Ltd**. will not recognise any complaint resulting from the use of unauthorised spare parts.

Product Description

The FLEXI Generation 4 trucks are designed for use in ambient thermal conditions between 0ºC and + 35ºC (+ 32ºF and + 100ºF) providing that the correct hydraulic oils, lubricating oils, and greases are used.

The standard truck must not be operated in flammable areas, or in a corrosive atmosphere, or in areas containing a high degree of dust contamination.

Each fork lift truck must be used strictly within the operating parameters given by the specification sheet and in accordance with the operating instructions. All safety regulations / recommendations of the country in which the truck is being operated (e.g. F.E.M., I.S.O., B.I.T.A., etc.) must also be followed.

Product Identification

The specification plate, located on the inside of the driver overhead guard details the model code, serial number and safe working load.

WARNING

The safe working load detailed on the specification plate must NEVER be exceeded.

Modifications

No modifications or alterations to the truck which could affect, for example, capacity, stability or safety requirements of the truck, shall be made without the prior written approval of the original truck manufacturer or their authorised representative. This includes changes affecting, for example, braking, steering, visibility and the addition of removable attachments.

Only if the truck manufacturer is no longer in business and there is no successor in the interest to the business, may the user arrange for a modification or alteration to a powered industrial truck, provided, however, that the user

a) Arranges for the modification or alteration to be designed, tested and implemented by an engineer(s) expert in industrial trucks and their safety.

b) Maintains a permanent record of the design, test(s) and implementation of the modification or alteration.

c) Approves and makes appropriate changes to the capacity plate(s), decals, tags and instruction handbook.

d) Affixes a permanent and readily visible label to the truck stating the manner in which the truck has been modified or altered together with the date of the modification or alteration and the name and address of the organisation that accomplished those tasks.

Dimensions

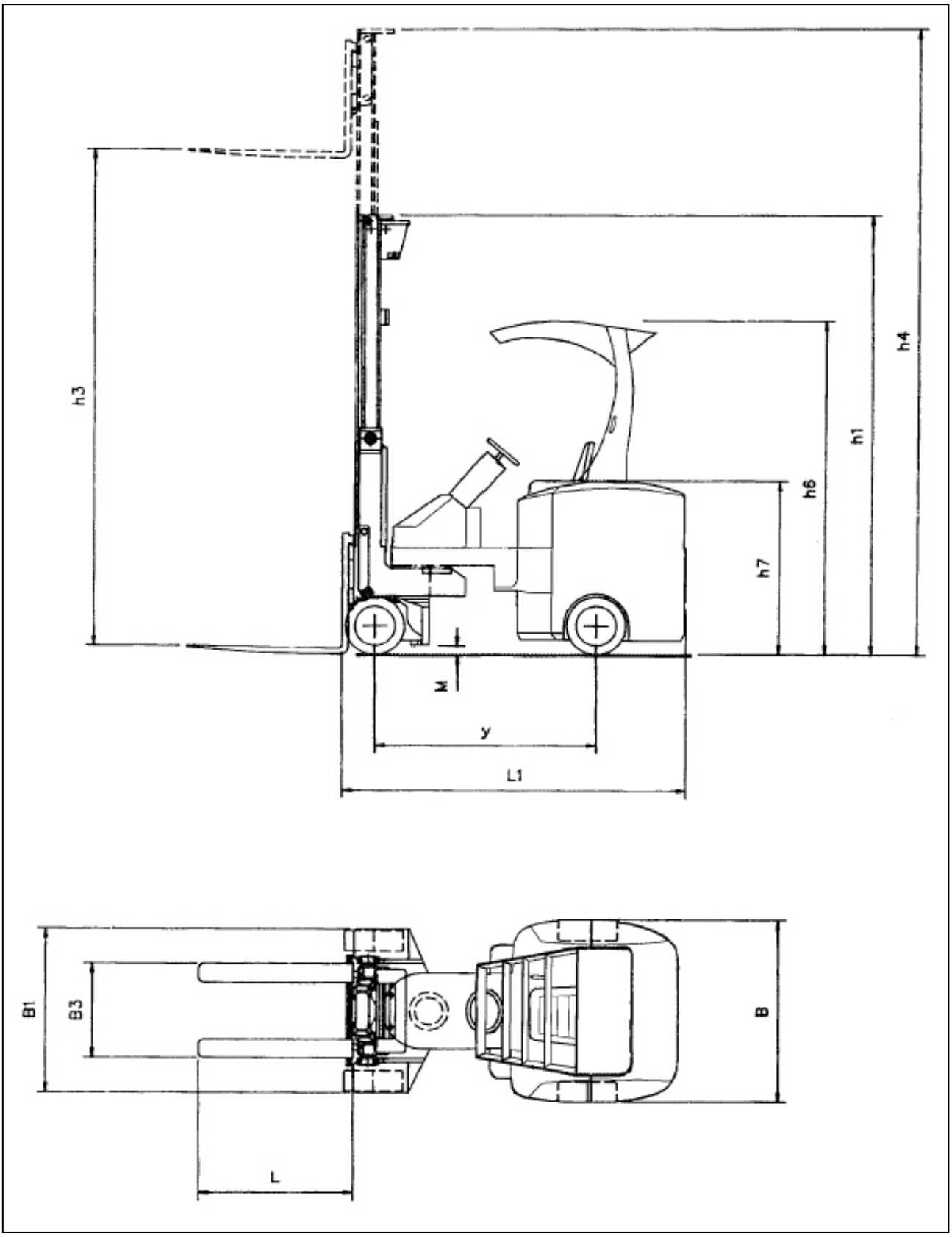


Figure A1 – Truck Dimensions

Specification Plate

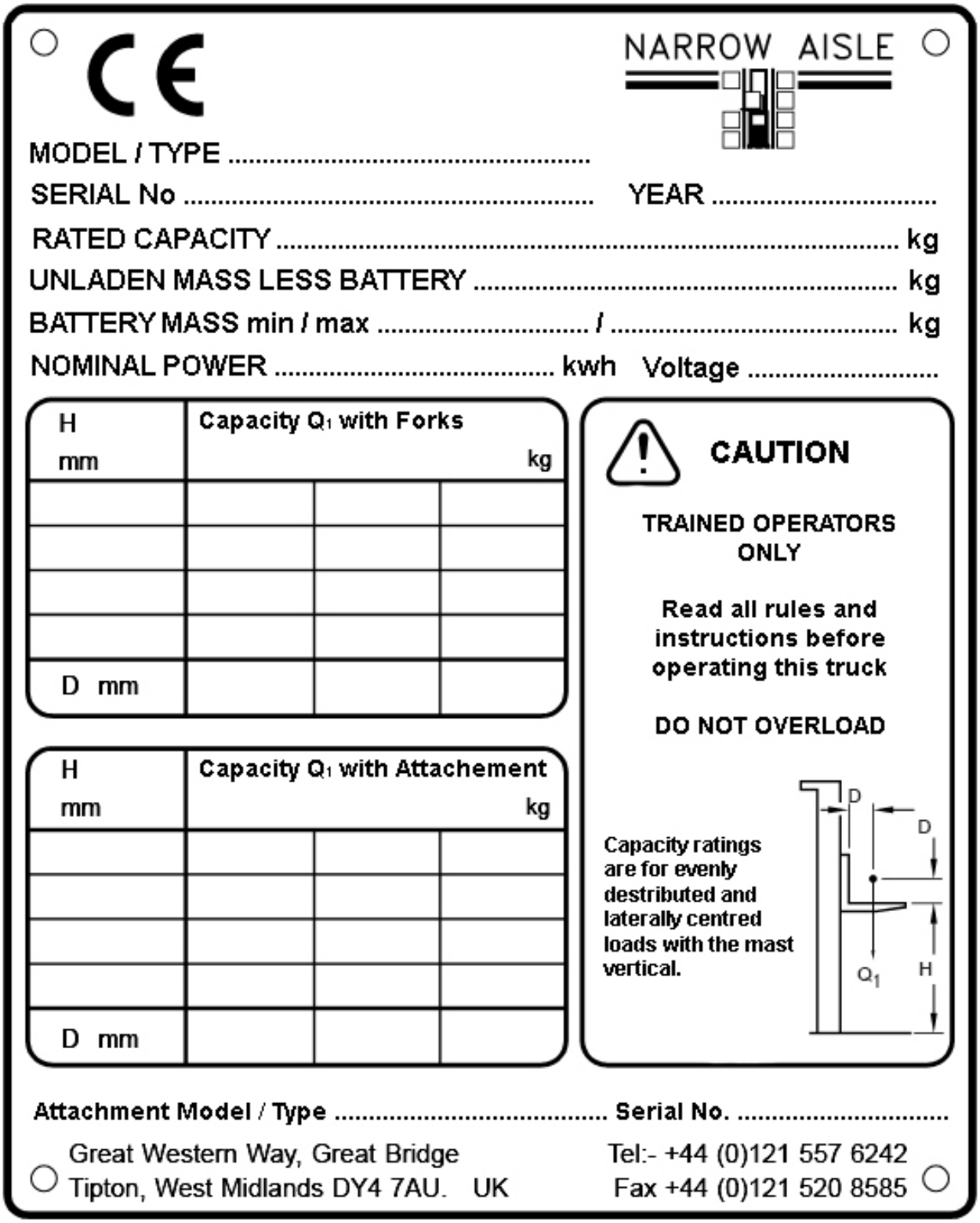


Figure A2 – Specification Plate

Jacking Points

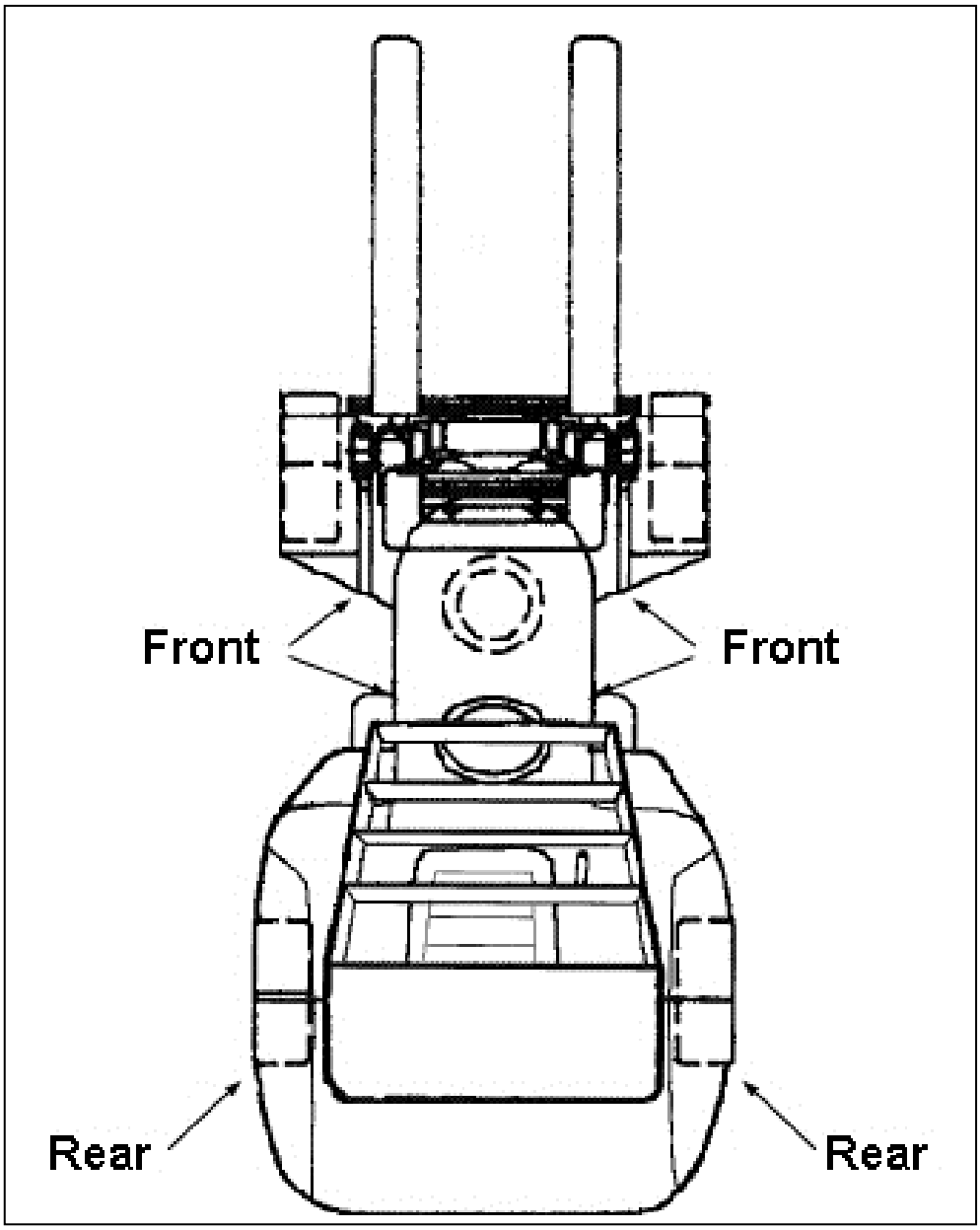


Figure A3 – Jacking Points

Jacking points are situated:-

On the side weight immediately behind **REAR** wheel,

Underneath main chassis member where step is attached to chassis, **DO NOT USE STEP AS JACKING POINT.**

Underneath front ballast weight door. **DO NOT USE MUDGUARD AS JACKING POINT.**

Maintenance Procedures

Component Accessibility

For regular maintenance, access to various truck components is accomplished by removing covers, panels and/or doors. The following is a general explanation of what cover, panel, etc., must be removed to allow for the most efficient access when performing services and/or maintenance to components. More details are given in following sections on hydraulics, electrical, brakes etc.

Rear Articulated Section

The seat may be lifted to allow access to:

1. Hydraulic tank filler and filter.
2. Hydraulic Steering Pump and motor
3. Hydraulic lift pump and motor.

The front cover may be removed to allow access to:

1. Electrical components.
2. Traction controller.
3. Hydraulic control valve.
4. Brake master cylinder.
5. Handbrake lever assembly.

Floor panel may be removed to allow access to:

1. Brake pedal linkages.
2. Traction speed unit.
3. Steering control switch.

Front nose cone allows access to:

1. Steering motor orbital.
2. Steering lock valve.
3. Steering slew motor.
4. Horn
5. DC/DC Converter (if fitted)

Front Articulated Section

Swing out balance weight allows access to:

1. Drive motor.
2. Drive axle anchor bolt.
3. Drive motor anchor bolts.

Safety Precautions

WARNING

To prevent risk of serious injury to yourself and others observe the following safety instructions.

Industrial trucks may become hazardous if maintenance is neglected. Maintenance and inspection shall be performed in conformance with the following practices:

- Ensure that the recommended maintenance procedures are performed at the specified intervals.
- Ensure that only qualified, authorised personnel maintain, repair, inspect and adjust the truck.
- Ensure that any lifting or jacking equipment to be used is of the correct capacity and in good condition.
- Ensure that when using lifting equipment, the specified truck lifting points are used.
- Ensure the truck is positioned on a firm level surface when jacking-up the truck.
- Disconnect the battery at the connector before working on the truck. DO NOT pull the cables attached to the connector.
- Refer to the applicable procedure when undertaking maintenance and overhaul operations.
- Remember that the cooling fans are running continuously as long as the battery is connected to the truck when warm. Take great care not to allow items of clothing or hair in the vicinity of the fans.
- Never guess or assume polarity or connections of the truck electrical system. Refer to the electrical wiring diagram.
- Never guess or assume hydraulic connections. Refer to the hydraulic circuit diagram.

- Avoid fire hazards and have fire protection equipment present. Do not use an open flame to check level or for leakage of gas, fluids or oil. Do not use open pans of fuel or flammable cleaning fluids for cleaning parts.
- Keep workshop well ventilated, clean and dry.
- Brakes, steering mechanisms, control mechanisms, lift overload devices, guards, and safety devices shall be inspected regularly and maintained in a safe operating condition.
- Capacity, operation and maintenance instruction plates or decals shall be maintained in legible condition.
- All parts of lift mechanisms shall be inspected to maintain them in safe operating conditions.
- All hydraulic systems shall be regularly inspected and maintained in conformance with good practice. Cylinders, valves, and other similar parts shall be checked to assure that “drift” has not developed to the extent that it would create a hazard.
- Batteries, motors, controllers, limit switches, protective devices, electrical conductors, and connections shall be maintained in conformance with good practice. Special attention shall be paid to the condition of electrical insulation. To minimise fire hazards and facilitate detection of loose or defective parts.
- Trucks should be kept in a clean and dry condition
- Modifications and additions which affect capacity and safe truck operation shall not be performed by the customer or user without manufacturer’s prior written approval. Capacity, operation and maintenance plates or decals shall be changed accordingly.
- Care shall be taken to assure that all replacement parts are interchangeable with the original parts and of equal quality to that provided in the original equipment.
- Before leaving the truck:
  a. Stop truck.
  b. Fully lower the load engaging means.
  c. Place directional controls in neutral.
  d. Apply the parking brake.
  e. Turn off power (power disconnect).
  f. Remove key.
  g. Disconnect battery.
  h. Block the wheels if truck is on an incline.
- Before working on truck:
  a. Raise drive wheel free of floor or disconnect power sources.
  b. Use chocks or other positive positioning devices.
  c. Block load engaging means, inter masts, or chassis before working under them.
  d. Operation to check performance of truck or attachments shall be conducted in an authorised safe clearance area.
- Before starting to operate truck:
  a. Be in operating position.
  b. Apply brake.
  c. Place directional control in neutral.
  d. Before operating truck, check functions of lift systems, directional control, speed control, steering, warning devices, brakes and any attachments if fitted.

Lubricants

To obtain maximum life of any industrial equipment, a well planned maintenance program should be followed. The following information is intended to provide guidelines for proper lubrication intervals as called out in the lubrication chart. Lubrication intervals called for are according to hours of truck operation and/or specific number of days or months. These recommended figures should be used as an aid in maintaining safe and efficient truck operation. Some operating conditions will require more frequent checks and lubrication than listed. Applications with much dust or moisture will require modification of the schedule to fit that particular application.

Only high grade lubricants and fluids should be used. Sources of these lubricants may be from almost any of the oil companies; those listed below are typical and any lubricant with equal specifications may be used (See Lubricant Table below).

Note: Any truck used in freezing temperatures must use suitable low temperature fluids.

Type of Lubricant	Brand Name	Manufacturer
A Drive transmission, temperature range -10C to 30C	See B – 11	
B. Grease (Multipurpose)	Retinax A L.M. Grease	Shell Castrol
BB. Grease (low Temp.)	Acuania RA Helueum O	Shell Castrol
C. Hydraulic Fluid	Mobil DTE 24 Tellus 27	Mobil Shell
CC. Hydraulic Fluid (low temp)	Mobil Aero HFA Hyspin AWH-1-5	Mobil Castrol
D. Brake Fluid	DOT 4/5	Shell
E. Chain and Cable	Silkolene	Silkolene
F. Oil (General)	SAE 40	Shell

Routine Maintenance Contract

All routine maintenance must be carried out by fully trained Service Engineers from Narrow Aisle Ltd. or their authorised agents, or engineers who have been trained by Narrow Aisle Ltd. to carry out this work in a safe manner in accordance with the Workshop Maintenance Manual.

Narrow Aisle Ltd. recommends that you enter into a routine maintenance contract.

A qualified service engineer will make regular visits dependant upon the number of hours the truck is used per week in conjunction with the operational environment.

Regular Service intervals in normal use are:

- Three months, or 500 hours (whichever comes first)
- Annually, or 2000 hours (whichever comes first)

As part of, or in addition to the regular maintenance of the truck, there is a statutory requirement for a recorded inspection at 12-monthly intervals. During this inspection all working parts of the truck, including the lift chains will be examined to ensure they are in working order. A report will be issued by the examiner detailing the condition of the truck, an example of which is shown on the next page.

Service Inspection Report - Electric

Great Western Way, Great Bridge, Tipton, West Midlands DY4 7AU • Tel: 0121 557 6242 • Web: www.flexi.co.uk • Email: info@flexi.co.uk

Customer Name	
Address	
Model	
Serial Number	

Delivery Date	
Hour Meter	
Inspection Date	

		TRAVEL TIMES	HOURS ON SITE	TOTAL HOURS	MILEAGE	
START					Finish	
ARRIVE ON SITE					Start	
LEAVE SITE					Miles	
FINISH						

Chassis, Mast & Carriage Assembly

- ☐ 1 Check mast bearings
- ☐ 2 Check mast pivot shaft / bushes for wear and tightness
- ☐ 3 Check tightness of all mast anchorage bolts
- ☐ 4 Check all welds visually for deterioration
- ☐ 5 Check tilt cylinder mountings for wear and deterioration
- ☐ 6 Check axle clamp bolts for tightness

Lubrication

- ☐ 7 Grease slewing ring bearing and pinion gear
- ☐ 8 Grease side shift tracks
- ☐ 9 Grease mast channels on bearing track
- ☐ 10 Grease axle articulation shaft bearings
- ☐ 11 Grease tilt pivot bushes
- ☐ 12 Grease wheel bearings
- ☐ 13 Grease mast / carriage roller bearings
- ☐ 14 Lubricate mast chains
- ☐ 15 Check oil level in drive axle gearbox

Steering

- ☐ 16 Check tightness of wheel nuts front and rear
- ☐ 17 Check wheel bearings
- ☐ 18 Check tightness of half shaft bolts - front axle
- ☐ 19 Check slewing ring and steer pinion for wear and tightness of bolts
- ☐ 20 Check correct operation steering switch

Hydraulic System

- ☐ 21 Check oil tank / reservoir level
- ☐ 22 Check pipe work for damage or leakage
- ☐ 23 Check all hoses for chafing and leakage
- ☐ 24 Check steering orbital unit and motor for leaks
- ☐ 25 Check lift cylinder seals for leakage
- ☐ 26 Check lift cylinder bleed pipes for damage or leakage
- ☐ 27 Check tilt cylinders for leakage
- ☐ 28 Check spool valve for leaks

General

- ☐ 29 Check lift speed : laden
- ☐ 30 Check and report condition of wheels and tyres
- ☐ 31 Check and report condition of seat belt
- ☐ 32 Wipe and clean truck
- ☐ 33 Check general condition of truck for damage / distortion

Electrical

- ☐ 34 Check drive motor brushes and springs for wear and free movement
- ☐ 35 Check lift motor brushes and springs for wear and free movement
- ☐ 36 Check power steering motor brushes and springs for wear and free movement
- ☐ 37 Check condition of contact tips and Insulators on all contactors
- ☐ 38 Check drive / lift / steering motor terminals for tightness and insulation covers fitted
- ☐ 39 Check wiring harness and terminal ends for damage or corrosion
- ☐ 40 Check all heavy power cables for chafing/wear or damage
- ☐ 41 Check operator instruments and controls
- ☐ 42 Check battery electrolyte level and S.G.
- ☐ 43 Check condition of battery, battery charger, plugs and leads
- ☐ 44 Check accelerator foot switch for wear and adjustment
- ☐ 45 Check correct operation of cooling fans
- ☐ 46 Check condition of traction motor cables for chafing / wear / insulation
- ☐ 47 Check traction panel and contactor terminal connections are secure
- ☐ 48 Check operation of hill start function

Safety

- ☐ 49 Check mast chains and anchors visually for deterioration and wear
  Maximum stretch wear allowance for all chains 3% Stretch.....%
- ☐ 50 Check forks for deterioration and wear
  Maximum wear allowance for forks 10%
- ☐ 51 Check operation of hydraulic hold valve
- ☐ 52 Check brake fluid level
- ☐ 53 Check operation and adjustment of all micro and limit switches
- ☐ 54 Check all traction speed functions
- ☐ 55 Check all audible warning devices
- ☐ 56 Check that the battery container is securely fastened
- ☐ 57 Ensure truck capacity plate is visible, legible and secure
- ☐ 58 Ensure truck warning labels are complete and legible
- ☐ 59 Check operation of warning beacon, if fitted
- ☐ 60 Check hand brake operation for wear, adjustment and efficiency
- ☐ 61 Check foot brake operation for wear, adjustment and efficiency

Part No.	Qty	Description	Price Each	Price Ex	Discount

Comments

Receipt for work carried out

Signature ..... Print Name .....

Order No. ..... Engineer .....

For Office Use Only

COST	
ADD LABOUR	
TOTAL	

Front Axle Assembly

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

Front Axle Assembly

Removal

1. Disconnect the motor cables at the electrical control panel end and withdraw. Disconnect & withdraw hydraulic hoses. Support the front of the truck.

2. Remove the pivot shaft as set out in **Section D – Mast Support Assembly** jack up the front of the truck and withdraw the axle assembly.

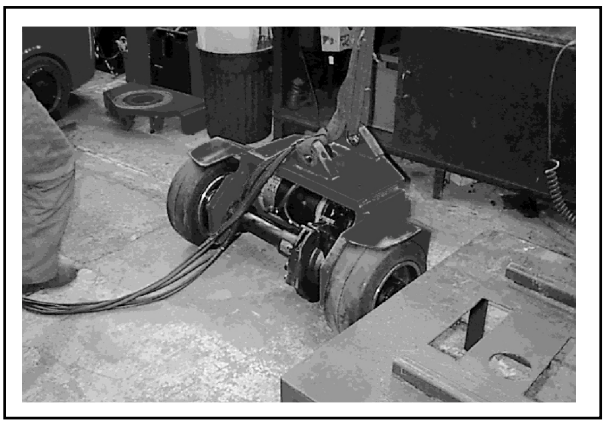


Figure B1 – Removal

3. Either block up truck or lower truck to ground, ensuring that there is no danger of movement of the truck

Removing Drive Motor - Workshop

1. Invert the assembly and transfer to a suitable place of work.

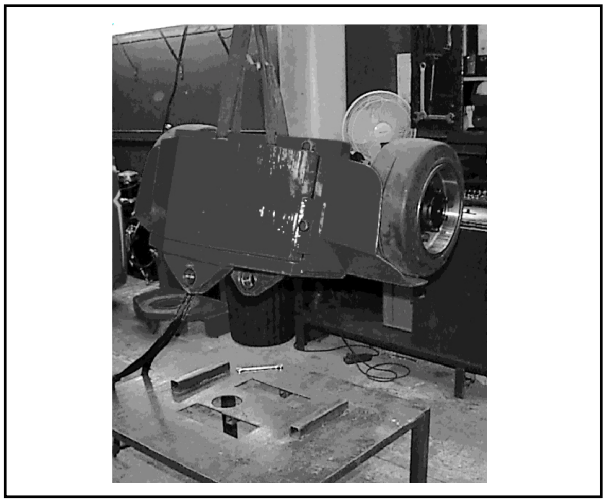


Figure B2 – Removing Drive Motor

2. Remove the drive wheels.

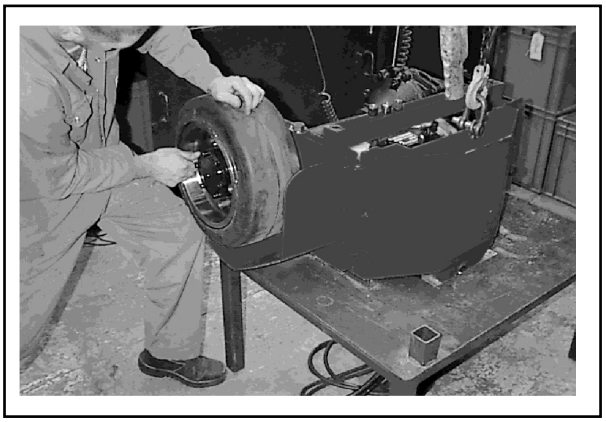


Figure B3 – Removing Drive Motor

3. Open the ballast weight door.

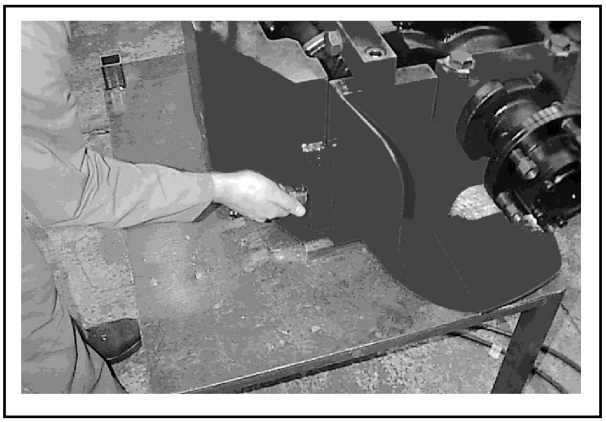


Figure B4 – Removing Drive Motor

4. Disconnect motor cables.

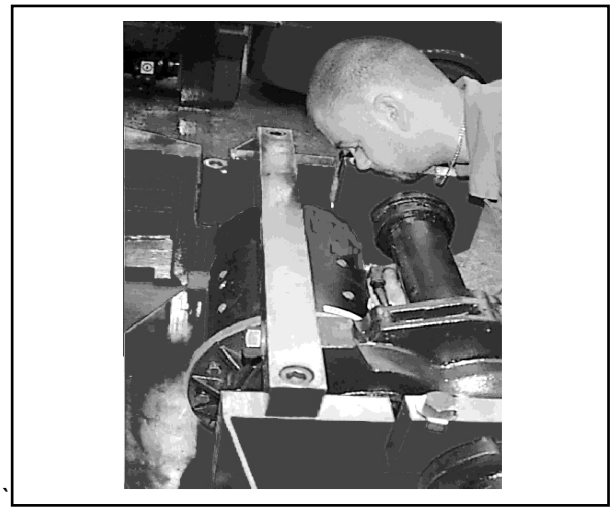


Figure B5 – Removing Drive Motor

5. Remove the transmission unit rear support beam.

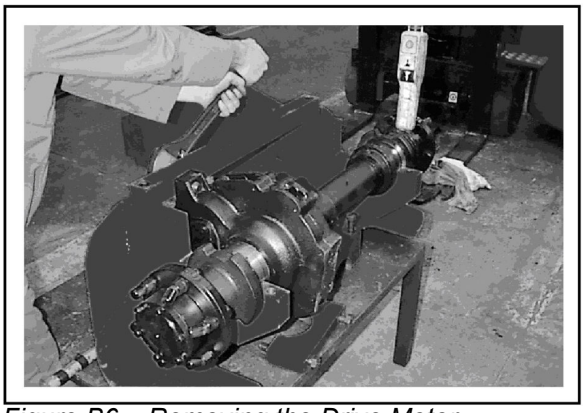


Figure B6 – Removing the Drive Motor

6. Attach a sling to the motor and undo the bolts and nyloc nut securing the motor to the drive axle. **Note:** Heavy Load

Note: On some axles, the bolt nearest to the stud fixed to the motor end plate is shorter than the others. When the motor is refitted to the drive axle the short bolt MUST be fitted in the hole adjacent to the stud. The longer bolts will not clear the drive axle housing.

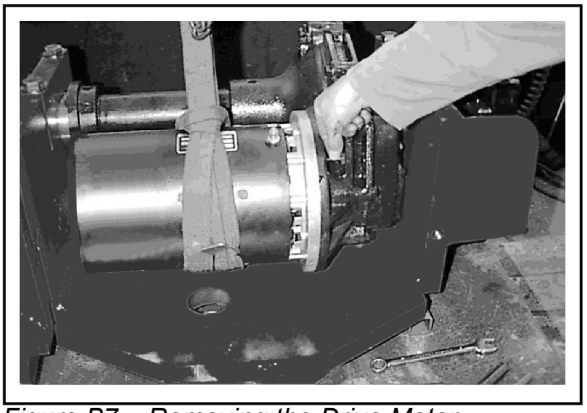


Figure B7 – Removing the Drive Motor

7. Withdraw the motor from the axle.

Figure B8 – Removing the Drive Motor

8. Transfer the motor to a suitable place of work.

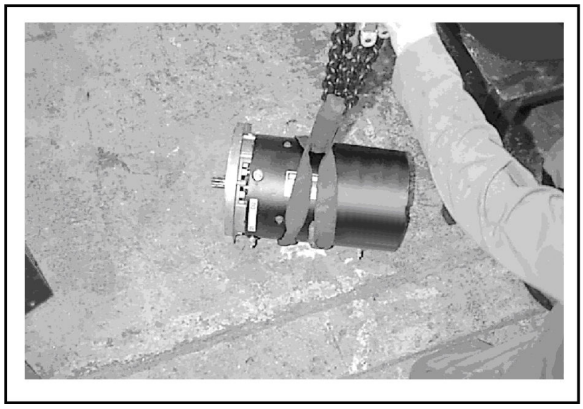


Figure B9 – Removing the Drive Motor

With the motor removed service repairs or overhaul can take place. For details on the overhaul procedure of the motor follow the instructions contained later in this section.

Refitting Drive Motor

Refitting of the drive motor to the drive axle is the reversal of the above instructions except:

Smear copper slip on the splines of the motor.

When lining the motor up with the axle, the fixed stud on the motor flange is aligned with the last hole on the drive axle flange. Ensure that the spline on the motor is engaged within the spline of the drive axle.

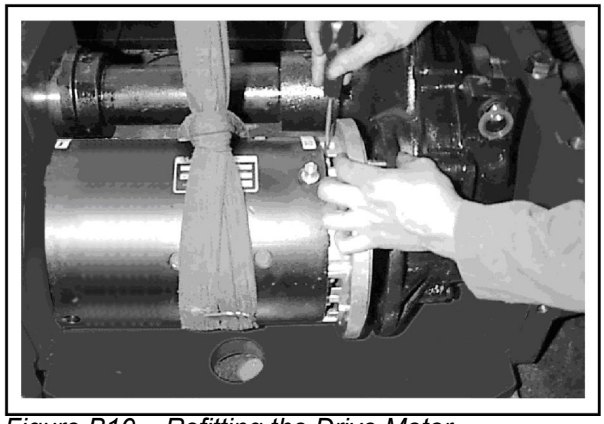


Figure B10 – Refitting the Drive Motor

Note: On some axles, the bolt nearest to the stud fixed to the motor end plate is shorter than the others. When the motor is refitted to the drive axle the short bolt MUST be fitted in the hole adjacent to the stud. The longer bolts will not clear the drive axle housing.

Removing Drive Axle

Remove the front axle assembly as described in **Section D - Mast Support Assembly** and the drive motor as described above.

1. Undo the tab washers holding the four hex. head bolts in place.

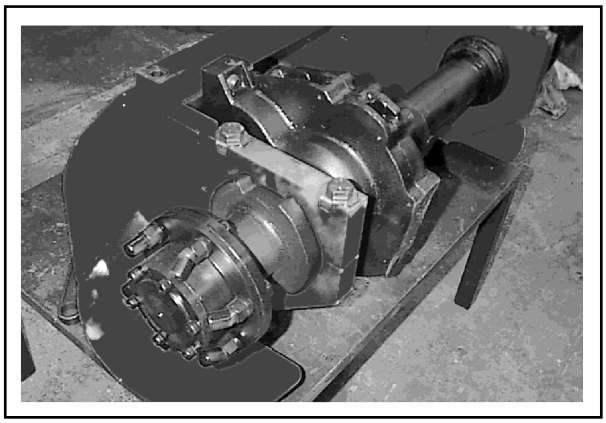


Figure B11 – Removing Drive Axle

2. Remove the four hex. head bolts and withdraw the axle caps.

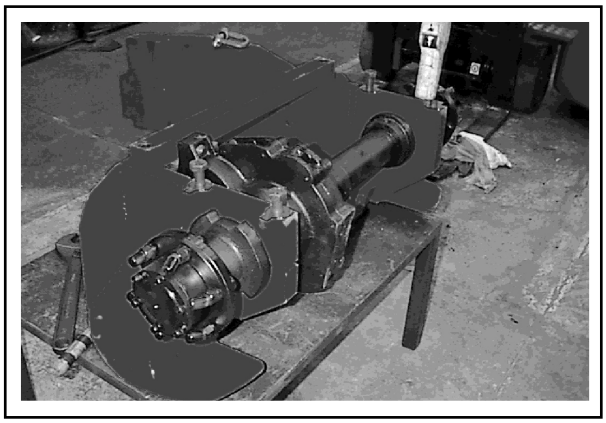


Figure B12 – Removing Drive Axle

3. Lift the axle clear and transfer to a suitable place of work.

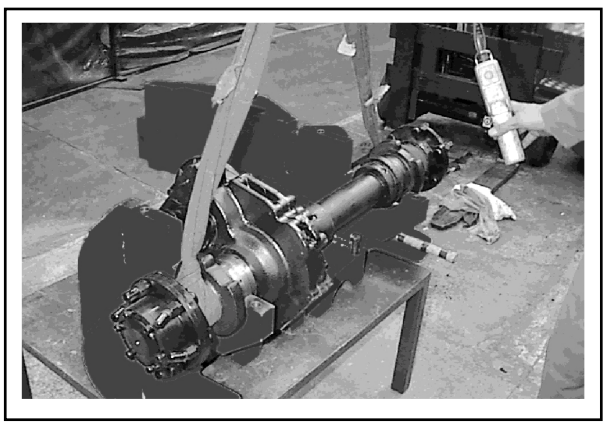


Figure B13 – Removing Drive Axle

With the axle removed, service repairs or overhaul can take place. For details on the overhaul procedure of the axle follow the instructions contained later in this section.

Refitting Drive Axle

Refitting the axle is the reversal of the above removal instructions except:

Before locking the drive axle into position with the caps, fit the rear support arm.

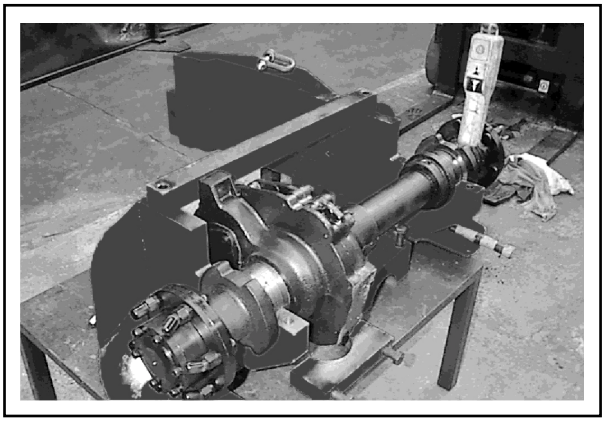


Figure B14 – Refitting Drive Axle

Check the gap between the arm and the rear of the drive axle and shim as necessary to ensure faces are parallel.

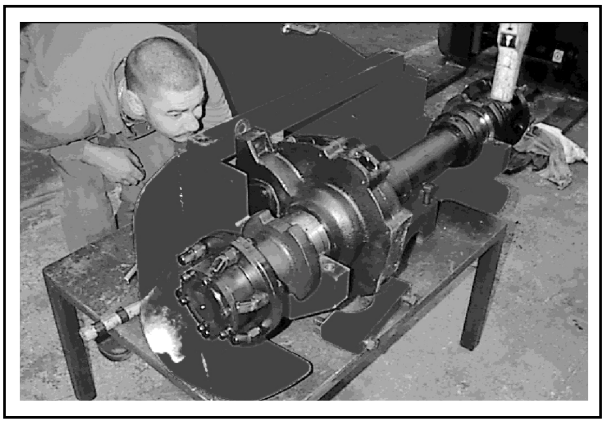


Figure B15 – Refitting Drive Axle

Bolt the axle to the arm.

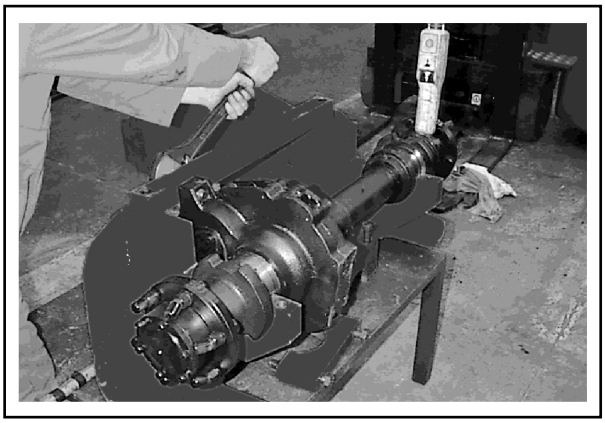


Figure B16 – Refitting Drive Axle

Clamp the drive axle into position with four bolts, lock the hex. head bolts into place with the tab washers, then remove the rear support arm.

If this is carried out then the drive axle will remain in the correct position during reassembly.

Removal of Units In-situ

The traction motor and drive axle can both be removed for repair; overhaul or replacement whilst either unit is still within the drive axle fabrication and while the axle fabrication is still in situ.

Traction motor

1. Operate steering until the drive axle is turned onto full right hand lock.

2. Disconnect the power supply to the truck by removing the battery plug.

3. Remove the M20 hex head bolt and swing the front counterweight open to allow access to the drive axle assembly.

4. Remove three 50mm^2 power cables and sensor cables.

5. Support the weight of the traction motor and remove seven M8 x 35mm set screws and one M10 nut.

6. Using suitable levers, prise the traction motor away from the transmission taking care not to damage the flanges of either the motor or transmission.

7. Using suitable lifting equipment, lift the traction motor away from the truck. If the motor is to be replaced or sent away for repair, remove the M10 x 40mm stud from the motor and store with the other fasteners to enable the replacement / reconditioned motor to be properly secured to the transmission.

The motor can now be repaired, overhauled or replaced as necessary.

Refitting of the drive motor to the drive axle is the reversal of the above instructions except:

If removed as above, Loctite the M10 x 40mm stud into the hole near D2 and flange on traction motor. Smear copper slip on the splines of the motor and when lining the motor up with the axle, as the fixed stud on the motor flange is aligned with the last hole on the drive axle flange, ensure that the spline on the motor is engaged within the spline of the drive axle.

Note: On some axles, the bolt nearest to the stud fixed to the motor end plate is shorter than the others. When the motor is refitted to the drive axle the short bolt MUST be fitted in the hole adjacent to the stud. The longer bolts will not clear the drive axle housing.

Drive Axle

1. Remove the traction motor as outlined above.

2. Insulate the ends of all the cables disconnected from the traction motor, reinstate the power supply to the truck and operate the steering until the axle is facing forward.

3. Disconnect the power supply to the truck.

If it is decided to remove the drive wheels, slacken the drive wheel nuts before jacking the front of the truck up.

CAUTION

Do not remove the wheel nuts with the wheels still in contact with the ground.

4. Jack up the front of the truck by positioning the jack beneath the **chassis** at the point where the step is attached. **Do not use the step as a jacking point.**

5. Remove the drive wheels if required.

6. Remove the M24 hex head setscrew securing the axle to the cross member.

7. Remove two M20 cap head setscrews and remove the cross member from the axle fabrication.

8. Support the drive axle.

9. Mark the axle clamps and fabrication to assist reassembly. Release the four tab washers securing the four M20 hex head setscrews. Undo the four M20 hex head setscrews and remove the axle clamps.

10. Remove the drive axle from the truck.

The axle can now be repaired, overhauled or replaced as necessary.

Refitting the axle is the reversal of the above removal instructions.

Clamp Bolts Toque 410 Nm.

Front wheel nuts 210Nm.

Note: When refitting the drive axle, fit new tab washers to the M24 hex head setscrews securing the axle clamps to the axle fabrication.

Rigid Drive Axle

Description

Axle casing and mounting arms

The axle casing assembly is constructed in modular form from three castings and a tube, and is supplied in two basic forms. One form suits a rigid frame mounting and is supplied with integral mast mounting lugs. The second form suits trunnion mounting, the trunnions are also suitable for mounting the mast. The tube length can be changed to obtain various widths. Assembly of the unit takes place in a special fixture to ensure accurate alignment of the critical features.

Centre Section

The centre section contains a two stage helical gear reduction and incorporates the axle differential. The helical gears are precision manufactured to reduce noise. The differential is of the four bevel pinion type. Taper roller bearings are used to mount the helical gears and differential cage. Shims are used to provide adjustment of the bearings.

Hubs

The hubs run in high capacity, long life taper roller bearings. Adjustment of the bearings is provided to effect optimum running conditions. The hub is sealed using a cassette seal having an integral sealing journal.

Commissioning and Routine Maintenance

On receipt of unit

Check oil level in the installed position, fill or top up as necessary.

Check breather/relief valve is fitted (refer to Installation Drawing), especially if unit is supplied with transit plugs and breather/relief valve is supplied loose.

After 50 hours running

Check the oil level and top up if necessary.

After 200 hours running

After the first 200 hours running, drain the oil while the axle is warm and refill with fresh oil.

Every 50 hours (weekly)

Check tightness of road wheel nuts. Tighten to 210 Nm.

Every 200 hours (monthly)

Remove, clean and refit the axle casing breather. Inspect the area around the input oil seal, hub seal, drive flange and casing joints for any sign of oil leakage. Where signs occur, make good the joint or replace the oil seal as appropriate.

Every 500 hours (3 months)

Check torque tightness of all external nuts and bolts.

Every 1000 hours (6 months)

Check hub bearing adjustment as detailed in section - ***Hubs***.

Every 2000 hours (12 months)

Drain and refill with fresh oil. See next section - ***Lubrication***.

Lubrication

General

The differential and the hubs use the same oil. Transfer of oil occurs between the two. It is important that the axle is drained completely at all oil changes. Only use high quality extreme pressure oil of the following viscosities:

SAE 80 for temperatures from -25ºC (-15ºF) to -10ºC (15ºF)

SAE 90 for temperatures from -10ºC (15ºF) to 30ºC (90ºF)

See lubrication chart for details of the various grades.

Dispose of all spent oil correctly.

Oil Draining

A magnetic drain plug is situated in the base of the axle casing for the purpose of draining the oil. Remove the filler/level plug to allow air into the axle. Remove the drain plug and allow oil to drain into a suitable container. A small residue of oil will remain in the hubs after draining. This oil must be drained by releasing the drive flange retaining bolts and easing the drive flanges away from the hubs using the extractor holes provided. One of the retaining bolts may be used as an extractor bolt.

Oil Filling

Withdraw drive flanges sufficiently to remove all traces of sealing compound from abutment faces of flanges and hubs. Re-assemble drive flanges to hubs (see section - ***Hubs***). Clean and refit the magnetic drain plug. Fill the axle through the filler/level plug hole (see figure B17) until the oil begins to emerge from the filler hole. Allow a few minutes for the excess oil to drain away and then replace the filler/level plug. Clean any surplus oil from casing and hubs.

Approximate oil capacity

0.8 Litres.

Figure B17 – Oil Filler / Level Plug

Recommended Lubricants

Oil Company	Ambient Temperature Range			Needle Rollers and Axle Grease Points
	-20°C	-10°C to 30°C	Above 30°C	
B.P	† Hypogear EP 80W-90 † Hypogear FE 80W-80	† Hypogear EP 80W-90 † Hypogear 90 EP † Energear FE 80W-90	† Hypogear EP 85w-140 † Energear FE 85w-140	Energrease LS – EP2
Castrol	† EPX 75W - 80	† EPX 80W – 90S	† EPX 85W - 140	Castrol MS3 Spheerol LMM
Duckhams	† Hypoid 80W – 90S	† Hypoid 80W – 90S	† Hypoid 90W – 140S	Adomax LEP2
Daltons	† Silkolene BOA 80W	† Silkolene BOA 85W-90	† Silkolene BOA 85W-140	G62
Esso	† GX 80W - 90	† GX 85W - 90	† GX 85W - 140	Esso MP Grease Beacon EP2 Beacon Q2
Fina	† Pontonic MP 80	† Pontonic MP 90		Marson EPL2
Gulf	† Gulf Multipurpose Gear Lubricant 80	† Gulf Multipurpose Gear Lubricant 90		Gulfcrown Grease
Mobil	† Mobilube HD80. Mobilube SHC 75W90	† Mobilube HD80. Mobilube SHC 75W90	† Mobilube HD140	Mobilplex 47 Mobilgrease Super
Shell	Spirax 80EP Omala Oil 100	† Spirax HD90 Omala Oil 220	Spirex HD 85W-140 Omala Oil	Retinax A (UK only) Alvania EP2 (Overseas)
Texaco	Lastona 80	Lastona 90		Multifak EP2 Marfak All Purpose

Note: All oils quoted are Extreme Pressure Lubricants.

Those oils marked † meet the specification MIL-L-2105B AP1-GL5 class.

Should the climatic conditions vary from those listed, please consult the oil manufacturer.

Hubs

General

The item numbers in the text refer to the components shown on **Figure B22**. The diagram is schematic only and as such does not accurately represent the actual shape of the components. For identification of actual parts, part numbers and quantities, please refer to the Parts List supplied as a separate manual.

Dismantling

The axle should be drained of oil before dismantling. For draining instructions refer to section - ***Lubrication***.

1. Raise the axle until the attached wheels are clear of the ground.

2. Remove wheel nuts (and collets if applicable). Remove road wheels.

3. Unscrew and remove capscrews (item 1) complete with spring washers (item 2).

4. Withdraw the drive shaft (item 3) using the M10 x 1.5 tapped extractor hole provided. One of the fixing capscrews may be utilised for this purpose.

5. **Twin hub nut type** (See figure B22)

   5.1. Slacken the hub nut locking screws (item 5).

   5.2. Unscrew the hub locknut assembly (items 5, 6 & 7) using hub nut spanner. (See figure B19)

   5.3. Hold hub (item 8) square to the axle and tap off with a soft face hammer against the hub flange. This will remove hub complete with bearings (item 9) and seal (item 10).

6. **Single hub nut with lock washer** (See figure B22)

   6.1. Knock back tabs on lockplate (item 14).

   6.2. Unscrew the hub locknut (item 15) using the hub nut spanner (See figure B20).

   6.3. Withdraw lockplate (item 14) and thrust washer (item 16).

   6.4. Hold hub (item 8) square to the axle and tap off with a soft face hammer against the hub flange. This will remove hub complete with bearings (item 9), spacer (item 17), shims (item 18) and seal (item 10).

7. Remove and discard the seal (item 10).

8. If necessary, drift out bearing cups from hub.

Cleaning and inspection

1. Thoroughly clean all components with a suitable solvent prior to inspection. Discard all used oil circlips and self locking nuts prior to assembly.

2. Clean off all old sealing compound from joint faces.

3. Examine all components for cracks, corrosion, wear, distortion or any other damage and renew any part found to be defective.

Assembly

1. New wheel studs (item 13) may be fitted into the hub (item 8), if required.

2. Fit cups of bearing (item 9) into hub (item 8) ensuring they are fully seated.

3. **Twin hub nut type.** (See figure B22)

   3.1. Position cone of inner bearing (item 9) into its mating bearing cup before fitting seal (item 10) using special tool 9104-M-006/49. (See figure B21).

   3.2. Position hub assembly on axle stub taking care not to damage seal (item 10).

   3.3. Fit cone of outer bearing (item 9).

   3.4. Tighten inner locknut (item 7), using special tool 9104-M-138/9, to 13.8 Kgm whilst rotating the hub assembly. When the correct torque is achieved, slacken back this locknut.

   3.5. Re-tighten locknut (item 7) to 0.7 Kgm.

   3.6. Fit outer locknut (item 6) and tighten until finger tight. Ensure inner locknut (item 7) does not move

3.7. Back off outer locknut (item 6) between 1/2 and 2/3 of a turn, until the holes for the lockscrews align in both nuts.

3.8. Fit lockscrews (item 5) applying Loctite 245 to the threads and tighten to 0.7 Kgm.

3.9. Check locknut assembly by attempting to unscrew by applying a torque of 11Kgm. Movement of locknut must not occur.

4. **Single Hub Nut with Lockwasher**
(See figure B22)

This locknut arrangement, including locknut (item 15), lockwasher (item 14), spacers (item 16 & item 17) and shims (item 18) may be replaced with the twin locknut arrangement (as above) using locknut assembly (items 5, 6 & 7).

Referring to figure B2 below, accurately determine the dimensions B, C, D & E. using appropriate measuring equipment.

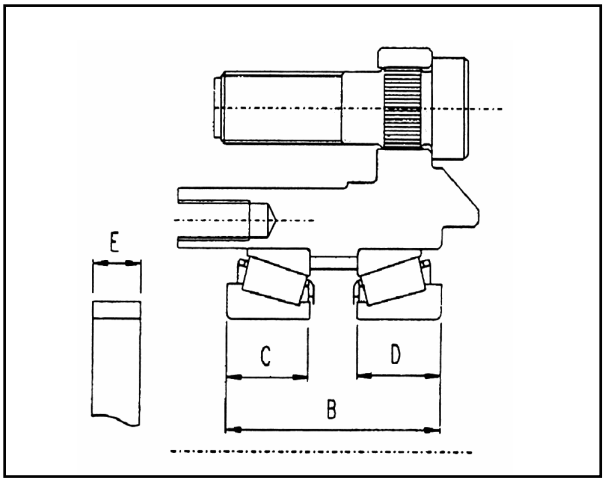


Figure B18 - Diagram of Hub Shim Selection Method

4.1. Calculate the shim pack thickness as follows:

Shims pack thickness A = B – C – D – E.

4.2. Select shims (item 18) to give a pack thickness between

(A) & (A + 0.05) mm.

4.3. Position cone of inner bearing (item 9) into its mating cup before fitting seal (item 10) using special tool 9104-M006/49.

4.4. Position hub assembly on axle stub (item 12) taking care not to damage seal (item 10).

4.5. Fit spacer (item 17), shims (item 18) and cone of outer bearing (item 9).

4.6. Fit thrust washer (item 16), lockplate (item 14) and locknut (item 15).

4.7. Tighten locknut using hub nut spanner 9104-M122/12 to 20Kgm.

4.8. Check hub bearing end float using dial gauge indicator. End float must be 0.01 to 0.07 mm.

4.9. If the end float exceeds this value, adjust shims (item 18) accordingly.

4.10. Ensure nut (item 15) is tightened to 20 Kgm and bend over tabs of lockplate (item 14) into appropriate slot in locknut (item 15) to secure.

5. Fit dowels (item 11) into hub (item 8) if removed.

6. Apply jointing compound to the abutment face of the hub (item 8) and assemble drive shaft (item 3). Ensure splines in differential gears are engaged and the locating holes in the flange align with dowels (item 11). Fit spring capscrews (item 1) complete with washers (item 2) and tighten to 8 Kgm.

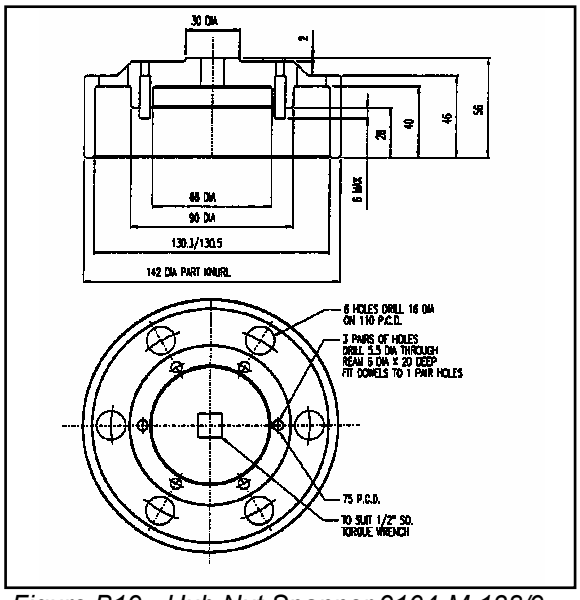


Figure B19 - Hub Nut Spanner 9104-M-138/9

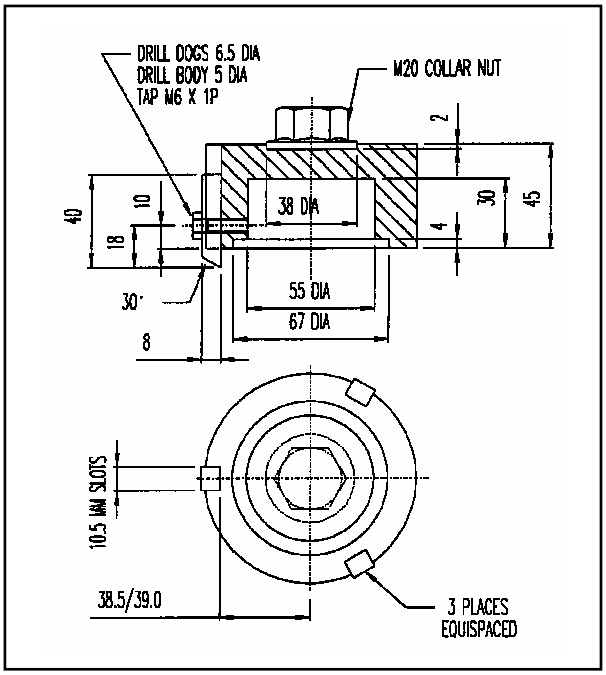


Figure B20 - Hub Nut Spanner 9104-M-122/12

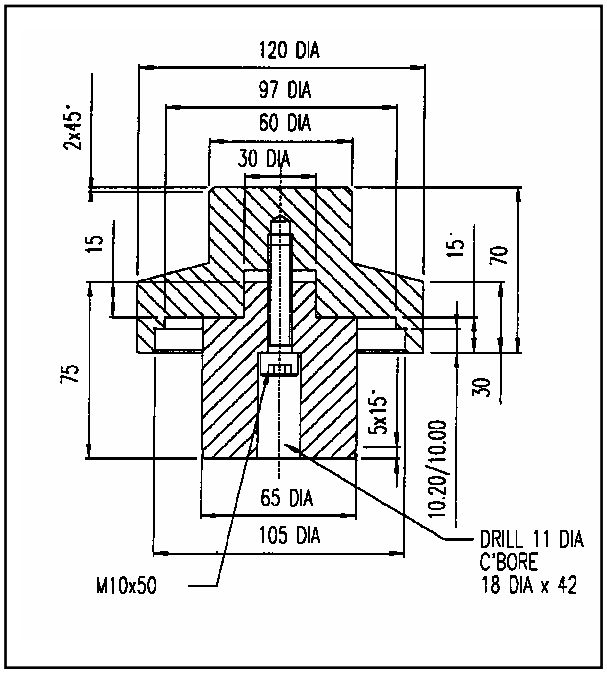


Figure B21 - Special Tool 9104-M-006/49

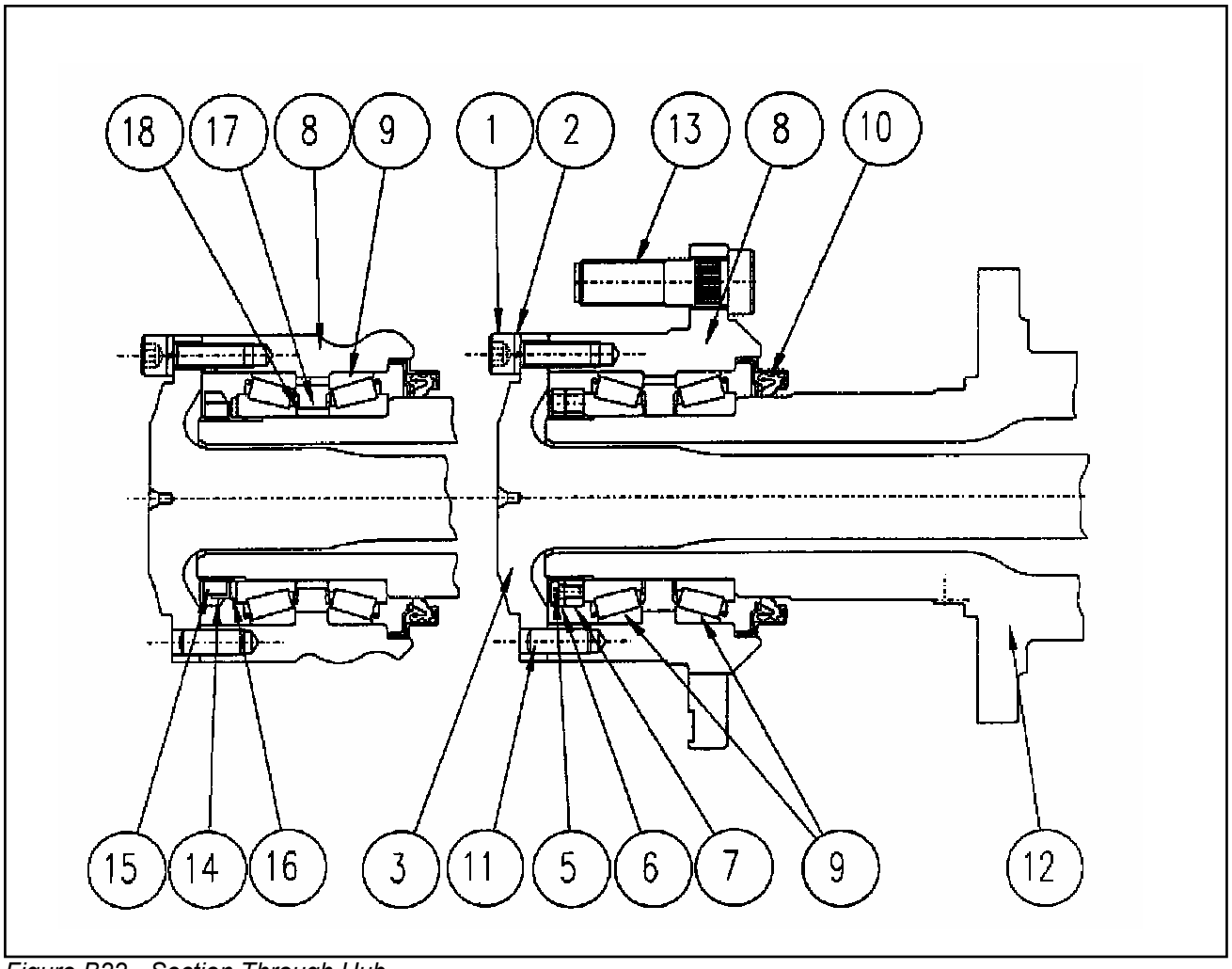


Figure B22 - Section Through Hub

Centre Casing Assembly

General

The item numbers in the text refer to the components shown on **Figure B25**. The diagram is schematic only and as such does not accurately represent the actual shape of the components. For identification of actual parts, part numbers and quantities, please refer to the Parts List supplied as a separate manual.

Dismantling

The axle should be drained of oil before dismantling. For draining instructions refer to section - ***Lubrication***.

Dismantling of the centre casing assembly can only be carried out with the axle removed from the vehicle.

1. Suitably support the axle so that the short arm of the axle is uppermost.

2. Unscrew and remove setscrews (item 1) with spring washers (item 2) that hold the casing halves together.

3. Carefully separate the axle casing halves (items 3 & 4).

Note: Splitting the casing halves releases the input shaft, intermediate shaft and differential assemblies. Care must be taken not to allow these assemblies to fall from the casings.

4. Withdraw input pinion assembly (item 5), intermediate shaft assembly (item 6) and differential assembly (item 7).

5. Remove setscrews (item 8) and spring washers (item 9). Withdraw the two bearing covers (item 10) and shims (item 11) taking care not to lose shims (item 19). They may be required for reassembly.

6. Extract cups of input shaft and intermediate shaft bearings (items 12, 13, 14 & 15) from casing halves.

7. Remove and discard oil seal (item 16).

8. Extract cups of differential bearings (item 17 & 18) from each casing half taking care not to lose shims (item 19). They may be required for reassembly.

9. Input Shaft Assembly

   9.1. Remove cones of bearings (item 9 & 11).

   9.2. Remove circlip (item 20) and spacer (item 21).

10. Intermediate Shaft Assembly

    10.1. Remove cones of bearings (items 14 & 15).

    10.2. The remaining components (input gear wheel, output pinion and key) of this assembly are only replaceable as a complete unit. This unit is assembled using specialised tooling and processes and must not be dismantled.

11. Differential Assembly

    11.1. Unscrew nuts (item 22), remove bolts (item 23) and withdraw output gear wheel (item 24) from differential cage (item 25).

    11.2. Check differential cage halves (items 25 & 26) for mating markings. Mark adjoining halves of necessary.

    11.3. Unscrew and remove bolts (item 27) with washers (item 28).

    11.4. Split differential cage halves and remove differential pinions (item 29), pinion thrust washers (item 30) and trunnion (item 31) as a unit.

    11.5. Slide the differential pinions and thrust washers from the trunnion.

    11.6. Remove differential wheels (item 32) and thrust washers (item 33) from differential cage halves.

    11.7. Remove cones of bearings (items 17 & 18) from the differential cage halves.

Cleaning and inspection

1. Thoroughly clean all components with a suitable solvent prior to inspection. Discard all used oil circlips and self locking nuts prior to assembly.

2. Clean off all old sealing compound from joint faces.

3. Examine all components for cracks, corrosion, wear distortion or any other damage and renew any part found to be defective.

Assembly

1. Differential Assembly

1.1. Fit cones of bearings (items 17 & 18) to differential cage halves (items 25 & 26) ensuring that they are fully abutted.

1.2. Position side washer (item 33) into each differential cage half, ensuring that grooves of washer are adjacent to differential cage.

1.3. Fit one differential wheel (item 32) into each differential cage half.

1.4. Position one differential pinion (item 29) onto each leg of the trunnion (item 31) followed by one thrust washer (item 30).

1.5. Place the trunnion with the differential pinions and washers into one differential cage half, ensuring all pinions mesh with the wheel.

1.6. Position the second differential cage half onto the above assembly, ensuring that the markings on each half are aligned.

1.7. Fit bolts (item 27) with washers (item 28) and tighten to 2.3 Kgm.

1.8. Ensure all differential pinions rotate freely, otherwise dismantle and rework this assembly.

1.9. Fit output gear wheel (item 24) using bolts (item 23) and nuts (item 22) and tighten to 12 Kgm.

2. Intermediate Shaft Assembly

The output pinion, input gear wheel and key is assembled using special tooling and processes and must only be replaced as a complete assembly.

2.1. Fit cones of bearings (items 14 & 15) onto intermediate shaft ensuring that they are fully abutted.

3. Input Shaft Assembly

3.1. Fit circlip (item 20) and spacer (item 21) onto input pinion (item 5).

3.2. Fit cones of bearings (items 12 & 13) onto input shaft ensuring that they are fully abutted.

4. Fit oil seal (item 16) into casing half (item 3).

5. Fit cups of bearings (items 13 & 14) into casing half (item 3), ensuring that they are fully abutted.

6. Position cups of differential cage bearings (items 17 & 18) onto their respective cones.

7. Measure dimension across cups (Dimension A) (See figure B23)

8. Ascertain the dimensions (B) and (C) (see figure B23). These dimensions are normally stamped on the inner faces of casing

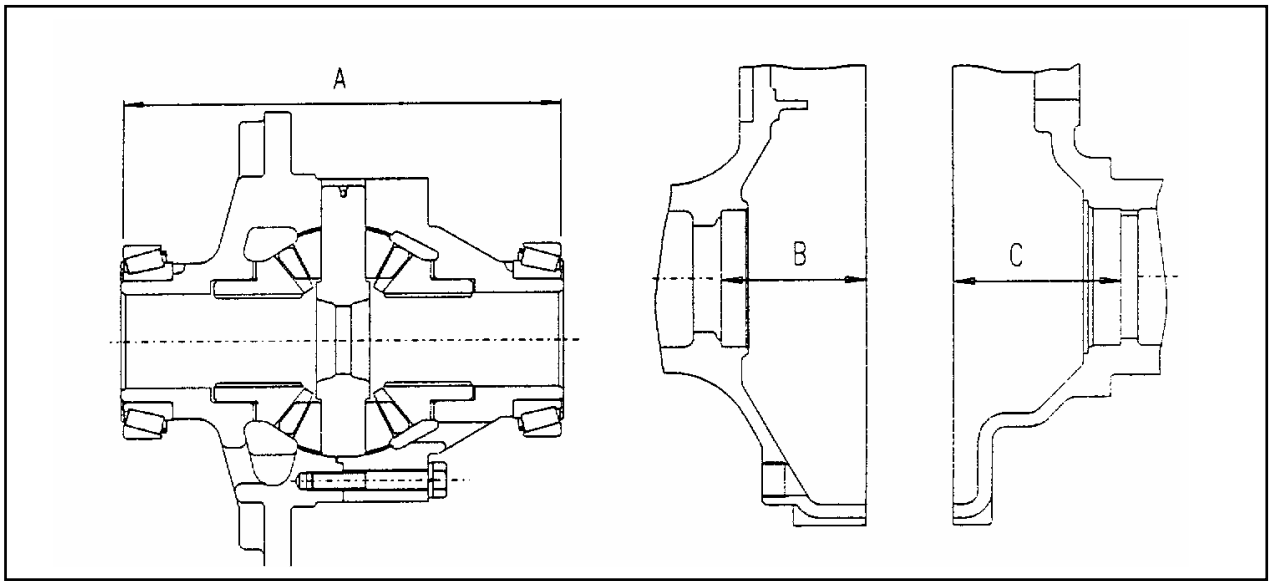


Figure B23 - Dimensions Required for Shimming Differential Bearings

9. Calculate shim pack thickness (D)

   D = (B + C) - A

   Select shims to give actual pack thickness between (D) and (D + 0.05mm). This gives optimum bearing running clearances.

10. Position shims in casing half (item 4) and fit remaining cup of differential bearing on top of shims. Ensure bearing is fully abutted.

11. Suitably support the axle casing half (item 3) such that the joint face is uppermost.

12. Position differential assembly (item 7), intermediate shaft assembly (item 6) and input shaft assembly (item 5) into the casing half, locating on their appropriate bearing cups.

13. Apply jointing compound (Loctite 574) to the joint face of the casing half. Ensure location dowels (item 34) are fitted.

14. Carefully place the second casing half over the assembled components ensuring that each sub assembly is positioned correctly and the casing dowels are aligned.

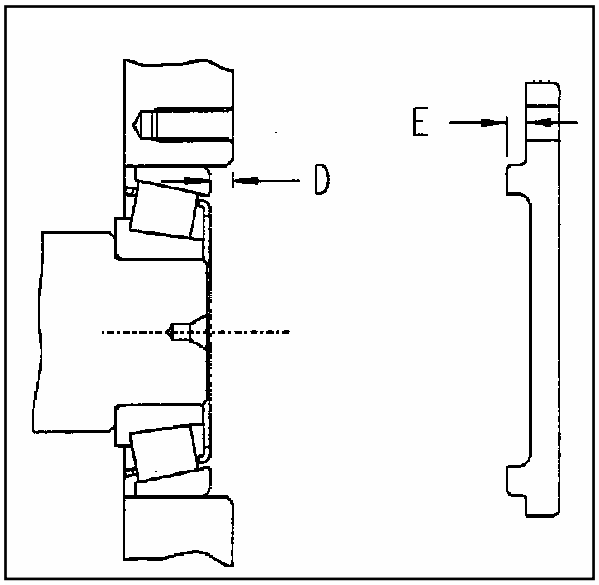


Figure B24 - Dimensions Required for Shimming Gear Shaft Bearings

15. Close casing halves using setscrews (item 1) with washers (item 2) and tighten to 4.7 Kgm.

16. Fit cups of input and intermediate shaft bearings (items 12 & 15) ensuring they are aligned with their already assembled cones and are fully abutted.

17. Determine shim pack thickness for both input shaft and intermediate shaft bearings by ascertaining dimensions D & E (see figure B24) for each position.

18. Calculate the required shim pack thickness (F) = (D - E) for each position. Select actual shims to give a pack thickness between (F) and (F - 0.05mm). This gives optimum clearances for bearings.

19. Position shims (item 11) on bearing cups. Apply sealing compound to mating face and fit bearing covers (item 10) using setscrews (item 9) with washers (item 8) and tighten to 2.3 Kgm.

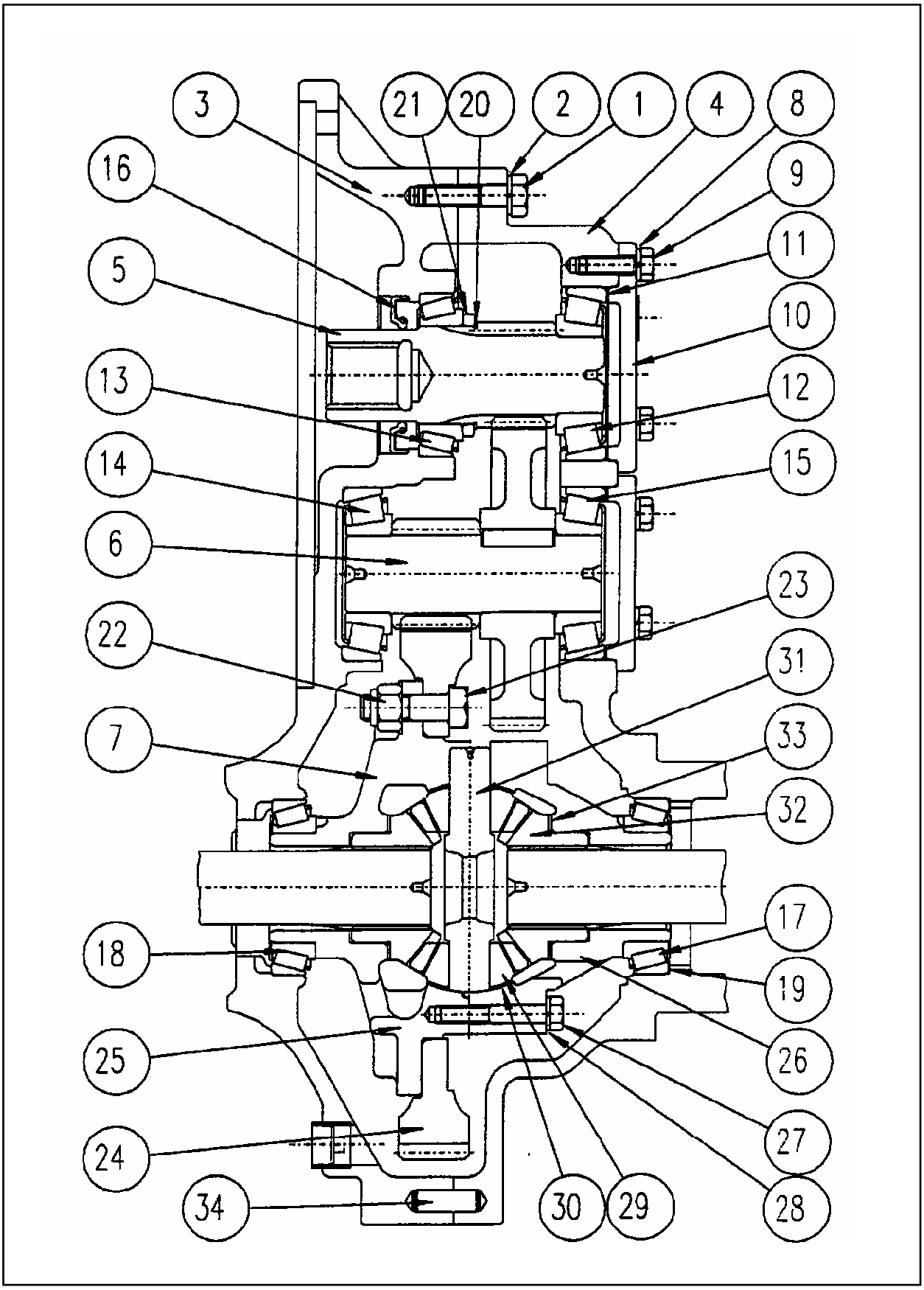


Figure B25 - Section through Centre Section

Recommissioning

A - Fully coat spline of electric motor with copper slip (See section - ***Recommended Lubricants***).

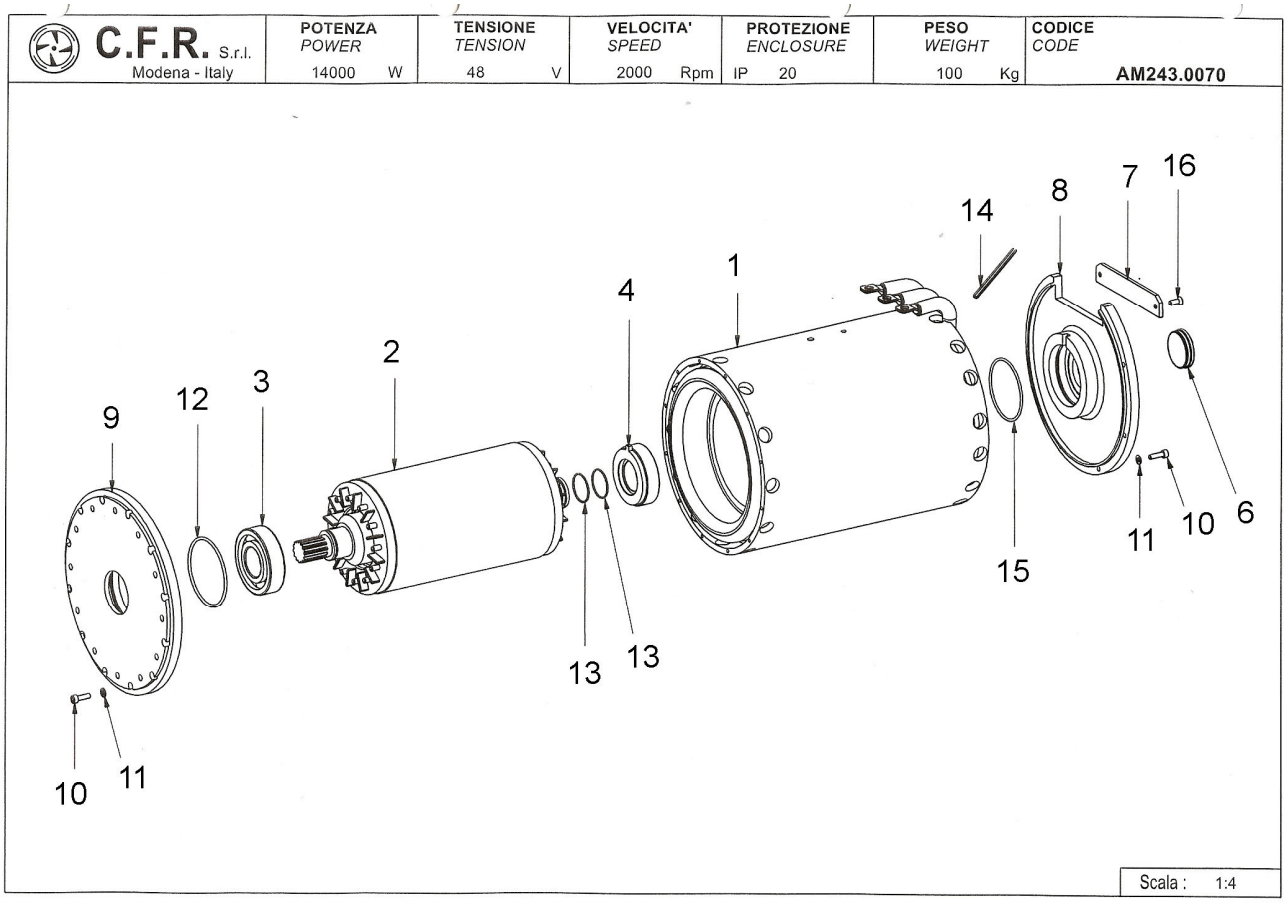
B - Connect motor to axle using appropriate fasteners.

C - Install the axle in the machine (if removed) by positioning the axle on the machine frame and fitting the retaining fasteners.

D - Check that all drain plugs and breathers are fitted (Refer to Installation drawing).

E - With the vehicle on level ground fill the axle casing and hubs with oil as detailed under section - ***Lubrication***.

CFR AC Motor



1. Motor Housing
2. Armature
3. Bearing
4. Encoder Bearing
5. n/a
6. End Cap
7. Cover Plate
8. End Plate
9. Mounting Plate
10. Bolt
11. Washer
12. Seal
13. Seal
14. Temperature Sensor
15. Seal
16. Bolt (M6)

Encoder Bearing Replacement

1. Disconnect cables U, V, W, the encoder cable and the thermal sensor from the truck.

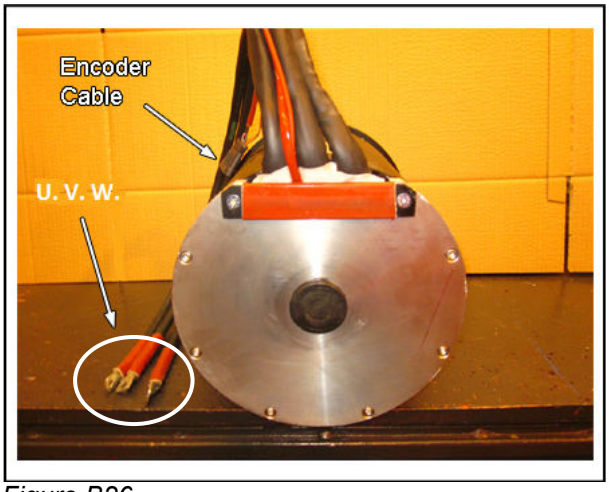


Figure B26

2. Remove retaining bolts & cover plate.

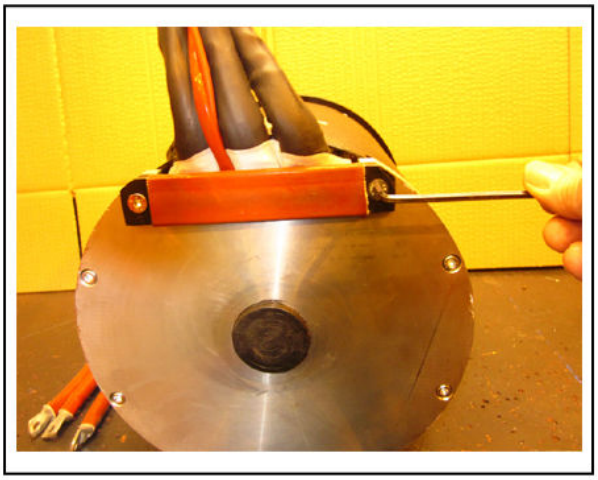


Figure B27

3. Unscrew & remove end plate. Taking care not to damage the cables.

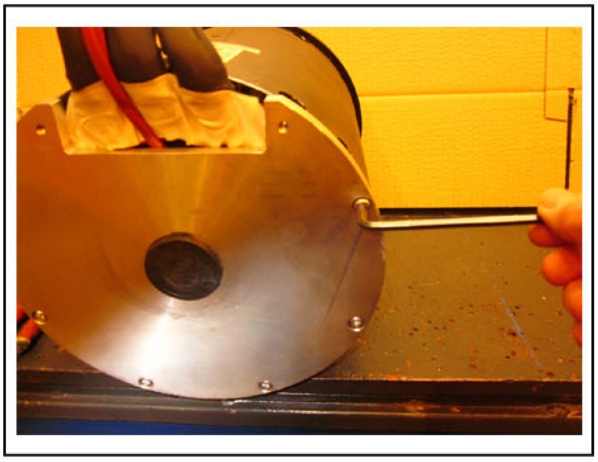


Figure B28

4. Screw 2 long screws (M6 by at least 40mm) into the holes left empty from removing the cover plate to touch the motor casing, pulling the end plate out by approximately 5mm. Gently Tap the face of the end pate with a mallet to knock the plate loose. Repeat for a second 5mm

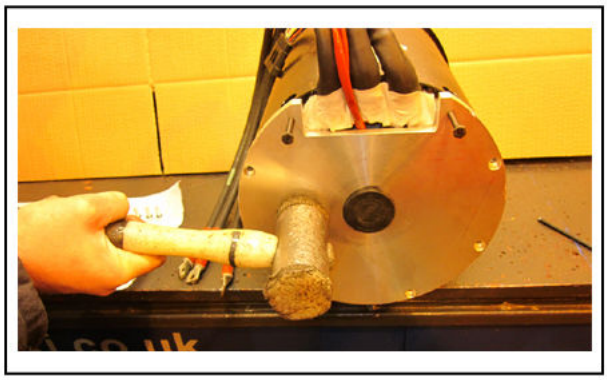


Figure B29

5. Tap the end plate, first one side and then the other, to remove

Figure B30

6. Remove the bearing from the Shaft.

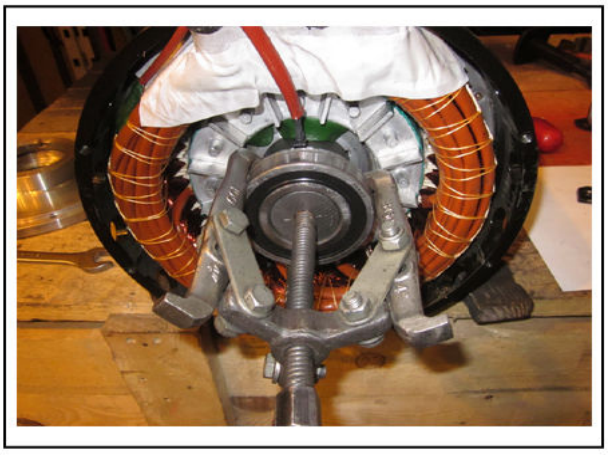


Figure B31

7. Install the new bearing onto the motor rotor with the electronic bridge facing the drive end side.

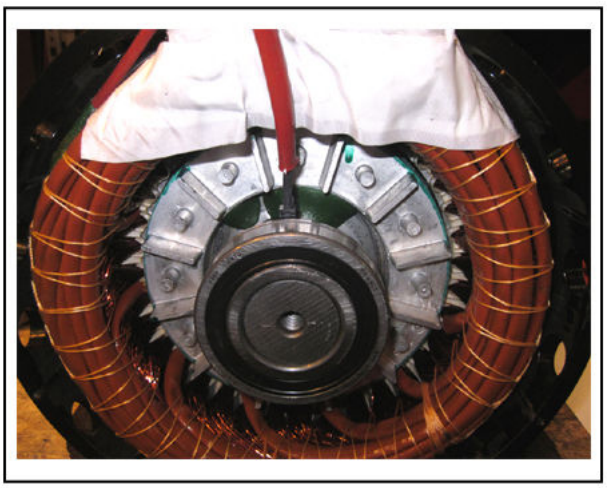


figure B32

8. Slowly press the outside ring of the bearing with a round tool of the same diameter.

WARNING

Do not use a sharp tool or hammer the bearing onto the armature, this will result in damage to the encoder bearing.

9. Reinstall the end plate, ensuring that the electric cable of the bearing does not become trapped, but instead ensure it is aligned with the slot present in the end plate.

Figure B33

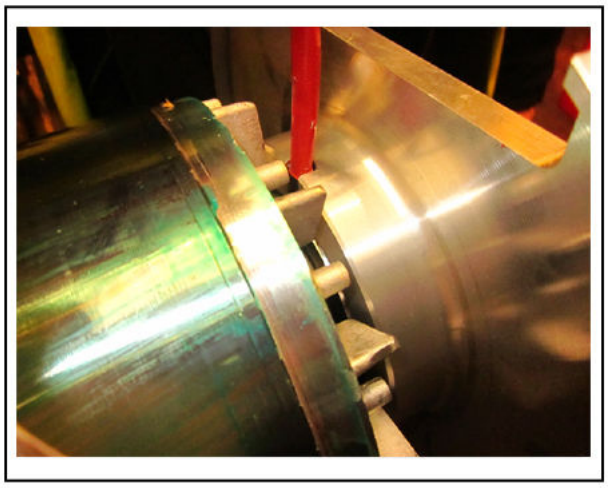


Figure B34

10. Use two screw-nut-washer assemblies, one either side (symmetrically) to draw the end plate back onto the motor casing. Tightening the nuts evenly.

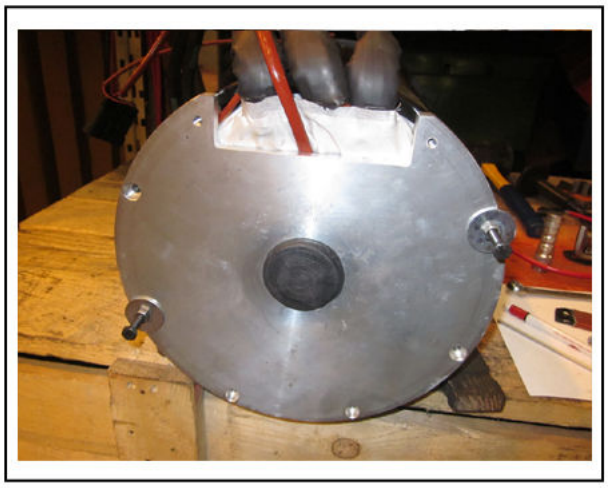


Figure B35

Figure B36

11. Replace the screws removed from the end plate during stage 3. First the 4 into the holes that remain empty, tightening evenly & symmetrically. Followed by the last 2, having removed the screw-nut-washer assemblies.

12. Reinstall the cover plate and retaining bolts.

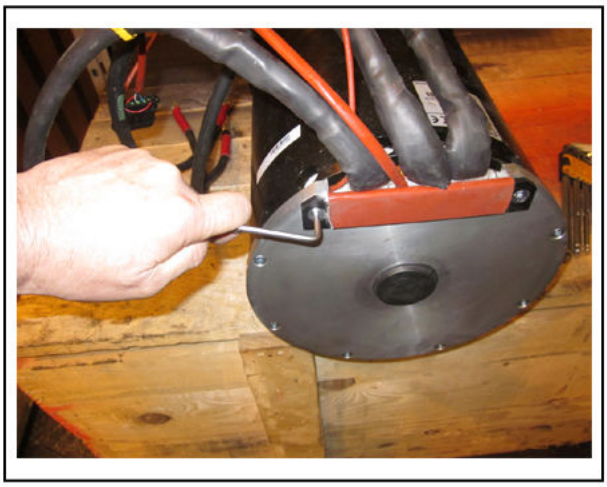


Figure B37

13. Re-fit the motor back into the truck and reconnect all cables.

Temperature Switch Replacement

1. Disconnect cables U, V, W, the encoder cable and the thermal sensor pins from the truck.

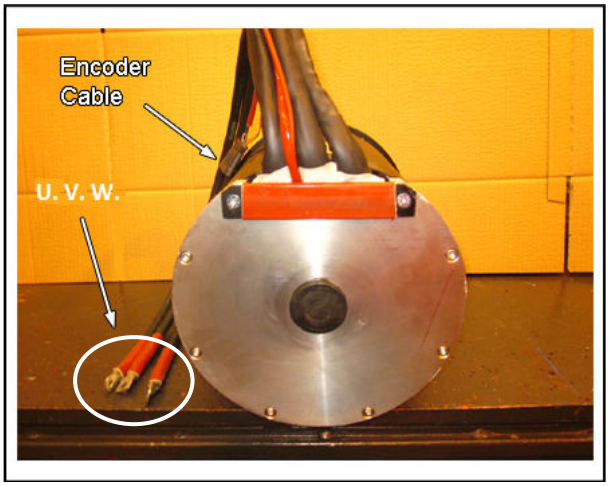


Figure B38

2. Remove retaining bolts & cover plate.

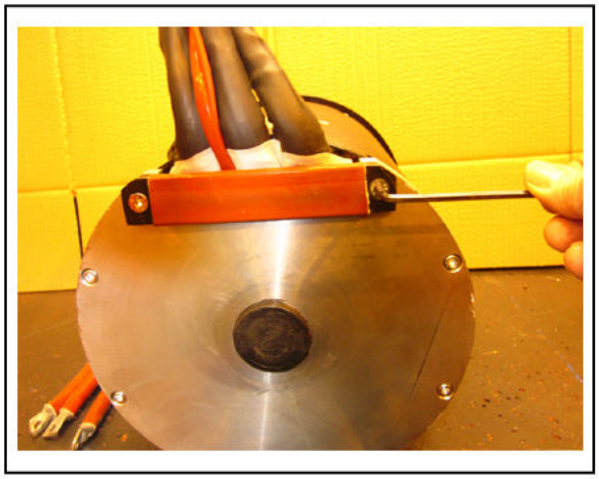


Figure B39

3. Unscrew & remove end plate. Taking care not to damage the cables.

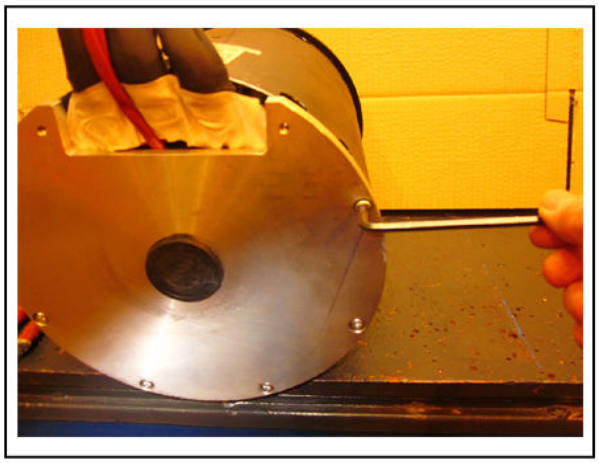


Figure B40

4. Screw 2 long screws (M6 by at least 40mm) into the holes left empty from removing the cover plate to touch the motor casing, pulling the end plate out by approximately 5mm. Gently Tap the face of the end plate with a mallet to knock the plate loose. Repeat for a second 5mm

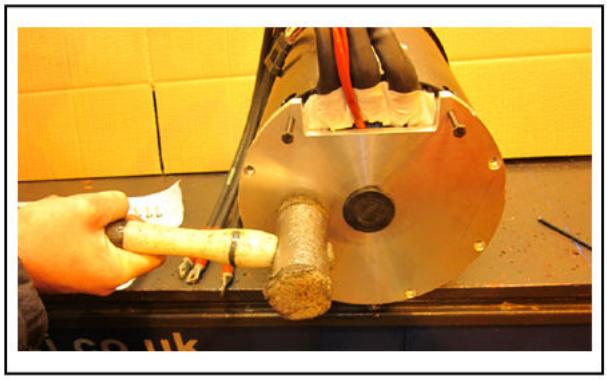


Figure B41

5. Tap the end plate, first one side and then the other, to facilitate extraction of the armature.

Figure B42

6. Gently pull armature out of housing, with encoder bearing & endplate still attached.

7. Removal of the old temperature sensor should not be attempted. Cut the wire as close to the putty cement as possible.

8. The new temperature sensor should be attached on the opposing side to that from which the old one has been removed.

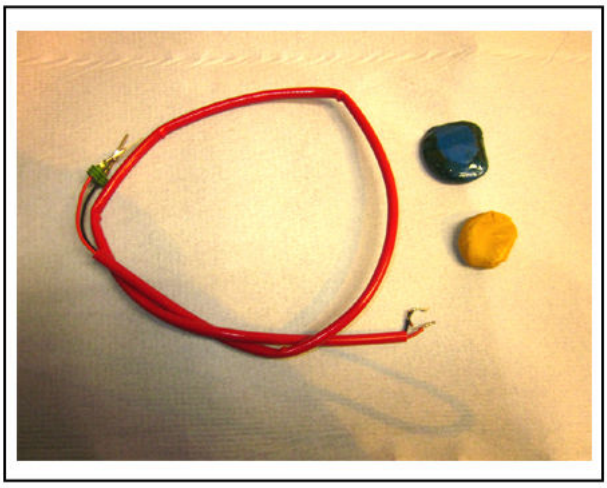


Figure B43 – Temperature Sensor Kit

9. Remove debris and grease from the area where the replacement sensor is to be fixed.

10. The sensor end of the wire should easily slide between the field coils and the motor housing.

Figure B44

11. Mix the blue and yellow parts of the putty cement to an even consistency.

12. Embed the temperature sensor in the putty and attach to the area of field coils previously degreased.

CAUTION

The putty takes approximately 4 hours to harden. Take care not to dislodge the sensor from the field coils.

13. Carefully push the armature and end plate back into position

14. Run the wire out of the housing with cables U. V. W. and the encoder cable Ensure that the sensor cable will not become trapped when the end plate in reattached

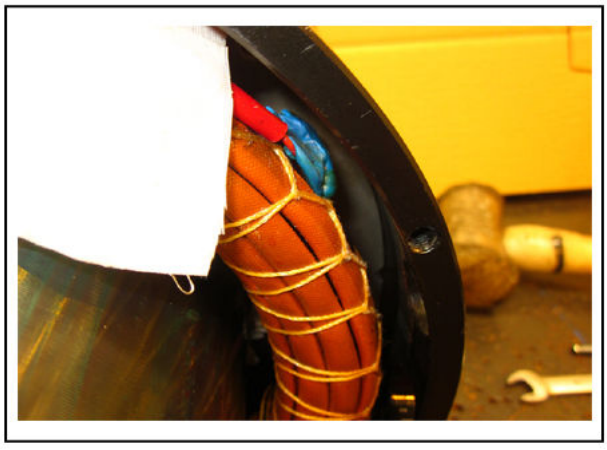


Figure B45

15. Use two screw-nut-washer assemblies, one either side (symmetrically) to draw the end

plate back onto the motor casing. Tightening the nuts evenly.

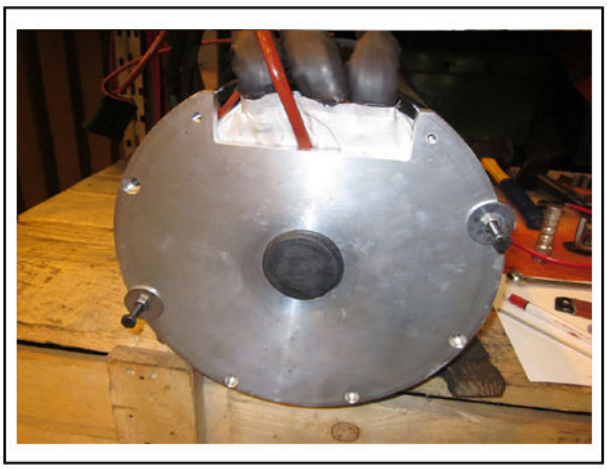


Figure B46

Figure B47

16. Replace the screws removed from the end plate during stage 3. First the 4 into the holes that remain empty, tightening evenly & symmetrically. Followed by the last 2, having removed the screw-nut-washer assemblies.

17. Reinstall the cover plate and retaining bolts.

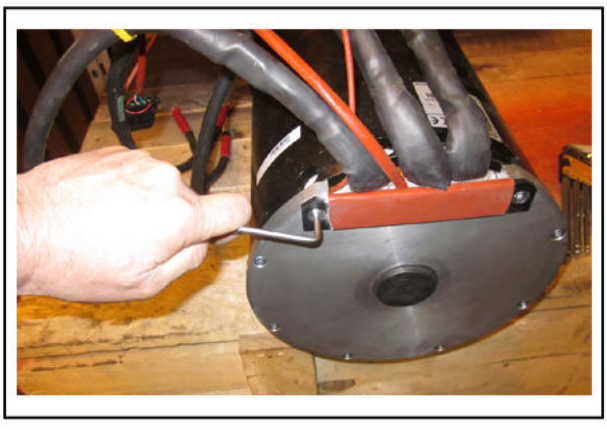


Figure B48

18. Re-fit the motor back into the truck and reconnect all cables.

Steering

This Page is Intentionally Left Blank

Contents

Steering

To gain access to the steering components remove the front nose cone cover as detailed in Section K Seat and Covers.

Steering Column Module

Removal

1. Disconnect all hydraulic hoses to steer orbital valve and steer lock valve.

2. Remove any electrical connections to steer column dash.

3. Undo four M10 setscrews and remove steer column module.

Refitting

1. Secure the completed module to the chassis with four M10 x 25 setscrew and four M10 spring washers.

2. There are five hydraulic pipes to connect. Feed pipes numbered 5, 6 and 7 under the steering module, along the left hand side of the chassis up to the oil tank.

3. Attach pipe No. 6 to the bottom of the tee on top of the tank.

4. Attach pipe No. 7 to the bulkhead fitting next to the suction filter on the oil tank.

5. Attach pipe No. 5 to the remaining bulkhead fitting next to the steer motor.

6. Pipe No. 3 goes to the top adaptor on the left hand side of the hydraulic steer motor.

7. Pipe No. 4 goes to the bottom adaptor underneath pipe No. 3.

Hydraulic Steer Motor

Removal

1. Remove the steer column module as detailed above.

2. Remove all hoses to hydraulic steer motor.

3. Remove four M12 hex head screws and lift motor clear from the drive pinion extension case.

Overhauling

Overhauling the hydraulic steer motor is not normally recommended. The unit is available as a service exchange item. However, should the need arise for a hydraulic steer motor to be overhauled, follow the instructions contained later in this section.

Refitting

Refitting is the reversal of the removal instructions. When refitting the hydraulic steer motor, the four M12 hex head screws securing the motor to the chassis must be torqued to 145Nm.

Fitting a New Steer Motor

Place motor upside down on a flat surface, lubricate the motor shaft with copperslip prior to assembly and fit drive shaft extension. Ensure that the shoulder on the drive shaft extension is facing downwards; ensure also that the key provided is located in the motor shaft. The drive shaft extension should fit tightly all the way down the shaft. Secure the drive shaft extension onto the motor and tighten.

Remove plastic plugs from ports and fit two 1/2" BSP x 3/8" BSP MM adaptors and two 1/2" Dowty seals.

On the opposite side of the motor fit one brass elbow. Before fitting, use P.T.F.E. tape on threaded end of elbow, then screw in tight. Ensure elbow is pointing down towards the bottom of the motor.

Fit the assembled hydraulic steer motor. The four M12 hex head screws securing the motor to the chassis must be torqued to 145Nm.

Connect the hydraulic hoses to the appropriate ports.

Steer Orbital Valve

Removal

1. Remove steering column cover.

2. Remove all hydraulic hoses from steer orbital valve.

3. Remove the centre cap on the steering wheel.

4. Remove nut.

5. Remove the two fixings that hold on the steering column cover.

F - Undo four M10 bolts securing the steer orbital valve to the steer column module.

Overhaul

Overhauling the steer orbital valve is not normally recommended. The unit is available as a service exchange item. However, should the need arise for a steer orbital valve to be overhauled, follow the instructions contained later in this section.

Refitting

Refitting is the reversal of the above instructions.

Steer Lock Valve

Removal

1. Disconnect all the hoses from the steer lock valve.

2. Undo the two M8 hex head bolts and withdraw steer lock valve.

Overhaul

Overhauling the steer lock valve is not normally recommended. The unit is available as a service exchange item. However, should the need arise for a steer orbital valve to be overhauled, follow the instructions contained later in this section.

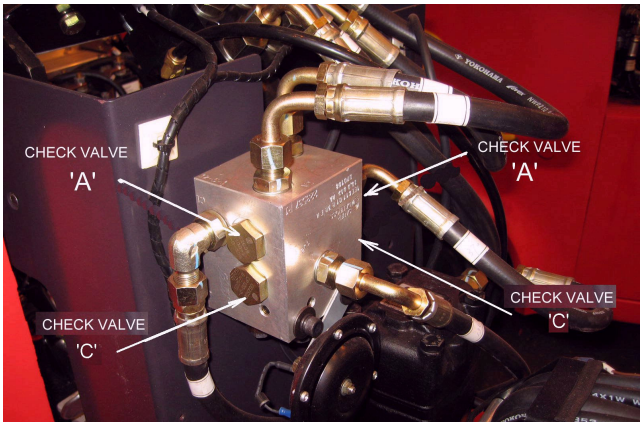
Refitting

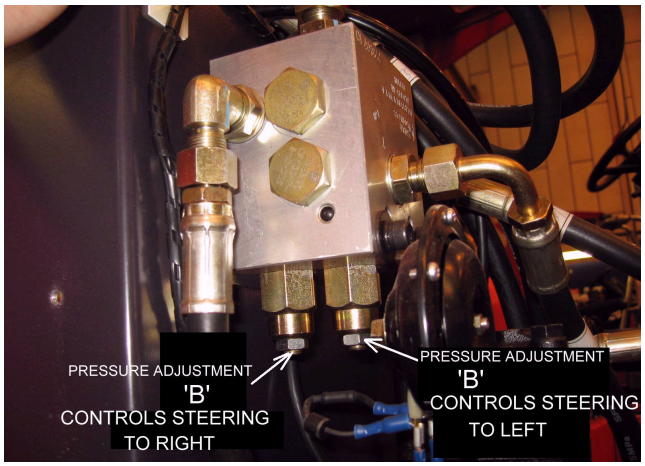
Refitting is the reversal of the above instructions.

Note: Adjustment of the lock valve is not required and is factory set to 3000 psi prior to installation. DO NOT adjust unless advised by **Narrow Aisle**.

Adjustment

In some instances, a difference in steering effect may be experienced between turning to either side. This may be corrected by adjustment of the Steer Lock Valve (4973.01.000)





The adjustment screws are located on the underside of the valve.

To adjust the relevant direction of steering:

- Release the lock nut (14mm Spanner)
- Turn the screw to adjust the cross relief pressure. (anti-Clockwise to INCREASE pressure, results in more steering effect) (4 mm Allen key)
- Tighten the lock nut while maintaining the position of the adjuster screw.
- Note: adjust in steps of ½ turn.

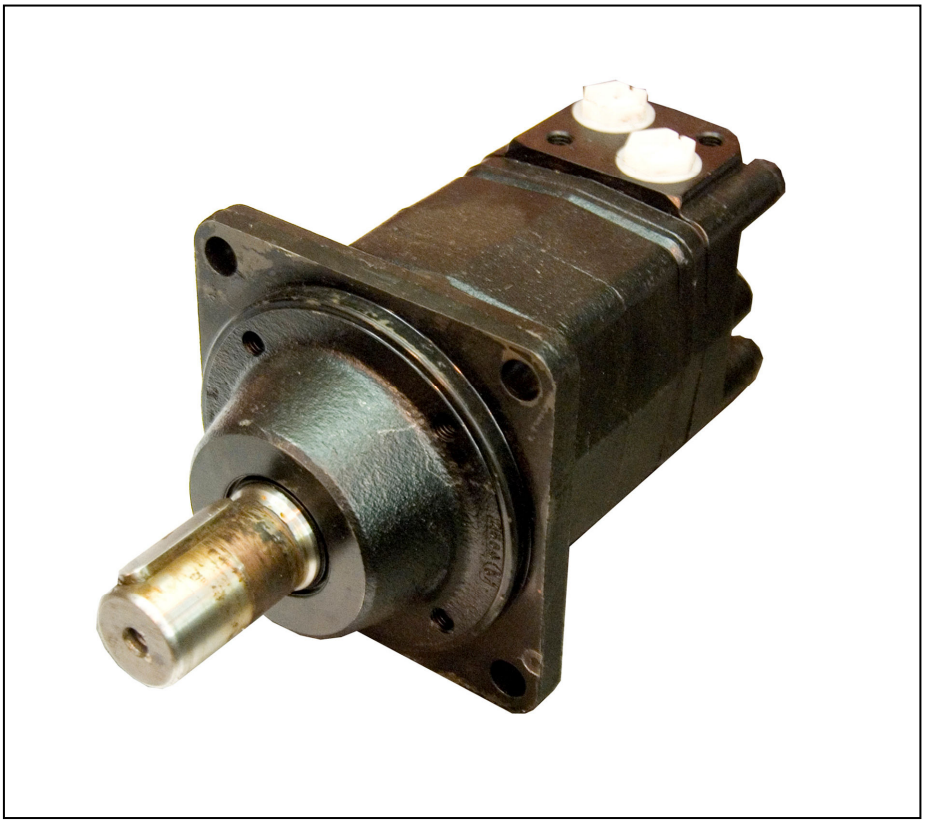
In some instances, the performance of the steering may be affected by contamination of the oil by small particles. In this case the check valves (A & C) and Pressure adjustment cartridges (B) may be removed and cleaned using clean hydraulic fluid and a lint-free wiper, prior to replacement. If this is not effective, the cartridges should be changed.

Replacement valve cartridges are available from Narrow Aisle Parts dept. Part numbers depend on the manufacturer of the valve (Name is engraved in the valve block)

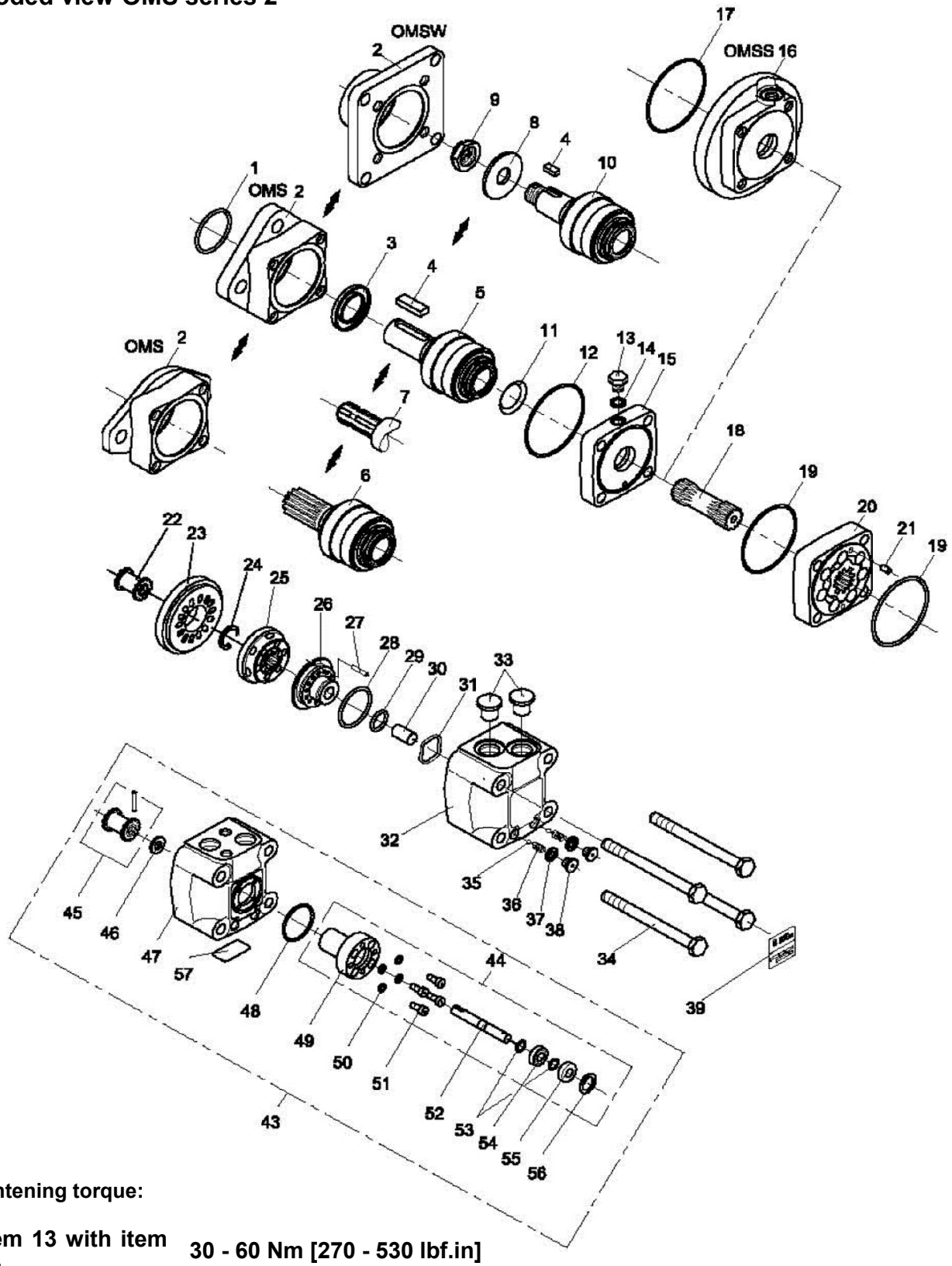
	Sauer Danfoss	CD Eng
Check Valve 'A' (Reverse Flow)	**4973.01.001**	**4973.02.001**
Check Valve 'C'	**4973.01.002**	**4973.02.002**
Pressure Relief Valve 'B'	**4973.01.003**	**4973.02.003**

Note: The setting for the Pressure relief valves should be 3000 psi (200 Bar)

Hydraulic Steer Motor



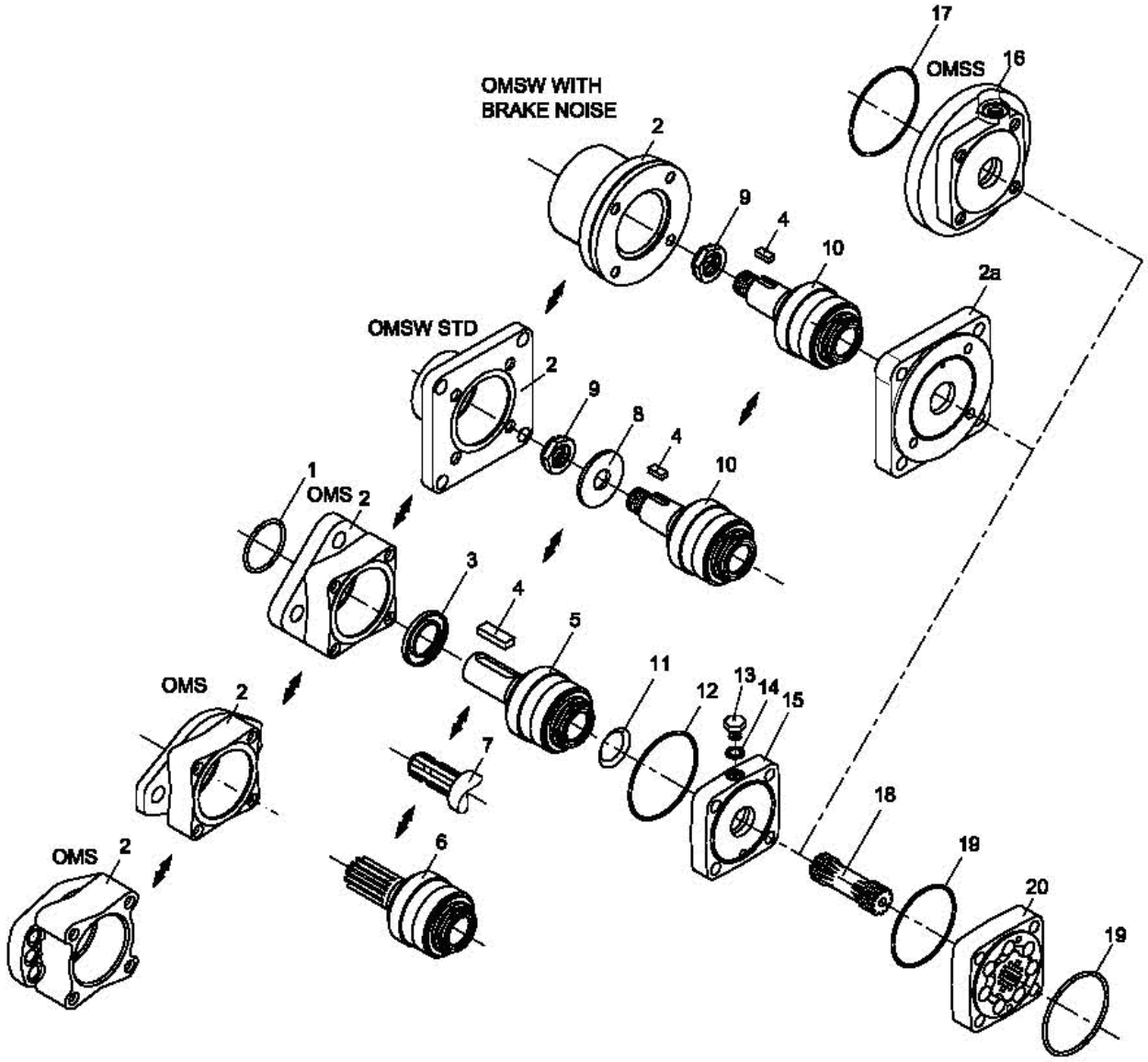
Exploded view OMS series 2



Tightening torque:

Item 13 with item 14	**30 - 60 Nm [270 - 530 lbf.in]**
Item 34	**75 - 80 Nm [660 - 705 lbf.in]**
Item 38	**10 - 15 Nm [90 - 130 lbf.in]**
Item 51	**4 - 6 Nm [35 - 55 lbf.in]**

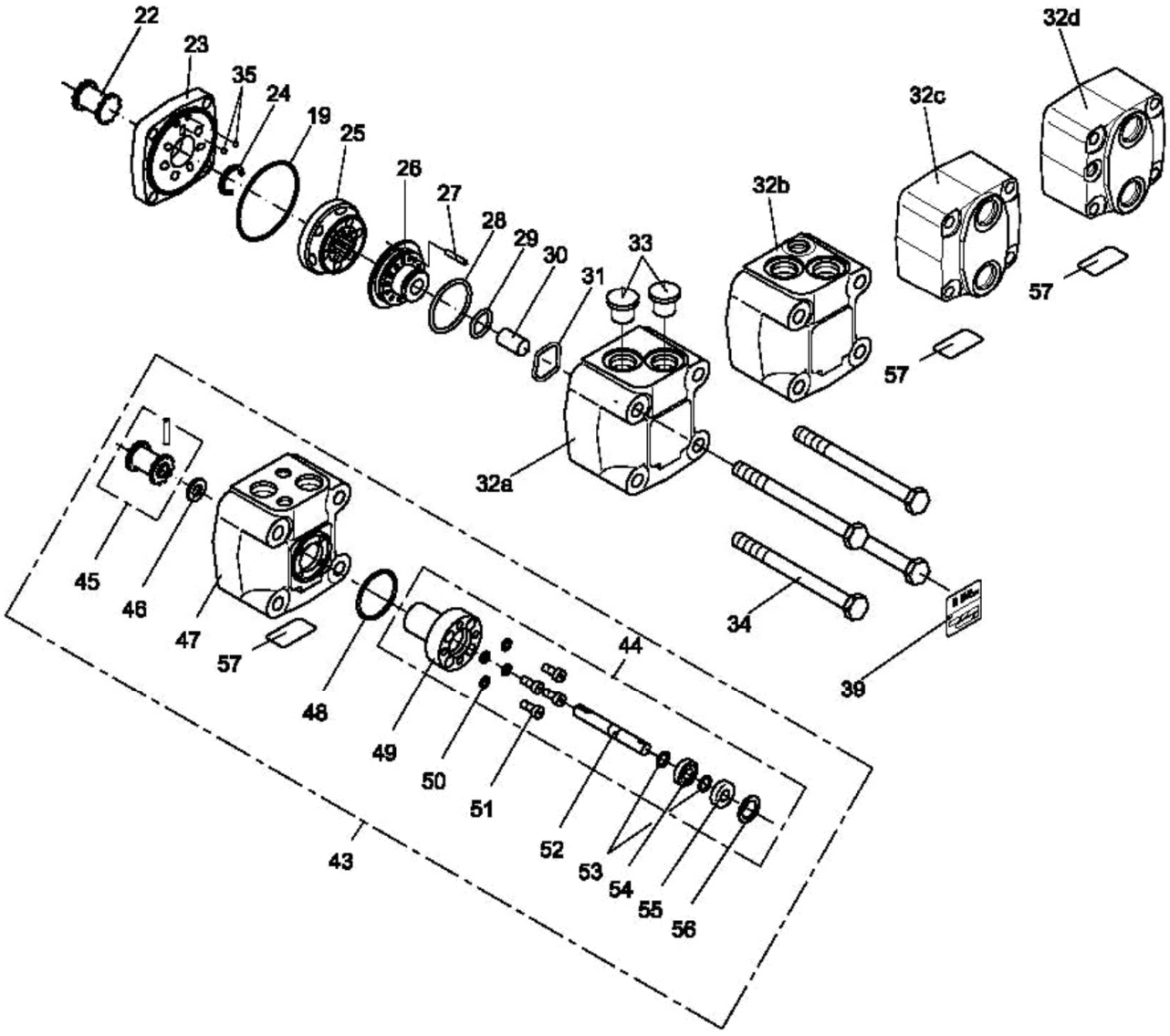
Exploded view OMS series 3



Tightening torque:

Item 13 with item 14	**30 - 60 Nm [270 - 530 lbf.in]**

Exploded view OMS series 3 cont.



Tightening torque:

Item 34	**75 - 80 Nm [660 - 705 lbf.in]**
Item 51	**4 - 6 Nm [35 - 55 lbf.in]**

Item	Description	Number Per Motor	
		Series	
		2	3
1	Dust Seal Ring 35 – 42 – 3.5mm [1.38 – 1.65 – 0.14in] (p.t.o.shaft) 40 – 47 – 40mm [1.57 – 1.85 – 0.16in]	1 1	1 1
2	Bearing Housing OMS Standard Flange OMS Special Flange and (p.t.o.shaft) OMS Special Flange OMS A – Flange OMS Magneto Flange OMS SAE B Flange OMSW Metric Standard OMSW SAE Standard OMSW with Brake Nose	 1 1 1 1 1 1 1 1 1	 1 1 1 1 1 1 1 1 1 1
2a	Mounting Flange		1
3	Shaft Seal 35 – 52 – 5mm [1.38 – 2,05 – 0.20in] NBR 35 – 52 – 5mm [1.38 – 2,05 – 0.20in] FPM p.t.o shaft 40 – 60 – 6mm [1.57 – 2.36 – 0.24in] NBR	1 1 1	1 1 1
4	Parallel Key Metric: A10 – 8 –45mm for 32mm cyl.shaft Metric: B6 – 6 – 20mm for tap.shaft SAE: 5/16 – 5/16 – 1 ¼ in for 1 ¼ in cyl.and tapered shaft SAE: 1/4 – 1/4 – 1 ¼ in BS 46 for 1 in cyl.shaft	1 1 1 1	1 1 1 1
5	Cylindrical Shaft Metric: 32mm with bearings incl.item 4 SAE: 1 ¼ in with bearings incl.item 4 SAE: 1 in with bearings incl.item 4	1 1 1	1 1 1
6	Splined Shaft Metric: 1 ¼ in with bearings SAE: 1 ¼ in with bearings SAE: 1in with bearings SAE: 0.875 in with bearings	1 1 1 1	1 1 1 1
7	P.t.oshaft incl.bearing, DIN 9611	1	1
8	Washer metric version only	1	1
9	Castellated Nut Metric: M20 – 1.5mm SAE: 1 – 20 UNEF	 1 1	 1 1
10	Tapered Shaft Metric: 35mm with bearings incl.item 4, (8) and 9 SAE: 11/4 in with bearing incl.item 4 and 9	 1 1	 1 1
11	Conical Seal Ring	1	1
12	O Ring 70 – 2mm [2.75 – 0.08] NBR	1	1

13	Drain Plug — Metric: G ¼ SAE: 7/16 – 20 UNF	1 1	1 1
14	Washer	1	1
15	Intermediate Plate	1	1
16	Mounting Flange for OMSS	1	1
17	O Ring for OMSS — 100 – 3mm [3.94 – 0.12 in] NBR	1	1
18	Cardan Shaft OMS/OMSW/OMSS 80 — l = 70mm [2.75 in] OMS/OMSW/OMSS 100 — l = 73mm [2.87 in] OMS/OMSW/OMSS 125 — l = 78mm [3.07 in] OMS/OMSW/OMSS 160 — l = 84mm [3.31 in] OMS/OMSW/OMSS 200 — l = 91mm [3.58 in] OMS/OMSW/OMSS 250 — l = 99.5mm [3.92 in] OMS/OMSW/OMSS 315 — l = 111mm [4.37 in] OMS/OMSW/OMSS 400 — l = 124.5mm [4.90 in] OMS/OMSW/OMSS 500 — l = 120.5mm [4.71 in]	 1 1 1 1 1 1 1 1 1	 1 1 1 1 1 1 1 1 1
19	O Ring — 82.5 – 2mm [3.25 – 0.08 in] NBR	2	3
20	Gearwheel Set Series 3 OMS/OMSW/OMSS 80 — w = 14mm [0.55 in] OMS/OMSW/OMSS 100 — w = 17mm [0.67 in] OMS/OMSW/OMSS 125 — w = 22mm [0.87 in] OMS/OMSW/OMSS 160 — w = 28mm [1.10 in] OMS/OMSW/OMSS 200 — w = 35mm [1.38 in] OMS/OMSW/OMSS 250 — w = 44mm [1.73 in] OMS/OMSW/OMSS 315 — w = 55mm [2.16 in] OMS/OMSW/OMSS 400 — w = 68.4mm [2.69 in] OMS/OMSW/OMSS 500 — w = 68.4mm [2.69 in]	 	 1 1 1 1 1 1 1 1 1
21	Gearwheel Set Series 3 OMS/OMSW/OMSS 80 — w = 14mm [0.55 in] OMS/OMSW/OMSS 100 — w = 17mm [0.67 in] OMS/OMSW/OMSS 125 — w = 22mm [0.87 in] OMS/OMSW/OMSS 160 — w = 28mm [1.10 in] OMS/OMSW/OMSS 200 — w = 35mm [1.38 in] OMS/OMSW/OMSS 250 — w = 44mm [1.73 in] OMS/OMSW/OMSS 315 — w = 55mm [2.16 in] OMS/OMSW/OMSS 400 — w = 68.4mm [2.69 in]	 1 1 1 1 1 1 1 1	
22	Valve Drive — OMS 80 – 400 OMS 500	1 1	1 1
23	Channel Plate	1	1
24	Stop Ring — (OMSS 200, 250, 315, 400 and 500 only)	1	1
25	Disc Valve	1	1
26	Balance Plate a)	1	1
27	Guide Pin — 5mm [0.20 in], l = 14 [0.55 in] ISO 8752 a)	1	1

28	O Ring 45 – 2mm [1.77 – 0.08] NBR 45 – 2mm [1.77 – 0.08] FPM	1	1
29	O Ring 24 – 2mm [0.94 – 0.08] NBR 24 – 2mm [0.94 – 0.08] FPM	1 1	1 1
30	Spacer	1	1
31	Spring Washer a)	1	1
32	Valve Housing	1	1
33	Seal Plug	2	2
34	Screw M10: OMS/OMSW/OMSS 80 l = 120mm [4.72 in] OMS/OMSW/OMSS 100, 125 l = 130mm [5.12 in] OMS/OMSW/OMSS 160, 200 l = 140mm [5.51 in] OMS/OMSW/OMSS 250 l = 150mm [5.91 in] OMS/OMSW/OMSS 315 l = 160mm [6.30 in] OMS/OMSW/OMSS 400, 500 l = 180mm [7.09 in]	4 4 4 4 4 4	4 4 4 4 4 4
	OMS/OMSW/OMSS 80 l = 100mm [3.94 in] OMS/OMSW/OMSS 100, 125 l = 110mm [4.33 in] OMS/OMSW/OMSS 160, 200 l = 120mm [4.72 in] OMS/OMSW/OMSS 250 l = 130mm [5.12 in] OMS/OMSW/OMSS 315 l = 140mm [5.52 in] OMS/OMSW/OMSS 400, 500 l = 150mm [5.91 in]	4 4 4 4 4 4	4 4 4 4 4 4
35	Check Valve Ball 3/16 in ¼ in	2	2
36	Check Valve Spring	2	
37	Washer 10.2 – 13.5 – 7mm [0.40 – 0.53 – 0.27 in]	2	
38	Check Valve Plug G 1/8	2	
39	Name Plate Aluminium OMS, OMSW, OMSS Brass OMS, OMSW, OMSS	1 1	1 1
43	Tacho Valve Housing Complete	1	1
44	Tacho Connection Complete	1	1
45	Tacho Valve drive + Guide Pin	1	1
46	Spacer Ring	1	1
47	Tacho Valve Housing	1	1
48	O Ring 40 – 2mm [1.57 – 0.08]	1	1
49	Bearing Housing	1	1
50	Washer 5.6 – 8.5 – 1mm [0.22 – 0.33 – 0.04 in]	4	4
51	Screw M5 l = 15mm [0.59 in]	4	4
52	Tacho Drive Shaft	1	1
53	Locking Ring UR 6 – 0.7mm [0.24 – 0.03in] DIN 6799	2	2

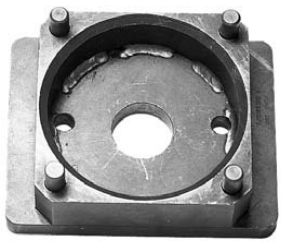
54	Bearing 8 – 22 – 7mm [0.31 – 0.87 –0.58in]	1	1
55	Shaft Seal	1	1
56	Locking Ring N22 – 1mm [0.87 – 0.04in] DIN 427	1	1
57	Name Plate (Tacho)	1	1
A	Set of Seals NBR OMS, OMSW item 1, 3, 11, 12, 19, 28, 29 OMS (p.t.o) item 1, 3, 11, 12, 19, 28, 29	 1 1	 1 1
B	Set of Seals NBR OMS, OMSW, OMSS item 11, 17, 19, 28, 29	1	1
C	Set of Seals FPM OMS, OMSW, OMSS item 1, 3, 28, 29	1	1
D	Set of Seals NBR OMSS item 11, 17	1	1

Tools Required

A

B

C

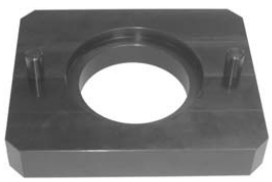


D

E

F

G



A. Main holding tool
B: Holding tool for OMSS
C. Holding tool for OMSW
D. Mandrel for fitting shaft seal
E. Mandrel for fitting PTO shaft seal
F. Holding tool for OMSW with brake nose
G. Holding tool for OMS SAE B – flange

Disassembly

Item	Part to Remove	Comments
4	Parallel key	Cylindrical or tapered shafts
*11	Conical seal ring	
13,14	Drain plug and washer	
33	Seal plugs (2off)	Place the motor in holding tool.
38	Plugs (2 off) Series 2 only	Use 5mm Allan head spanner
37	Washer (2 off) Series 2 only	
36	Springs (2 off) Series 2 only	Tilt motor, springs and balls come out.
35	Ball (2 off) Series 2 only	
34	Screw (4 off)	Use 17mm socket spanner.
32	Valve housing	Lift off carefully as a unit, holding your fingers under the channel plate (Item no. 23).
23	Channel plate	
19	O ring	Series 3 (2 off), Series 2 (1 off)
37	Ball (2 off) Series 3 only	
24	Stop ring	Only on OMSS 200, 250, 400 and 500
25	Disc valve	
30	Spacer	
26	Balance plate	Fill in oil into the spacer hole and use the 14.25mm [0.56 in] mandrel as a piston to press up the balance plate.
27	Guide pin	
28	O-ring	
29	O-ring	
31	Spring washer	
22	Valve drive	
21	Guide pin	Series 2 only
20	Gearwheel set	Hold fingers under the gearwheel set to prevent the parts from dropping out
19	O-ring	
18	Cardan shaft	
15	Intermediate plate	
11	Conical seal ring	Not on OMSS, is already removed.
12	O-ring	

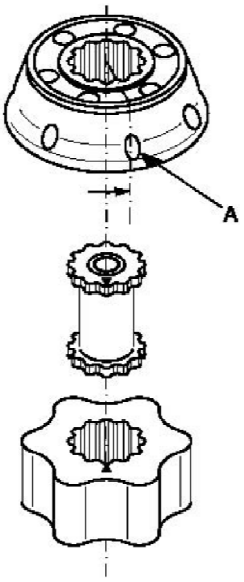
Item	Part to Remove	Comments
5,6, 7,10**	Shaft incl. bearings	Turn the bearing housing. Press out the shaft/bearing assembly using a hydraulic press (pressing Force max. 2500 N [550lbf]
		Note Shaft/bearing assembly should not be dismantled.
1**	Dust seal ring	Item no. 1 and 3 to be knocked out by means of the special mandrel.
3**	Shaft Seal	

* OMSS only
** OMSS except

Note

1. After dismantling, clean all parts in low aromatic kerosene.
2. Examine the parts and exchange them if necessary.
3. Immediately before assembly, lubricate each
4. part with hydraulic oil and grease rubber parts with Vaseline

Reassembly

Item	Part to assemble	Comments
3*	Shaft sea!	Knock into position in the bearing housing, using the assembly mandrel. Grease lip with Vaseline.
1*	Dust sea! ring	Use assembly mandrel and plastic hammer. Grease lip with Vaseline.
5,6, 7,10*	Shaft incl. bearings	Use the hydraulic press, (max. 2500 N [550 lbf])
		Note Always press on the bearing outer ring.
15,12, 11	Intermediate platen-ring, conical seal ring	Screw the guide bolts into the bearing housing. Fit the O-ring into the bearing housing. Fit the conical seal ring (biggest diameter facing the intermediate plate) in the recess in the intermediate plate. Place the intermediate plate in position on the bearing housing with the conical seal ring downwards.
18	Cardan shaft	Guide the cardan shaft down into the output shaft so that the splines engage.
19	O-ring	Grease with Vaseline.
20,21	Gearwheel set 	Hold fingers under the gearwheel set to prevent parts falling out. Carefully lay the gearwheel set on the intermediate plate so that the O-ring groove (OMS series 3) or guide pin hole (OMS series 2) is upwards. The through-hole (6 mm [0.24 in]) must line up with the hole in the intermediate plate. Fit the guide pin (OMS series 2 only) in the gear rim. Mark the wheel of the gearwheel set at the point where the bottom of an internal tooth is opposite the bottom of an external tooth (see drawing).
22	Valve drive	Mark the tip of a spline tooth on the end of the valve drive with the widest splines. Line up mark on rotor and valve drive. The end with the widest splines must point upwards.
		Note Applies to motors with Tacho connection: Pin on valve drive must point upwards.

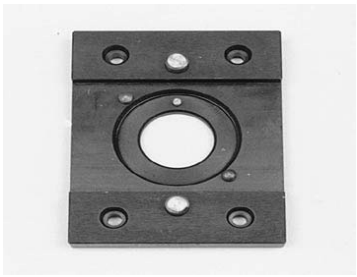
Item	Part to assemble	Comments
19	O-ring OMS series 3: 2 off OMS series 2: 1 off	Grease with Vaseline. Mount in the gearwheel (only OMS series 3) and channel plate groove.
23	Channel plate (OMS series 3)	Fit the channel plate so that the O-ring groove is upwards and the check valve holes line up with the through-hole in the gearwheel set.
	Channel plate (OMS series 2)	Fit the channel plate so that the guide pin engages with the hole in the channel plate.
35	Ball (2 off) Series 3 only	
25	Disc valve	Align mark on valve drive with a hole in the outer rim. (A on drawing). Turn disc valve counter clockwise until splines in the two parts engage.
31	Spring washer	Place into valve housing
28,29	O-ring	Fit the two O-rings (greased with Vaseline) in the balance plate grooves.
27	Guide pin	Mount in valve housing.
26	Balance plate	Mount in valve housing.
30	Spacer	Grease with Vaseline to prevent the spacer from dropping out.
32	Valve housing	Mount unit on the rest of the motor. Ports should face in the same direction as the drain port
34	Screw (4 off)	Lubricate threads and cross tighten screws to 75 - 80 Nm [660 - 705 lbf in].
35	Ball (2 off) Series 2 only	
36	Spring (2 off) Series 2 only	
37	Washer (2 off) Series 2 only	
38	Plug (2 off) Series 2 only	Tighten to 10 - 15 Nm [90 - 130 lbf in]
4	Parallel key	Secure with plastic ring or tape.
13,14	Drain plug and washer	Fill motor with oil before plugging. Tighten to 30 - 60 Nm [270 - 530 lbf in].
11*	Conical seal ring	Grease with Vaseline to keep in place

* OMSS only

Steering Orbital

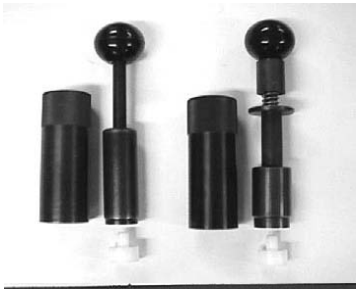
Tools Required

A

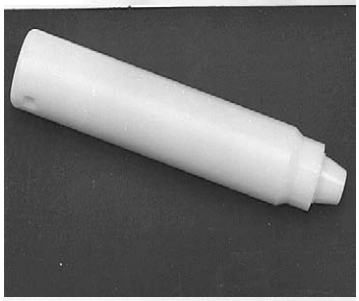


B

C



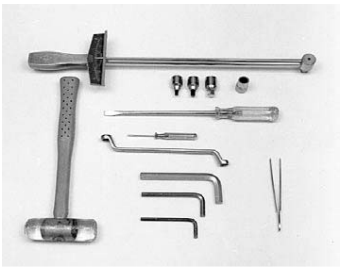
D



E

F

G



A - Holding tool

B - Guide ring

C - Assembly tool for O-ring and kin-ring /Roto Glyd

D - Assembly tool for lip seal

E - Assembly tool for cardan shaft

F - Assembly tool for dust seal

G - Torque wrench 0 - 70 Nm.
13mm socket spanner.
6.8 and 12 mm sockets.
12mm screwdriver.
2mm [0.08 in] screwdriver.
13mm ring spanner.
6.8 and 12 mm socket spanners.
Plastic hammer.
Tweezers

Disassembly

1. Dismantle steering column from steering unit and place the steering unit in the holding tool. Screw out the screws in the end cover (6-off plus one special screw).

Figure C1 – Disassembly

2. Remove the end cover, sideways.

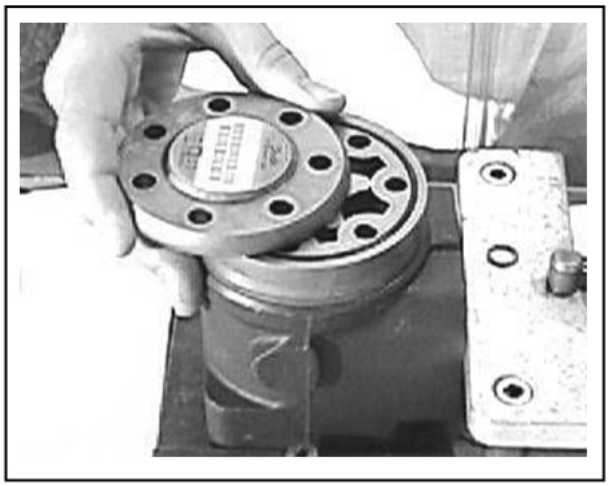


Figure C2 - Disassembly

3. Lift the gearwheel set (with spacer if fitted) off the unit. Take out the two O-rings.

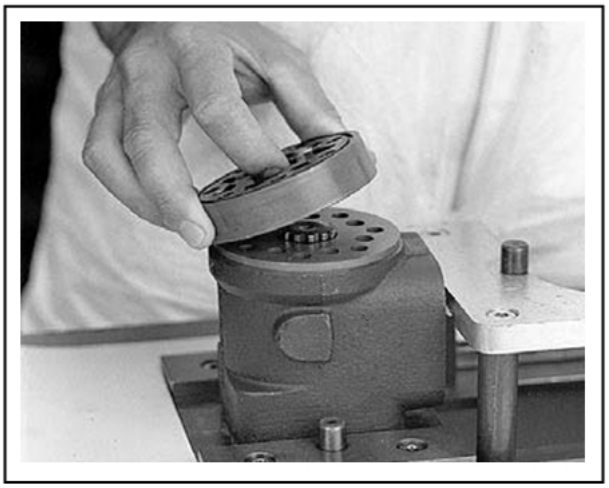


Figure C3 - Disassembly

4. Remove the cardan shaft.

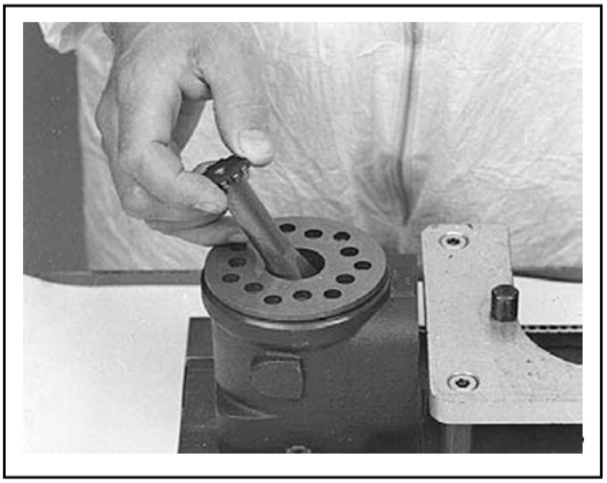


Figure C4 - Disassembly

5. Remove distributor plate.

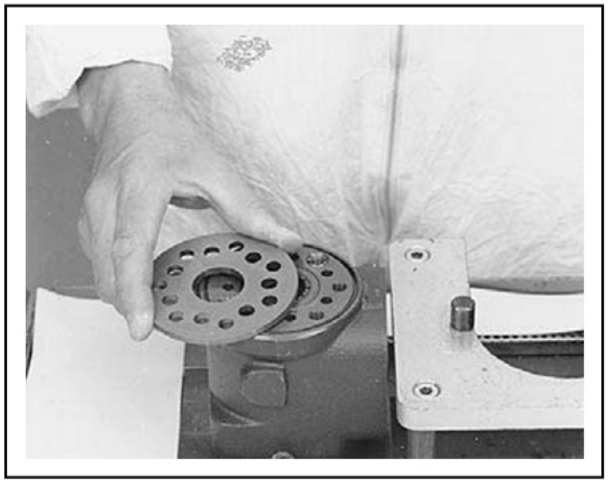


Figure C5 – Disassembly

6. Screw out the threaded bush over the check valve.

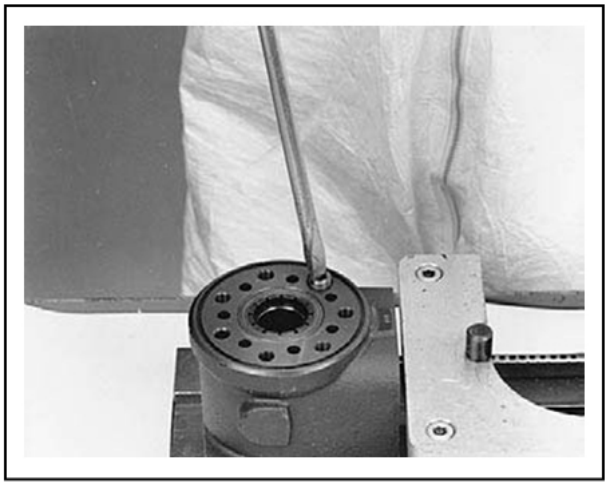


Figure C6 - Disassembly

7. Remove O-ring.

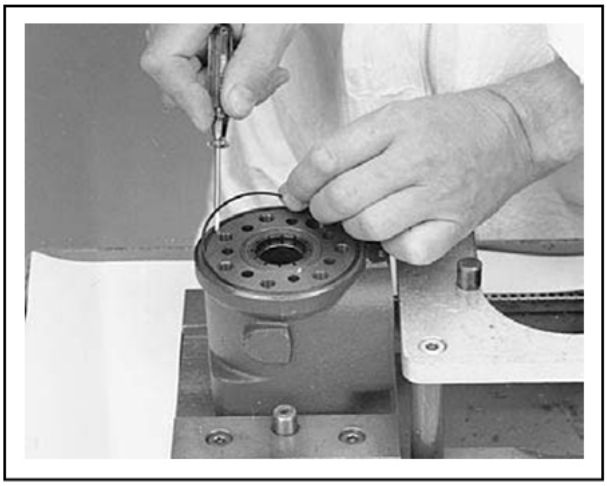


Figure C7 - Disassembly

8. Shake out the check valve ball (ø8 mm).

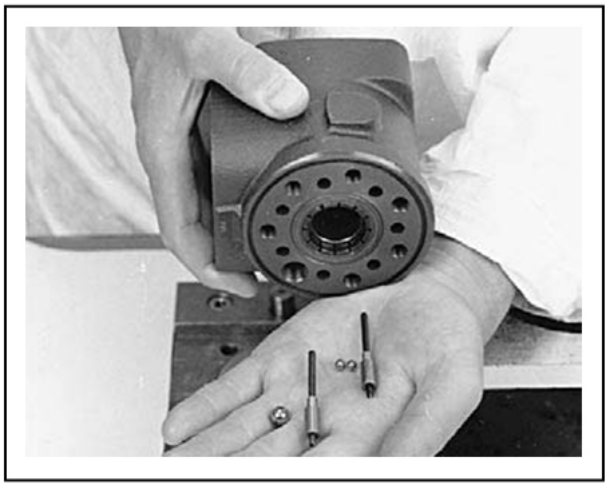


Figure C8 - Disassembly

9. Take care to keep the cross pin in the sleeve and spool horizontal. The pin can be seen through the open end of the spool. Press the spool inwards and the sleeve, ring, bearing races and needle bearing will be pushed out of the housing together.

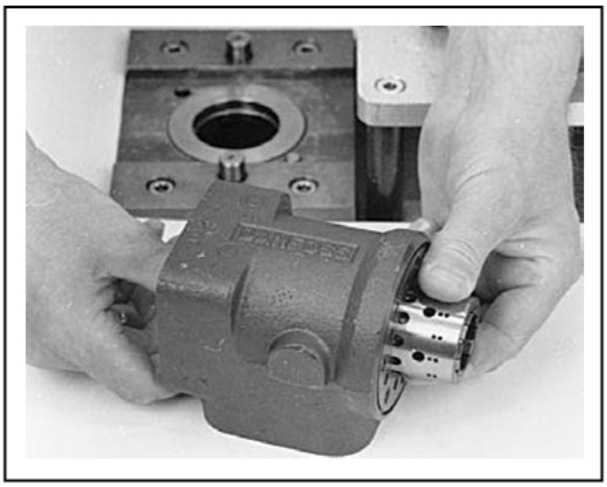


Figure C9 - Disassembly

10. Take ring, bearing races and needle bearing from sleeve and spool. The outer (thin) bearing race can sometimes “stick” in the housing, therefore check that it has come out.

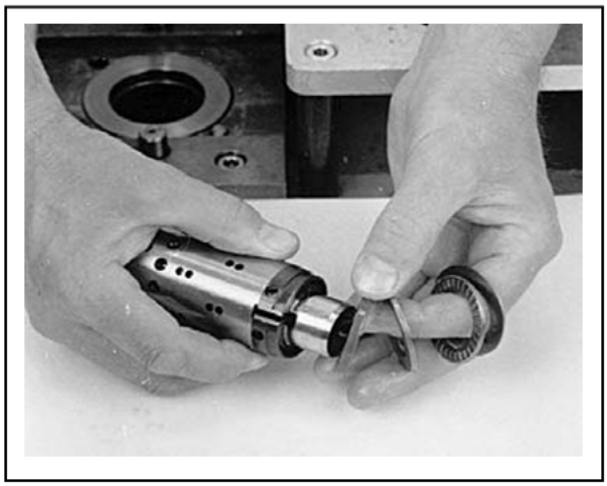


Figure C10 – Disassembly

11. Press out the cross pin. Use the special screw from the end cover.

    Note next point/paragraph!

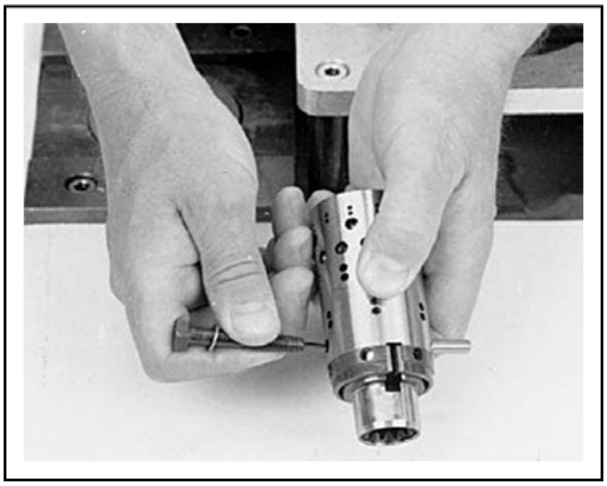


Figure C11 - Disassembly

12. A small mark has been made with a pumice stone on both spool and sleeve close to one of the slots for the neutral position springs (see drawing).

    If the mark is not visible, remember to leave a mark of your own on sleeve and spool before the neutral position springs are dismantled.

    For OSPF both marks should be placed opposite each other

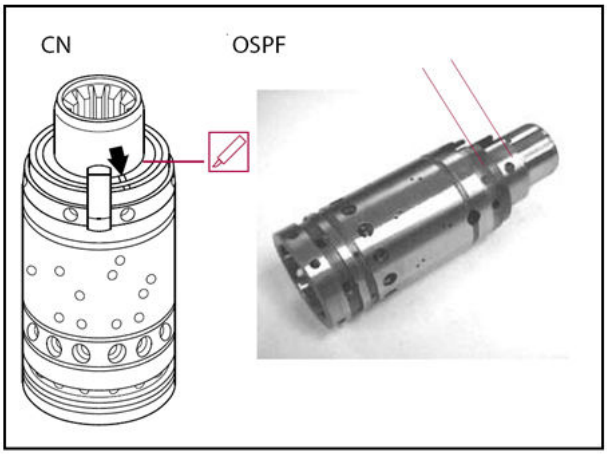


Figure C12 - Disassembly

13. Carefully press the spool out of the sleeve.

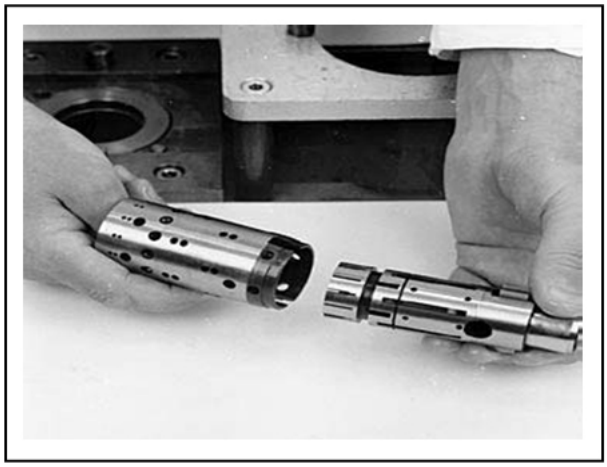


Figure C13 – Disassembly

14. Press the neutral position springs out of their slots in the spool.

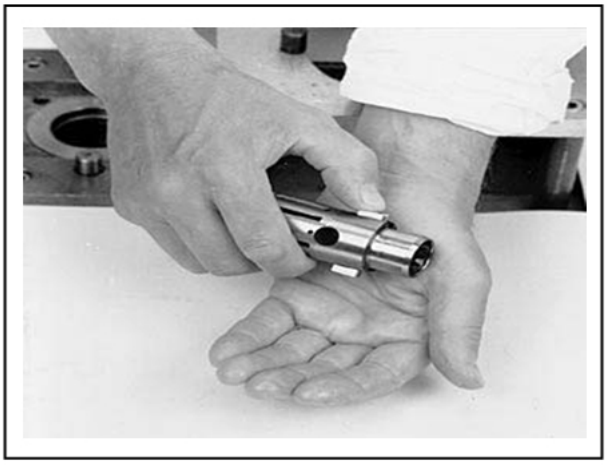


Figure C14 - Disassembly

15. Remove dust seal and O-ring / Kin-ring / Roto Glyd.

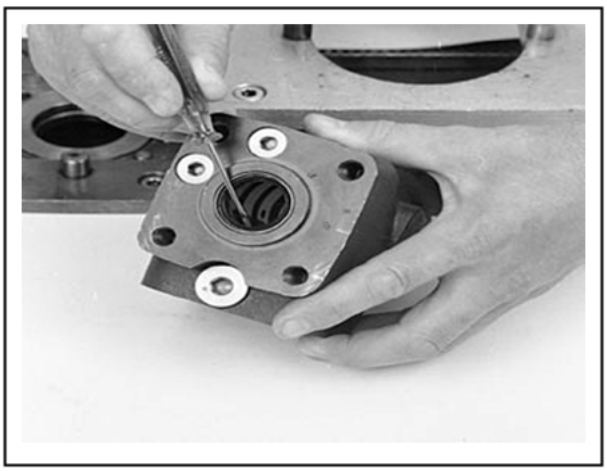


Figure C15 – Disassembly

16. Remove plugs from shock valves using a 6 mm hexagon socket spanner.

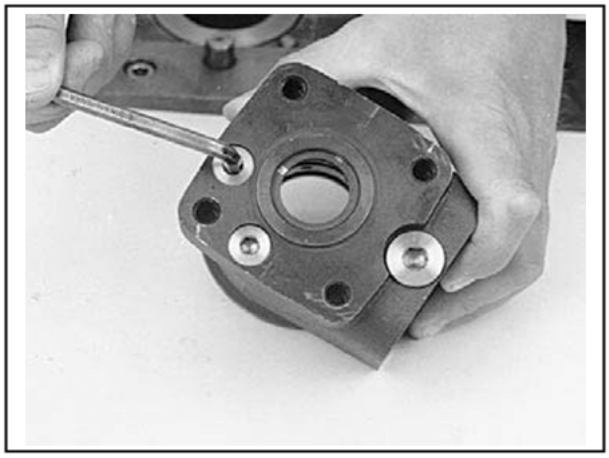


Figure C16 - Disassembly

17. Remove seal washers (2-off).

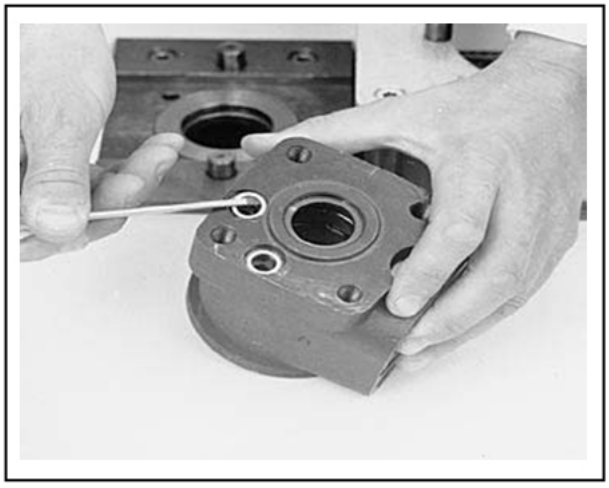


Figure C17 - Disassembly

18. Unscrew the setting screws using a 6 mm hexagon socket spanner.

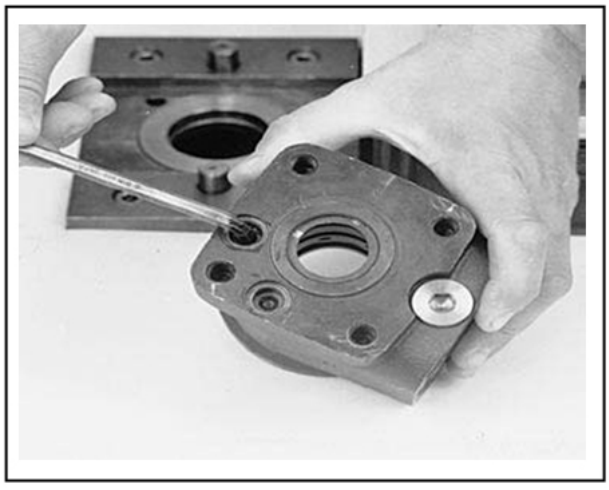


Figure C18 - Disassembly

19. Shake out the two springs and two valve balls into your hand. The valve seats are bonded into the housing and cannot be removed.

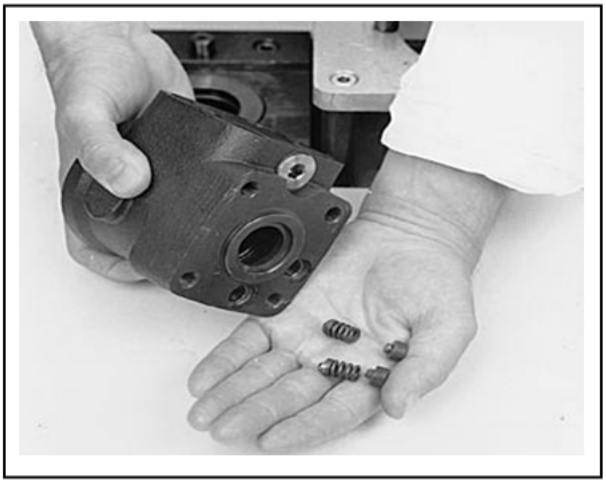


Figure C19 - Disassembly

20. The shock valves are now dismantled.

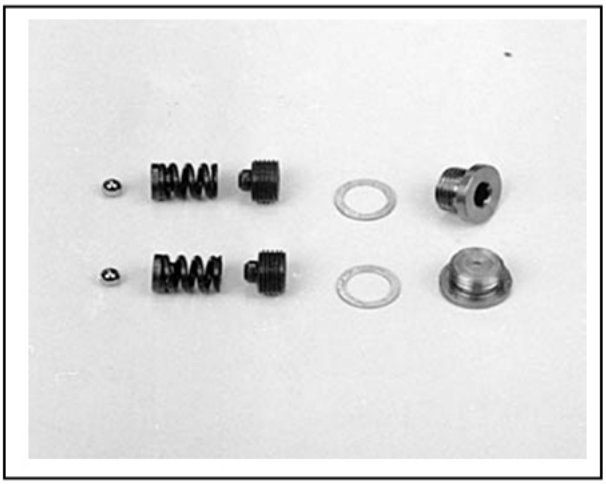


Figure C20 - Disassembly

Dismantling the pressure relief valve for OSPC

1. Screw out the plug using and 8 mm hexagon socket spanner. Remove seal washers.

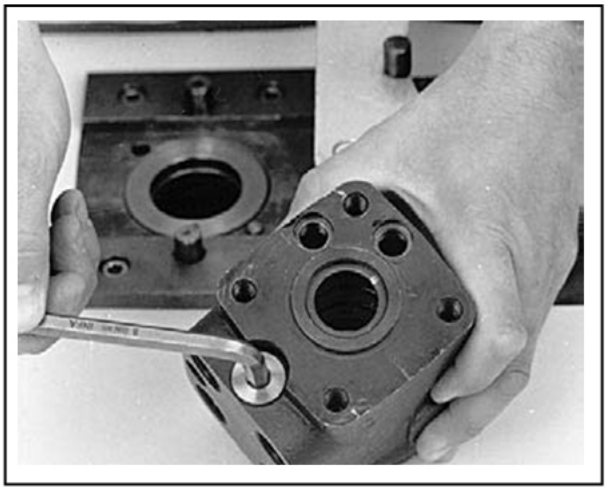


Figure C21 – Disassembly (pressure relief valve)

2. Unscrew the setting screw using an 8 mm hexagon socket spanner.

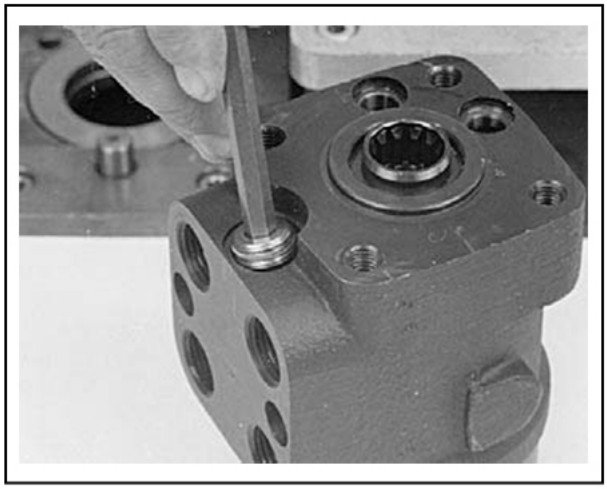


Figure C22 – Disassembly (pressure relief valve)

3. Shake out spring and piston. The valve seat is bonded into the housing and cannot be removed.

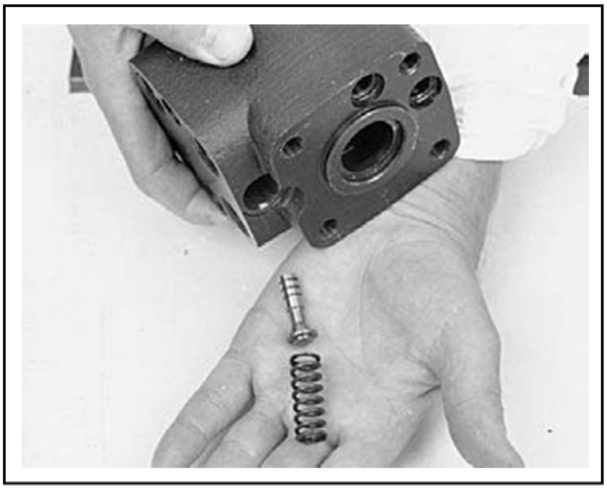


Figure C23 – Disassembly (pressure relief valve)

4. The pressure relief valve is now dismantled.

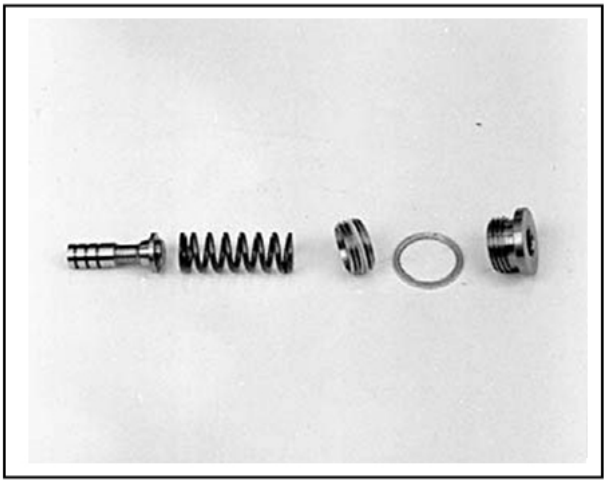


Figure C24 – Disassembly (pressure relief valve)

Dismantling the pressure relief valve (cartridge)

1. Screw out the pressure relief valve using and 8 mm hexagon socket spanner. Remove the seal ring. If the valve is defective it must be replaced.

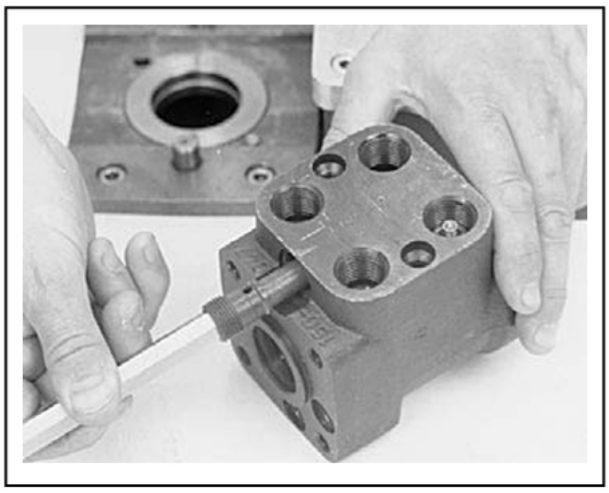


Figure C25 – Disassembly (cartridge)

2. The pressure relief valve is now dismantled.

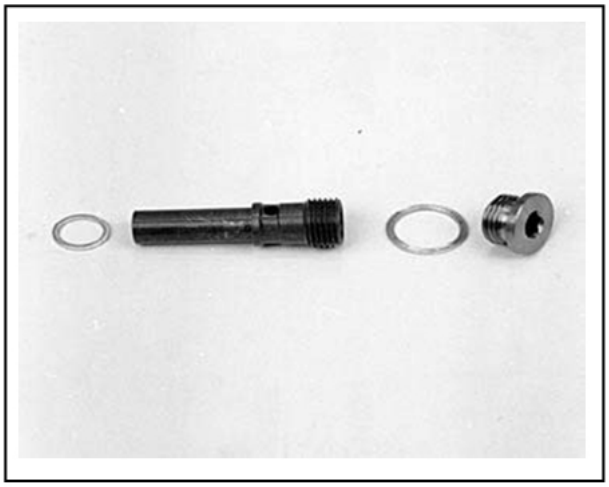


Figure C26 – Disassembly (cartridge)

OSPB Disassembled

The steering unit OSPB is now completely dismantled.

Figure C27 – Disassembled (OSPB)

OSPB LS Disassembled

The steering unit OSPB LS is now completely dismantled.

Figure C28 – Disassembled (OSPB LS)

OSPC Disassembled

The steering unit OSPC is now completely dismantled.

Figure C29 – Disassembled (OSPC)

Cleaning

Clean all parts carefully.

Lubrication

Before assembly, lubricate all parts with hydraulic oil.

Inspection and replacement

Replace all seals and washers. Check all parts carefully and make any replacements necessary

Reassembly

1. Place the two flat neutral position springs in the slot. Place the curved springs between the flat ones and press them into place.

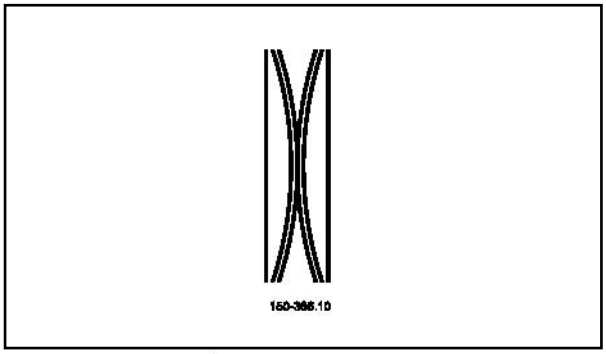


Figure C31 – Reassembly

2. Line up the spring set.

Figure C32 – Reassembly

3. Guide the spool into the sleeve. Make sure that spool and sleeve for OSPB LS, OSPBX LS, OSPC LS, OSPC LSR and OSPF are placed correctly in relation to each other.

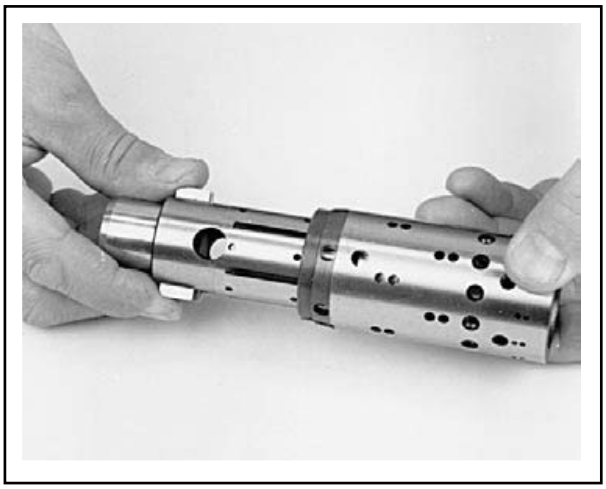


Figure C33 – Reassembly

4. Assemble spool and sleeve

Figure C34 – Reassembly

OSPB LS, OSPBX LS, OSPC LS, OSPC LSR and OSPF

When assembling spool and sleeve only one of two possible ways of positioning the spring slots is correct. There are three slots in the spool and three holes in the sleeve in the end of the spool/sleeve opposite to the end with spring slots. Place the slots and holes opposite each other so that parts of the holes in the sleeve are visible through the slots in the spool

OSPB CN and OSPC CN

Assemble the spool/sleeve and make sure the marks on spool and sleeve are opposite each other

1. Press the springs together and push the neutral position springs into place in the slave.

Figure C35 – Reassembly

2. Line up the springs and centre them.

Figure C36 – Reassembly

3. Guide the ring down over the sleeve.

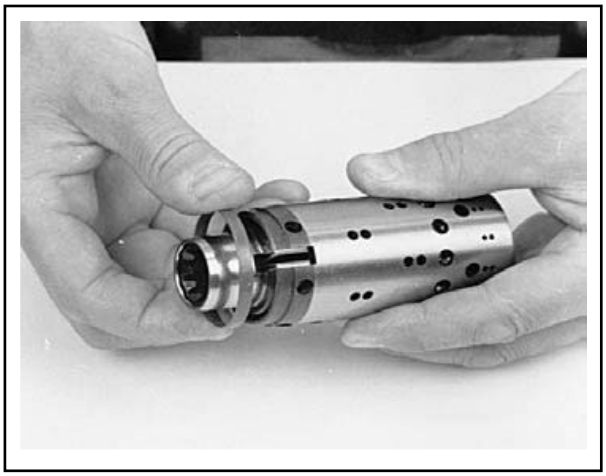


Figure C37 – Reassembly

Note The ring should be able to move - free of springs.

4. Fit the cross pin into the spool/sleeve.

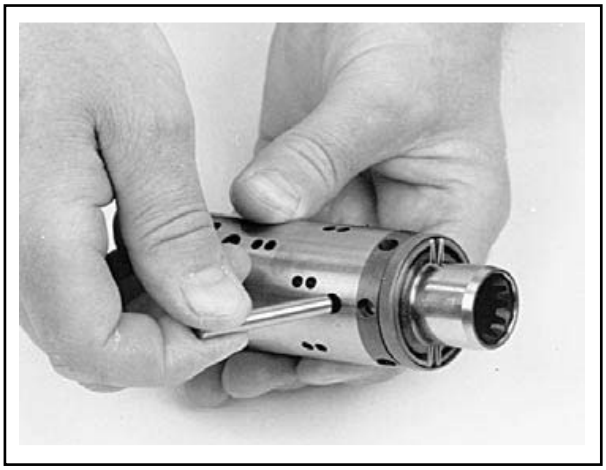


Figure C38 – Reassembly

5. Fit bearing races and needle bearings as shown on the drawing next page.

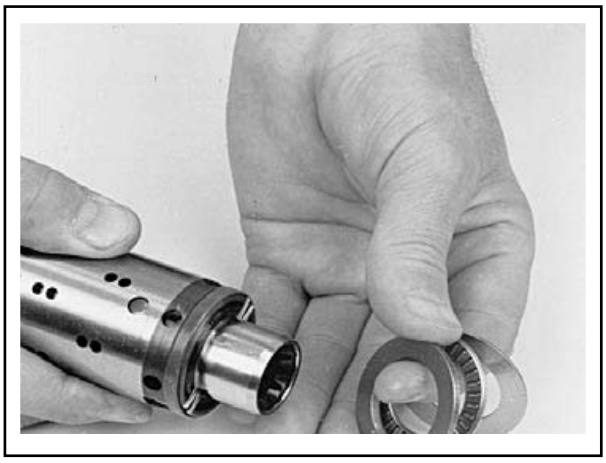


Figure C39 – Reassembly

Assembly pattern for standard bearing

1. Outer bearing race
2. Needle bearing
3. Inner bearing race

* The inside chamfer on the inner bearing race must face the inner spool

4. Spool
5. Sleeve

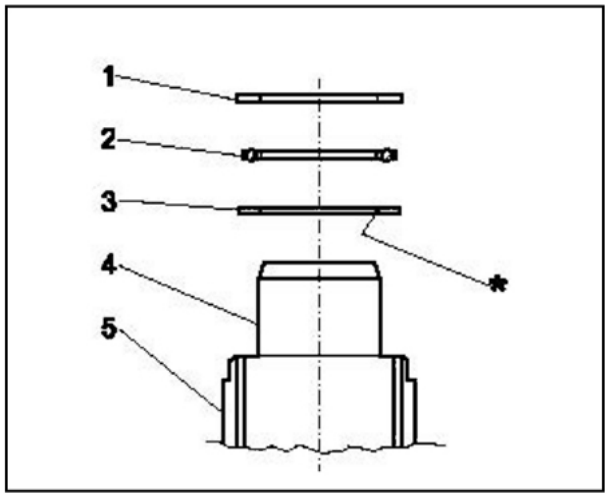


Figure C40 – Assembly Pattern (standard bearing)

Assembly pattern for double bearing

1. Washer for axial bearing
2. Outer needle bearing
3. Outer bearing race
4. Spool
5. Sleeve
6. Inner needle bearing
7. Inner bearing race

* The inside chamfer on the inner bearing race must face the inner spool

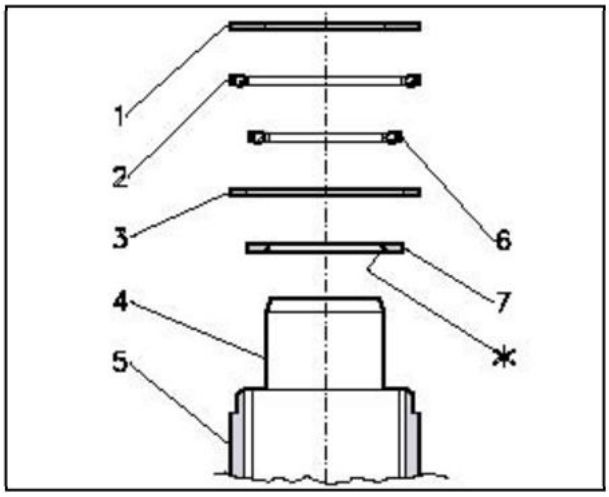


Figure C41 – Assembly Pattern (double bearing)

Installation instruction for O-ring / kin-ring /roto Glyd

1. Turn the steering unit until the bore is horizontal. Guide the outer part of the assembly tool into the bore for the spool / sleeve.

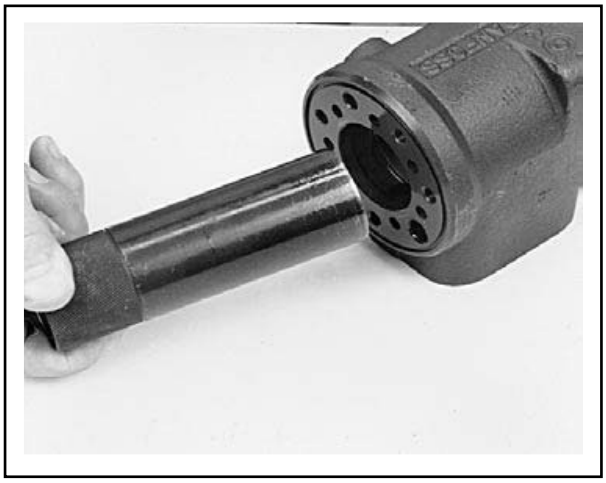


Figure C42 – 'O' Rings

2. Grease o-ring and king-ring / roto Glyd with hydraulic oil and place them on the tool.

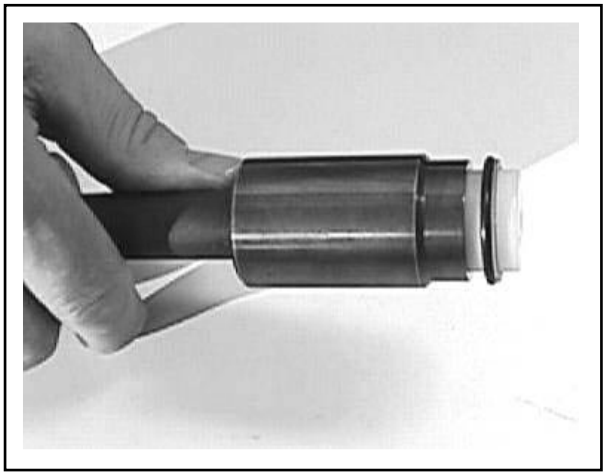


Figure C43 – 'O' Rings

3. Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.

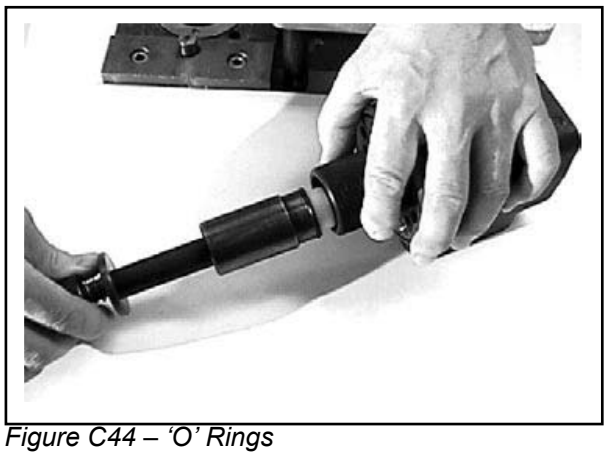


Figure C44 – 'O' Rings

4. Press and turn the o-ring/kin-ring into position in the housing.

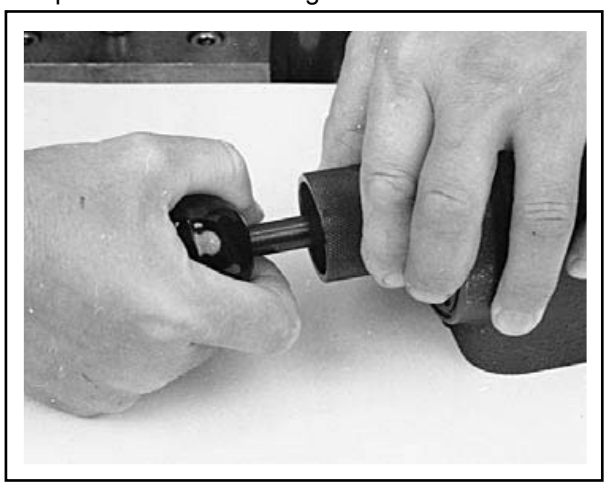


Figure C45 – 'O' Rings

5. Draw the inner and outer parts of the assembly tool out of the steering unit bore, leaving the guide from the inner part in the bore.

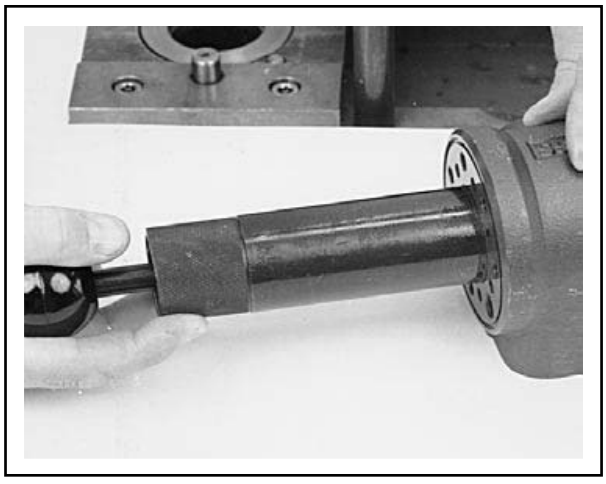


Figure C46 – 'O' Rings

Installation instruction for lip seal

1. Lubricate the lip seal with hydraulic oil and place it on the assembly tool.

Figure C47 – Lip Seal

2. Guide the assembly tool right to the bottom.

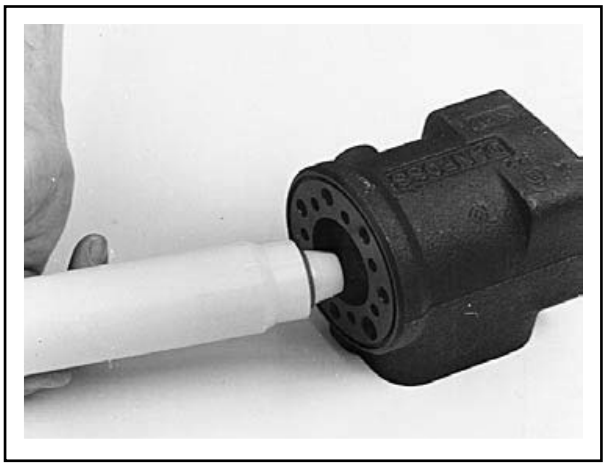


Figure C48 – Lip Seal

3. Press and turn the lip seal into place in the housing.

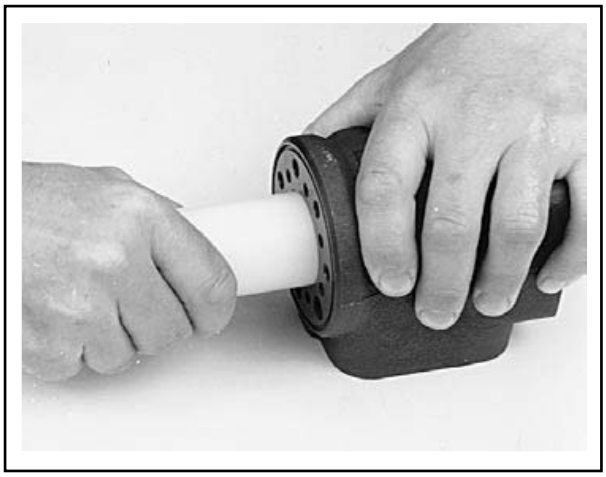


Figure C49 – Lip Seal

4. With a light turning movement, guide the spool and sleeve into the bore.

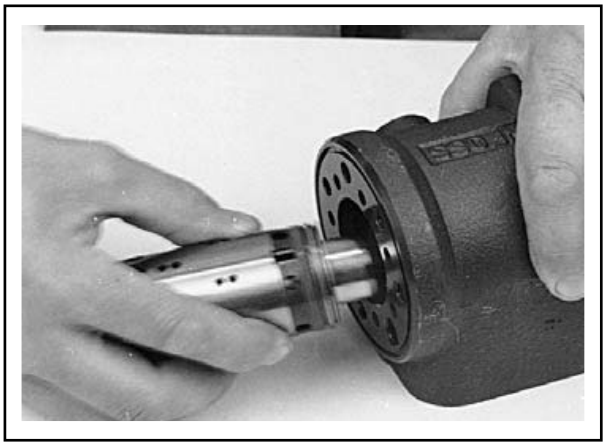


Figure C50 – Lip Seal

Note Fit the spool set holding the cross pin horizontal.

5. The spool set will push out the assembly tool guide. The o-ring and kin-ring/roto Glyd are now in position.

Figure C51 – Lip Seal

6. Turn the steering unit until the bore is vertical again. Put the check valve ball into the hole indicated by the arrow.

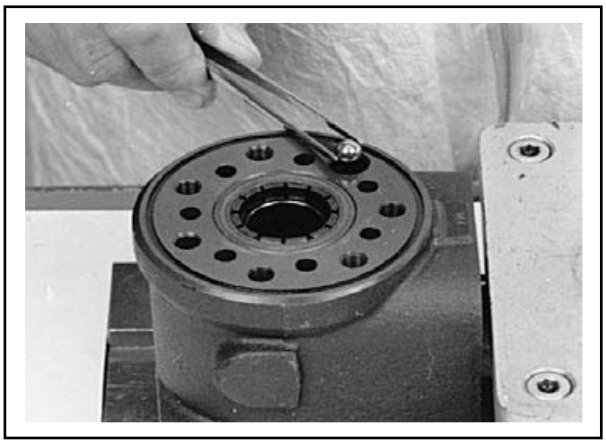


Figure C52 – Lip Seal

7. Screw the threaded bush lightly into the check valve bore. The top of the bush must lie just below the surface of the housing.

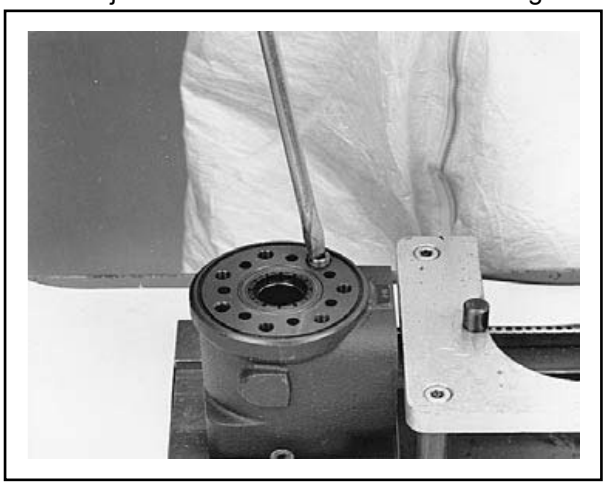


Figure C53 – Lip Seal

8. Place a ball in the two holes.

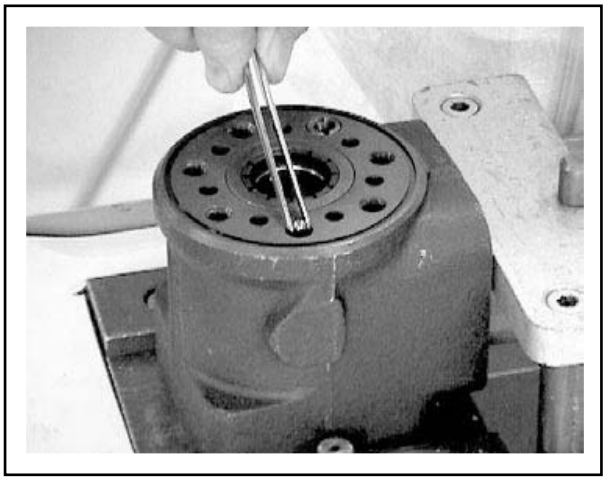


Figure C54 – Lip Seal

9. Place a new pin in the same two holes.

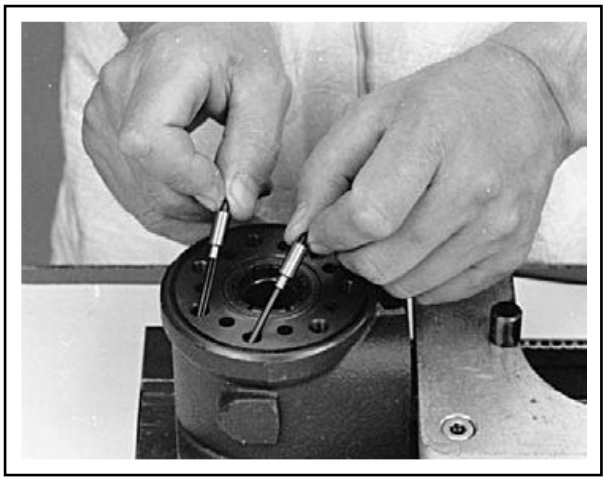


Figure C55 – Lip Seal

10. In some cases a spring has to be fitted (see page 4 pos. 38) on the pin before it is placed in the Housing.

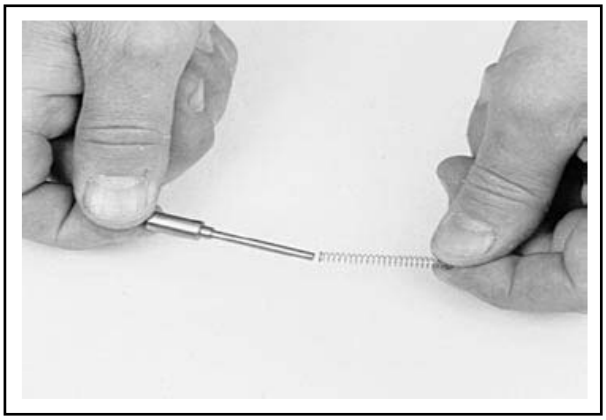


Figure C56 – Lip Seal

11. Grease the o-ring with mineral oil approx. viscosity 500 mm_2/s [SUS] at 20°C [68 °F].

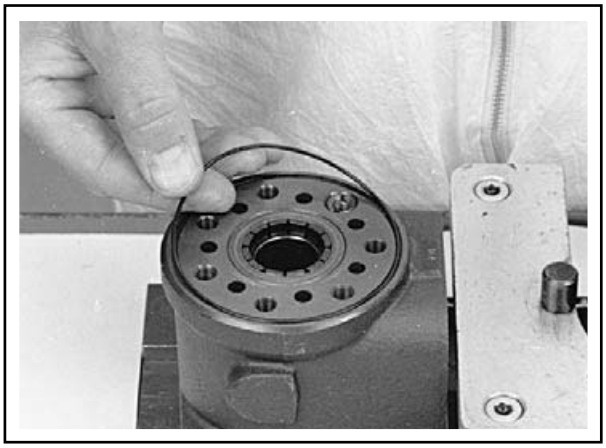


Figure C57 – Lip Seal

12. Place the distributor plate so that the channel holes match the holes in the housing.

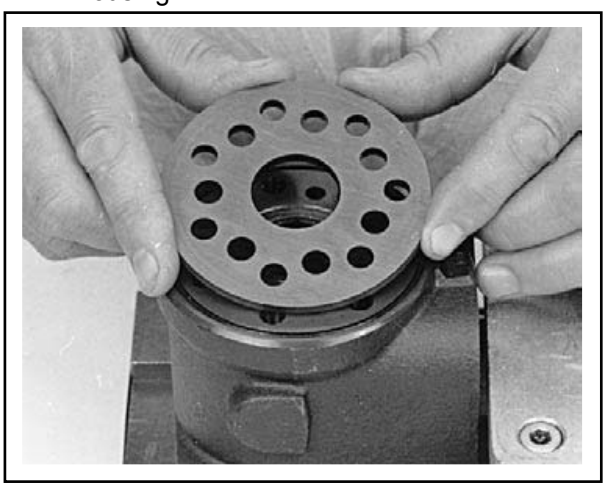


Figure C58 – Lip Seal

13. Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.

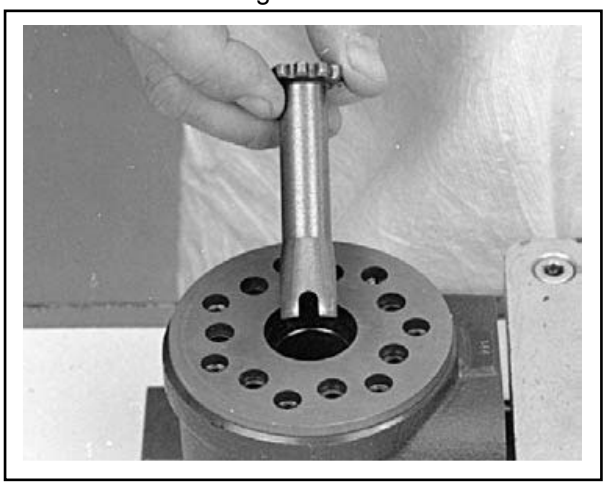


Figure C59 – Lip Seal

14. Place the cardan shaft as shown - so that it is held in position by the mounting fork.

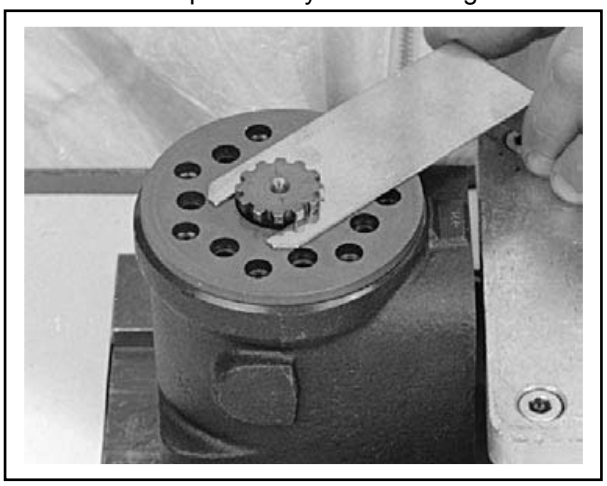


Figure C60 – Lip Seal

15. Grease the two o-rings with mineral oil approx. viscosity 500 mm_2/s [SUS] at 20°C [°F] and place them in the two grooves in the gear rim. Fit the gearwheel and rim on the cardan shaft.

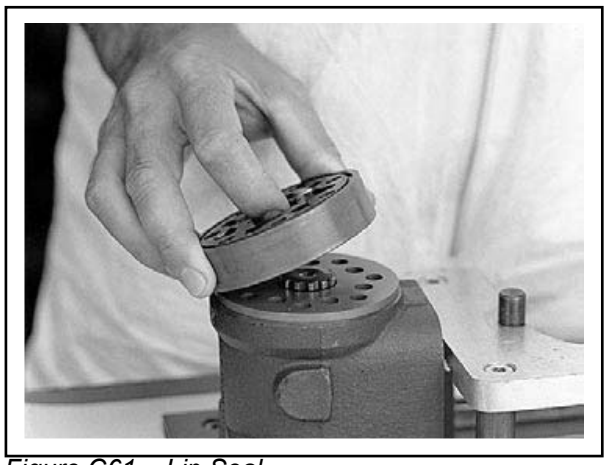


Figure C61 – Lip Seal

CAUTION

Fit the gearwheel (rotor) and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown. Turn the gear rim so that the seven trough holes match the holes in the housing

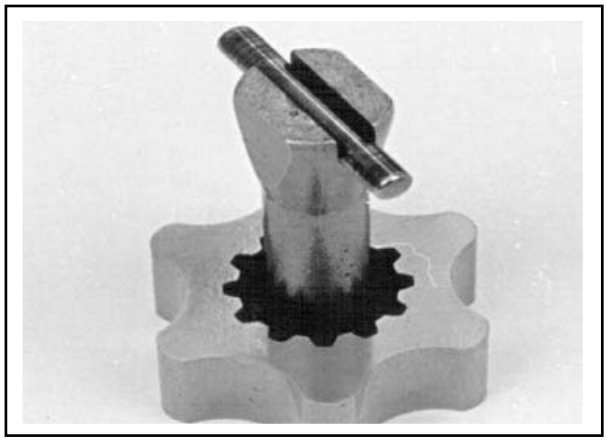


Figure C62 – Lip Seal

16. Fit the spacer, if any.

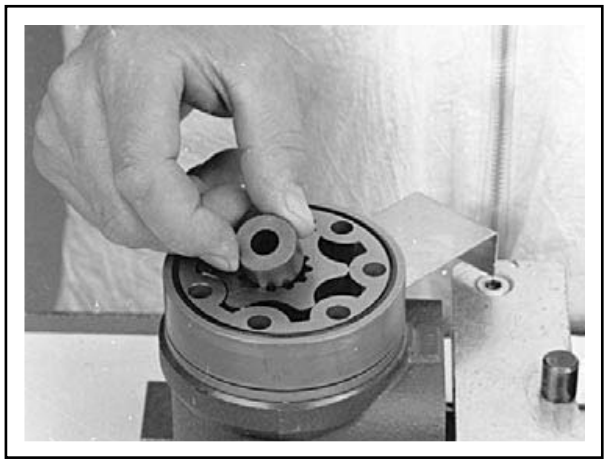


Figure C63 – Lip Seal

17. Place the end cover in position.

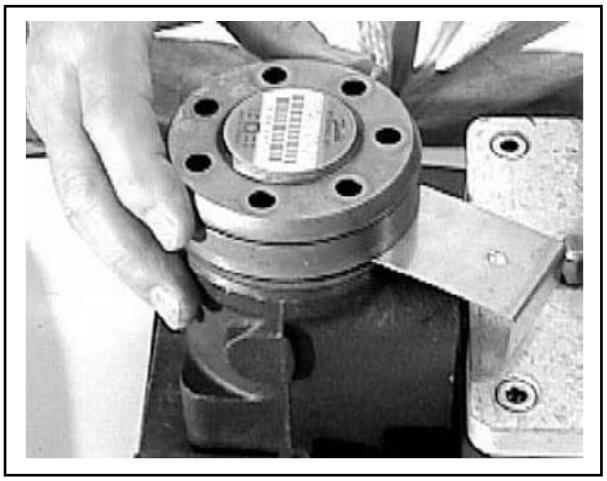


Figure C64 – Lip Seal

18. Fit the special screw with washer and place it in the hole shown.

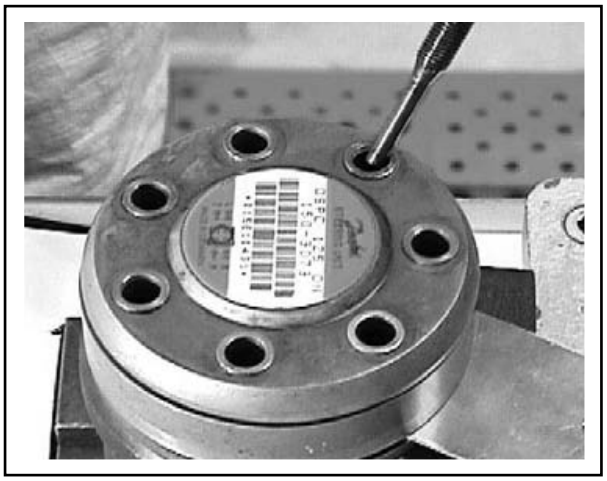


Figure C65 – Lip Seal

19. Fit the six screws with washers and insert them. Cross-tighten all the screws and the rolled pin with a torque of 30 +/-6 Nm [265.5 +/- 53 lbf.in]. The OSPB, OSPB LS and OSPBX LS can now be function tested

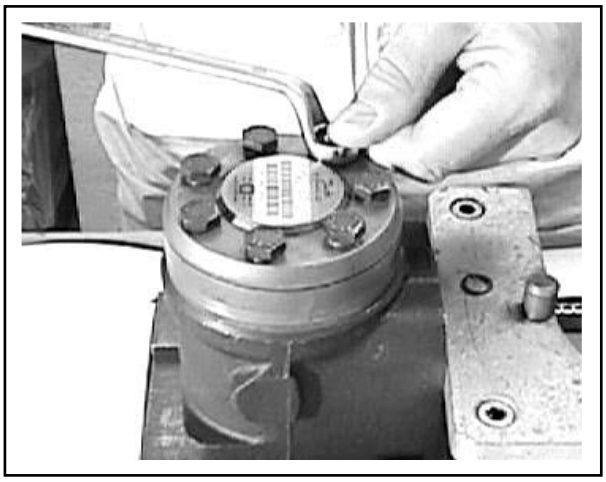


Figure C66 – Lip Seal

Reassemble of the pressure relief valve for OSPC

1. Fit the piston.

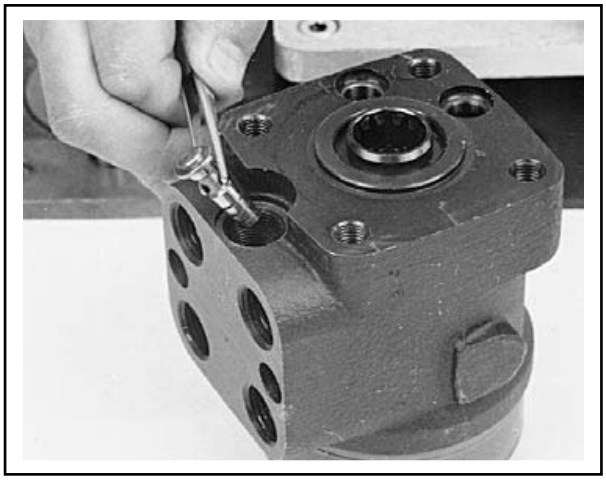


Figure C67 – Reassembly (pressure relief valve)

2. Fit the spring

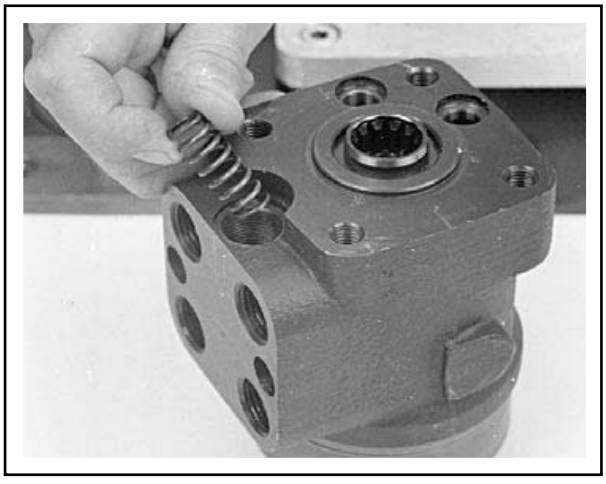


Figure C68 – Reassembly (pressure relief valve)

3. Screw in the setting screw with an 8 mm hexagon socket spanner.

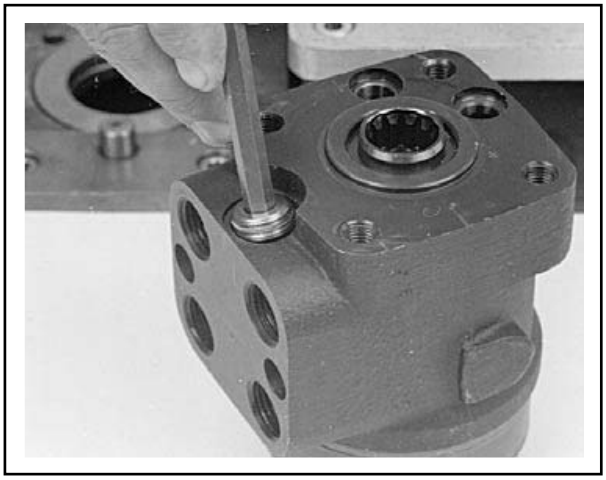


Figure C69 – Reassembly (pressure relief valve)

4. Screw plug with dust seal into the housing using an 8 mm hexagon socket spanner. Tightening torque: 50 +/-10 Nm. [443 +/-8.85 lbf.in]

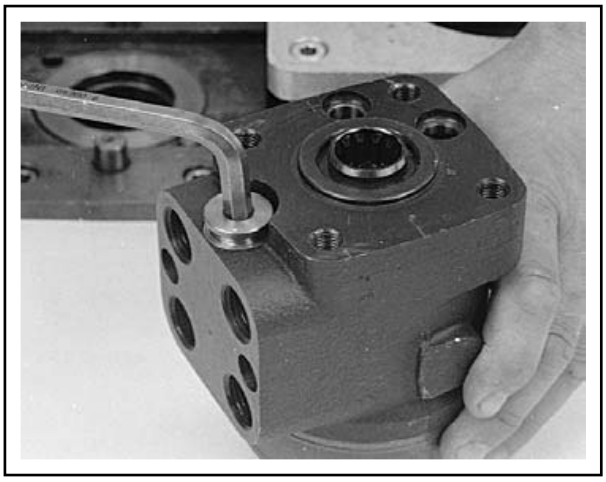


Figure C70 – Reassembly (pressure relief valve)

Reassembly of the shock valves for OSPC/OSPC LS/OSPC LSR

1. Put a ball in the two holes.

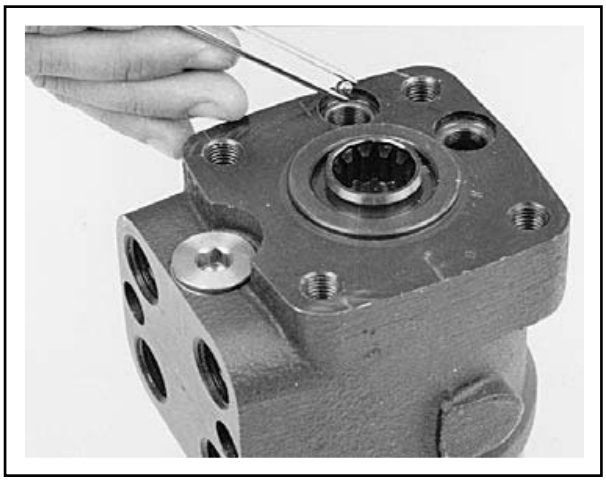


Figure C71 – Reassembly (shock valve)

2. Place springs and valve cones over the two balls.

Note The blue spring applies to setting range 90-180 bar [1305-2610 psi]. The untreated spring applies to setting range 170-260 bar [2465-3770 psi]

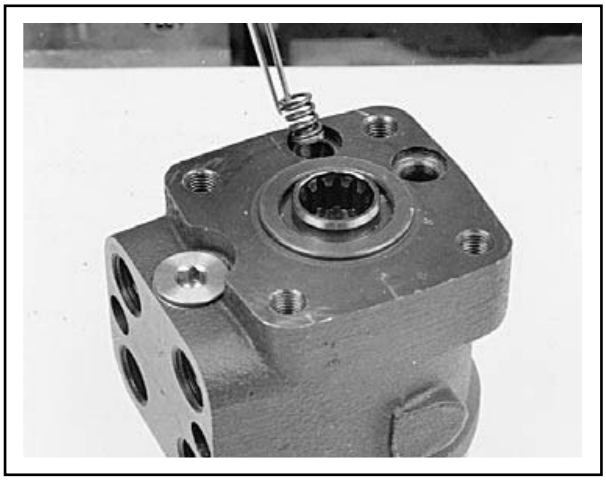


Figure C72 – Reassembly (shock valve)

3. Screw in the two setting screws using a 6 mm hexagon socket spanner. Make the pressure setting on a panel or the vehicle.

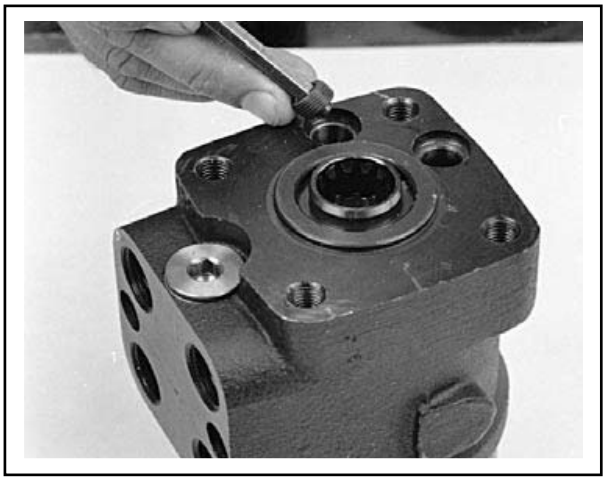


Figure C73 – Reassembly (shock valve)

4. Screw plug with seal ring into the two shock valves and tighten them with a torque of 30 +10 Nm [265.5 + 88.5 lbf.in] using a 6 mm hexagon socket spanner. Steering unit type OSPC, OSPC LS or OSPC LSR is now assembled.

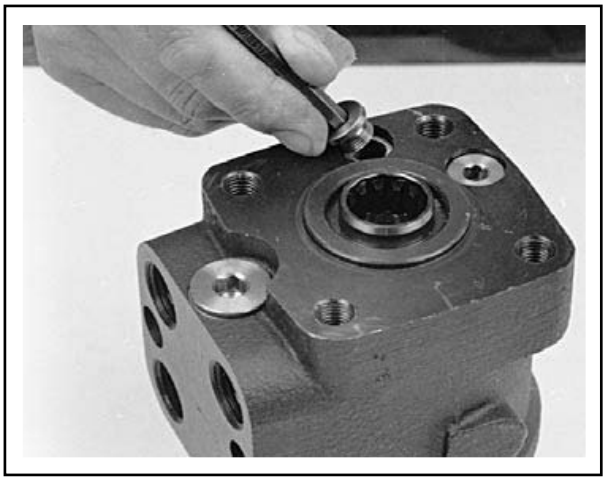


Figure C74 – Reassembly (shock valve)

5. Place the dust seal ring in the housing. With the OSPC, OSPC LS and OSPC LSR the dust seal ring must be placed only after the pressure relief valve and shock valves have been fitted.

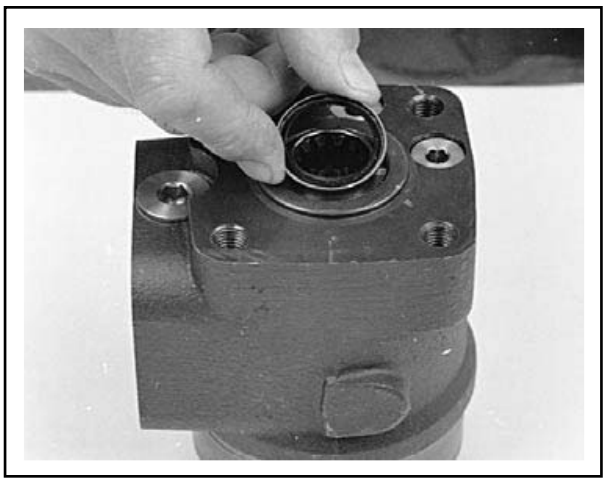


Figure C75 – Reassembly (shock valve)

6. Fit the dust seal ring in the housing using special tool SJ 150-9000-22 and a plastic hammer.

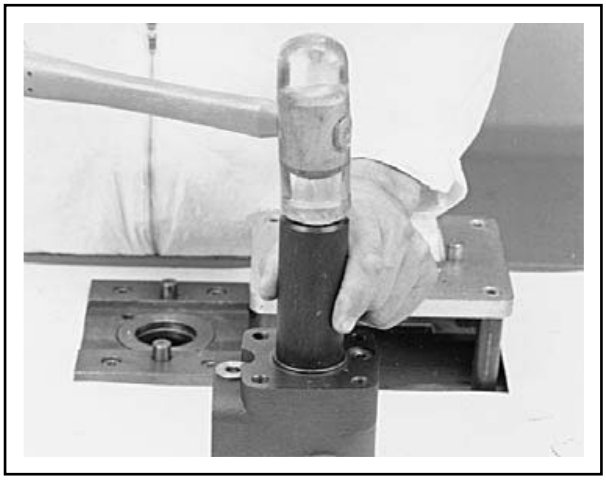


Figure C76 – Reassembly (shock valve)

7. Press the plastic plugs into the connection ports.

Note Do not use a hammer.

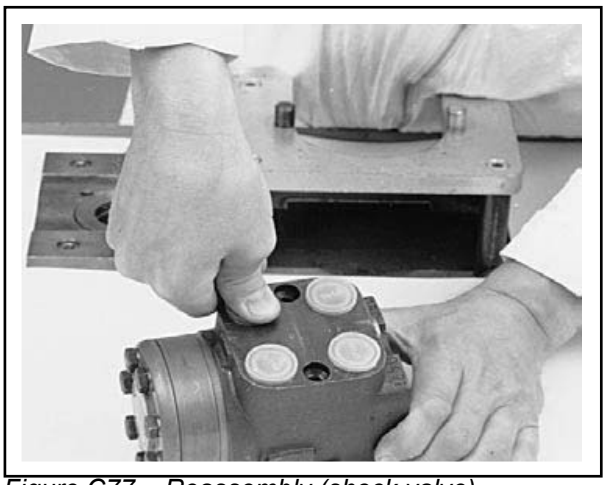


Figure C77 – Reassembly (shock valve)

Max. Tightening Torque and Hydraulic Connections

T: Tank

L: Left port

P: Pump

R: Right port

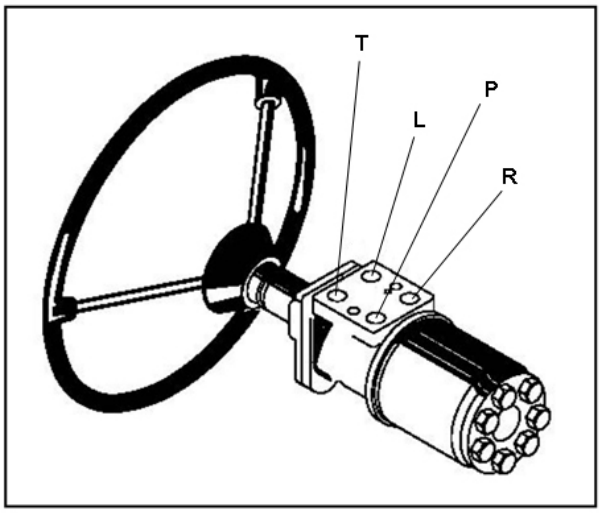
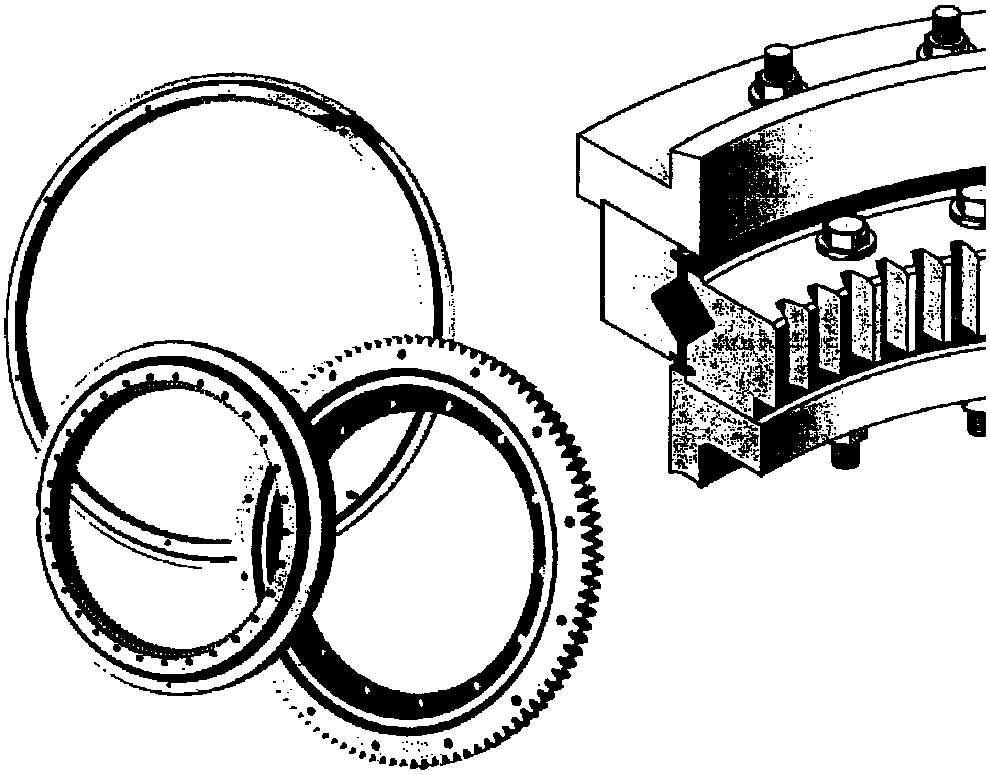


Figure C78 – Tightening Torque

All ports are ½" BSP

Screwed connection	Max. tightening torque Nm [lbf.in]
½ BSP	100 (900)

Slewing Ring



Removal

1. Remove the mast as detailed in Section J Mast.
2. Remove front axle assembly as detailed in Section B Front Axle Assembly.
3. Disconnect hoses to tilt cylinders.
4. Attach lifting gear to mast support and remove 23 M12 hex head screws. The mast support assembly will now come away from the truck.
5. Remove 24 hex head screws and lift the slewing ring off the mast support assembly.

Overhaul

The instructions for overhauling the slewing ring are given later in this section.

Refitting

Refitting the slewing ring is the reversal of the above instructions.

Note: All the bolts securing the slewing ring to the mast support and all the bolts securing the slewing ring to the chassis MUST be torqued to 87Nm.

Installation

Transportation

Slewing rings are carefully packed in order to avoid any damage during transport. Transport and storage are to be carried out in horizontal position only; transport in other positions requires special methods.

As with any mechanical precision part, the rings must be handled with care avoiding any shocks, particularly along the radial axis. Handling should be carried out with suitable equipment for the weight of the part, which is indicated on the identification tag.

Storage

The packed rings have an anticorrosive surface protection allowing a six month storage in a covered and temperate room. A suitable protection must be applied for longer storage. It is necessary to re-grease after each 18 month period (see paragraph **Maintenance - Lubrication**).

Unpacking

When unwrapping the bearing:

- Take care not to cut the protective seals when removing the packing paper.
- Cut this paper, preferably on the external diameter, not on the upper or lower faces.

When degreasing the bearing:

- Use a standard commercially available solvent. Chlorine containing solvents are prohibited.
- Take care not to introduce any solvent under the seals or in the raceways.
- Before fitting the grease nipples or junction pipes, remove the plastic caps or the Hc screws from the greasing holes.

Installing

- Make sure that supporting structures comply with specifications.
- Check for chips, weld seam particles, corrosion signs, etc.
- Check the good mating of the rings on the supports.

Positioning

The hardening junction which is marked by a red line on the geared ring, and located at the filler plug on the other ring, must be placed at 90° to the main load axis or to the arm supporting the load. (see chapter Marking).

Fastening

- Check that fasteners are really of the recommended grade, e.g. marked 10.9 on the head and that threads are properly lubricated.

- For bearings in normalised steel Z or N, the use of treated hardened flat washers is required as follows:

  The yield strength is greater than or equal to 600MPa.

  The diameter D_R= 2d

  The thickness h > 0.3d

  Note: The elastic washers type Belleville, Grower or others of whatever type or pattern are absolutely prohibited and will void all warranty.

- Install all fasteners and tighten lightly.

- Then tighten to the specified value using a properly calibrated torque wrench; hydraulic devices are advisable.

Use a "star shape" pattern when torquing which ensures a uniform tightening over the whole periphery. The tightening torque to be applied is 120 Nm for bolt grade 10.9 and a screw/nut friction factor of 0.12 according to VDI 2230.

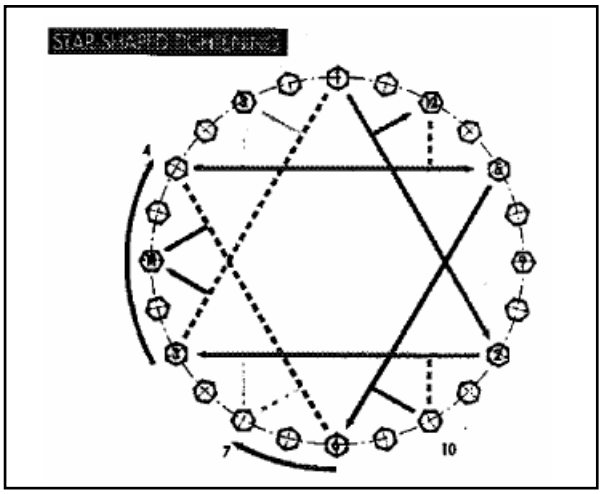


Figure C79

Gear

- Adjust the driving pinion to the maximum eccentric point of the ring gear, marked by a blue line.

- At this stage, the backlash must be within the limits of the calculated values or minimum at
- 0.05 x module. The backlash is not adjustable.

- During tests, make sure that good alignment of the pinion and of the slewing ring axes permits a satisfactory contact across all the

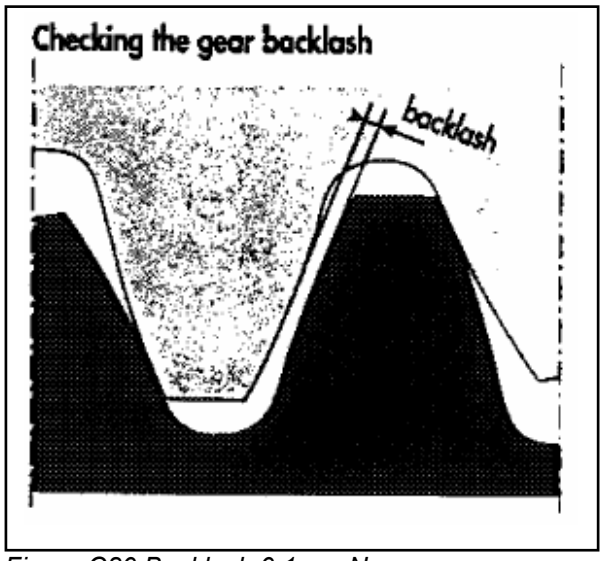


Figure C80 Backlash 0.1mm Nom.

- Before running, lubricate the teeth of the slewing ring gear and of the pinion (see chapter Maintenance).

Maintenance

Lubrication

A suitable lubrication is essential for the longevity of the raceways and gears. The operating conditions such as loads, temperatures, speeds, vibrations, etc. determine the choice of lubricant.

Raceway

Unless otherwise specified, the slewing rings are delivered greased. Standard grease: ESSO Beacon EP 2 or equivalent.

Main properties required for purpose grease

As being a significant component of the bearing, grease will improve the bearing capabilities and longevity.

Recommendations for bearing lubricant

- Lithium based soap.
- Minimum viscosity of the base: 150 mm^2/sec.
- Grade NLGI 2.
- Anti-wear and extreme pressure additives.
- Service temperature: -30°C + 120°C
- 4 ball test: weld load: ASTM D 2596 (NT24) >300
- Maximum ND_M:
  for balls = 60 000
  for rollers = 30 000

Gear

A protection against oxidation is applied.

Greasing holes

Radially or facially located, depending on design, these holes are generally tapped M10 x pitch. 1.00 and closed by plastic caps or Hc screws. Remove these plugs before fitting the slewing ring with grease nipples or linked to a centralised lubrication system.

Caution: The filler plug for the rolling elements has a blind tapped hole which is not a greasing hole.

Re-greasing methods

Whenever the application allows it, greasing must be carried out during rotation at slow speed, on two revolutions minimum, through all the greasing holes.

Greasing frequency

Raceway and gear

The greasing frequency varies according to utilisation and environment. We recommend regreasing every 150 hours in normal usage. This frequency is to be reduced to 50 hours when the conditions of application are severe or if the environment is dusty or wet.

Greasing is required, before and after a long idle period.

Regrease every 6 months, while rotating, during prolonged idle periods.

Grease quantity

Raceway

The grease quantity is defined by the Engineering Department whenever a detailed bearing calculation is provided.

Approximate practical formula to determine the minimum necessary quantity "Q" in cm^3:

$$Q = 0.05/3 \times D \times H$$

where:
D = raceway mean Dia. of the bearing in mm
H = overall height of the ring in mm.

In all cases, a light extrusion of new grease must appear at the protection seal lips.

Gear

The grease must cover the entire flank of the pinion and of the ring gear whether applying by brush or spraying.

Correspondence table

According to our experience, the greases mentioned in the below table are compatible with each other and with the components of the bearings.

It is possible to use other lubricants provided you are sure of their compatibility with the Rollix standard recommendation beforehand. Greases containing molybdenum disulphide MoS_2 are strictly forbidden.

Bearing	Grease Brand	Gear
Aralub HLP2	ARAL	Aralub LFZ1
Rhus L 474/2	MOTUL/BECHE M	Berulit GA 400
Energrease LS-EP2	BP	Energol WRL/GR 154 GS
Grease LMX	CASTROL	
Epeaxa2 Epexelf 2	ELF	Cardrexa DC1
Beacon EP2	Esso	Surret Fluid NX
Mobilux EP2	MOBIL	Mobiltac 81
Calithia EP2	SHELL	Malleus Fluid D
This table is subject to change with the manufacturer's research works.		

Preventive Maintenance

Protection survey

A visual examination makes it possible to ensure the integrity of the protective seals:

- absence of excessive stretch or tears,
- correct positioning,
- wear of the friction lip.

If necessary, replace the seal.

After regreasing, wipe clean residue of old grease and check for pollutants such as sand, coal, metallic particles, etc.

Fastener survey

It is particularly important to check that the required preload level of the bolts is still maintained as the fasteners of the slewing ring are essentially working in fatigue.

The fasteners should be retightened after the first two to four months of utilisation and then proceeding to a systematic yearly check. If any bolt is found loose, a further in deep examination is essential. The necessary preservative measures must then be exercised.

Orientation survey

During cleaning prior to regreasing of the gear:

- Check carefully for any foreign body at the tooth root, ring and pinion.
- Check the even load distribution of the pinion on the entire width of the ring gear and correct the alignment of the axes if needed.
- Check backlash value.

Utilisation limits

Checking the deflection under load

Slewing rings are delivered with a preload ensuring proper functioning and optimum safety. During the product life, the preload decreases resulting in a noticeable increase in deflection under load. The bearing must be replaced when the deflection becomes incompatible with the proper functioning of the machine and with the required safety conditions for the type of material used.

Technical Bulletin No. 223

SUBJECT: Replacement of Slewing ring

- Remove forks
- Remove nose cover
- Remove mast – Disconnecting tilt cylinder pins & hoses
- Remove footplate
- Remove 4 screws securing steering column support
- Disconnect hydraulic hoses connecting chassis to hydraulic steering motor and lock valve
- Remove steering column support
- Remove swivel hose bracket
- Disconnect traction motor
- Pull back traction cables through chassis
- Pull back Lift / sideshift / tilt hoses through chassis
- Support front of chassis and under front counterweight
- Remove articulation axle
- Remove axle fabrication / axle / traction motor complete
- Support mast support
- Remove screws securing slewing ring
- Remove mast support/ slewing ring assembly

- Remove slewing ring from mast support
- Clean mounting faces of chassis, mast support and new slewing ring
- Fit new slewing ring to mast support. Use screws grade 10.9. M12 x 75. Torque screws to 120Nm in 'Star' sequence.

- Using an angle grinder fitted with cutting disc, carefully remove the Steer motor mounting block from the chassis.
- Ensure that the area of the chassis where the steer mounting block is located is flat, smooth and square. Remove any remaining weld.
- Remove any remaining weld from periphery of mounting block and ensure mounting faces are flat, smooth and square.
- Clean area thoroughly to remove grinding debris

- Lift mast support into place under chassis. Note: Blanked hole of inner ring should be aligned with truck centreline nearest to operator.
- Fit retaining screws M12 x 70 and torque to 120Nm in 'Star' sequence. Grade 10.9

- Separate the hydraulic steer motor from the steer extension
- Attach steer extension to mounting block. Torque approx 40Nm
- Place a piece of 0.10mm shim steel between the 2 teeth of the slewing ring on the centreline of the chassis (retain with a small quantity of grease)
- Locate the steer extension in the appropriate aperture in the chassis and move forward until 1 tooth is firmly in engagement with the slewing ring via the piece of shim. Check that mounting block is flat on the chassis.
- Tack weld mounting block in place ensuring that Steer extension is square to chassis.
- Remove steer extension and fully weld mounting block. (6mm fillet weld)
- Lubricate motor shaft with 'copperslip' prior to assembly. Fit hydraulic steer motor and steer extension. Torque screws to 145Nm.
- Remove and discard shim.

- Re-assemble Axle fabrication assembly, Articulation shaft, Steering column support, covers etc as a reverse of the disassembly procedure.

Lubricate slewing ring / Pinion with grease

Mast Support Assembly

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

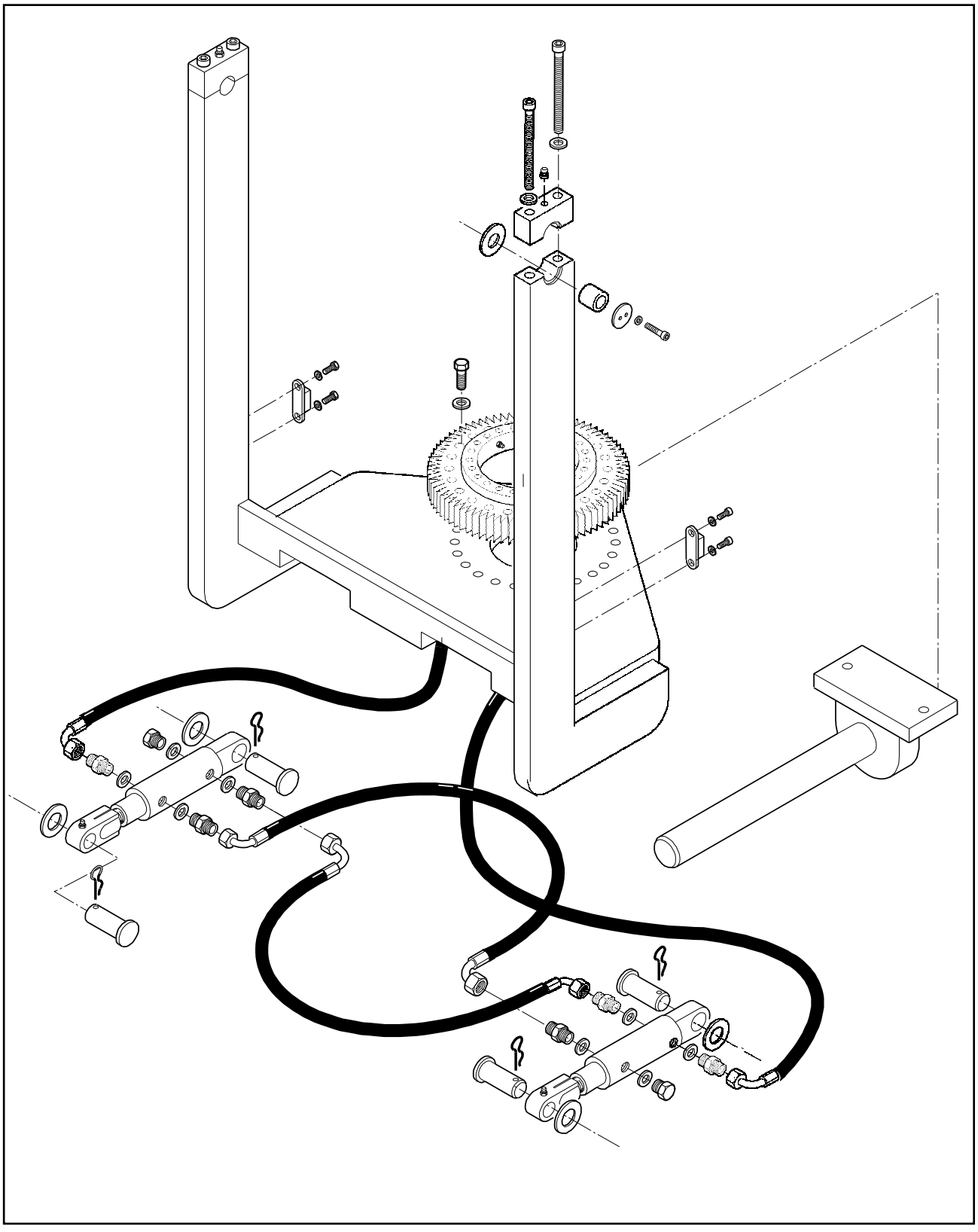


Figure D1

Mast Support Assembly

Pivot Shaft

Removal

To remove the pivot shaft, first remove the mast as described in Section J.

Turn the truck front section to one side to allow access to the pivot shaft.

Remove the fixings holding the pivot shaft assembly in position.

Place lifting chains or sling around chassis and allow to just take the weight.

Refitting

Refitting is a reversal of the removal instructions but first ensure that all the pivot shaft locating rings are aligned.

Pivot shaft fixing screws should be tightened to a torque of 325-360Nm.

Rear Wheel Assembly

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

Rear Wheel Assembly

Removal

1. Jack up truck and, if necessary, chock wheels. Release handbrake and slacken off brake adjustment.

2. Remove grease cover.

3. Disengage tab of lockwasher from locknut and remove locknut.

4. Ease wheel assembly off shaft.

Overhaul

1. Remove seal. If the seal is to be re-used take great care not to damage it during removal.

2. Remove bearing outer races.

3. Fit new outer races into wheel. Ensure that they are fully inserted into wheel.

4. Grease up inner bearing and fit into wheel. Fit seal taking care not to damage it. (Or refit original seal if it is re-usable).

5. Offer wheel assembly to stub axle and push on until fully seated. Grease small bearing and insert into wheel assembly.

6. Secure wheel assembly by fitting locking nut and washer. Tighten locknut sufficiently to take up all free play in the bearings, Secure the washer to the locking nut with fixing screw.

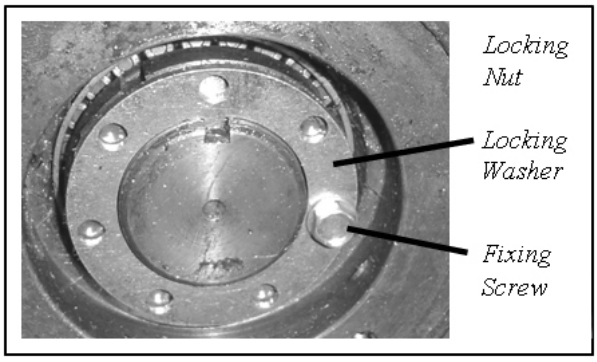


Figure E1

7. Fit grease cover to wheel and secure with M6 x 12 counter sunk head screws.

8. Repeat the above, if necessary, for the remaining wheel.

Adjusting Brakes and Handbrake

Master Cylinder

To set cylinder you must achieve small amount of free play (2mm in the push rod) by screwing cylinder push rod into brake pedal push rod. When amount of free play is set, tighten up locknut.

Bleeding Brake Pipes

Fill reservoir with DOT4 brake fluid, pump several times, immerse cylinder, open bleed point and prime left and right cylinders, then lock off bleed points. Next pump test pedal to ensure brake mechanism.

Drum Brakes

Before adjusting drum brakes, ensure handbrake adjustment is slack. Next jack up chassis off floor, work through wheel clearance hole follow the instructions – **Adjusting Brake Shoes**.

Handbrake Cables

Adjust handbrake cables to allow two clicks free movement at handbrake lever, then lock off nuts.

Adjusting Brake Shoes

Full Setup Procedure

1. Release the handbrake lever and release any tension on the handbrake cables.

2. Check for ~2mm free play on the brake master cylinder pushrod.

3. Check the brake fluid reservoir is at the correct level (Fill with DOT4 if low)

4. Check for correct operation of pedal & master cylinder.

5. Check thoroughly for fluid leaks.

6. Jack one rear wheel clear of the ground

7. Remove rear wheel.

8. Inspect the inner braking surface of the wheel & check for burnishing or oil contamination. Remove any glazing present by rubbing with coarse emery cloth.

9. Inspect the friction material on the shoes for oil contamination. If contamination is present, replace the shoes. Remove any glazing with coarse emery cloth.

10. Disassemble the brake shoes & springs.

11. Loosen the hexagonal bolt on the rear of the backplate.

12. Set dimension “A” to 79mm by turning each side of the adjuster. Ensure that both sides are equal (dimension “B”).

    NB: Each end is unscrewed a different amount.

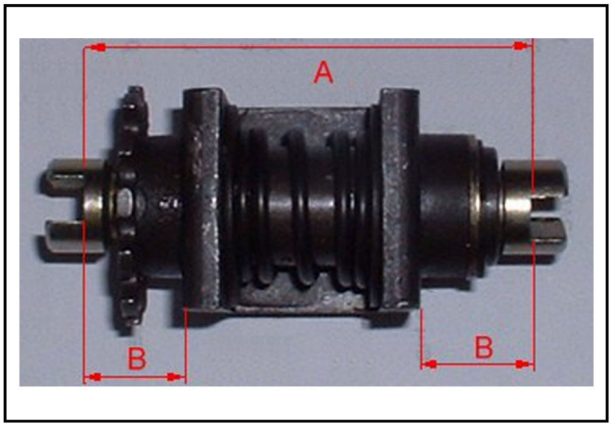


Figure E2

13. For easiest setting, use the ‘Brake Setting Gauge’ available from Narrow Aisle Ltd. This should fit snuggle at each end and either side of the central bracket.

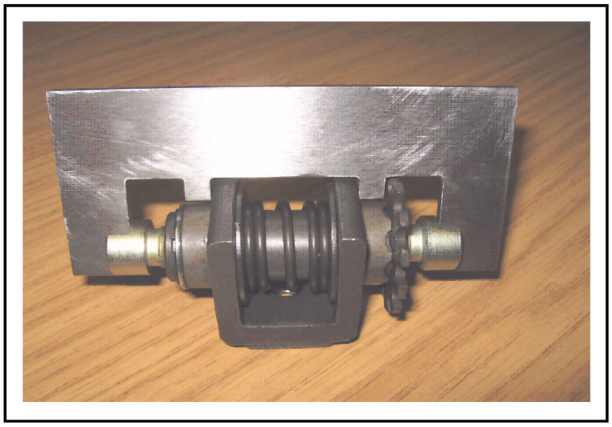


Figure E3

14. Assemble the brake shoes & springs. Apply a thin smear of ‘Copper slip’ to the sliding faces.

    NB: Do not use excessive amounts, as this will contaminate the friction material.

15. Fit the wheel according to the procedure. Ensure that the drum face is clean and oil seal is located correctly.

16. Tighten the star wheel by inserting a screwdriver through the access holes in the rear wheel until the wheel can no longer be turned freely.

17. Tighten the hexagonal bolt on the rear of the backplate ensuring that the adjuster does not swivel.

18. Back off the star wheel by ~6 clicks.

19. Operate the brakes a few times before checking that the wheel can turn freely. Check that the clearance between the shoes and the drum is equal on each sude (approx 0.2mm).

20. Repeat steps 6 to 19 for the other wheel.

21. Adjust the brake cable tension at the pendulum lever to remove the slack. Check that the wheels can still turn freely.

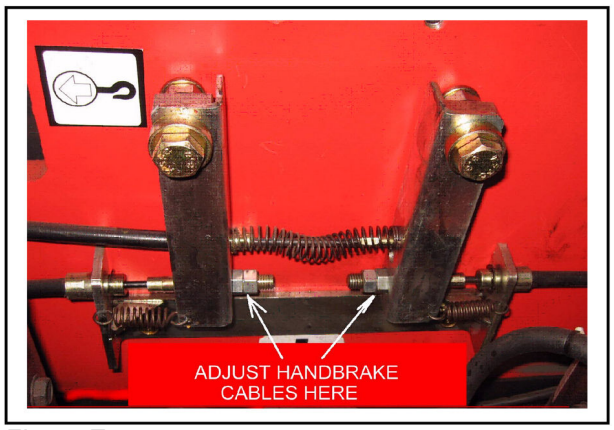


Figure E4

22. The cables should have equal tension.

23. Check the operation of the brake pedal switch (it should operate as brakes just start to make contact with the brake drum – adjust if necessary).

24. Check the operation of the handbrake.
    3 clicks – Brakes start to operate
    6 clicks – Wheel locked
    9 clicks – maximum travel

25. Lower the wheels to the ground.

26. Check for the correct operation of both hand & foot brakes during travel in both the forwards and reverse directions.

27. The brakes may need a small amount of ‘bedding in’ before full efficiency is reached.

Brake Setting Procedure at Service

1. Release the handbrake lever and release any tension on the handbrake cables.

2. Check for ~2mm free play on the brake master cylinder pushrod.

3. Check the brake fluid reservoir is at the correct level (Fill with DOT4 if low)

4. Jack one rear wheel clear of the ground.

5. Using a screwdriver, via the access holes in the rear wheels, adjust the star wheel adjuster to give 0.2 – 0.25mm clearance between the brake shoe and drum. Check clearances at the lower end of the brake shoe. (locations “A”)

   NB: Clearances *must* be equal. If not, follow the full setup procedure

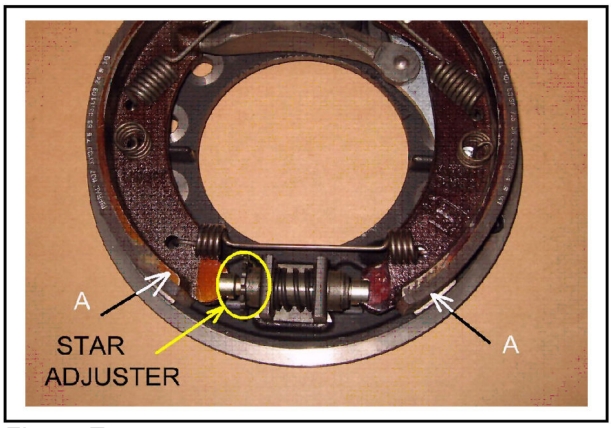


Figure E5

6. Adjust the brake cable at pendulum lever to remove slack. Check that the wheel can still turn freely.

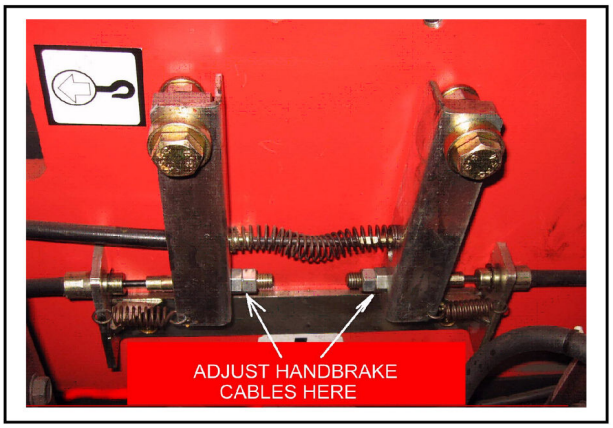


Figure E6

7. Repeat for the other wheel. Cables should have equal tension.

8. Check the operation of the brake pedal switch (it should operate as brakes just start to make contact with the brake drum – adjust if necessary).

9. Check the operation of the handbrake.
   3 clicks – Brakes start to operate
   6 clicks – Wheel locked
   9 clicks – maximum travel

10. Lower the wheels to the ground.

11. Check for the correct operation of both hand & foot brakes during travel in both the forwards and reverse directions.

If the above sequence does not restore full braking efficiency, then a full setup is required.

This Page is Intentionally Left Blank

Parking Brake System

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

Parking Brake System

Handbrake lever

Access to the handbrake lever is gained by removing the cover as outlined in Section K Seat and covers.

Limit switch replacement

1. Unscrew the two M4 self tapping screws holding switch in place and withdraw switch.
2. Disconnect wires from switch.
3. Refitting is a reversal of the above.
4. Adjust switch so that the electrical contact is made when the handbrake is fully released.

Removal

1. Unscrew adjuster until enough free play in the cable is apparent and undo the M10 x 35 mm hex. head bolt securing the cable to the lever.
2. Undo the two M10 fasteners securing the lever to the spool valve mounting bracket and withdraw the lever.
3. Refitting is the reversal of the above instructions. When the cable is attached, screw the adjuster up until the top of the adjuster is level with the top of the plate.
4. Adjust the brakes in accordance with the instructions given in Section E Rear wheel assembly.

Handbrake cables

The handbrake cables are made in three sections:

One cable runs from the handbrake lever behind the spool valve assembly to the handbrake linkage.

Two cables then run from the handbrake linkage one down each side of the electrical panel.

To gain access to the handbrake linkage and cables to wheels, remove rear cover and lift up seat pan.

Removal

Cable from Lever to Linkage

1. Slacken handbrake lever to eliminate tension in cable.
2. Remove bolt securing cable to lever.
3. Pull up handbrake lever to improve access to adjuster and unscrew adjuster completely.
4. Slide the cable out of the slot in the handbrake lever bracket.
5. Undo the nuts securing the left hand cable to the handbrake linkage.

Note: The nut that is fitted to the cable first, i.e. the one in contact with the handbrake linkage, has a dome end which is fitted towards the linkage.

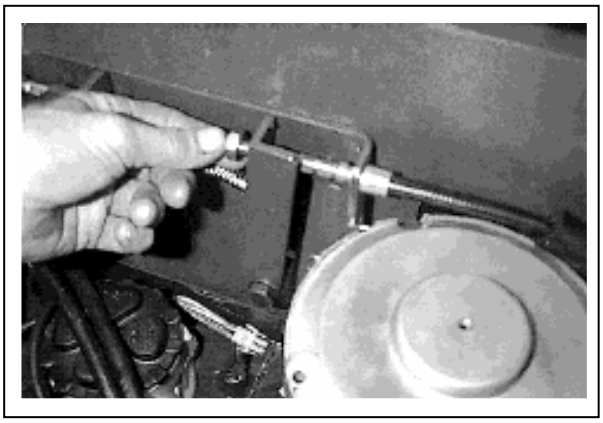


Figure F1

6. The handbrake linkage is now free to move.
7. Fold the arm in sufficiently to allow the cable to be withdrawn.
8. Remove the nipple on the end of the cable from the slot in the handbrake linkage.
9. Withdraw the spring from the cable.
10. Withdraw the cable.

Replacement of the cable is the reversal of the above instructions.

Adjust cables to correct adjustment, see section E.

Cable from Linkage to Brakes

1. Remove nuts securing cable to handbrake linkage. (If not already done so).

2. Remove wheel as described in Section E Rear wheel assembly.

3. Remove the brake shoe that is nearest the rear of the truck, i.e. on the left hand wheel remove the right hand shoe and vice-versa.

4. Unhook the cable eye from the lever on the brake shoe and withdraw cable. (It may be advisable to attach a drawstring, piece of wire, etc., to the cable eye prior to withdrawing it.

Hydraulic System

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

General Precautions

Before performing maintenance on the truck, it should be taken to an area set aside for maintenance or where there is adequate space to perform the required work. This is a must to insure the safety of others and to insure that proper maintenance is performed on the unit.

1. ALWAYS ensure that the recommended maintenance procedures are performed at the specified intervals.

2. ALWAYS ensure that only qualified, authorised personnel maintain, repair, inspect, and adjust the truck.

3. ALWAYS ensure that any lifting or jacking equipment to be used is of the correct capacity and in good condition.

4. ALWAYS ensure that when using lifting equipment to the truck, the specified truck lifting points are utilised.

5. ALWAYS ensure the truck is positioned on a firm, level surface when jacking-up the truck.

6. ALWAYS disconnect the battery at the connector before working on the truck. DO NOT pull the cables attached to the connector.

7. ALWAYS refer to the applicable procedure when undertaking maintenance and overhaul operations.

8. NEVER guess or assume polarity or connections of the truck electrical system. Refer to the truck wiring diagram.

9. NEVER guess or assume hydraulic connections. Refer to the truck circuit diagram.

Note: The truck is designed and manufactured to operate to accepted safety standards. To ensure these standards are maintained, the truck must not be operated with safety devices inoperative, or with modifications and alterations (including removal of any parts) that do not have prior written approval from the manufacturer, Narrow Aisle Ltd.

General Description

The Hydraulic system comprise of two systems:

- Lift, Tilt and auxiliary hydraulics.
- Steering control hydraulics.

Lift tilt and aux. hydraulic system is powered by an engine driven pump which supplies the hydraulic pressure.

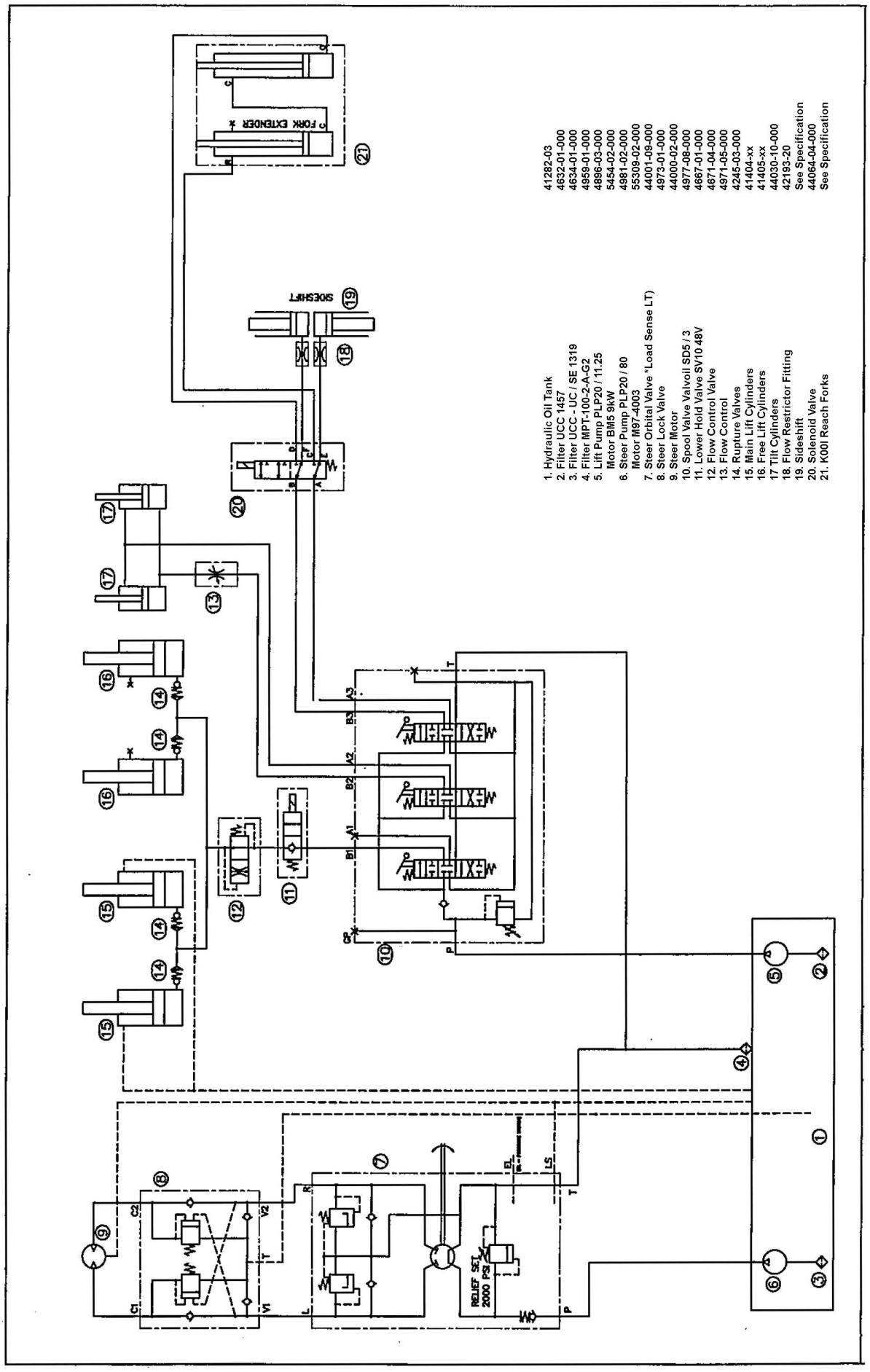
The following is a general description of the systems shown in the hydraulic schematic diagrams in Figure G1 (Your truck may vary - see appropriate hydraulic schematic diagram supplied with the truck).

Lift and Tilt System

Refer to figure G1

A 100 micron filter (Item 2) mounted inside the reservoir-tank (Item 1) strains the oil as it enters the suction line of the hydraulic pump (Item 5). Pressurised oil from the pump flows through the spool valve (Item 10) that contains integral raise- lower valves, tilt and auxiliary valves and a relief valve back to reservoir tank through a 25 micron filter (Item 4). Operation of the lower hold valve (Item 11) allows controlled oil to pass through the pressure control valve (Item 12) to the lift cylinder (Item 15). Operation of the tilt valve (Item 17) allows controlled oil to pass though a flow control valve (Item 13) to the tilt cylinders (Item 17). The relief valve, contained in the spool valve (Item 10) limits the maximum load that can be lifted or tilted. (There is provision in the spool valve for auxiliary hydraulics and works the same as the tilt operation)

Lowering is controlled by the spool valve (Item 10) and pressure compensated flow control valve (Item 12) to provide a controlled lowering speed. This can only be controlled when the lower hold valve (Item 11) is energised (switch in the seat). Mounted in the base of lift cylinder is a velocity fuse which will stop lowering, should an accidental break of the hydraulic line occur causing uncontrolled lowering. The return flow of oil is filtered through the 25 micron filter (Item 4) before it is returned to the reservoir tank (item 1).


1. Hydraulic Oil Tank 41282-03
2. Filter UCC 1457 4632-01-000
3. Filter UCC - UC / SE 1319 4634-01-000
4. Filter MPT-100-2-A-G2 4959-01-000
5. Lift Pump PLP20 / 11.25 4896-03-000
Motor BM5 9kW 5454-02-000
6. Steer Pump PLP20 / 80 4981-02-000
Motor M97-4003 55309-02-000
7. Steer Orbital Valve *Load Sense LT) 44001-09-000
8. Steer Lock Valve 4973-01-000
9. Steer Motor 44000-02-000
10. Spool Valve Valvoil SD5 / 3 4977-08-000
11. Lower Hold Valve SV10 48V 4667-01-000
12. Flow Control Valve 4671-04-000
13. Flow Control 4971-05-000
14. Rupture Valves 4245-03-000
15. Main Lift Cylinders 41404-xx
16. Free Lift Cylinders 41405-xx
17 Tilt Cylinders 44030-10-000
18. Flow Restrictor Fitting 42193-20
19. Sideshift See Specification
20. Solenoid Valve 44064-04-000
21. K00l Reach Forks See Specification
FORK EXTENDER
SIDESHIFT
RELIEF SET 2000 PSI
LS
P
T

Steering System

Refer to Figure G1

The power steering system pump (item 6) draws hydraulic oil from the reservoir (item 1) through the
100 micron filter (item 3) and supplies pressurised oil to the steering valve (item 7) providing the energy to the steering motor (item 9) via a steering lock valve (item 8).

When the steering valve is turned right or left and hits the stop, a relief valve will bypass the steering valve and dump oil back to the reservoir tank through the 25 micron filter. In addition, the steering lock valve (item 8) will prevent unselected movement of the steering axle.

Steer on Demand

Built into the steering valve (item 7) is a pressure switch any small movement of the steering wheel will select power to the steering system. Any unused hydraulic oil will exhaust to the reservoir (item 1) via the steer priority valve (item 18)

Note: This valve is pre-set by Narrow Aisle Ltd. adjustment should only be made with prior permission.

Before removal of any parts to rectify a hydraulic fault, check the fault finding chart.

CAUTION

The mast, if elevated, must be blocked securely to prevent lowering when performing maintenance on hydraulic components. Be sure all hydraulic pressure has been released from the system.

Lift Cylinder Repair

Two types of cylinders are fitted to the Flexi Generation 3 Gas Truck, piston and displacement.

The main lift cylinders are of the piston type. The free lift cylinder(s) are of the displacement type.

Great care and cleanliness should be exercised in the disassembly and assembly of any hydraulic cylinders.

In order to receive the correct seals it is necessary to advise the parts department of the mast serial number. (MAXXX).

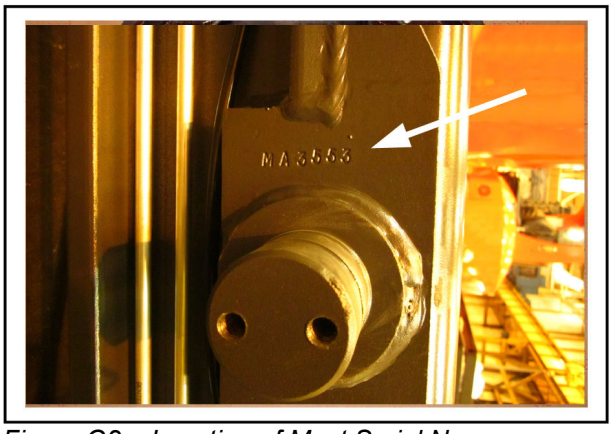


Figure G2 – Location of Mast Serial No.

Piston Cylinder Disassembly and Assembly

Hold cylinder body and unscrew gland counter clockwise from cylinder tube, carefully extract the ram assembly from the cylinder tube, never allowing the ram to come in contact with any sharp edges. The seals used in the cylinders are made of an extremely durable, hard polyurethane material which can be deformed temporarily to allow for installation without permanent damage.

Remove seal and back up ring from piston rod. (Figure G2). Fit new seal and back up ring.

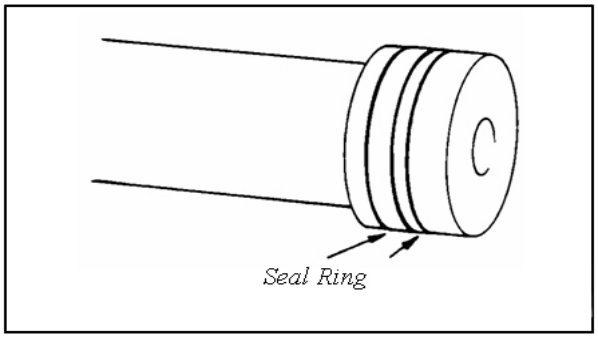


Figure G2

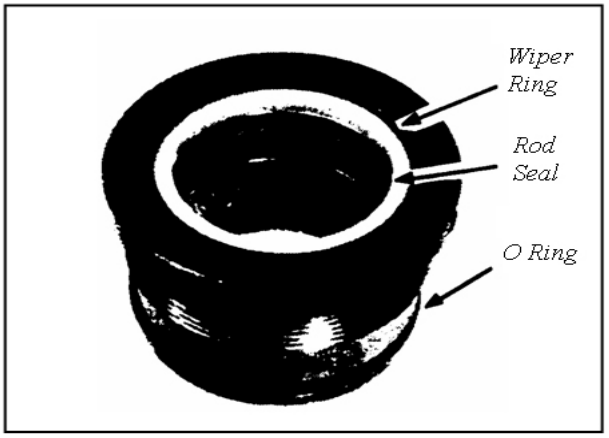


Figure G3

Note: Lubrication of seal for this type of installation is mandatory. Slide piston rod back into cylinder tube carefully.

With the gland removed, discard the wiper ring and rod seal from inside of the gland, remove the 'O' ring from the outside of the gland. Note their positions (Figure G3). Install the new wiper ring and rod seal on the inside of the gland.

Install the new '0' ring on the gland.
Install the gland and tighten.
Re-install cylinder into mast.

Tilt cylinders

Care must be taken when carrying out any work which entails the disconnection of one or more ends of the tilt cylinder(s). A means to ensure that the mast assembly cannot move in an uncontrolled manner must be put into place BEFORE any work is carried out on the tilt cylinder(s).

Tilt cylinder rod end setting

Adjust tilt cylinder rod ends so that with full forward tilt there is 5mm clearance between rear of fork and tyre. Adjust chain anchors to give 5mm clearance between fork carriage and tyre.

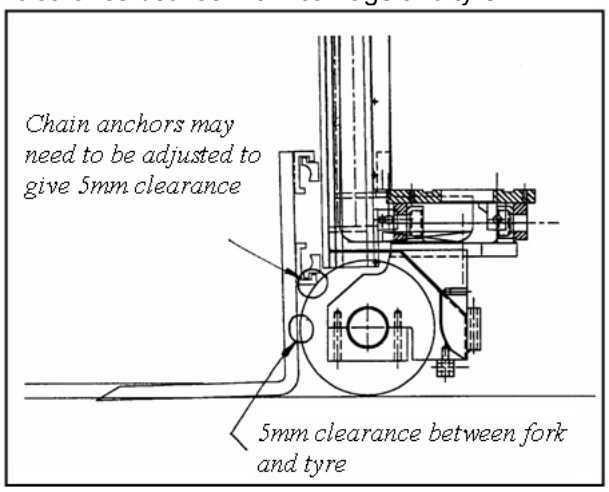


Figure G4

Parts Required

Treaded Cylinder	Seal Kit
End Plug	Piston Seal
Headbush	Gland Seal
Rod	Wiper Seal
Piston	O Ring (headbush)
Locknut	O Ring (spigot)
Inlet Port	

(This kit makes a basic ram less end fittings)

Set Procedure for Basic Ram

Ram is connected to test rig and filled with standard hydraulic ram oil (Shell Telus 27) and pressurised to 3000 PSI. The pressure is held for a period of ten seconds while the seals and welds are checked for leaks. Double acting cylinders are checked for leaks and both the open and closed centres.

Note: No ram testing is done under load.

Removal

Take the weight of the mast on an overhead crane or other lifting mechanism.

1. Unclip the clip on the shaft securing the front of the lift cylinder to the mast.
2. Drive out the shaft via the access hole in the mast support.
3. If necessary, repeat the above for the other cylinder.
4. Use the lifting equipment to lower the mast as far back as it will go and secure the mast to stop it from toppling forward.
5. With the mast out of the way, the cylinder front hose connections are accessible. Undo the hose connection(s) required.
6. Undo the tilt cylinder rear connection(s).
7. Unclip the clip from the shaft securing the rear of the tilt cylinder to the mast support assembly and drive out the shaft.
8. Withdraw the cylinder from the truck.

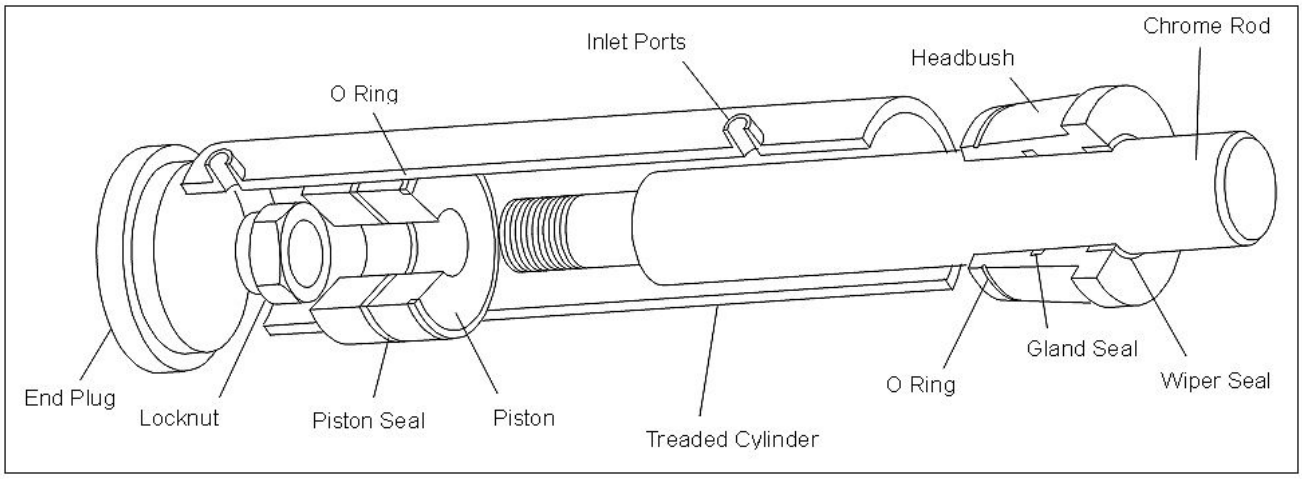


Figure G5

Overhaul

1. Remove the rod end eye from the cylinder rod.

2. Remove the head bush by unscrewing anti-clockwise.

3. Withdraw the rod.

4. Secure the rod in a vice in such a way that the chrome surface will not be damaged during strip down and remove locknut.

5. Remove the piston.

6. Remove and replace the seals as necessary.

7. Reassemble the cylinder by reversing the above instructions.

Note: Ensure that the seals are given a light coating of hydraulic oil before reassembly. Also note, the setting instructions regarding the clearance between the fork carriage and the drive wheels.

Note: Ensure a 5mm clearance between the rear of the forks and the tyre when the mast is tilted forward.

Displacement Cylinder Disassembly and Assembly

Note: Unless the cylinder tube needs replacing it is not generally necessary to remove the entire cylinder for reseal.

Lateral cylinders require the mast section to be raised 200/300 mm.

Unscrew gland anti-clockwise from cylinder tube and remove. With the gland removed, discard the wiper ring and seals from inside of the gland. Remove 'O' ring from the outside of the gland. Note their positions (Figure G3). Install the new seals into the gland and replace the outer '0' ring.

Install the gland into the cylinder tube. Re-assemble in reserve order of removal. Run and test for leaks.

Oil tank

Removal

1. Remove the cover as detailed in Section K Seat and Covers.
2. Raise seat pan.
3. Undo the bolts securing the spool valve assembly to the chassis and move the assembly clear.
4. Remove the handbrake linkage as detailed in
5. Section I Chassis.
6. Disconnect all hoses.
7. Disconnect all cables.
8. Attach lifting shackles to the tank.
9. Remove two M8 setscrews and lift the tank out.

Refitting

Refitting the oil tank to the truck is the reversal of the above instructions.

Filter Replacement

1. Remove filter lid by unscrewing anti-clockwise.
2. Remove retaining spring from locator on top of filter element.
3. Remove filter element from the bowl, using the pull handles on top of the element.
4. Remove spring from inside the replacement element.
5. Grease the O-ring seal in the bottom of the element.
6. Place the element in the bowl, pushing the element down forcing it to locate in the bottom of the bowl.
7. Place spring in locator on top of the element.
8. Replace filter lid ensuring the spring is properly located between lid and element.

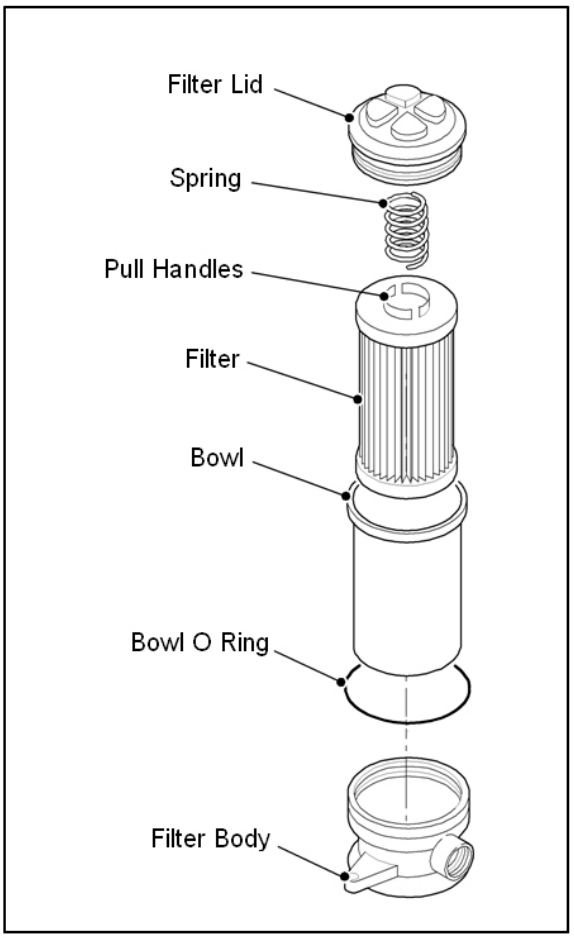


Figure G6 – Filter Replacement

Fault Finding Table

Fault	Possible Cause	Remedy
Noisy Pump	Low oil supply?	Fill oil tank
	Oil too heavy? (i.e. too viscous)	Change to proper viscosity
	Air leak in inlet line?	Check plumbing
	Partly blocked inlet line?	Check for foreign object and clean
Foaming Oil	Pump cavitating?	See remedies for Noisy Pump
	Water in the oil?	Check oil tank
Pump Or Oil Overheating	Oil too thin? (i.e. wrong viscosity)	Change to proper viscosity
	Oil contaminated?	Drain system, replace filters, refill with clean oil.
	Pump cavitating?	See remedies for Noisy Pump
	Pump drive shaft misaligned?	Check alignment
	Pump drive shaft axially loaded?	Check for: Clearance at ends of shafts. Shaft misalignment. Worn drive keys, keyways or splines. Belt alignment (if belt driven.
	System relief valve bypassing?	Check setting and for foreign object.
Low Flow	Pump cavitating?	See remedies for Noisy Pump
	Foaming oil?	See remedies for Foaming Oil
	Relief valve leaking or low setting?	Check setting and for foreign object.
	Speed too low?	Check prime mover speed.
	Oil too hot?	Check temperature, refer above if oil is hot.
Failure To Build Pressure	Defective relief valve?	Check and reset or replace
	Low oil supply	Fill oil tank
	Leakage	Check pressure pipe inside tank

Hydraulic Pump and Motors

The oil tank is designed to allow the removal of one or other of the pump and motor units (lift/tilt or power steer) without the need to disturb the other. Therefore the instructions for removing and overhauling one unit applies to the other, except where stated.

Removal

Whichever pump and motor unit is to be removed for repair or overhaul it is advisable to remove the four nyloc nuts securing the Electrical module to the chassis and move the module forward to increase the access to the oil tank compartment.

1. Remove the cables from the motor.

2. Remove the pressure hose from the bulkhead fitting. If the steer pump and motor is to be removed, remove the tee piece from the filler assembly.

3. Remove the six M6 hex. head screws and washers from the lid of the tank.

4. Prise the lid away from the tank. Although it is advisable to replace the gasket when repair work to the pump and motor units is carried out, take great care not to damage the gasket when the lid is being prised away from tank.

5. Once the gasket is loosened the motor and pump unit can be removed as an assembly. (With the electrical panel moved forward the unit should be capable of being lifted from the tank, however if this is not the case, remove the handbrake cable as described in Section F Parking brake system). When the unit is lifted clear the internal plumbing is lifted too.

Disassembly

1. Undo pressure hose from outlet elbow and suction hose from inlet elbow.

2. Remove four M8 cap head screws and the motor and pump can be separated.

3. Remove the inlet and outlet elbows after first noting which is the inlet and which is the outlet.

4. Remove the nut holding the serrated drive in place.

5. Remove the serrated drive.

6. For instructions on how to overhaul the pump, see separate section.

Assembly

1. Attach serrated drive to pump. Make sure shaft on pump is clear of grease and debris and that the woodruff key is in place. Then secure serrated drive with spring washer and nut provided, torque up to 55Nm. Remove plastic plugs from pump ports.

2. Fit 1/2" BSP cast flanged elbows to opposite sides of pump facing down from serrated drive and secure with spring washers and bolts provided.

3. Fit 3/4" BSP cast flanged elbow to appropriate port on lift pump, secure with bolts and spring washers provided. Then fit
4. 1/2" BSP cast flanged elbow to opposite side of pump, both elbows facing down from serrated drive.

5. Position oil tank lid on top of motor and line up in relevant position. Fit pump on top of motor and lid, smear copper slip on serrated drive and push into position. To secure motor to lid and pump use four M8 x 40 skt head bolt, four M8 spring washers, and to seal put Loctite RTV silicone gasket maker round the pump.

Lift Pump and Motor Assembly

1. Fit 3/4" BSP - 3/4" BSP M/M adaptor and 3/4" Dowty seal into 3/4" cast flanged elbow on lift pump and fit 1/2" BSP - 1/2" BSP M/M adaptor and 1/2" Dowty seal into 1/2" cast flanged elbow.

2. Fit hose assembly No. 10 to 1/2" adaptor on lift pump and secure in place, attach opposite end to bulkhead fitting and tighten.

3. Fit hose assembly No. 12 to 3/4" BSP adaptor on lift pump and secure. Attach 1" BSP - 3/4" BSP M/M adaptor to opposite end of pipe with a 1" BSP Dowty seal. Fit new filter to 1" BSP end of adaptor and tighten.

Steer Motor and Pump Assembly

1. Position oil tank lid on top of motor and line up in relevant position. Fit pump on top of motor and lid, smear copper slip on serrated drive and push into position. To secure motor to lid and pump use four M8 x 40 skt head bolt, four M8 spring washers, and to seal put Loctite RTV silicon gasket maker round the pump.

2. Fit a 3/8" BSP - 1/2" BSP M/M into right hand side 1/2" BSP elbow (as you look at
3. assembly motor bulkhead fitting on left) with one 1/2" BSP Dowty seal.

4. Fit hose assembly No. 9 to 3/8" BSP end of adaptor and other end to bulkhead fitting and tighten.

5. Fit 3/4" BSP - 1/2" BSP M/M to the left over port with 1/2" BSP Dowty seal.

6. Fit hose assembly No. 11 to adaptor, on the other end attach 3/4" BSP - 1/2" BSP M/M adaptor and 1/2" Dowty seal. Fit new filter.

Replacement

Replacement of the unit is the reversal of the removal instructions.

Note: If the gasket has been damaged during the removal process, fit a new gasket and seal with RTV silicon gasket maker (both sides of gaskets).

Spool valve

The O-rings on the spool valve shafts can be replaced with the spool valve in-situ. For more detailed overhaul the spool valve should be removed.

Removal

Gain access to the spool valve by removing the lever knobs, the spool valve cover and the front electrical cover.

The hoses to the spool valve are numbered and should be connected to their relevant port.

1. With the power off, operate each hydraulic lever to remove the pressure within that particular system.

2. Disconnect all the hoses and check to make sure that the numbers are still attached to each hose. If the number is absent, mark each hose in such a way that it can be easily identified for connection to the correct port later.

3. Unscrew the two M3 cap head bolts securing the spool valve microswitch to the bracket.

4. Unscrew the three M8 cap head screws securing the spool valve to the mounting plate and withdraw.

5. Overhaul or replace the spool valve as required.

6. Refitting is the reversal of the removal instructions.

Replacing the spool valve O-rings

1. Gain access to the spool valve as described above and release the pressure in the hydraulic system to be repaired.

2. Remove the microswitch.

3. Remove the shaft connecting all the spool valves to the microswitch.

4. Remove the top and bottom caps of the spool valve to be resealed, fit new O-rings and replace the caps.

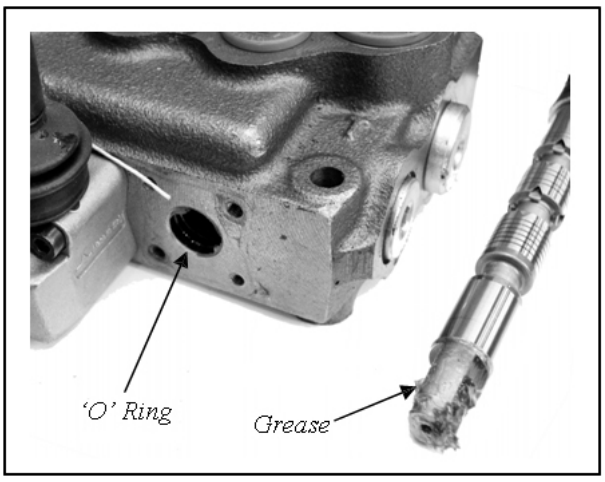


Figure G7 – Spool Valve

5. Reverse items 1 - 3 above to reassemble the spool valve. Check the adjustment of the microswitch and adjust if necessary.

Note: Grease the lever box and lubricate O-rings before application.

6. Ensure lower cross shaft and microswitch operate freely.

Lower hold valve

The lower hold valve is located on the bottom right hand side of the spool valve module.

Removal

1. Disconnect hydraulic hoses on hold valve.
2. Disconnect cables to hold valve solenoid.
3. Unscrew nut from coil securing the coil onto the hold valve and withdraw the hold valve.

Overhaul

1. Unscrew cartridge from body.
2. Unscrew working parts of cartridge from the head of the valve.
3. Clean the components with paraffin and flush with clean paraffin.

Note: Do not use thinners to clean the components of the lower hold valve as the seals within the valve may be damaged.

4. Reassemble lower hold valve.
5. Test. If the test is unsuccessful the complete unit will have to be replaced.

Refitting

Refitting is the reversal of the removal instructions.

Flow regulator

The flow regulators are located underneath the spool valve on the spool valve module.

Removal

1. Disconnect hose from bulkhead fitting at the rear of the spool valve module.
2. Disconnect remaining hose from flow regulator.
3. Undo bulkhead fitting locknut and withdraw regulator.

Overhaul

1. Undo the grubscrew.
2. Remove pin.
3. Unscrew cap.
4. Clean out body and needle valve.
5. Reassemble and test.

Refitting

Refitting is the reversal of the removal instructions.

Hydraulic pump

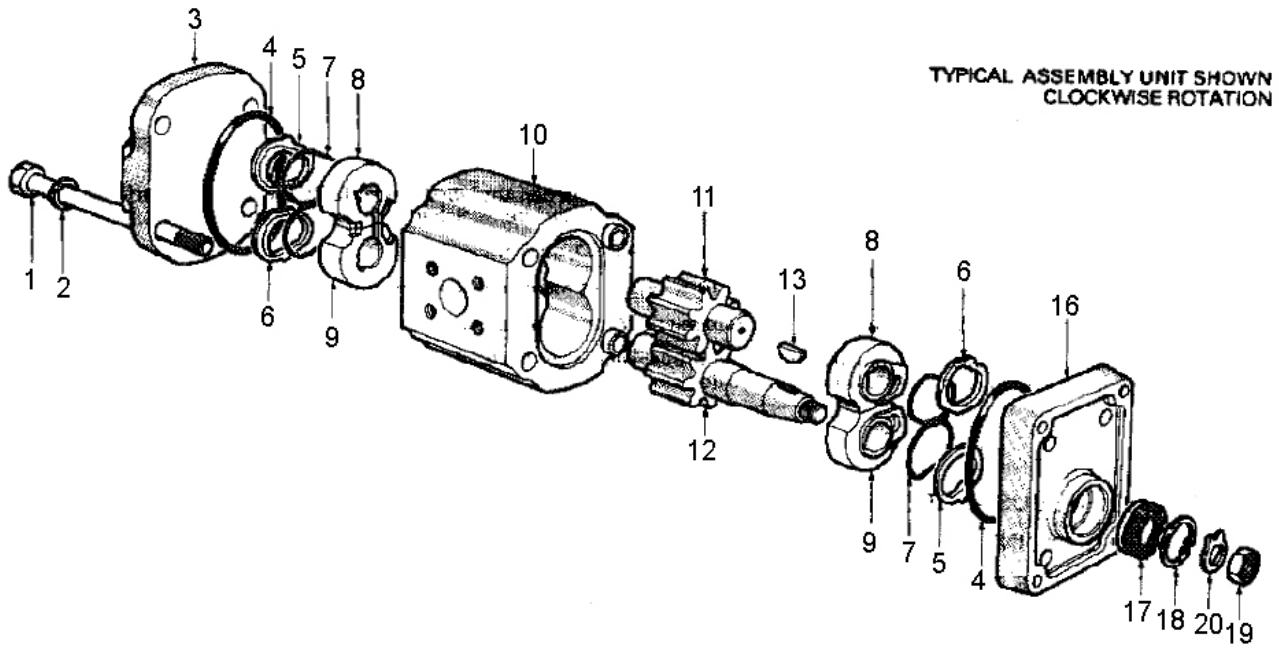
Hydraulic pumps are of the same 'whisper' low noise type.

It is recommended that all seals are changed as a matter of good practice. Units should not be dismantled any further than indicated. The arrangement of the gears and bushes relative to the body determine the direction of rotation and must not be disturbed.

Disassembly of the pump is not recommended. Exchange units are available from Narrow Aisle.

Item No.	Description
1.	Bolt
2.	Spring washer
3.	End cover
4.	Body 'O' ring*
5.	Backing ring*
6.	Backing ring*
7.	Bush lobe seal*
8.	Bush (matched pair)
9.	Bush (matched pair)
10.	Body
11.	Driven gear
12.	Drive shaft taper
13.	Woodruff key*
14.	Square key (not shown)*
15.	Circlip (not shown)*
16.	Mounting flange
17.	Shaft seal*
18.	Circlip (motor only)*
19.	Nut*
20.	Tab washer*
21.	Assembly sleeve (not shown)
22.	Mylar assembly sleeve (not shown)*

*Items comprise standard seal kits.



Seal change procedure

Before dismantling ensure that the unit, bench and tools are thoroughly clean.

1. Where applicable withdraw the drive coupling from the shaft using a suitable puller. The coupling must not be levered or hammered off the shaft as this will result in internal damage.

2. Remove the key and the wire circlip (15), (where fitted) from the drive shaft (12)

3. Lightly mark the end cover, body and mounting flange (3, 10 and 16) to ensure reassembly in the correct position.

4. Remove bolts, keeping the unit together stand it on the end cover, drive shaft uppermost.

5. Remove mounting flange, body 'O' ring, backing rings and bush lobe seal. Replace with new seals ensuring that backing rings are correctly fitted.

6. Remove circlip (18) when fitted and push shaft seal/seals squarely out of the mounting flange taking care not to damage any sealing surfaces. Ensure there are no burrs or scoring present in the seal bores and that threaded holes are clean and dry.

7. Push shaft seal(s) squarely into recess in the mounting flange with the garter spring facing in towards the pump. If the seal recess is scored then Loctite hydraulic sealant must be applied to the outer diameter of the replacement seal(s) to prevent leakage. Apply a coating of high melting point grease between the lips of the shaft seal for lubrication. The circlip should be replaced where fitted.

8. Fit the shaft sleeve assembly tool (21) or Mylar sleeve supplied with the seal kit, to the drive shaft.

9. Carefully refit the mounting flange (16) to the body (10), sliding it over the shaft sleeve tool (21) and fitting it squarely onto the body. If the mounting flange is not fitted squarely the nylon backing rings may become misplaced and trapped, resulting in internal damage if the unit is run in this condition.

10. Holding the whole unit together carefully turn it over, making sure it is supported on the mounting flange not the shaft.

11. Remove the end cover (3), backing rings (5 & 6), bush lobe seal (7) and the body 'O' ring (4) replace with new seals ensuring that backing rings are correctly fitted.

12. Fit the end cover, taking care not to dislodge the backing rings and bolt the unit together. Torque the bolts to 46 - 51.5 Nm.

13. Pour a small amount of oil into a 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.

14. Where applicable, refit wire circlip and key to the shaft.

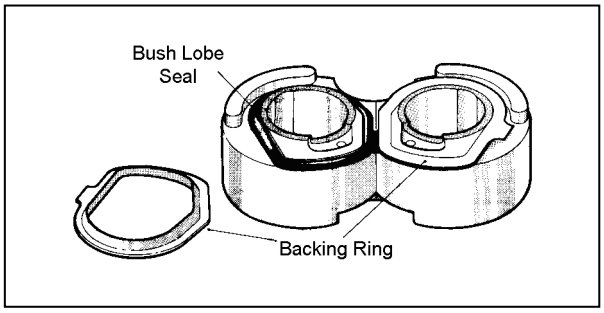
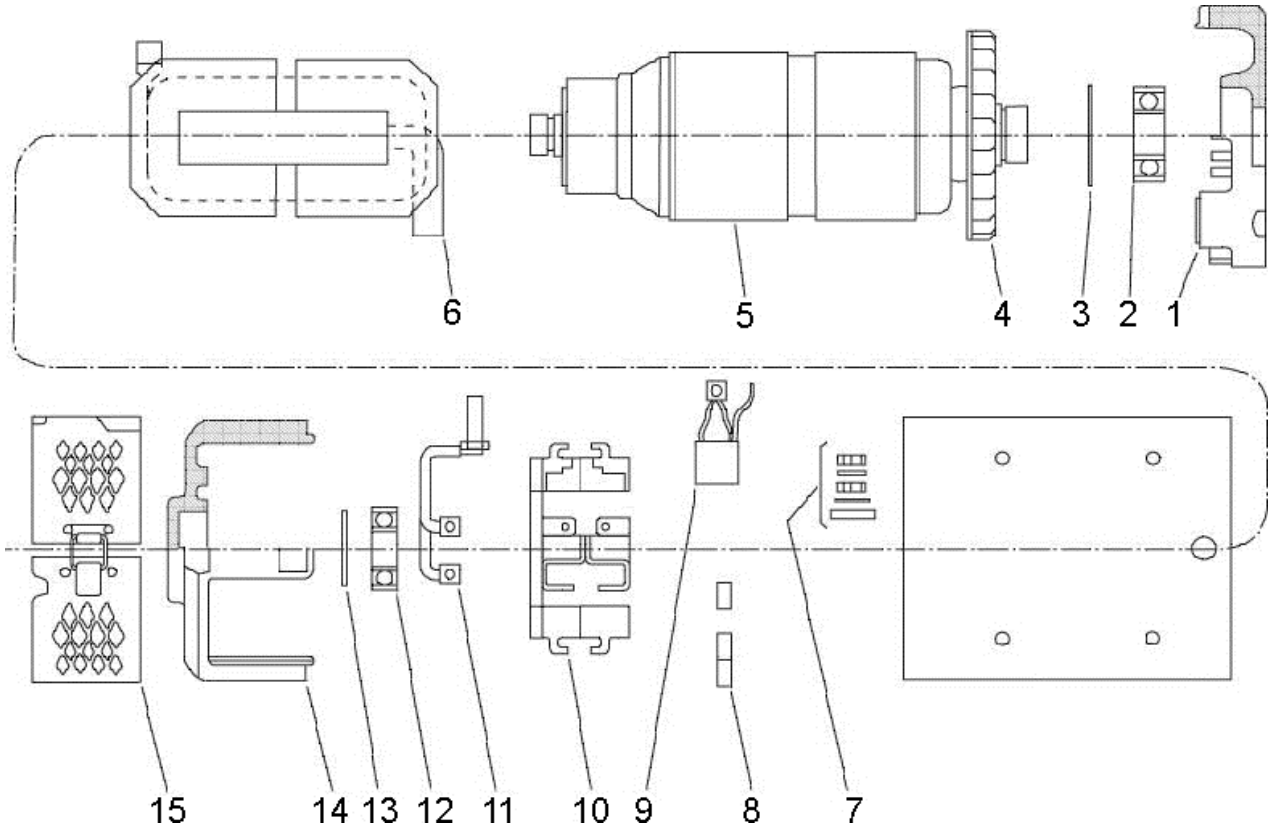


Figure G8

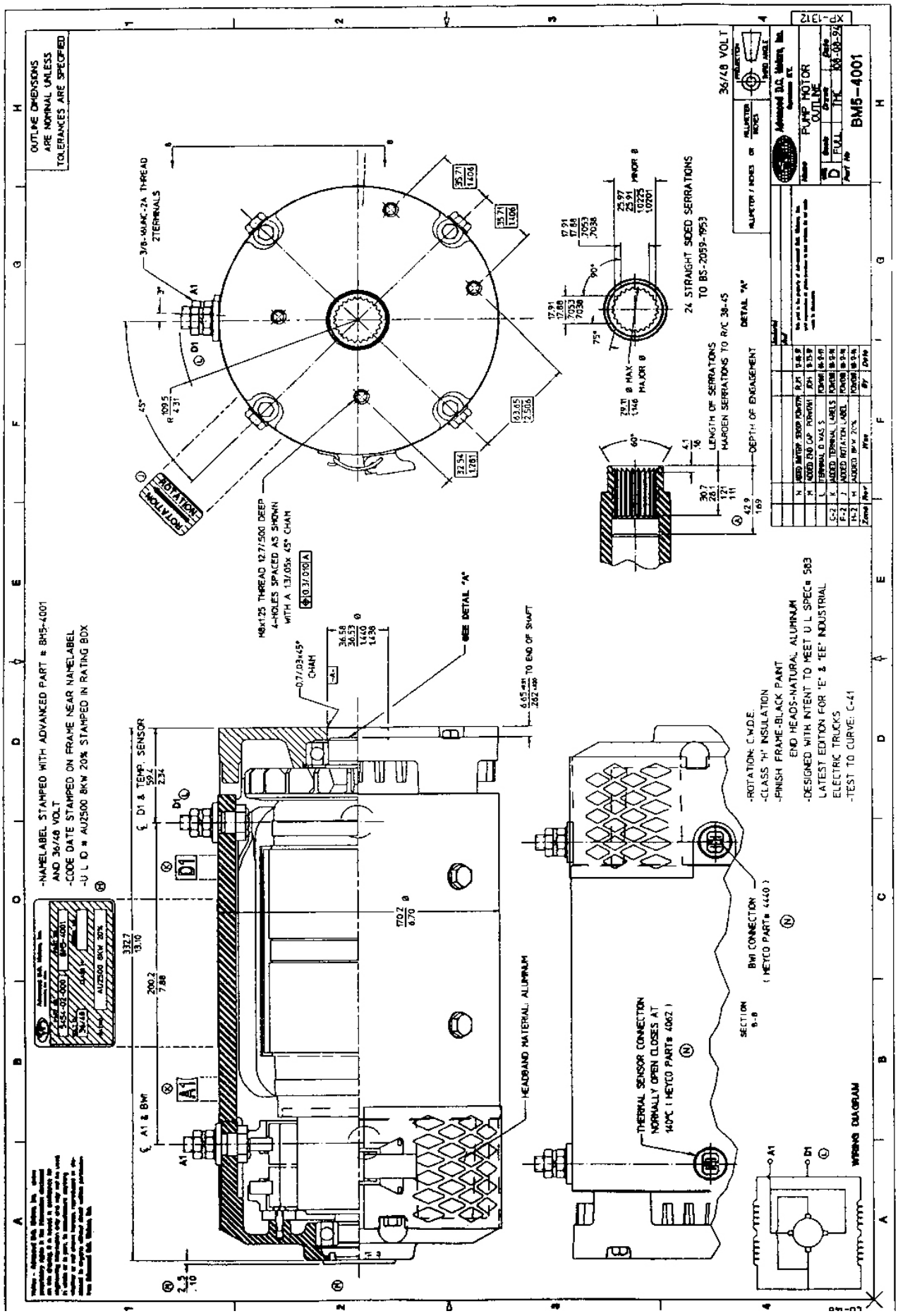
Lift Motor Parts Breakdown



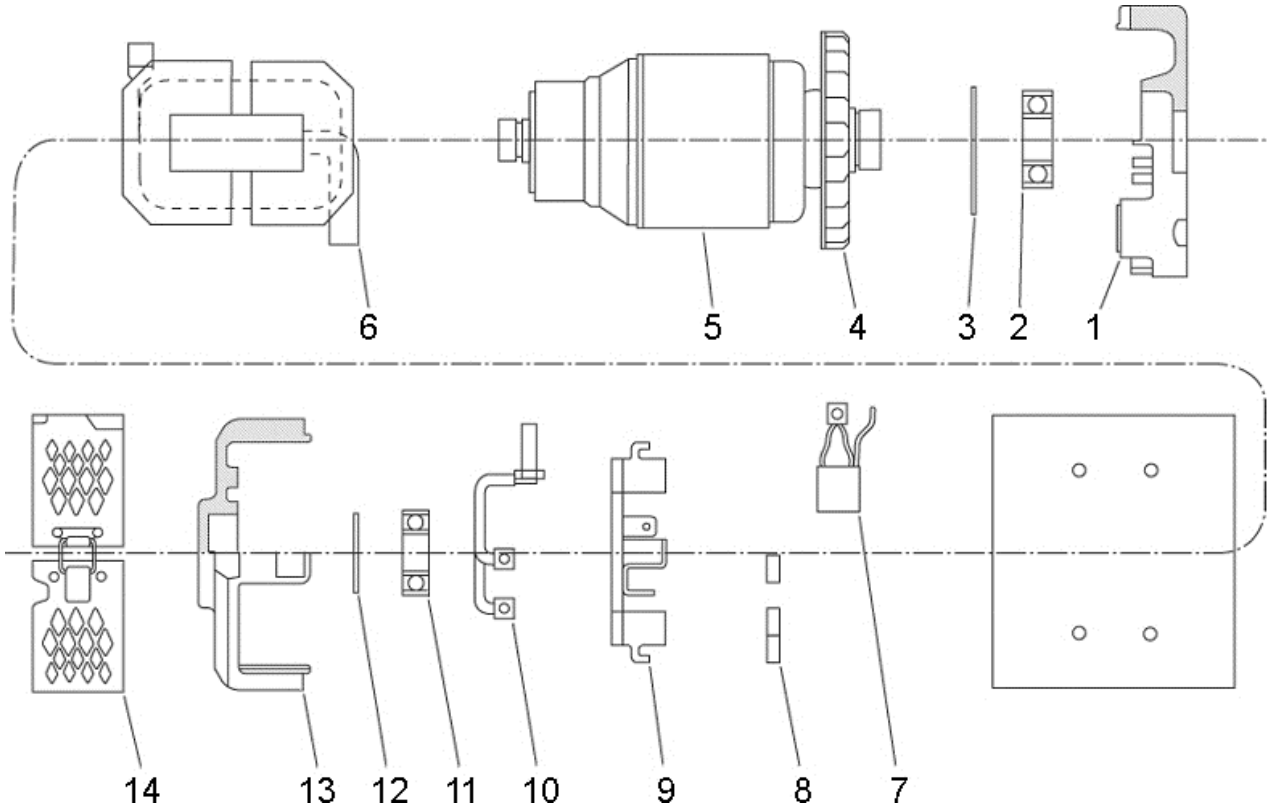
Parts Breakdown **Motor # BM5-4001**

Item No.	Description
1.	Drive Endhead
2.	Bearing
3.	Snap Ring
4.	Fan
5.	Armature & Fan Assembly
6.	Field Coil Kit
7.	Field Coil Kit
8.	Brush Spring
9.	Brush
10.	Brush Box Assembly
11.	Brush Lead Assembly Kit
12.	Bearing
13.	Wavy Washer
14.	Commutator Endhead
15.	Headband Assembly (M)

For Narrow Aisle part numbers contact **Narrow Aisle Parts Department**.


OUTLINE DIMENSIONS ARE NOMINAL UNLESS TOLERANCES ARE SPECIFIED
-NAMELABEL STAMPED WITH ADVANCED PART # BM5-4001 AND 36/48 VOLT
-CODE DATE STAMPED ON FRAME NEAR NAMELABEL
-U L ID # AU2500 BKW 20% STAMPED IN RATING BOX
3/8-16UNC-2A THREAD 2TERMINALS
ROTATION SHOWN FOR CW
M8x1.25 THREAD 12.7/.500 DEEP 4-HOLES SPACED AS SHOWN WITH A 13/.05x 45° CHAM
SEE DETAIL "A"
24 STRAIGHT SIDED SERRATIONS TO BS-2059-1953
LENGTH OF SERRATIONS HARDEN SERRATIONS TO R/C 38-45
DEPTH OF ENGAGEMENT
DETAIL "A"
36/48 VOLT
D1 & TEMP. SENSOR
A1 & BWI
HEADBAND MATERIAL: ALUMINUM
THERMAL SENSOR CONNECTION NORMALLY OPEN CLOSES AT 140°C (HEYCO PART# 4062)
BWI CONNECTION (HEYCO PART# 4440)
SECTION B-B
-ROTATION: C.W.O.E.
-CLASS "H" INSULATION
-FINISH FRAME-BLACK PAINT
END HEADS-NATURAL ALUMINUM
-DESIGNED WITH INTENT TO MEET U.L SPEC# 583 LATEST EDITION FOR "E" & "EE" INDUSTRIAL ELECTRIC TRUCKS
-TEST TO CURVE: C-41
WIRING DIAGRAM
PUMP MOTOR OUTLINE
BM5-4001

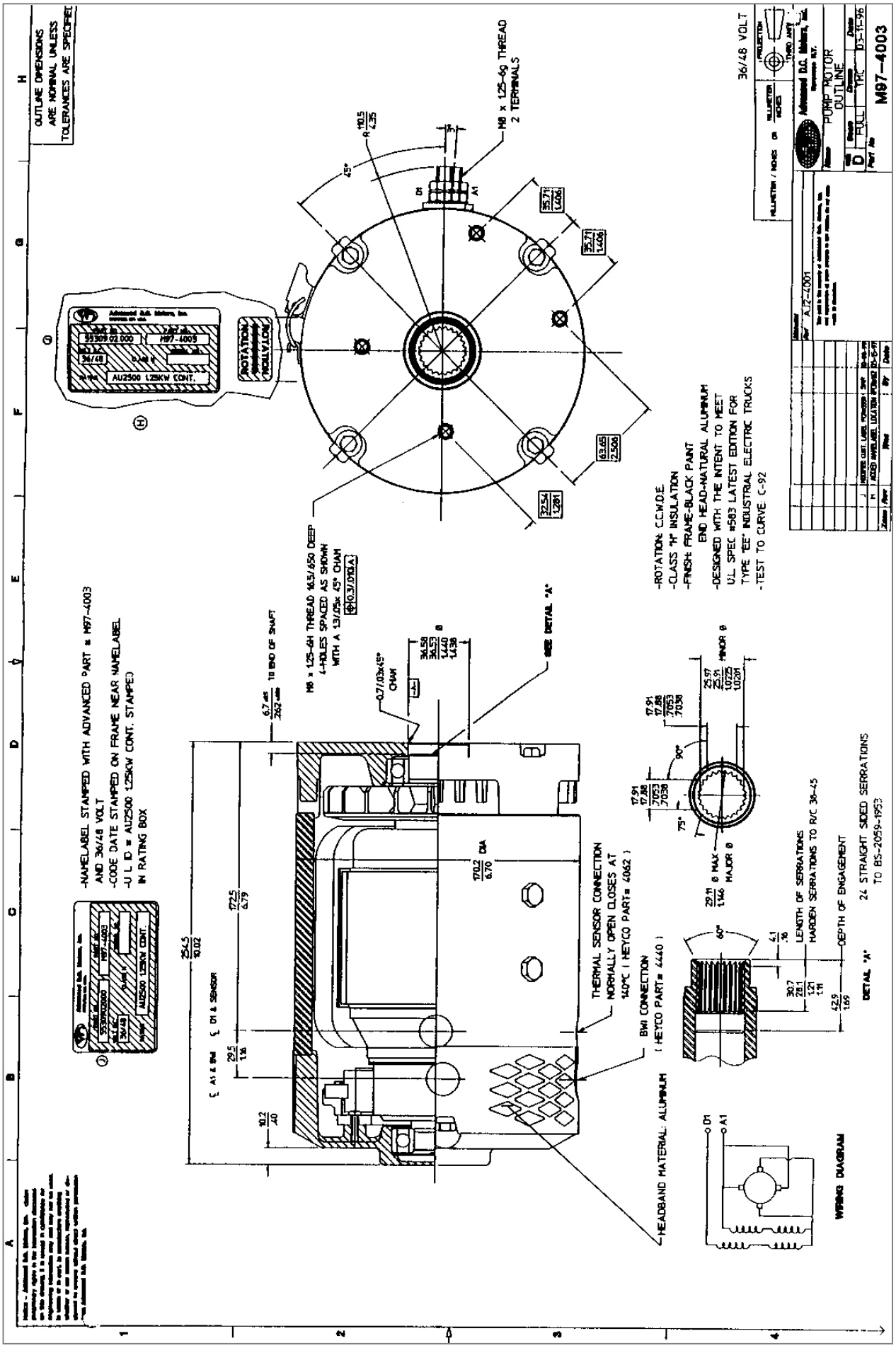
Steer Motor Parts Breakdown



Parts Breakdown **Motor # M97-4003**

Item No.	Description
1.	Drive Endhead
2.	Bearing
3.	Snap Ring
4.	Fan
5.	Armature & Fan Assembly
6.	Field Coil Kit
7.	Brush Assembly
8.	Brush Spring
9.	Brush Box Assembly
10.	Brush Lead Assembly Kit
11.	Bearing
12.	Wavy Washer
13.	Commutator Endhead
14.	Headband Assembly (M)

For Narrow Aisle part numbers contact **Narrow Aisle Parts Department**.


OUTLINE DIMENSIONS ARE NOMINAL UNLESS TOLERANCES ARE SPECIFIED
M8 x 1.25-6g THREAD 2 TERMINALS
36/48 VOLT
PUMP MOTOR OUTLINE
M97-4003
-NAMELABEL STAMPED WITH ADVANCED PART # M97-4003 AND 36/48 VOLT
-CODE DATE STAMPED ON FRAME NEAR NAMELABEL
-U L I D # AU2500 125KW CONT. STAMPED IN RATING BOX
-ROTATION: C.C.W.D.E.
-CLASS "H" INSULATION
-FINISH: FRAME-BLACK PAINT END HEAD-NATURAL ALUMINUM
-DESIGNED WITH THE INTENT TO MEET U.L. SPEC #583 LATEST EDITION FOR TYPE 'EE' INDUSTRIAL ELECTRIC TRUCKS
-TEST TO CURVE: C-92
M8 x 1.25-6H THREAD 16.5/650 DEEP 4-HOLES SPACED AS SHOWN WITH A 137.05x 45° CHAM
SEE DETAIL "A"
THERMAL SENSOR CONNECTION NORMALLY OPEN CLOSES AT 140°C (HEYCO PART# 4440)
BWI CONNECTION (HEYCO PART# 4442)
HEADBAND MATERIAL: ALUMINUM
LENGTH OF SERRATIONS HARDEN SERRATIONS TO R/C 36-45
DEPTH OF ENGAGEMENT
24 STRAIGHT SIDED SERRATIONS TO BS-2059-1953
DETAIL "A"
WIRING DIAGRAM
D1
A1

Advanced D.C. Motors

Planned Motor Maintenance

A good planned maintenance programme will save many hours of future "down time" on a piece of equipment. Maintenance schedules should consist of periodic routine inspections of motors, battery and wiring circuitry.

External Motor Inspection

Routine motor inspection should include the following:

1. Check for clean, tight terminal studs and mounting bolts.

2. Cooling holes must be kept free of any debris or restriction which would prevent proper airflow and hamper cooling.

3. Internal and external spline drives must be periodically lubricated. This may be in accordance with the Vehicle Manufacturer's recommendation.

4. Check for any sign of oil leaks.

5. Make visual inspection of brush and commutation area. Headband, if present, should be removed for clear, proper viewing.

Brush and Commutator

The most important part of any planned maintenance schedule is brush and commutator inspection. By recognising undesirable commutator and/or brush conditions, corrective action can be taken before a major component is damaged beyond serviceability.

Brush and commutator inspection can usually be accomplished by removing the cover band (if so equipped) from the commutator end of the motor. The brushes and commutator should be inspected for even wear and good communication.

Good communication will be indicated by a dark brownish, polished commutator and an evenly polished brush wearing surface.

If the commutator appears rough, pitted, scored or has signs of burning or heavy arcing between the commutator bars, the motor should be removed for servicing.

For a detailed inspection of the commutator the motor should be disassembled. With the armature supported on both bearing journal, check run-out of commutator with a dial gauge. Total indicated run-out should not exceed 0.003 inch or 0.001 inch bar to bar. If the readings fall outside this limit, the commutator must be turned and re-undercut. After the commutator has been undercut, the armature should be placed in a lathe and the commutator lightly sanded with No. 00 sandpaper. This will remove any burrs left from the undercutting operation.

Clean commutator with dry compressed air and recheck commutator run-out.

Brushes should be inspected for uneven wear and signs of overheating such as discoloured brush shunts and brush springs. Check the brush holders for physical damage and make sure they are not loose on the end head or the brush holder plate. Check the brush springs for correct alignment on the brush. A brush spring that does not apply equal pressure on the centre of the brush will cause the brush to wear unevenly. Check for correct clearance and freedom of brush movement in the brush holder. If any of the brushes are worn to the point that replacement is necessary, the complete brush set should be replaced. Do not replace just one or two brushes.

Do not substitute brushes. The brushes are matched to the motor type and application to provide the best service. Substituting brushes of the wrong grade can cause commutator damage or excessive brush wear.

After the installation of new brushes, the motor should be operated at 12v, no load and brushes seated to the commutator with a dressing stone. Stone dust must be blown out with dry compressed air.

Minimum commutator diameter before armature needs to be replaced is specified on Advanced D.C. Motors, Inc. Test Specification.

Bearings

After the motor has been disassembled, it is recommended new bearings are installed. Bearings may have been damaged during removal. Although the bearings may appear and feel good, the bearing races could be brinelled and fail within a relatively short period of service.

Armature - Electrical Check

Before the armature is reassembled into the motor, the following test should be performed.

Check armature for grounded circuits by placing one test lead of a Dielectric Breakdown Tester on the commutator and the other lead at the armature shaft. If the test light comes on, the armature is grounded.

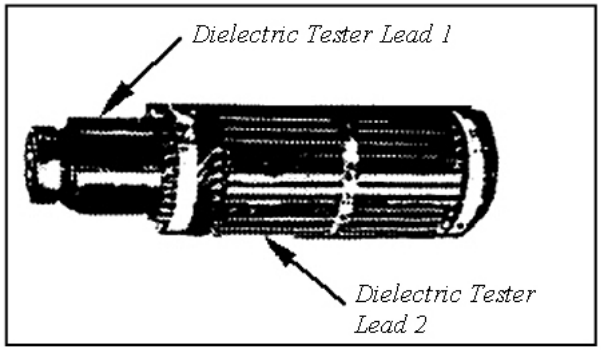


Figure G9 - Armature

For short circuit connection, the armature is tested on a growler using a hacksaw plate to locate any shorted windings. See figure below.

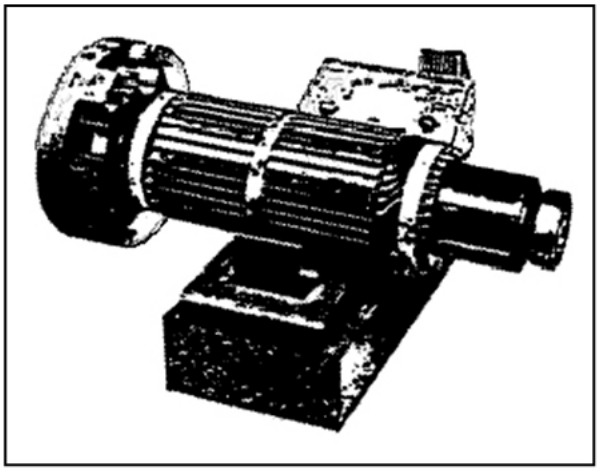


Figure G10 - Armature

Note: All of Advanced D.C. Motor's armatures are wave wound and can be short circuit tested in this manner.

Recommendations for Periodic Inspections

Since the operating environment of Material Handling Equipment varies widely, the following recommendations are suggested for periodic maintenance inspection.

Under Normal Service - 8 hours per day in a normal environment.

Routine inspection recommended every 1000 hours.

Under Severe Service - 24 hours of daily operation under harsh conditions such as:

1 Dusty or Sandy Locations, i.e., cement plant, lumber or flour mills, coal dust or stone crushing areas.

2 High Temperature Areas; i.e. steel mills, foundries, etc.

3 Sudden Temperature Changes (continuous indoor - outdoor movement) i.e. refrigeration plant, etc.

Routine inspection recommended every 500 hours.

Commutator Undercut Guide

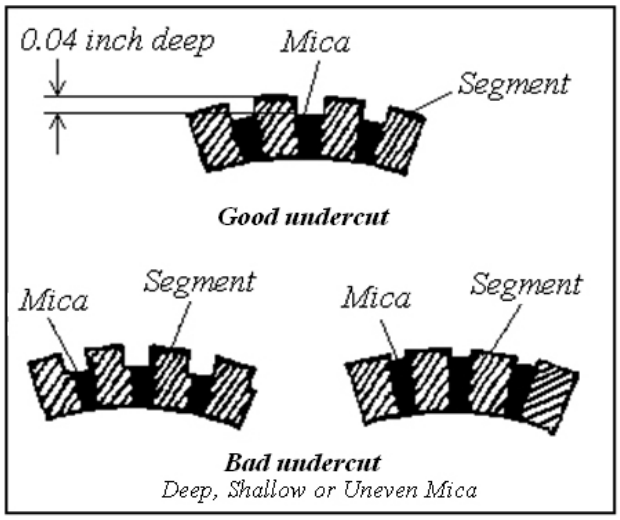


Figure G11 - Brushes

Method of checking brushes for proper tension

1. Place paper strip between brush face and commutators.

2. Hook spring scale as shown on sketch below.

3. Pull spring scale on a line directly opposite the line of force exerted. When the paper strip begins to move freely, read spring tension on scale.

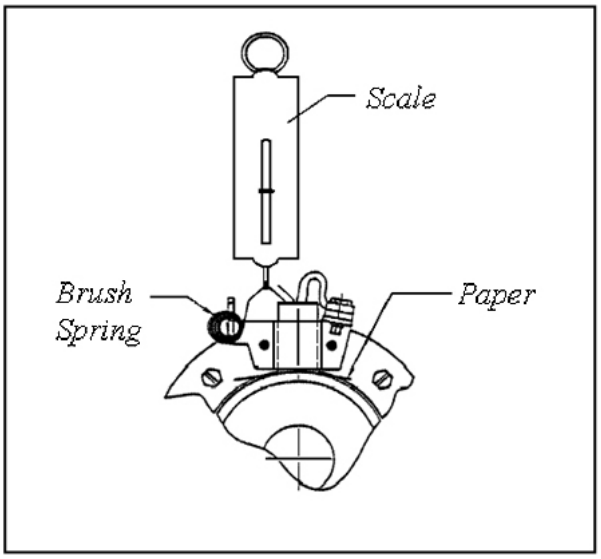


Figure G12 – Checking Tension

Pull paper in direction of rotation.

Spring Tension Chart

A.D.C. 5.5" Dia Motor
New Brush 55 oz/1540 Grams
Worn Brush 35 oz/980 Grams

A.D.C. 6.7" Dia Motor
8.0" Dia Motor
9.0" Dia Motor

New Brush 65 oz/1820 Grams
Worn Brush 40 oz/1120 Grams

Frame and Field Service Recommendations

Motors which have been disassembled for servicing should include a complete inspection of the frame and field assembly.

It is not uncommon that the frame and field of a motor becomes exceptionally dirty after many hours of operation. This may result in a grounding condition due to dirt, grease and other foreign materials.

In this case it is recommended to clean the complete frame and field in a cleaning solution on Safety-Kleen 105 washing solvent or an equivalent product.

After cleaning, the frame and field must be oven-cured for one hour at 300ºF (148ºC).

It is recommended to add a coat of ws-200 PT George varnish for proper insulation protection. This is a class M water soluble varnish. A similar air-dry varnish may also be used providing it has a class H thermal specification.

If new field coils are installed the cross-over connection should be brazed for a good sound connection and to prevent breakage due to vibration.

We do not recommend soldered connections.

Motor terminals should be torqued to 140 In /lbs.

Pole piece screws should be torqued to 250 - 300 In/lbs.

Note: We do not recommend the use of a torch for the cross-over connection. The insulation of the field coils is easily damaged by this method.

A high capacity resistance power unit with a plier-type handpiece may be used for brazing field connections. For example - American Beauty make several units of this type.

Assembly/Testing

Bearing Installations

Outlined below is a typical sketch which is recommended to be followed whenever a bearing is installed into and end head or shaft.

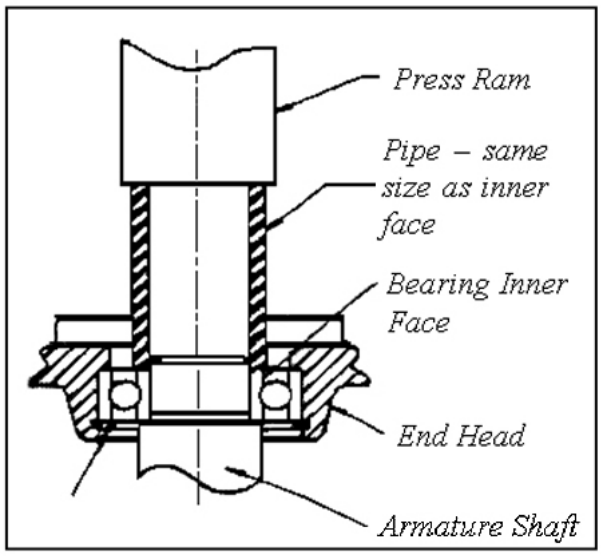


Figure G13 – Bearing Installations

Always press against the race that is absorbing the pressure.

Always use a new bearing when servicing a motor.

After assembly, the motor should be tested per Advanced D.C. Motors Test Specification.

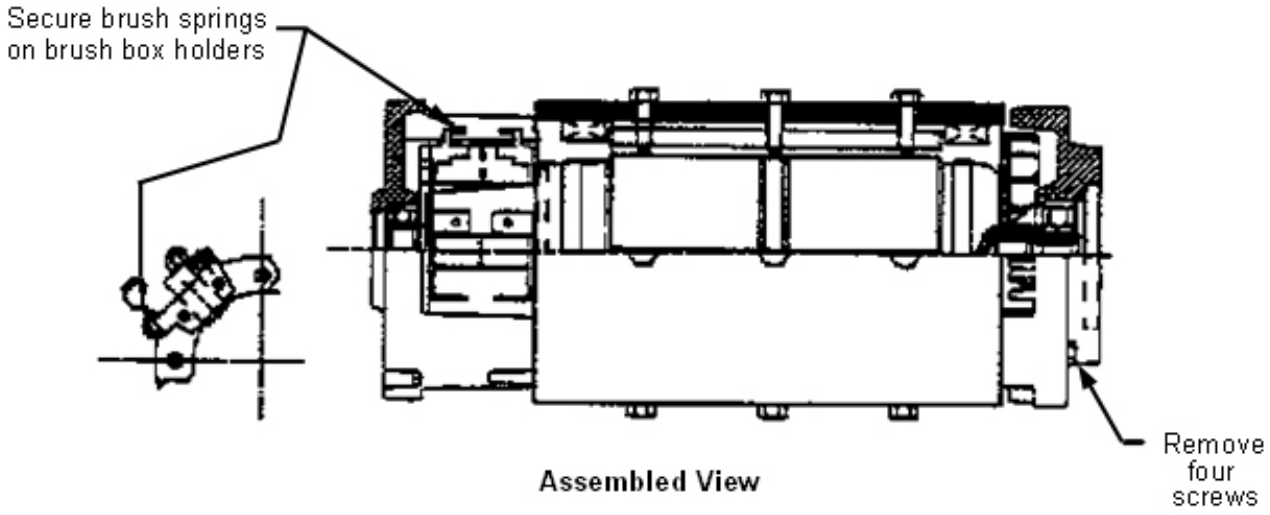
A specification is available for each Advanced D.C. Motor.

In the event that no dynamometer is available for testing, the motor should be tested against a **NO LOAD POINT** outlined in the specification.

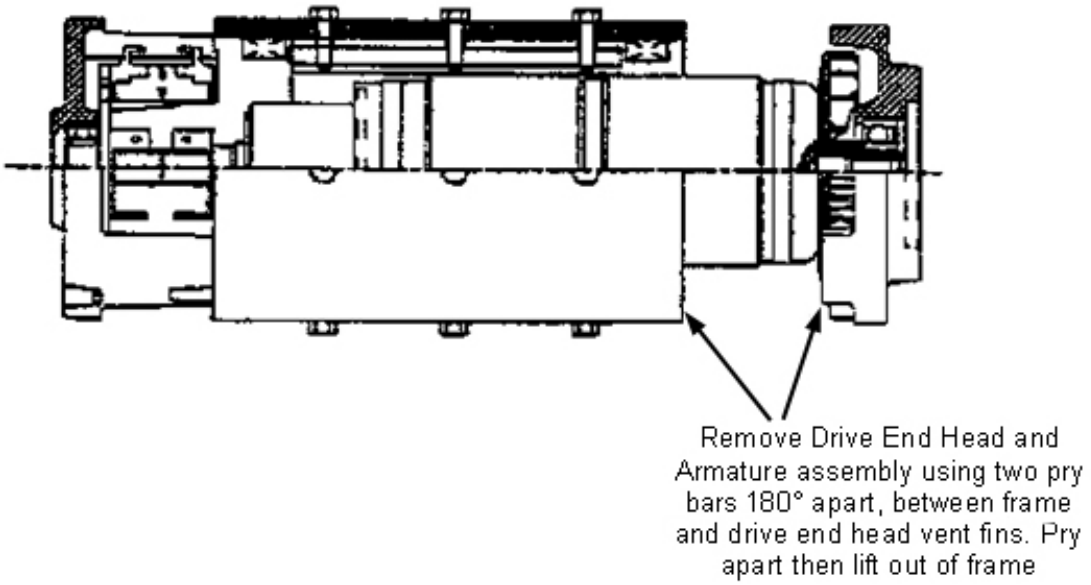
WARNING

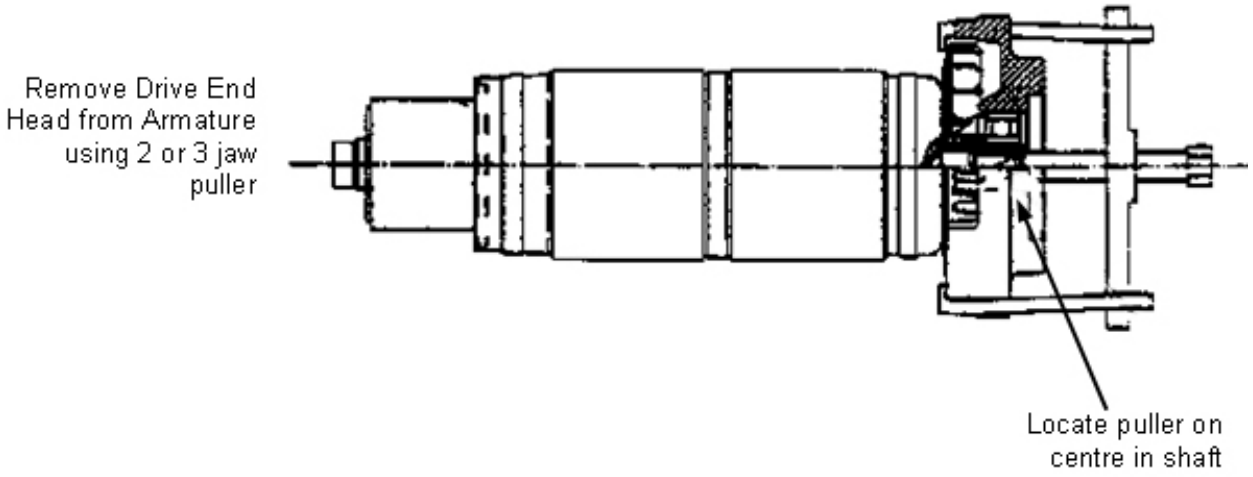
Do not run motor with No Load at full motor voltage.

Disassembly Procedure



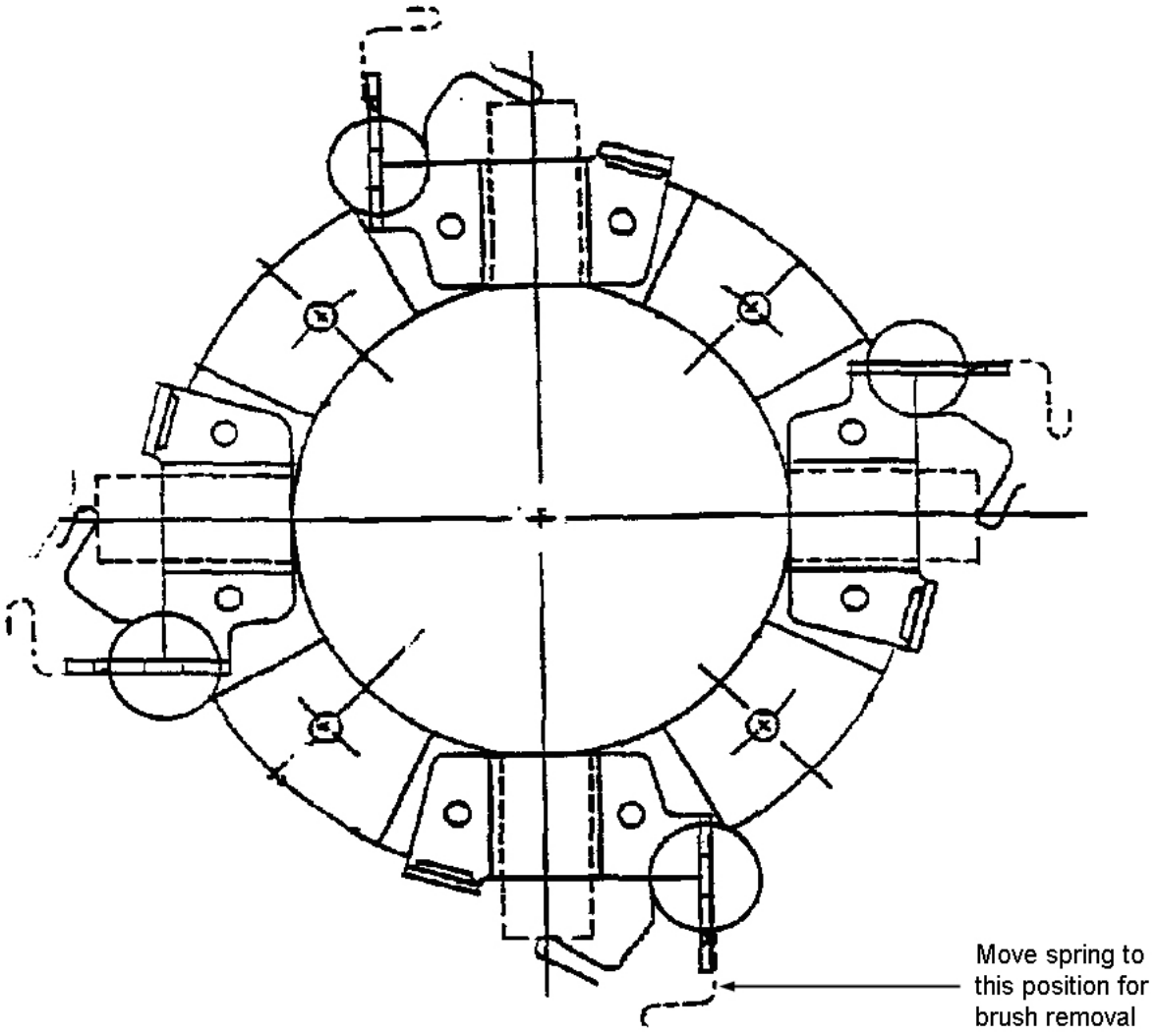
Assembled View





Service Bulletin

When brush service is required on all Advanced DC motors, please lift brush spring over holding bracket before lifting brush. See illustration below.



This Page is Intentionally Left Blank

Pedal Plate Module

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

Accelerator Unit

The accelerator unit used on the Flexi G4 truck is a Zapi model; reference number 1BUH.

Service work on the unit is best carried out with the unit removed from the truck.

Removal

Remove the truck footplate by unscrewing the four M6 countersunk setscrews and lifting clear. Unscrew the two M6 cap head setscrews and lift the accelerator unit from the pedal plate module. Disconnect the plugs from the rest of the truck wiring and transfer the accelerator unit to a suitable place.

Potentiometer

To replace the potentiometer:

1. Remove the unit top cover.

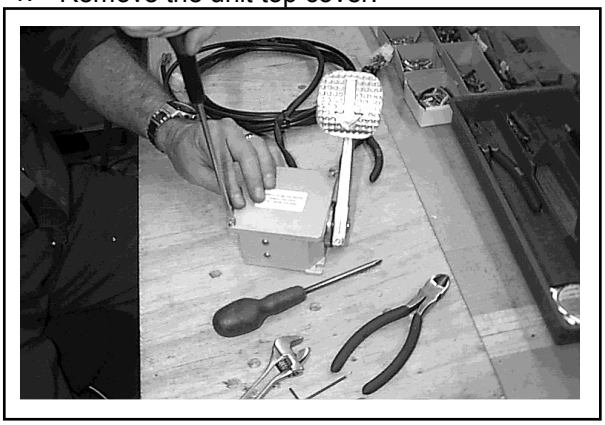


Figure H1

2. Unscrew the potentiometer mounting plate locating screw sufficiently to allow the mounting plate to be removed

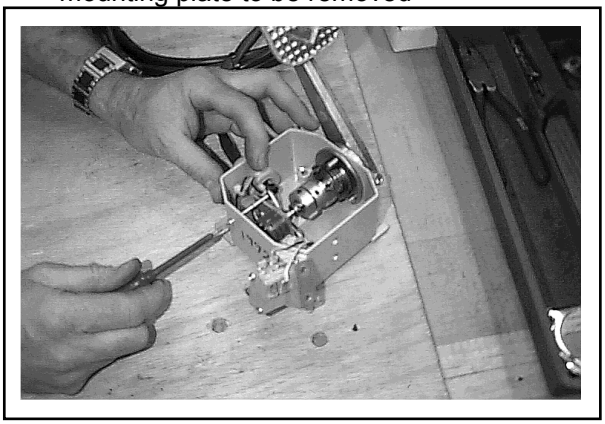


Figure H2

3. Withdraw the screw sufficiently to release the mounting plate return spring.

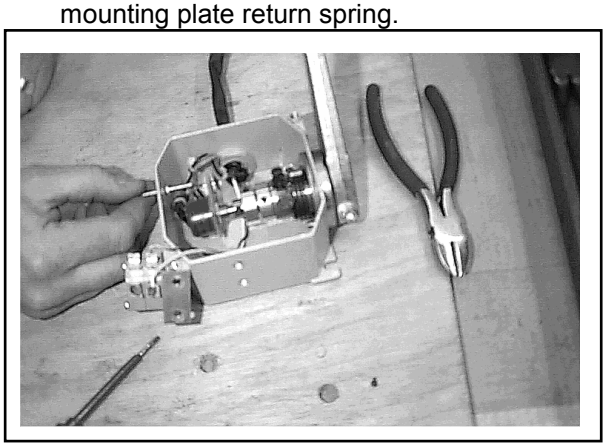


Figure H3

4. Unscrew the potentiometer spindle securing grub screw just enough to allow the spindle to be withdrawn.

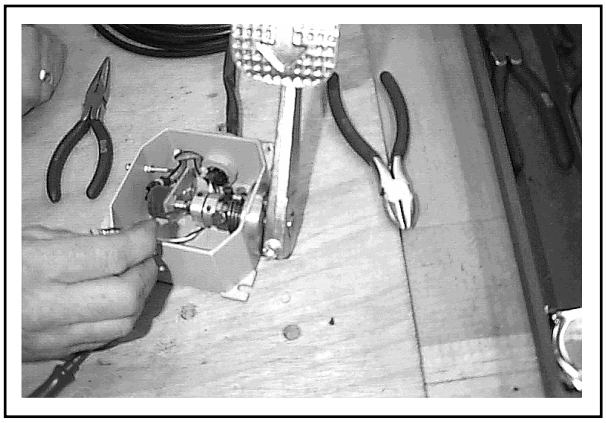


Figure H4

5. Withdraw the potentiometer spindle from the actuator shaft.

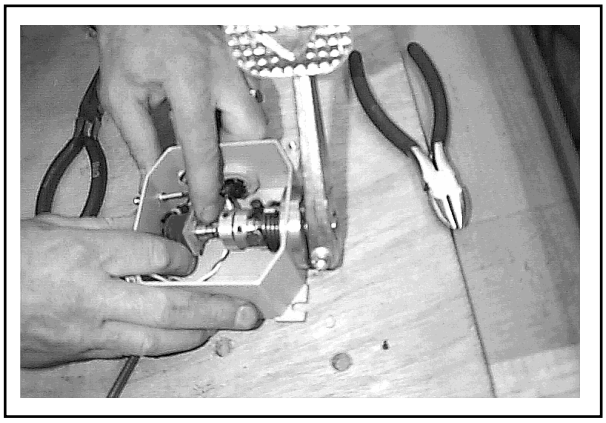


Figure H5

6. Move the potentiometer clear of the unit.

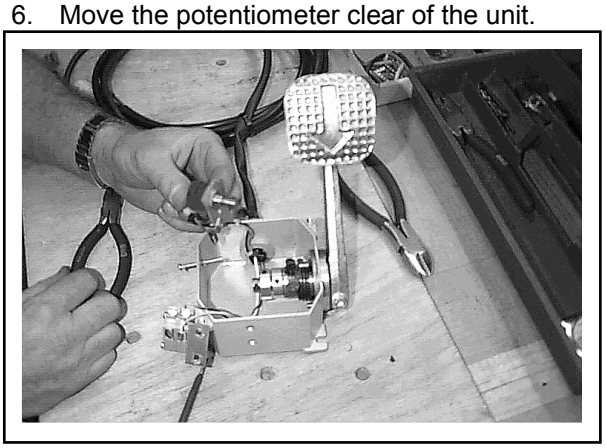


Figure H6

7. Carefully cut off the cable tie securing all the potentiometer cables together and pull back the insulating sleeving on each wire. Unsolder each connection. Remove the potentiometer from the mounting plate and fit new. Remember to fit the new potentiometer in the same orientation as the original. Solder the wires onto the new potentiometer. Re-position the insulating sleeving and re-secure the wires with a new cable tie.

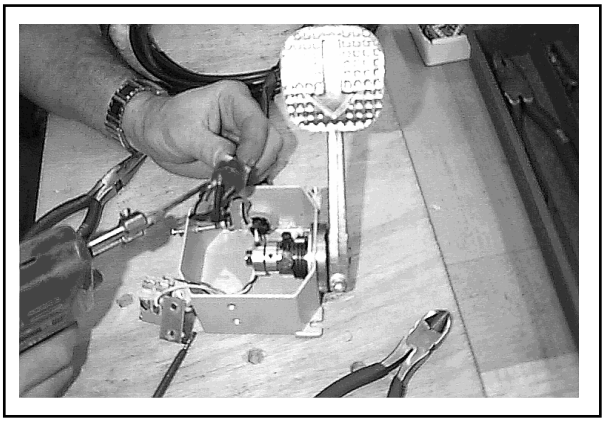


Figure H7

8. Re-attach return spring to the potentiometer mounting plate.

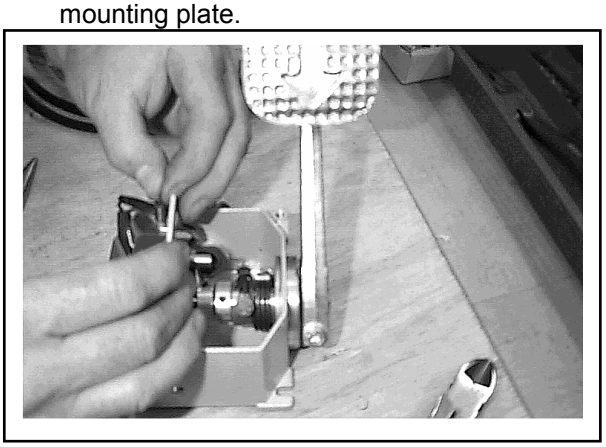


Figure H8

9. Ensure that the potentiometer cables are positioned underneath the potentiometer mounting plate locating screw and, whilst holding the return spring securely, place the potentiometer assembly back into position.

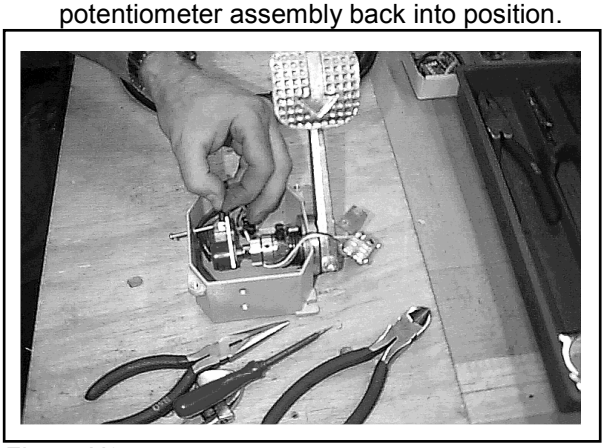


Figure H9

10. Reconnect mounting plate return spring to the locating screw.

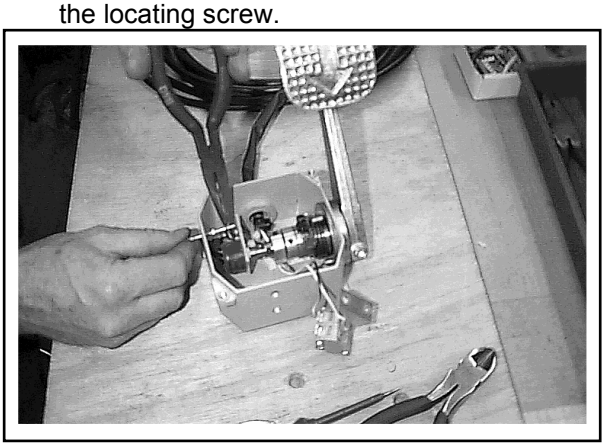


Figure H10

11. Locate the potentiometer mounting plate underneath the locating screw.

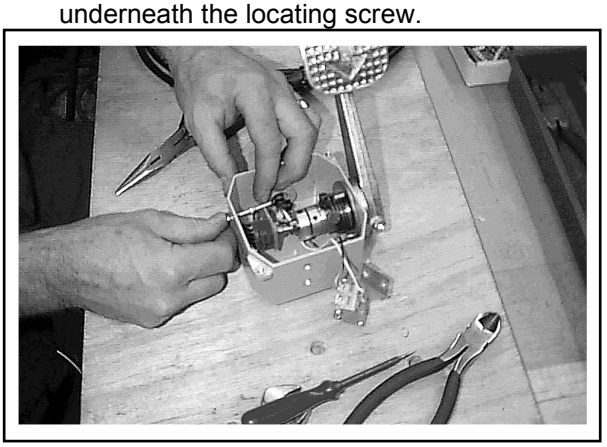


Figure H11

12. Re-secure potentiometer mounting plate locating screw.

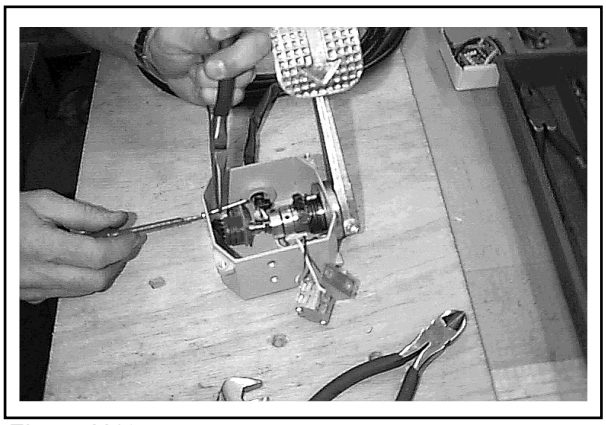


Figure H12

13. Ensure that the potentiometer wires are not trapped beneath the potentiometer mounting plate.

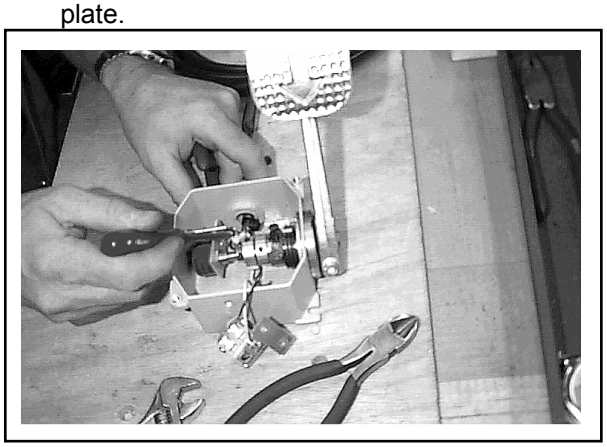


Figure H13

14. Slide the potentiometer spindle back into the actuator shaft.

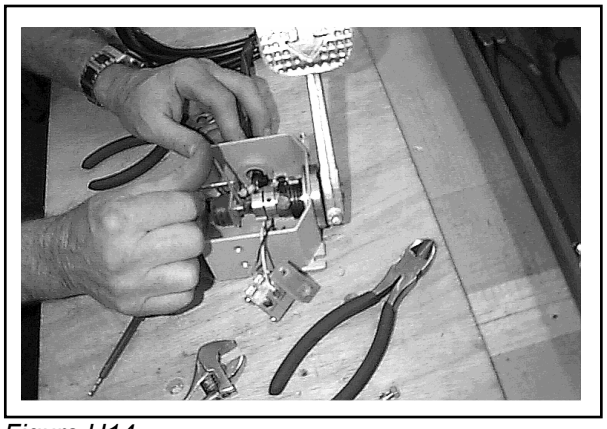


Figure H14

15. Lock the spindle in position with the grub screw.

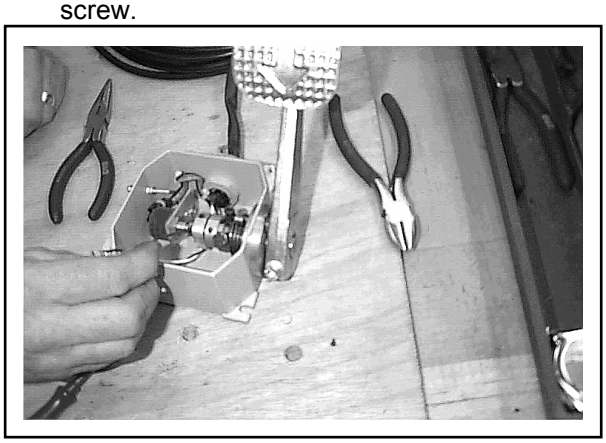


Figure H15

16. Replace the top cover.

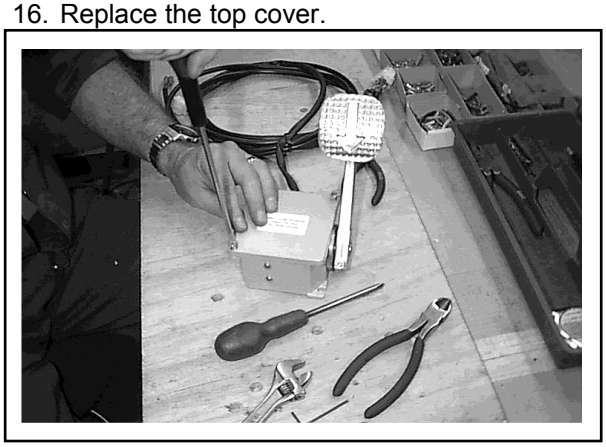


Figure H16

17. Refit the accelerator unit. To refit the accelerator unit simply reverse the removal instructions.

18. When the accelerator has been re-installed in the truck check to ensure that the pedal reaches its mechanical stop **BEFORE** the potentiometer assembly reaches its mechanical stop. Failure to do so will result in damage to the potentiometer assembly. Then the accelerator unit **MUST** be programmed in accordance with the instructions set out in the Electrical Section (see Section L) before the truck can be operated correctly.

Microswitches

To replace the microswitches:

Firstly, remove the accelerator unit as described previously and transfer to a suitable place for repair.

1. Remove the accelerator unit top cover.

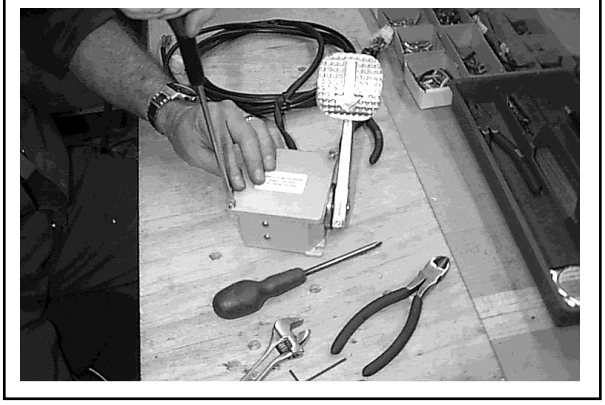


Figure H17

2. Unscrew the two microswitch bracket securing screws.

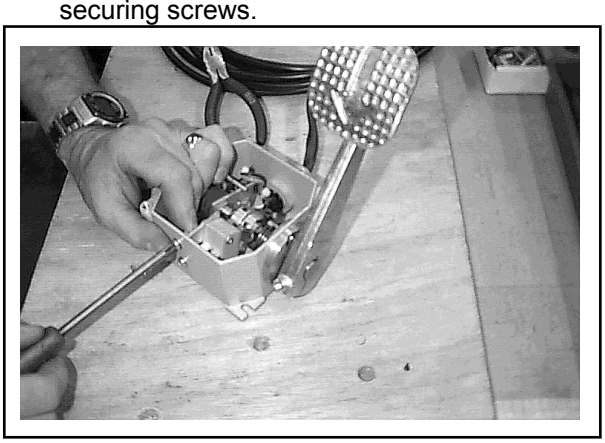


Figure H18

3. Withdraw the assembly from the unit.

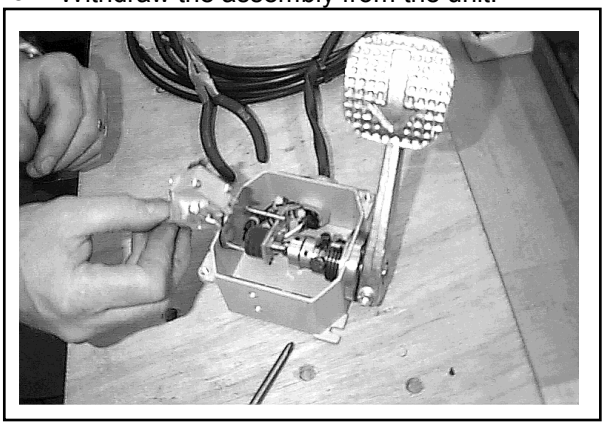


Figure H19

4. De-solder the connections to the switch. Remove the switch from the mounting plate and fit new. Re-solder the wires onto the new switch.

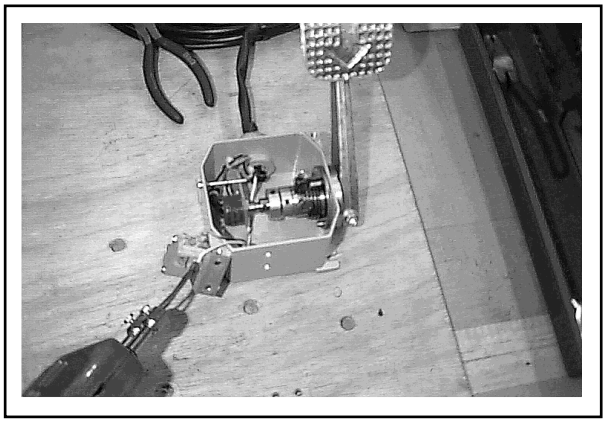


Figure H20

5. Ensure that the switches are the correct way round for re-assembly.

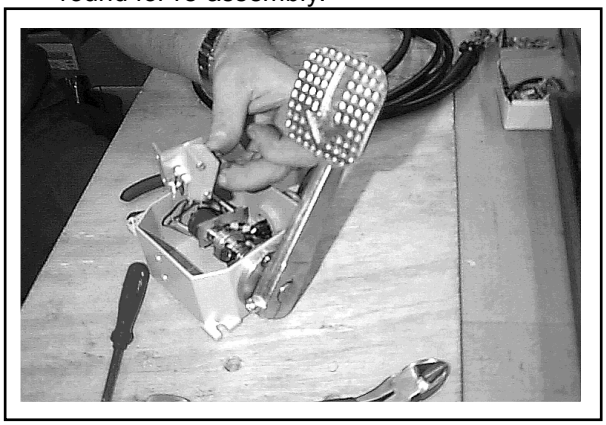


Figure H21

6. Place the switch assembly back into accelerator unit.

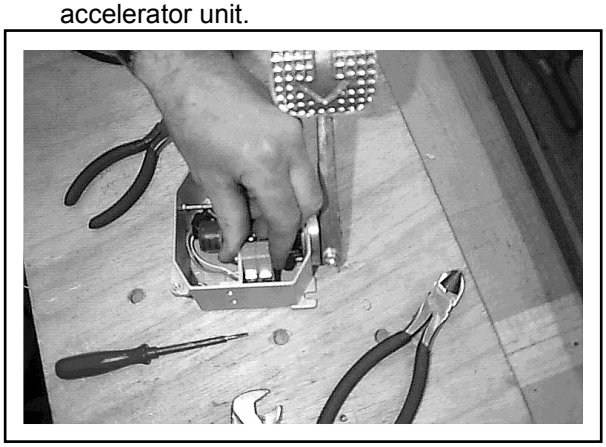


Figure H22

7. Re-engage the securing screws.

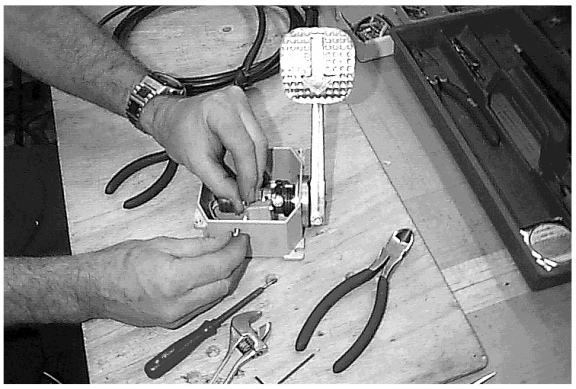


Figure H23

8. Ensure that the switches are aligned with the operating cams and secure in position.

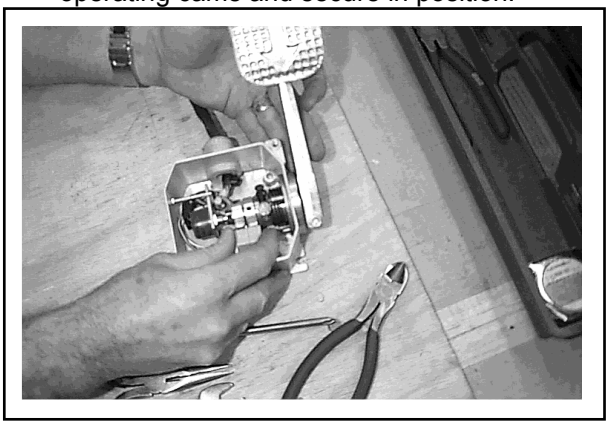


Figure H24

9. Replace the accelerator unit top cover.

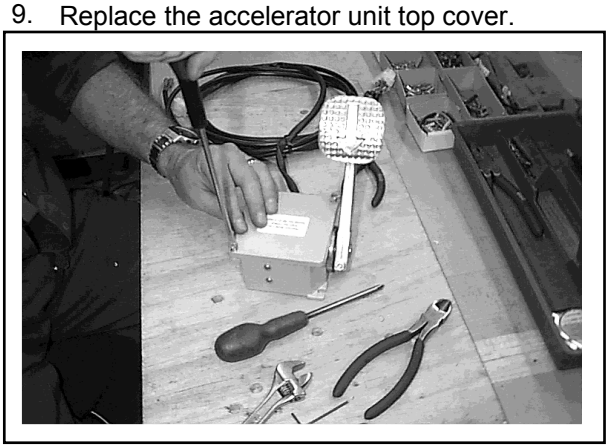


Figure H25

10. Refit the accelerator unit. To refit the accelerator unit simply reverse the removal instructions.

Brake master cylinder

Removal

1. Gain access to the brake master cylinder as described earlier.

2. Disconnect pipe leading from master cylinder to the tee piece.

3. Undo the two nuts and bolts securing the master cylinder to the pedal plate module and withdraw.

Overhaul

1. Discard any fluid remaining in the reservoir.

2. Remove the boot from the end of the master cylinder.

3. Remove the circlip.

4. Withdraw the circlip, washer, spring and piston assembly.

5. Remove the seal, and, if necessary, the non-return valve and replace.

6. Re-assembly is the reversal of the above.

Refitting

Refit the master cylinder by reversing the removal instructions.

Ease the master cylinder push-rod fully out and fill supply tank with clean brake fluid. Bleed the braking system by following the instructions in Section E, rear wheel assembly.

Adjust rod-end to obtain the correct free play.

Note: It is not recommended to reseal the cylinder and a new unit should be obtained from Narrow Aisle.

Maintenance of brake pedal switch

Removal

1. Gain access to the brake pedal switch.

2. Undo the nuts clamping the switch to the pedal plate.

Refitting

Refit the brake pedal switch by reversing the removal instructions.

Setting the brake pedal switch

Once the brake pedal switch is installed the switch push rod may require adjustment. Firstly operate the brake pedal to ensure the striker engages with the switch push rod. Adjust the switch backwards or forwards until a small amount of pressure on the brake pedal (10 – 20mm of travel) moves the switch push rod until it clicks.

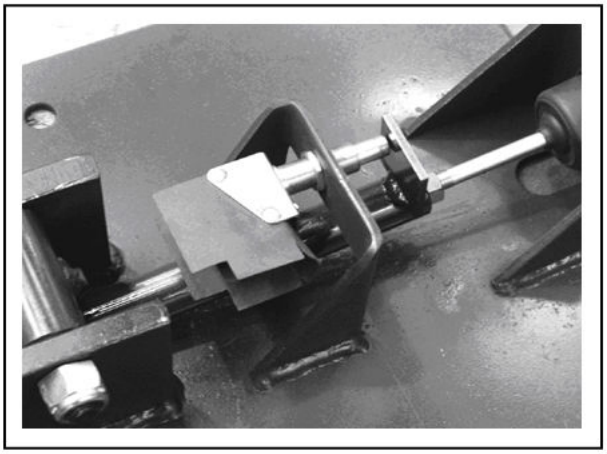


Figure H26 – Brake Pedal Pressed

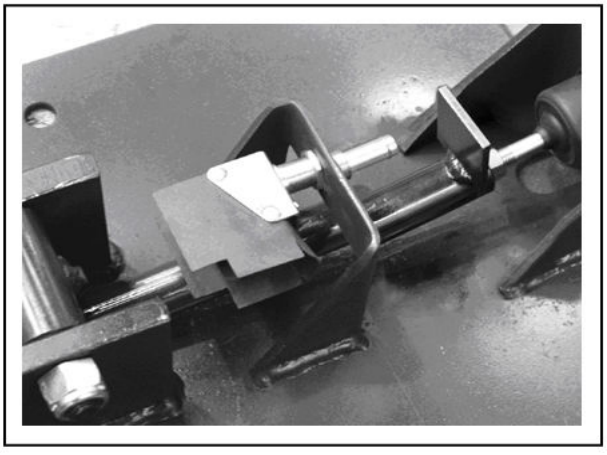


Figure H27 – Brake Pedal Released

Chassis

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

Ballast Weights

Note: Approx 325kg each

Should the need arise for the ballast weights to be removed, the following sequence should be followed.

Quarter Ballast Weight

Removal

1. Remove the spool valve lever cover.
2. Attach lifting equipment to the quarter ballast weight.
3. Undo the two M20 cap head screws and lift the weight clear.

Refitting

To refit the quarter ballast weight, lift quarter ballasts with lifting gear and lower onto ledges on either side of the chassis.

Secure using two M20 x 50 cap head setscrews, two M20 spring washers and two M20 flat washers. Ensure that all setscrews are Loctited using Threadlok 242 then tighten.

Weights may need to be packed to ensure alignment with the side ballasts.

Side Ballast Weights

Note: Approx 425kg each

Removal

1. Remove battery.
2. Attach lifting equipment to the side weight to be removed.
3. Grind off peened over end of M20 bolts and undo bolts.
4. Lift side weight clear of truck and position safely on the floor.

Refitting

1. Lift side ballasts with lifting gear and align with holes in the side of the chassis. Secure using three new M20 x 75 cap head bolts, each one having one M20 spring washer and one flat washer. Ensure that all bolts are Loctited using Threadlok 242 then tighten. Peen over the inside end of the M20 bolt to eliminate any possibility of accidental loosening.
2. Refit battery.

Overhead Guard

Removal

1. Remove both side ballast weights as described above.
2. Attach lifting gear to overhead guard.
3. Remove eight M14 bolts and lift overhead guard clear of truck.

Refitting

1. Use lifting gear to raise the guard above the chassis, then slowly lower onto the sides of the chassis until the lip on the guard is firmly resting on the edge. Secure using eight M14 x 45 Durlok bolts and tighten. Torque bolts to 266Nm.
2. Refit side ballast weights.

Handbrake Cable Linkage

Removal

1. Lift up seat pan to gain access to handbrake cable linkage.
2. Disconnect brake cables as outlined in section E, rear wheel assembly and F, parking brake system.
3. Remove each of the L shaped brackets by undoing the M12 hex head bolt.
4. Remove the M12 nut and washer from the rear of the bracket and withdraw bolt.

Overhaul

The only service items on the handbrake cable linkage are the bronze bushes on which the linkage pivots which should be checked and greased.

Replacing the Bushes

1. Drive out worn bushes. Take care not to damage the internal bore of the bracket.

2. Press in a new bronze bush and lightly grease the bore.

Refitting

1. Fit the L shaped bracket with the slot in the middle to the left hand side of the chassis above the oil tank using one M12 x 60 hex head bolt and one M12 flat washer. Push the bolt through the bronze bush, fit another M12 flat washer and one M12 plain nut onto the bolt and secure. Ensure that the flat face of the bracket is facing the front of the chassis.

2. Repeat instruction 1 with the right hand bracket.

3. Reconnect handbrake cables and adjust.

Brake Pipes

The pipes which make up the hydraulic braking system come in three pieces. One pipe connects the brake master cylinder to the tee piece on the chassis. Then one pipe goes from each side of the tee piece, down the side of the oil tank compartment, to the rear wheels.

To gain access to the brake pipes remove the front electric cover, the footplate, raise the seat pan and move the electrical panel clear of the components of the braking system. If the pipes to the rear wheels need to be replaced, or if the braking system needs to be bled, the battery must be removed.

When the following procedures have been completed the braking system must be bled as set out in Section E rear wheel assembly.

Removal

The sequence of steps covering the removal of elements of the braking system depends on which items of the system are being attended to.

Brake Tee Piece

1. Gain access to the tee piece as described above.

2. Disconnect the three pipes attached to the tee piece.

3. Remove the M6 hex head screw and remove the tee piece.

4. Refitting is the reversal of the above.

Brake Master Cylinder to Tee Piece

1. Gain access to the pipe.

2. Disconnect both ends of the pipe and remove.

3. Insert new pipe and reconnect.

Tee Piece to Left Hand Wheel

1. Gain access to tee piece as described above.

2. Disconnect the three hydraulic hoses and one pump motor cable shown.

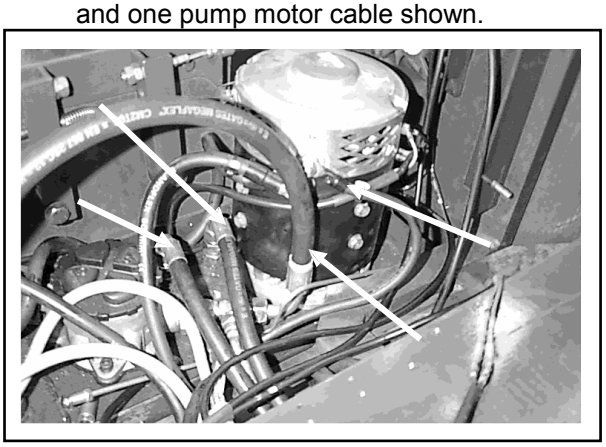


Figure I1

3. Disconnect both ends of the brake pipe.

4. Undo the three pipe clips and withdraw the pipe.

5. Carefully feed the new pipe down the side of the oil tank, through into the battery compartment and connect to the brake slave cylinder.

6. Connect the pipe to the tee piece.

7. Refit the hydraulic hoses and motor cable.

Tee Piece to Right Hand Wheel

1. Gain access to the pipework as described before.

2. Undo the bolts securing the spool valve assembly to the chassis and move the assembly clear of the pipework.

3. Disconnect both ends of the brake pipe.

4. Disconnect the hydraulic pipes shown.

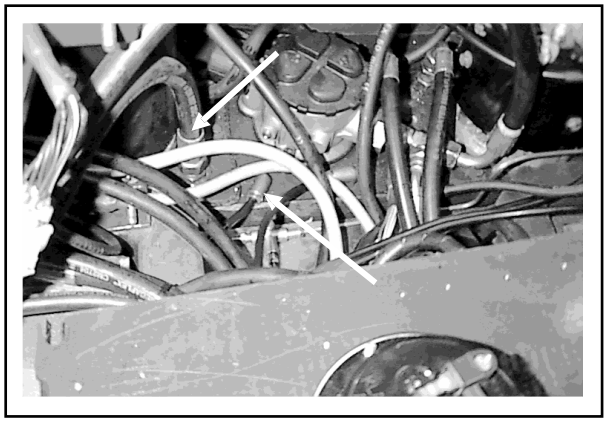


Figure I2

5. Withdraw the brake pipe.

Refitting

Refitting is the reverse of the above removal instructions.

This Page is Intentionally Left Blank

Mast

This Page is Intentionally Left Blank

Contents

Mast

Before removing mast ALWAYS ensure that the carriage is fully lowered.

Removal

1. Remove the cap head setscrew from the front of the carriage and remove forks.
2. Attach suitable lifting equipment to the mast to prevent it moving in an uncontrolled manner.
3. Disconnect mast microswitch.
4. Disconnect all hydraulic hoses.
5. Disconnect the two tilt cylinder pivot pins.
6. Remove mast support caps, lever the bottom of mast forward to allow tilt cylinder brackets to clear mast support assembly, and lift the mast clear of the truck.

Overhauling

Instructions for overhauling the mast are given later in this section.

Refitting

Refitting the mast is the reversal of the above instructions.

Tighten clamp bolts to 295Nm.

Identification of the Mast

The mast is stamped with a registration number, for which there are corresponding control and test certificates. This number is required when requesting spare parts.

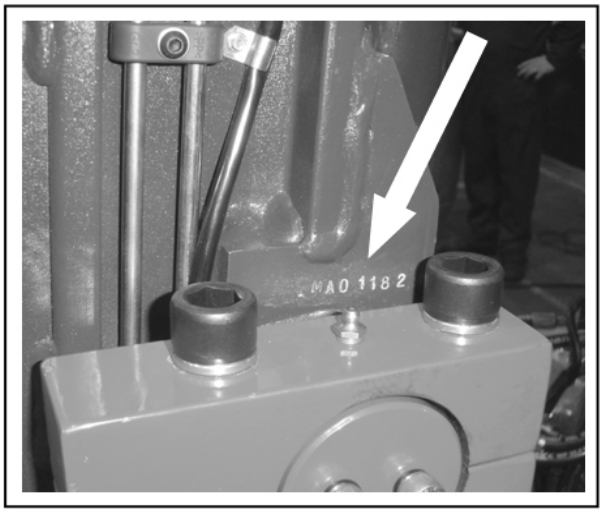


Figure J1

Operations to Carry Out After Mounting the Mast in the Truck

Connect the hydraulic hoses to the corresponding connection.

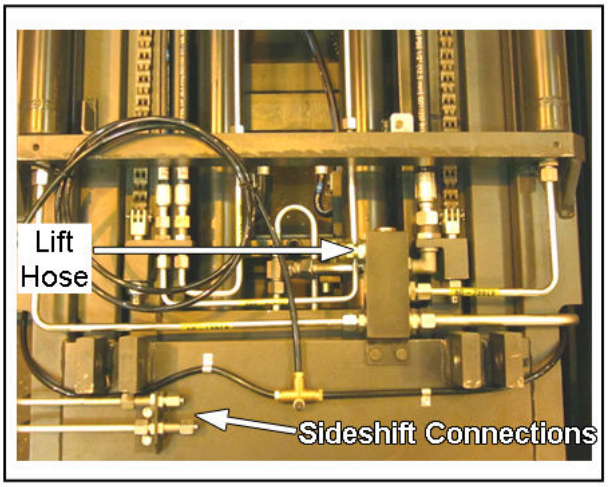


Figure J2b

Connect the drainage tubes.

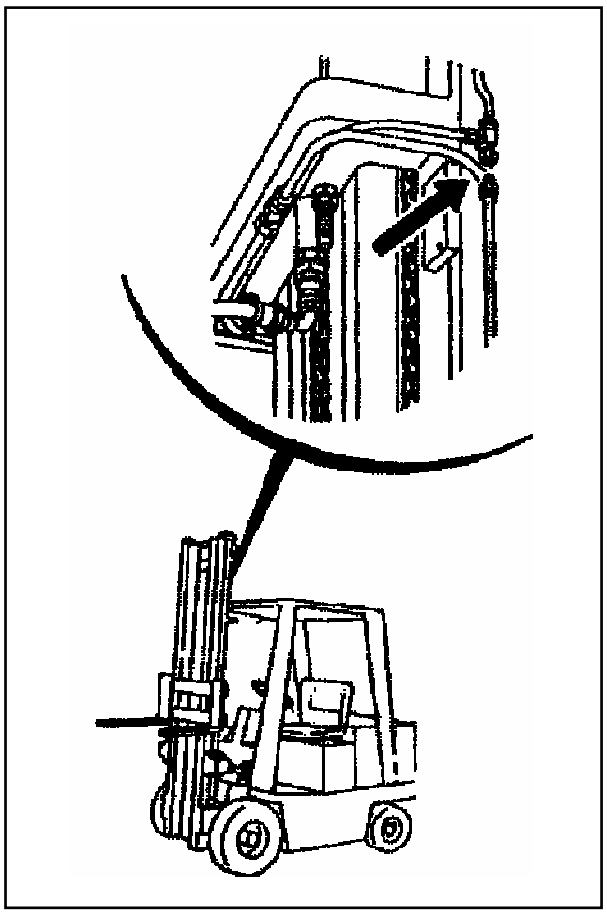


Figure J3

Test the tilt movement to ensure that there are no foul conditions between the truck and mast.

Note: The drainage tube must not be immersed in the reservoir below the oil level. IT MUST ALWAYS BE ABOVE THE SURFACE.

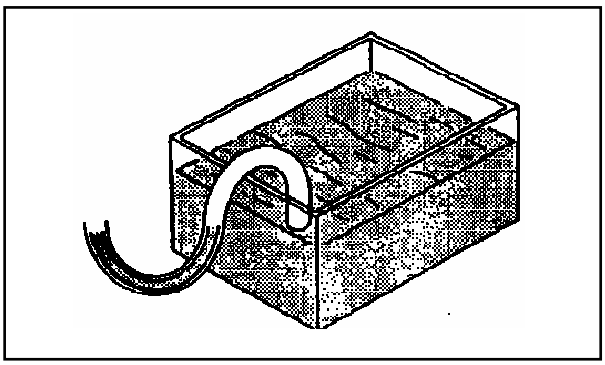


Figure J4

Note: The drainage tube should also form a bend before entering the reservoir in which there should be a small quantity of oil to act as a syphon. This helps to keep the internal surface of the cylinder case wet when it is closed.

The roller surfaces must be greased, both where the fork carriage and the mast run.

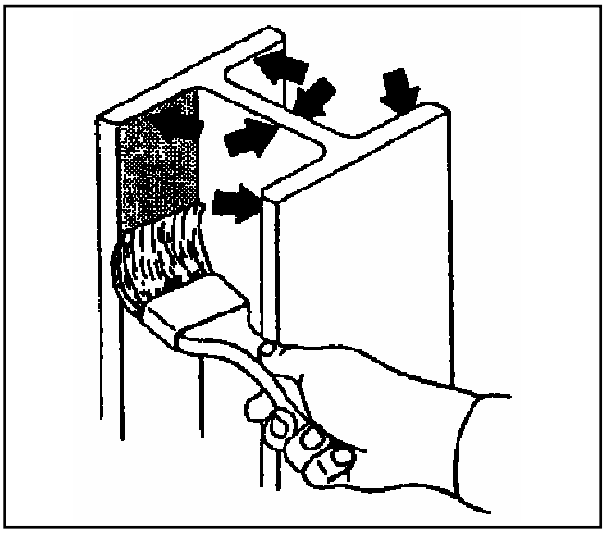


Figure J5

For this purpose use graphite grease, avoiding, if possible, spray greases.

Circulate the oil through the mast system three or four times.

Purge the air from the displacement cylinders. (free lift)

Lift the fork carriage about 500 mm.

Loosen the screw situated below the top cap. At the first sign of oil tighten it.

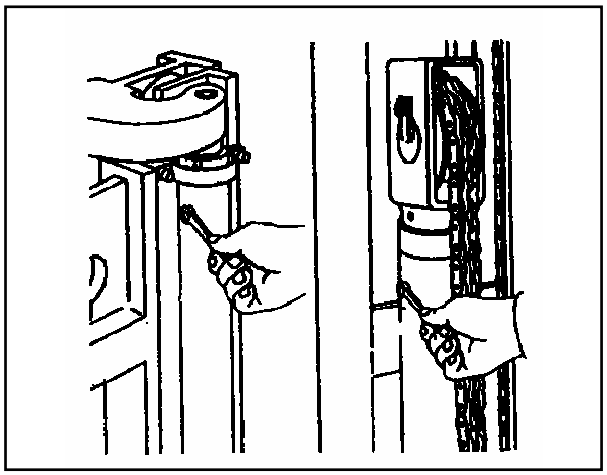


Figure J6

Put a load on the forks (30% of the nominal load), check that the descent is regular (during transport the cylinder may have been damaged).

Routine Maintenance

Ordinary maintenance will include the following operations:

Bearing lubrication.

To be carried out every 400 working hours.

Roller track lubrication.

To be carried out every 200 working hours.

Chain lubrication.

To be carried out every 200 working hours.

Sideshift lubrication (If fitted).

To be carried out every 200 working hours.

Chain adjustment.

To be carried out every 200 working hours.

Additional Maintenance

Replacement of cylinder seals.

Replacement of chains.

Replacement of rollers.

Bearings

Description of component construction

Rollers

The rollers used with the masts are of the combined type, in order to withstand both radial and lateral loads.

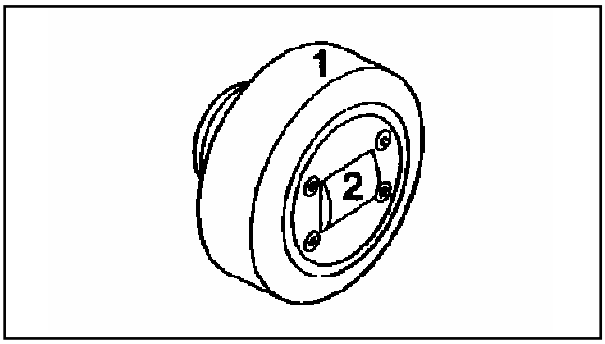


Figure J7

The main roller (1) and the side roller (2) are made in two versions: standard and oversize, to adjust to the profile reducing the play.

The dimensions of the bearing are such as to allow a large margin to withstand the possibility of accidental overloads that may occur during the life of the forklift.

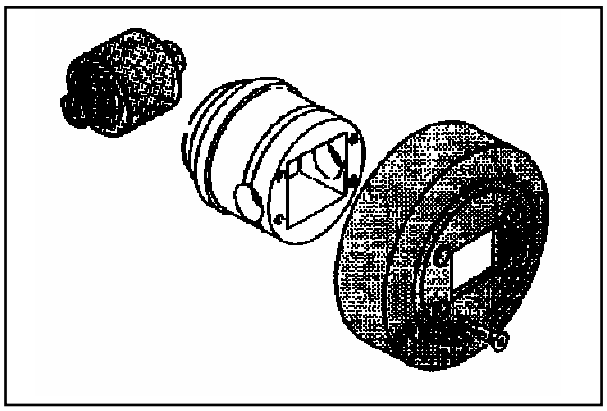


Figure J8

Bearing Lubrication

The extent of the life of the bearing essentially depends upon its lubrication conditions. For this reason, a lubrication duct has been constructed (11).

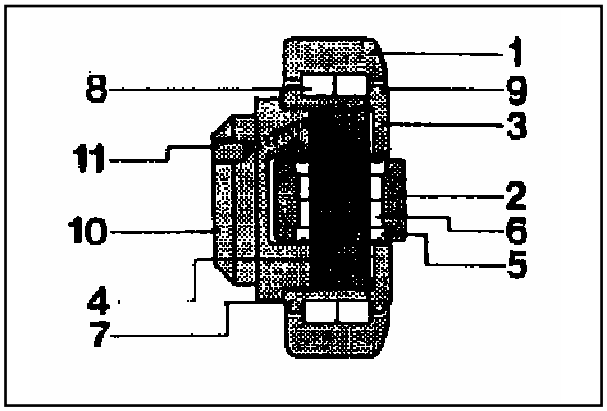


Figure J9

The bearings have been previously lubricated in both the masts and fork carriage.

This greasing point is closed by a plug in the bearings of the internal and intermediate mast.

To carry out the lubrication procedure, it is necessary to remove the plug, insert the lubricator, and when the procedure is finished, replace the plug.

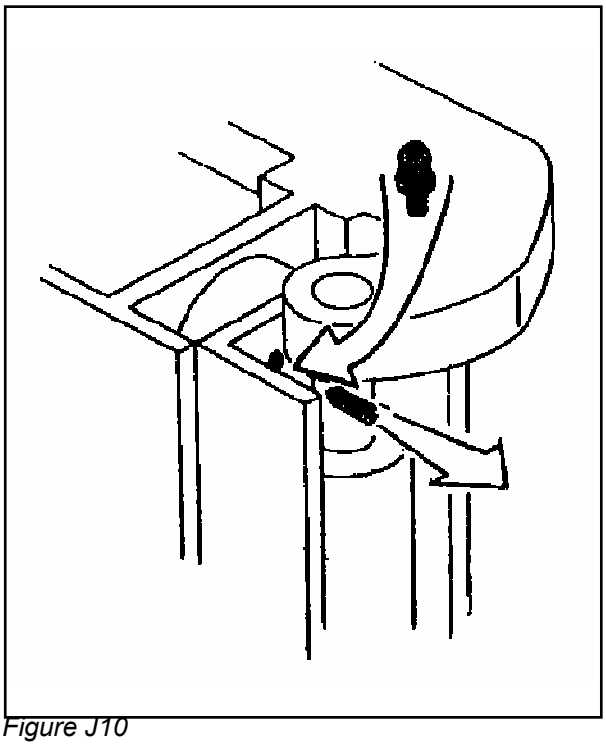


Figure J10

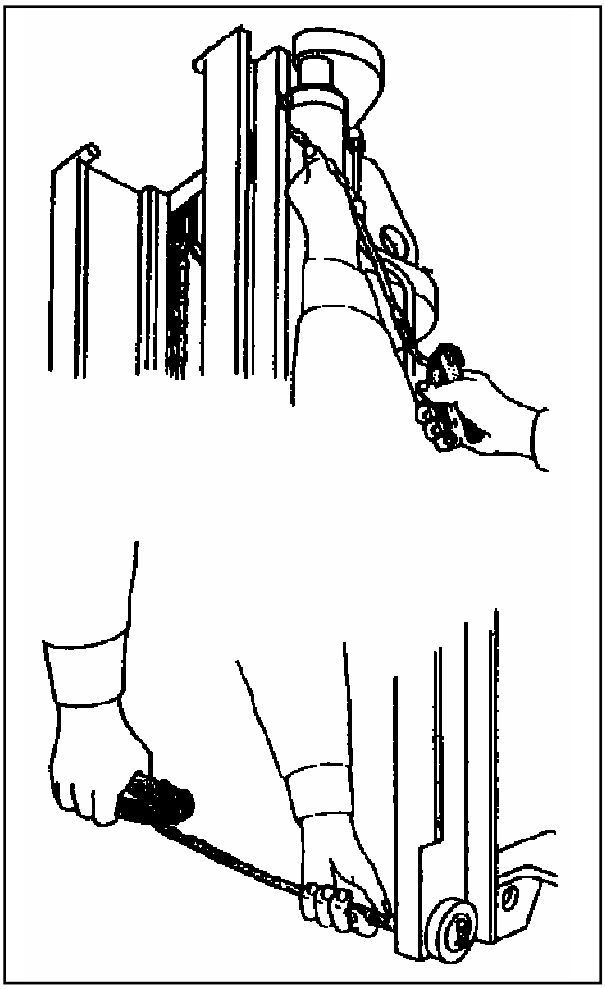


Figure J11

The frequency of the lubrication operation depends on many factors, such as the surroundings and the type of work in which the forklift is used.

Dusty or corrosive surroundings, with high temperatures, and the continued use of the forklift truck for many shifts, obviously calls for more frequent lubrication.

Under normal operating conditions the forklift should be used in dust free surroundings, with medium temperatures and intermittent work shifts.

In such conditions the lubrication should be carried out every 400 working hours.

All bearings provided have been lubricated with AGIP GR MU 3. Alternatively, the following greases may be used:

Chevron	Dura Light Grease 3
Esso	Beacon 3
Fina	Marson 3
Mobil	Mobilux 3
Castrol	Spherol APT3
Gulf	Gulfcrown 3
IP	Athesia Grease 3
Match	Grease LT3
ROL	Comet 3
Shell	Alvania Grease R3
Total	Nyctea 3

Replacement of the Rollers

After unscrewing the two or four screws situated on the cap (3) that retain the main roller in the axial direction, remove the external ring (1), together with the pieces (7, 8, & 9) as a single unit.

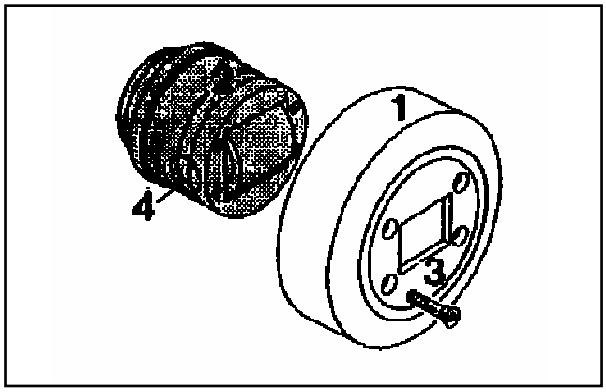


Figure J12

Now, the welded pivot is still together with the side roller (2). This can be easily replaced by removing the relative pivot (4).

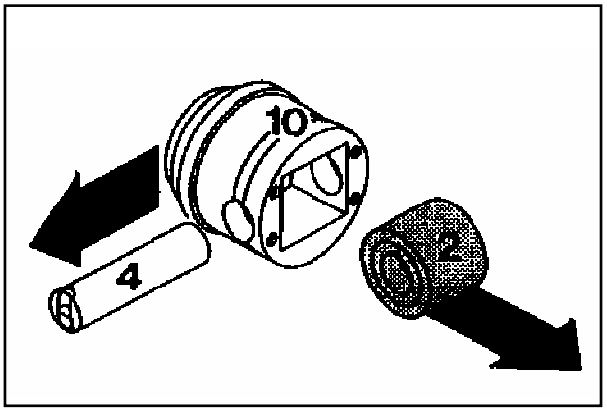


Figure J13

CAUTION

The pivot (4) has profiled ends enabling it to correspond with the surface of the pivot (10). If the pivot is incorrectly mounted, it will be impossible to mount the main roller (1).

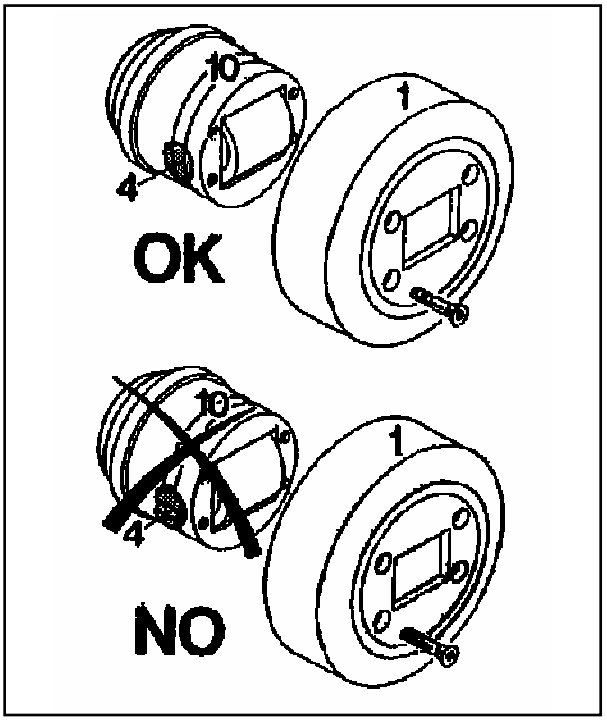


Figure J14

Clearance between the Rollers and Profile

All masts are provided with both front and side clearance between rollers and profile, to a maximum of 0.7mm (normal value 0.5mm).

If the forklift is subject to normal use the increment of such clearance will be minimum with time, and with 6,000/8,000 working hours it should be able to maintain a clearance of less than 2mm.

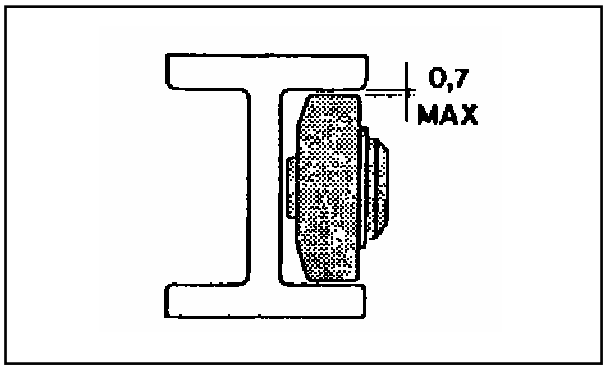


Figure J15

The clearance increment will naturally be more under poor work conditions or particularly hard jobs such as:

- Multiple work shifts;
- Use of movement mechanisms or other similar mechanisms;
- Dusty work environment with corrosive fumes;
- Loads receiving strong jolts, even if they are below nominal capacity;
- Bulky or off centre loads;
- Uneven paving and high manoeuvring speeds;
- Frontal collision.

When the clearance has reached the value mentioned above, it is advisable (although not essential, as the final decision rests with the user), to replace the roller assembly.

When, after the first replacement of the rollers, a clearance of 2mm is again reached, it is necessary to replace the mast.

Naturally, the most used section will always be the one that operates the fork carriage. Wear and tear on the other sections will seldom occur.

When, due to abnormal use of the forklift (in particular after violent shocks), the welded pivot (10) also becomes damaged (usually becoming oval) it will be necessary to remove the complete roller and replace it.

The new roller must be re-welded suitably shimmed to allow minimal side play.

In the eventuality of welding, always use basic electrodes.

Principle causes of Bearing Breakage

The following are the principle causes of bearing failure:

Lack of Periodic Lubrication

With time the track on the ring (7), the rollers (8) and (6) and the track on the pivot (4) become oxidised. Consequently, the rollers are coated and stop rolling.

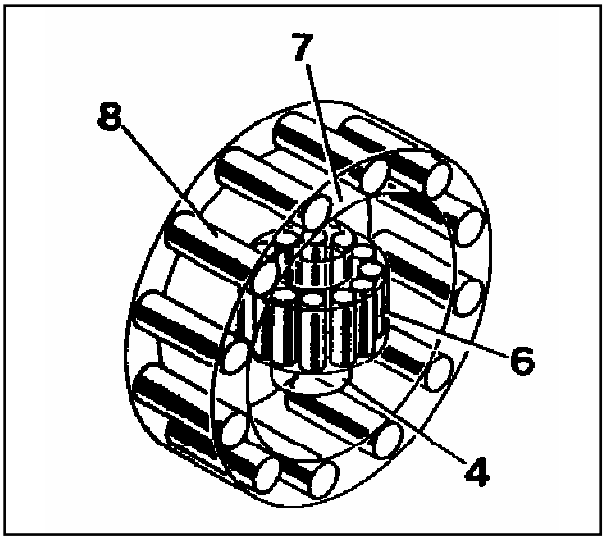


Figure J16

The external surfaces (1 & 2) rub on the profile and wear it off. They also wear themselves off obtaining a faceted surface.

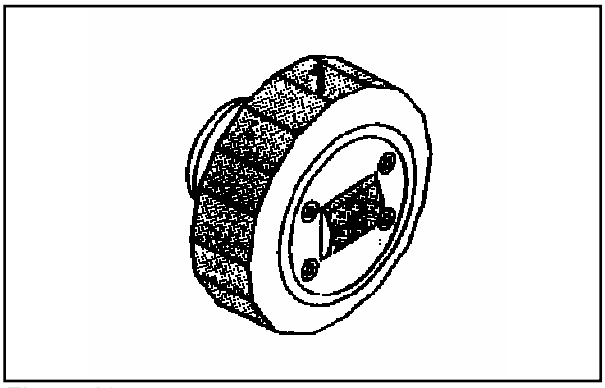


Figure J17

Shocks

Violent frontal collisions during loading may also cause bearing breakage.

The external surface will show cracks that cut the surface in lines parallel with the rolling axis.

Dimensions of the Load

Another possible cause of breakage, more difficult to prevent than the others, is the mounting of special equipment to transport very long loads (i.e. carpets), even if their weight is less than the nominal load.

This condition creates oscillations that cause detachment of the external hardened surface: in this case circumferential cracks will appear and will run completely around the roller.

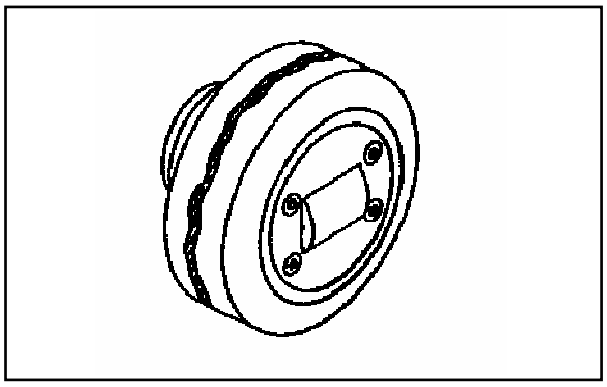


Figure J18

Profiles

Characteristics of the Profiles

The profiles used are made from the following kind of steel:

18 Mn Nb 6

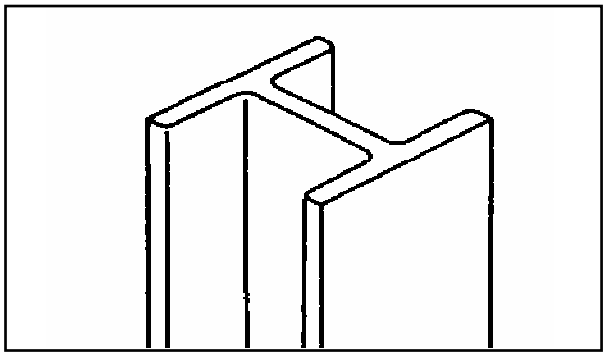


Figure J19

The compositions of such profiles are:

C	**about**	**0.18%**
Si	**about**	**0.5%**
Mn	**about**	**1.6%**
P	**<**	**0.016%**
S	**<**	**0.023%**
Al	**about**	**0.024%**
Nb	**about**	**0.05%**

Characteristic		
Yield stress	>	430 N/mm^2
Tensile strength	>	590 N/mm^2
% Elongation length A5	=	25%
Equivalent carbon	=	0.35

Manufacture of the Profiles

The profile is obtained by hot rolling, with very low dimensional tolerances.

The profile for forklifts with a range of 16,000 Kg or more is instead manufactured by welding.

Before use the profiles are tested, the rectangularity is checked and they are sanded to remove the superficial scale, residual from the rolling procedure.

Tolerances

The strict tolerance of the internal dimensions between the running tracks, permits an accurate clearance between the profile and roller.

During assembly, the clearance value is usually lower than 0.5mm.

The maximum acceptable limit is 0.7mm.

Run-in Period

If working correctly the rollers will produce a superficially hard surface on their tracks in the profiles.

An indication of the proper initial use is the shine the tracks assume after a few hours of work.

Lubrication of the Tracks

Before starting to use the mast the running tracks must be lubricated to allow a proper run-in period. Thereafter, the tracks will need periodic lubrication.

The frequency of this operation is at the discretion of the user and essentially depends upon the conditions of use and the workplace.
A lubrication interval of about 200 hours can be taken as a typical value under normal work conditions.

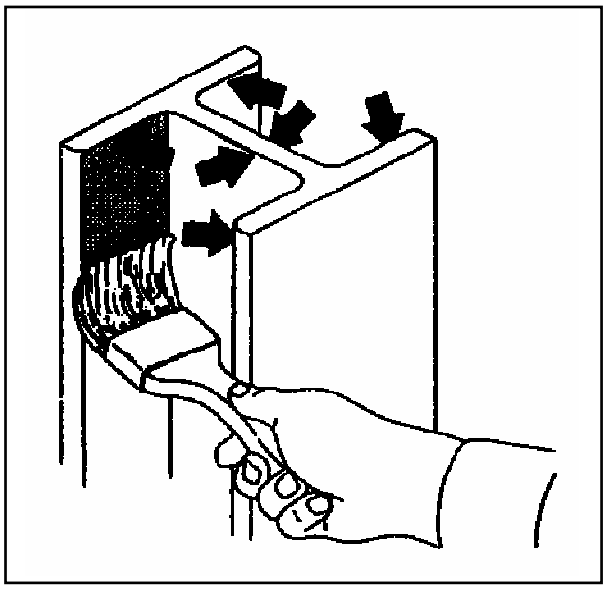


Figure J20

Wear and Tear of the Tracks

With time there is a certain wearing of the tracks, with a consequential increase of the clearance between the roller and profile.

When play reaches a value of 2mm, it is advisable to replace the standard roller with the oversize version.

The wear of the profile will start to have a certain influence, and therefore reduce the safety coefficient significantly only when the thickness of the wing has been reduced by about 15% of its initial value.

The wear limits are not the same on all masts or uniform in different points of the same mast.

The profiles on which the fork carriage runs will always be more worn out than the others, in particular the lower section compared to the middle and upper ones.

WARNING

Any modification to the mast may only be carried out after authorisation from narrow Aisle Ltd.

Always avoid making piercing and countersink operations on the profile.

In the eventuality of welding, always use basic electrodes.

Chains

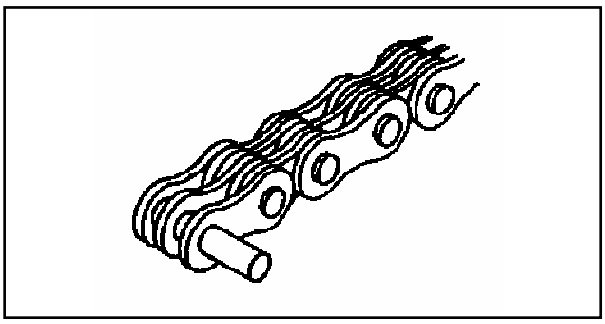


Figure J21

The chains used on masts are the link type, and have the characteristics of a first quality product.

They are used to withstand loads remarkably lower than their breaking point.

Normally, they work with a load that is 20% of their nominal load, which is always lower than the actual breaking point.

Lubrication of the Chains

Lubrication is essential for a long life of the chains.

A periodic lubrication is necessary, to be done with a brush, or spray bottle. Use SAE 20 oil in the winter and SAE 40 oil in the summer.

The frequency of this operation depends very much on work conditions.

For instance, long shifts and/or uneven ground surfaces that cause strong dynamic movements of the load will obviously require more frequent lubrications of the chain.

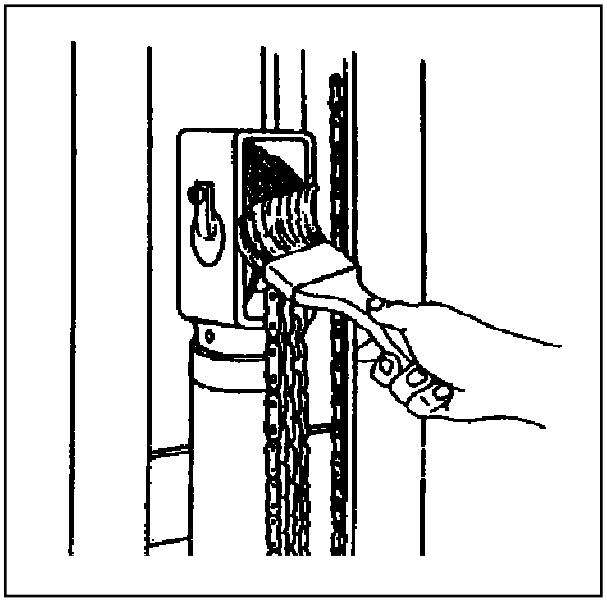


Figure J22

Wear and Tear of the Chains

With use, the chains might become stretched.

Such lengthening can be recuperated by adjusting the chain regulator. But if the full length of the chain regulator is used, it will be necessary to remove a link.

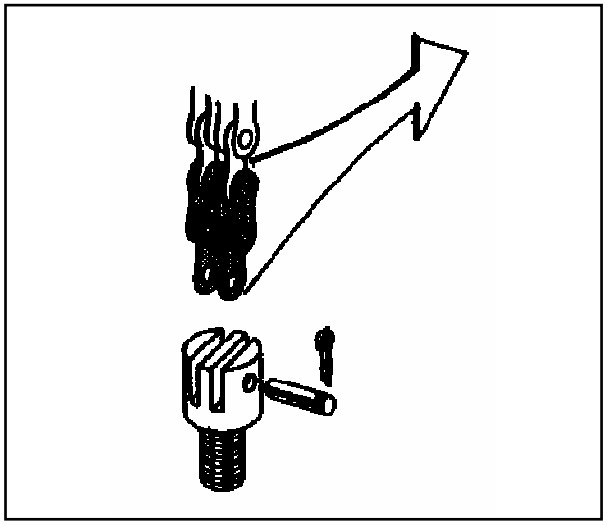


Figure J23

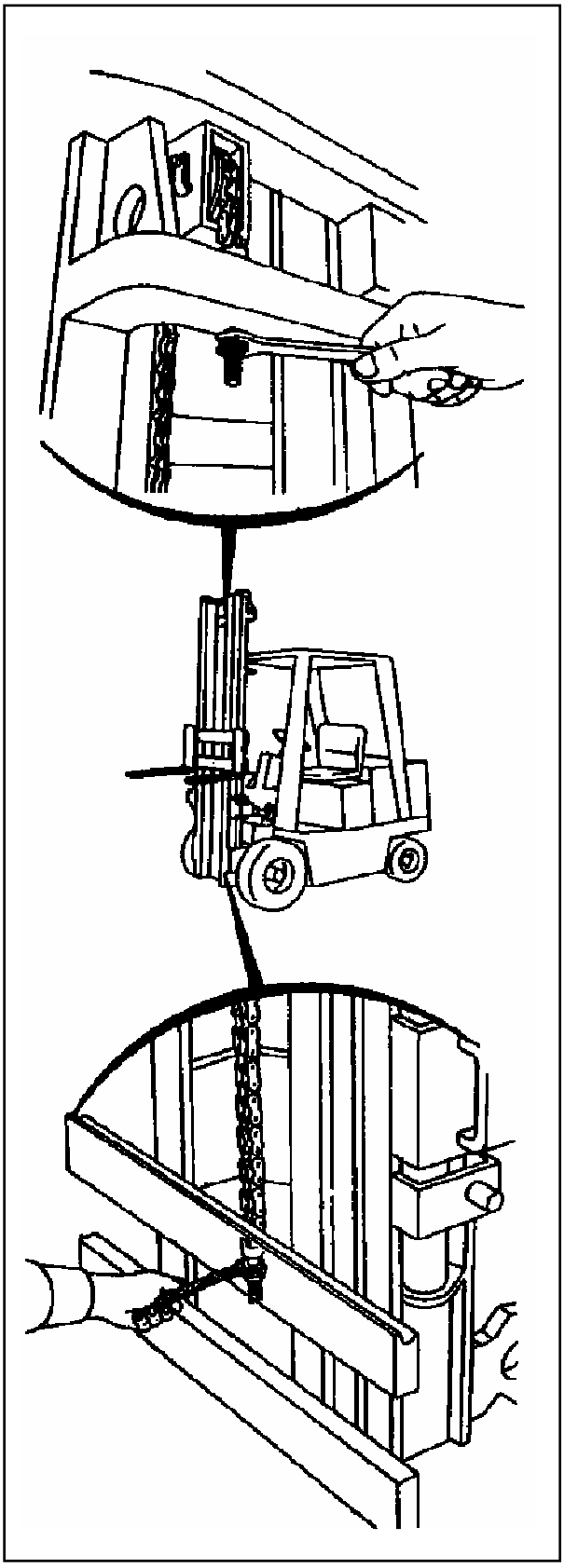


Figure J24

The maximum adjustment of the chain is dependent upon the regulations in force in the country in which the forklift is being operated.

Before measuring chain extension it is essential to take up any slack that may exist in the chain. For chains that are not removed the weight of the fork carriage or mast is sufficient.

Identify the most worn section of chain that regularly runs over the pulley. Measurement must then be made of a minimum of ten pitches in at least three separate locations on the most worn sections of the chain.

Up to 2% Elongation

On newly supplied chains, excessive deterioration compared with service history may be an indicator of manufacturing defects or unforeseen operating conditions. Under these conditions the competent person needs to make a judgement on the rate of deterioration which could lead to failure and advise on appropriate timescales for replacement of the chain.

>2% but <3% Elongation

Between these elongation limits a judgement on whether or not the chain can continue to be used safely up to the next thorough examination needs to be made. If not a timescale for replacement should be specified. When specifying the timescale, account should be taken of the following factors:

- Date of next thorough examination,
- Elongation measured, and
- Rate of deterioration since the last thorough examination.

When assessing the rate of deterioration account should be taken of the general condition of the chain and any local damage or wear which could significantly affect its performance or reliability.

With time, even the chain regulator, which is made from durable steel, is subject to wear and tear.

Therefore it is necessary to periodically check for wear, particularly ovalisation of the chain pin holes.

Adjustment of the Chains of the Fork Carriage

The chains must be adjusted so that the upper and lower blocks of the end-of-run stops never make contact.

The construction of the mast allows, when the chain is correctly regulated, a clearance of about 5mm between the upper and lower carriage stops.

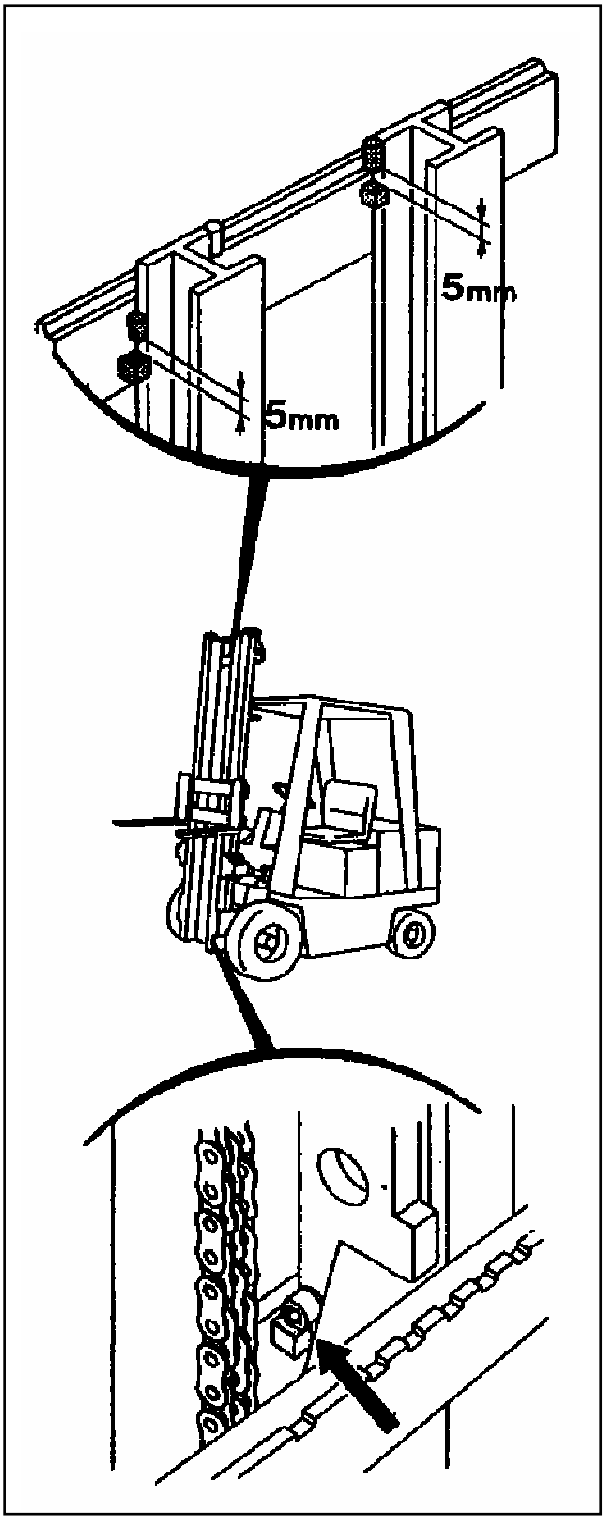


Figure J25

To adjust, remove the forks and adjust the chains in a way that between the lower stop of the carriage and the one situated on the internal mast there is a play of about 5mm.

Operate the central cylinder to the end of stroke and verify that the upper stop also has a minimum clearance of 1mm (with the load, the value of the clearance will have a tendency to increase reaching 5mm).

Keep in mind that, if this operation is not carried out and the stops are allowed to bind, (common case for machinery without forks), these will warp and the lower bearing of the carriage plate will come out of the mast.

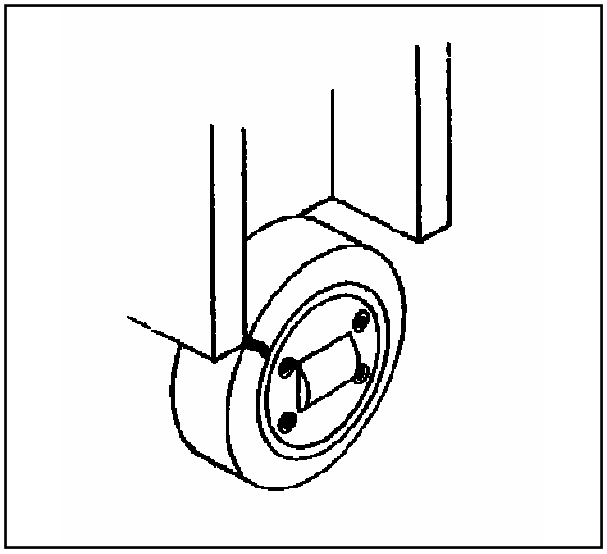


Figure J26

On the other hand, if too much clearance is allowed between the lower stops the upper ones could bind too much, causing large loads on themselves, the chain and in the cylinder.

Check that the chains that work in a parallel way always have the same tension. If not, adjust by means of the chain tensioner.

Cylinders

Cylinders used in the visibility series are of two types:

Displacement

With the seal in the cylinder plug.

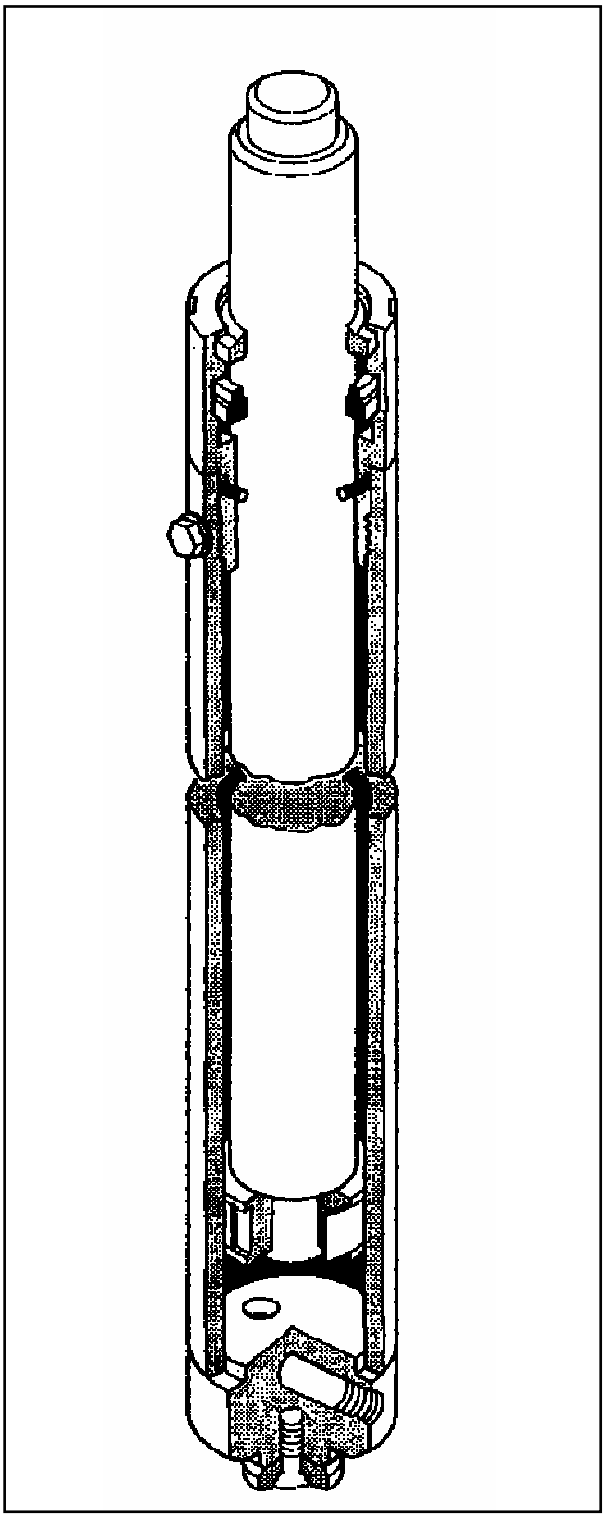


Figure J27

Piston

With the seal on the piston.

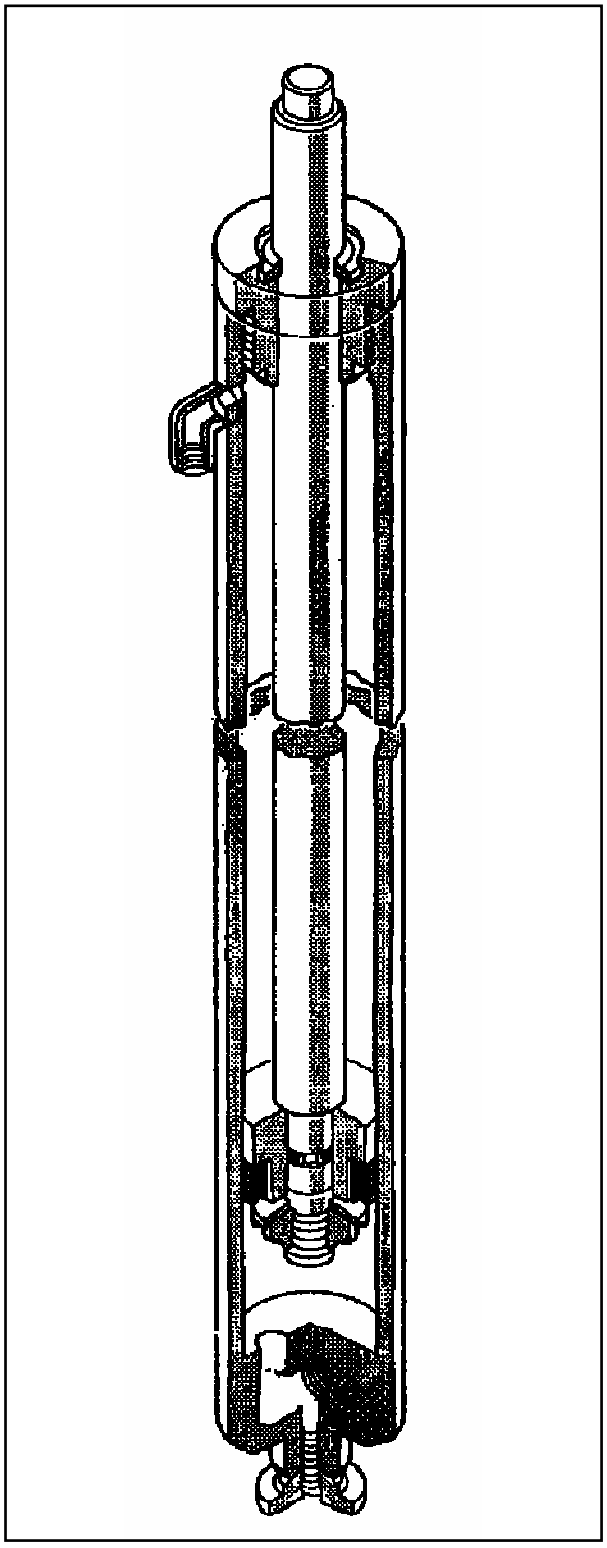


Figure J28

Displacement Cylinder

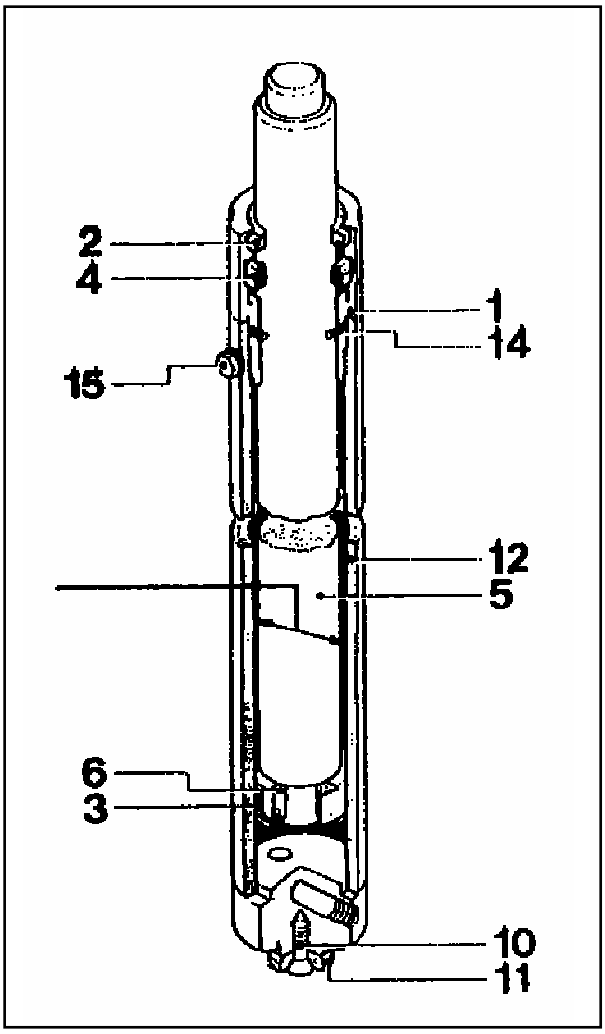


Figure J20

In these cylinders the seal is obtained by means of a seal (4) housed in the cap (1), in which the dust scraper (2) is also located. Also here are the 'O' ring (14) and the guide made of anti-friction material (when it is not, the cap itself provides this friction).

On the piston (6) there is also the seat of the other guide (3).

The dust scraper (2) stops dirt infiltrating under the seal (4).

This type of cylinder needs a purge screw (15) to allow the exit of the air that accumulates in the system.

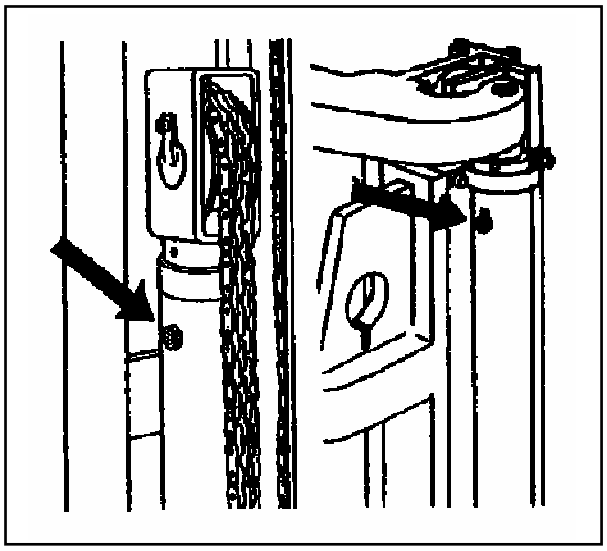


Figure J31

Piston Cylinders

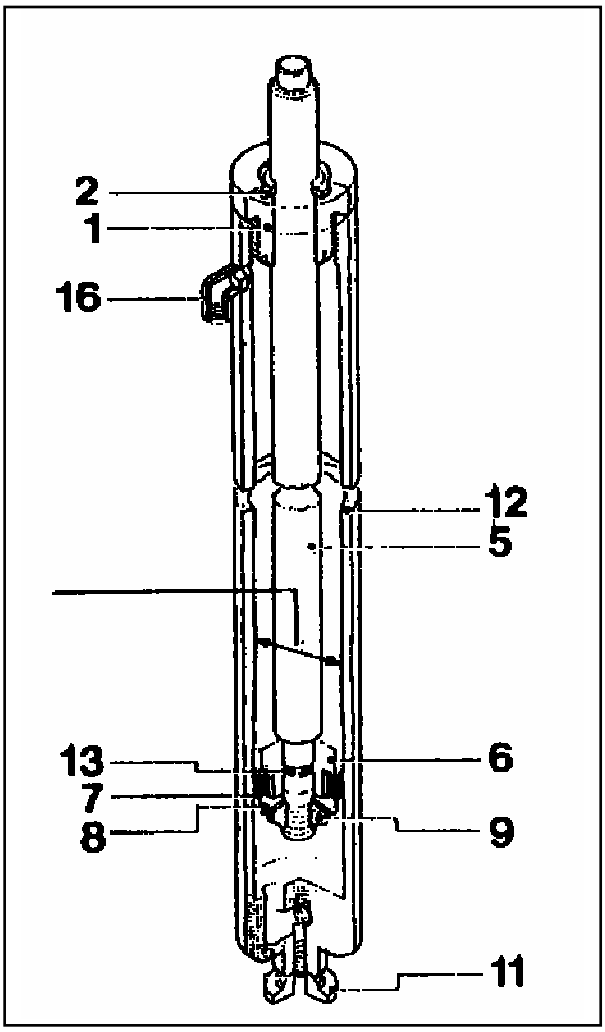


Figure J31

In these cylinders the seal is obtained by means of a seal (7), inserted on the piston (6), that works on the internal surface of the body (12).

The internal surface of the body is carefully polished, in fact its roughness values are between 0.18 and 0.25 microns. This guarantees the long life of the seal.

The rod guide is obtained by the cap (1) and the piston (6), by means of anti-friction rings.

Sometimes, instead, the piece (1) is made totally from cast iron and the ring is not necessary.

The O-ring (13) maintains the static seal between the piston and the rod.

The dust scraper (2) stops the dirt and water from seeping into the cylinder.

The little seepage that might occur is directed to the reservoir (tank) by means of the drainage tube joined to the body (16).

The drainage tube must reach the tank, yet always remain just above the oil level. Otherwise the cylinders could, during the descent phase, syphon a large quantity of oil that in the ascending phase, must be expelled through the drainage connection. This would create a strong counter pressure that would damage the dust scraper and would disconnect the drainage tube.

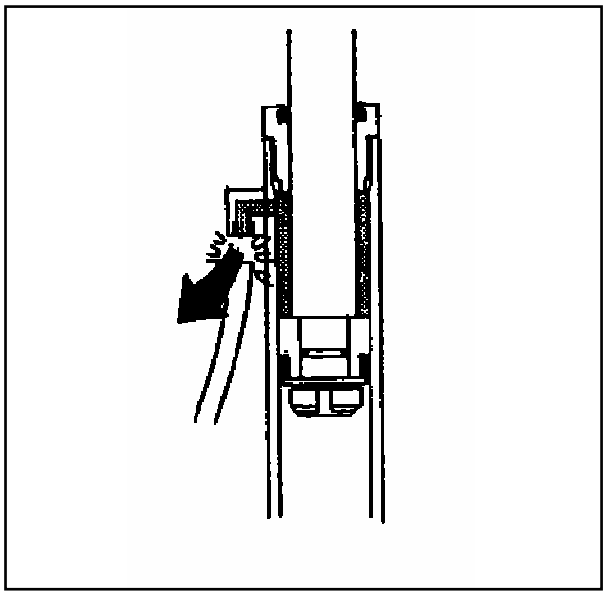


Figure J32

As already mentioned in the initial use instructions, there must always be a small amount of oil in the bend of the drainage tube just before it enters the tank.

Leaks in the Cylinders

Leaks in the displacement cylinders occur toward the outside. Therefore it will be very easy to recognise a damaged seal and to know when a replacement is necessary.

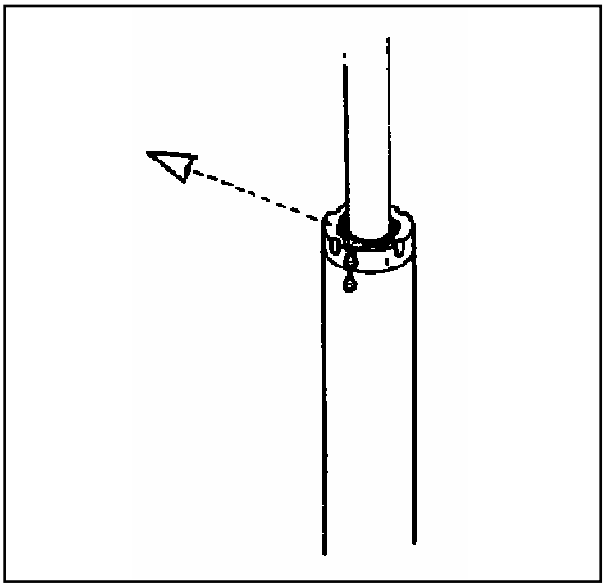


Figure J33

With the piston cylinders, the leaks are conducted to the reservoir by the drainage tube, and are not so easy to detect.

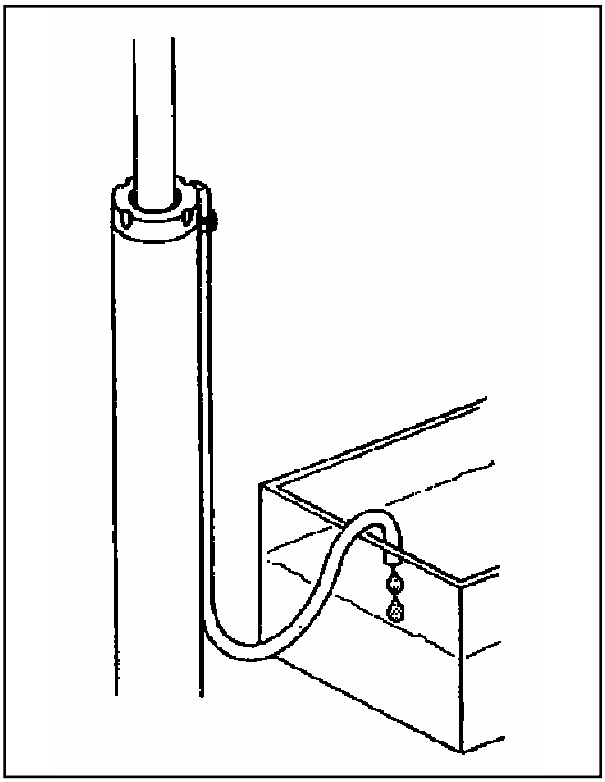


Figure J34

Instead it will be noticeable by a slow descent of the load. The presence of the drainage tube of the holding cylinders does not necessarily mean that leaks are present.

The drainage tube may in fact accumulate a certain amount of oil from the tank that could be expelled during lifting giving the impression of a leak.

Test Procedures for the Lateral Cylinders Static Test

Remove the drainage tube.

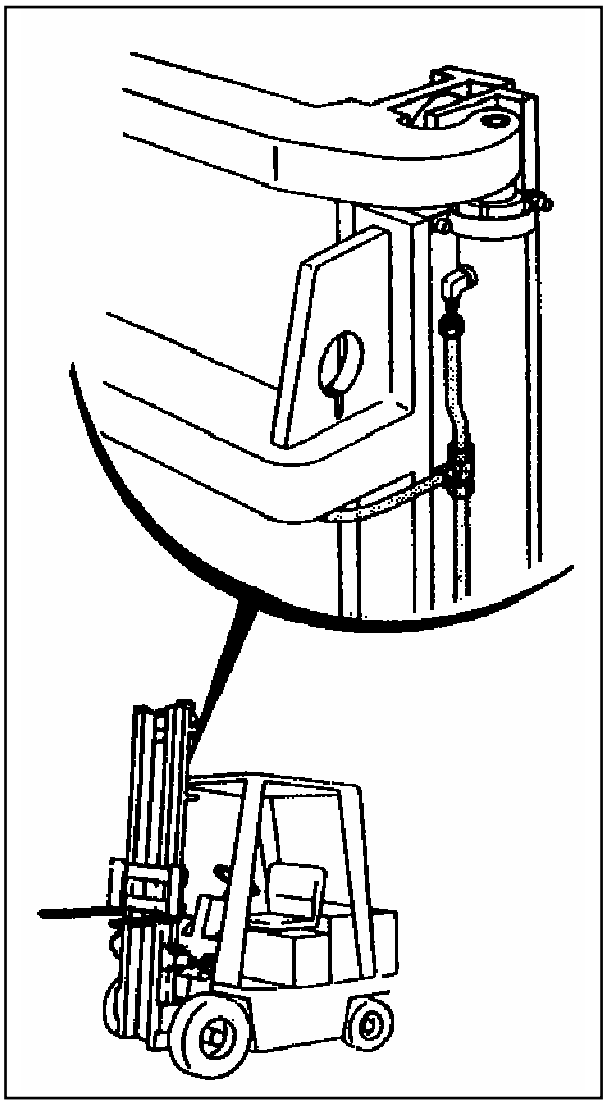


Figure J35

Repeatedly operate the cylinder to the end of stroke, so that all the oil may be expelled.

Put a load on the forks and lift it, so that the cylinder completes a stroke of at least 200mm.

Mark the position reached by the mobile mast

compared with the fixed mast.

After about 20 minutes, check how far the load has descended. A few millimetres are normal as there is always some leakage in the truck control valve. Now operate the cylinder to the end of stroke. If there is no oil expelled at the drainage connection, this means the seals are in good condition and that the load has lowered due to the control valve leakage. If oil is expelled, replace the seal. In this case inspect the bore of the cylinder.

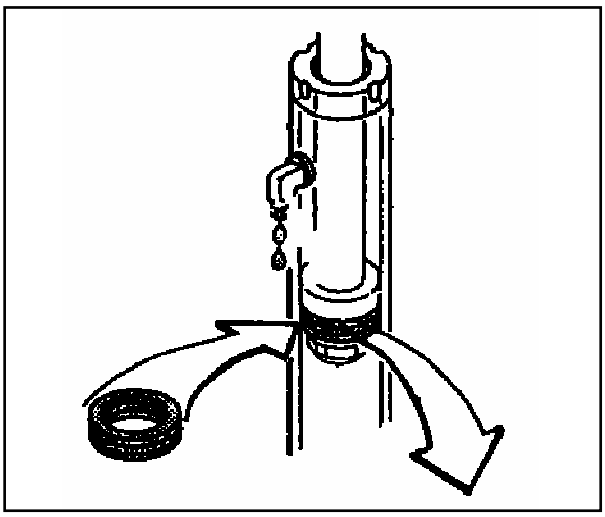


Figure J36

Dynamic Test

To be carried out after a good result of the static test and also after the replacement of the seals.

Always remove the drainage tube.

Repeatedly operate the cylinder to the end of stroke, so that all the oil is expelled.

Put a load on the forks and make it go up and down for 20 minutes, paying attention that it never reaches the end of stroke.

Finally send the cylinder to the end of stroke.

If leaks are present, it means that the cylinder must be replaced.

Dismounting the Lateral Cylinders from the Mast

The rod of the cylinder is normally anchored to the crossmember on which it pushes by means of a screw situated on the head.

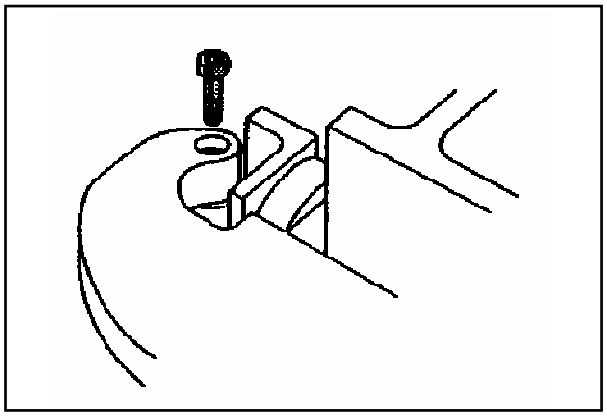


Figure J37

Unscrew the anchor screw that holds the rod to the crossmember. Remove the drainage tubes.

Hydraulically lift the mobile mast about 200mm to which the rod is connected.

Put a support between the lower part of the mobile mast, to which the cylinder is anchored, and the ground.

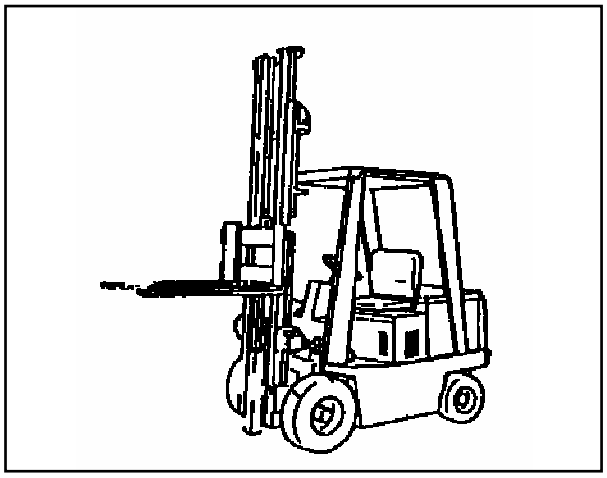


Figure J38

Lower the mast up to when it rests on the support.

When the mobile mast has rested itself on the support, it will stop and the free lift cylinder will lower.

The lateral cylinder body is attached by means of a little band on the upper part and a circlip on the lower one.

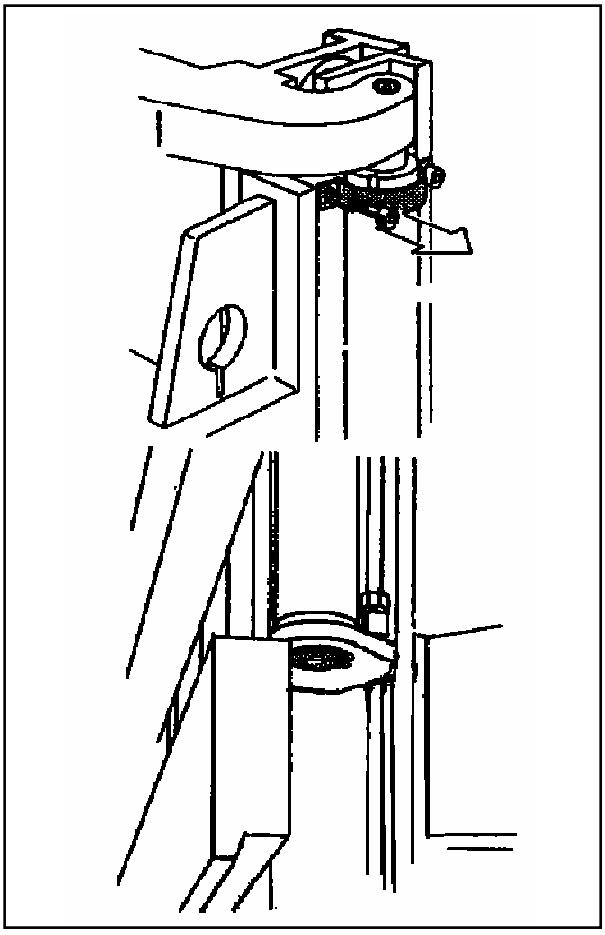


Figure J39

Remove the anchors mentioned above and the feeding tubes

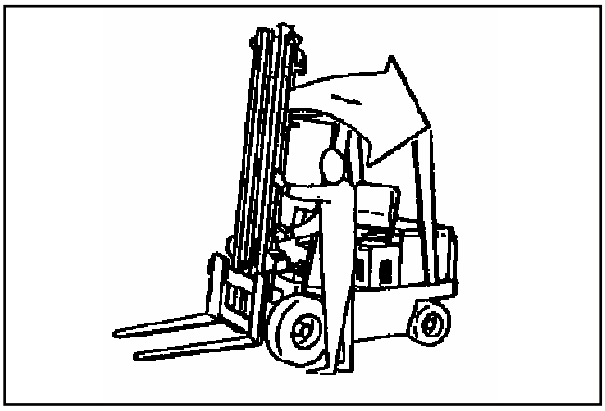


Figure J40

Remove the cylinder.

Sometimes the mast mounting brackets prevent removal of the cylinders in this way. In these cases the mast must be separated by a greater amount to allow the cylinders to be removed more or less vertically.

Replacement of the Seals in the Lateral Cylinders

It is necessary to provide the mast serial number (MAXXXX) to ensure correct replacement seal parts.

When it is necessary to replace the seals, observe the following procedure:

Unscrew the cap (1) by means of the proper tool. Avoid hitting it with pointed objects.

Pull out the rod.

Unscrew the metal ring (9). Dismantle the piston

(6). Substitute the parts (13, 7 and 2).

Reassemble the piston (6) and retighten the metal ring (9).

Remount the rod using the proper seal loader, as shown in the table below:

Remove all grease and oil from the cap (1).

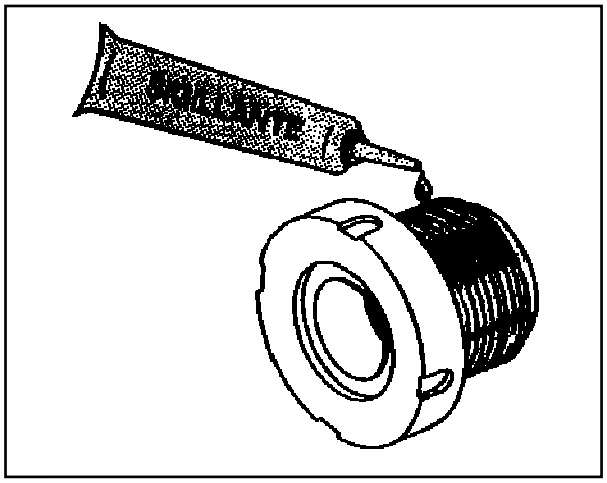


Figure J41

Apply two drops of sealer on the thread of the cap (1).

Retighten the cap.

Note: When the seal is replaced, also substitute all other parts contained in the kit.

Replacement of the Seals in the Displacement Cylinders

In the displacement cylinder all seals are located in the cap (1). Therefore it is not generally necessary to dismantle the cylinder from the mast.

In the central cylinders it will be necessary to remove the chain and unscrew the chain sheave holder assembly.

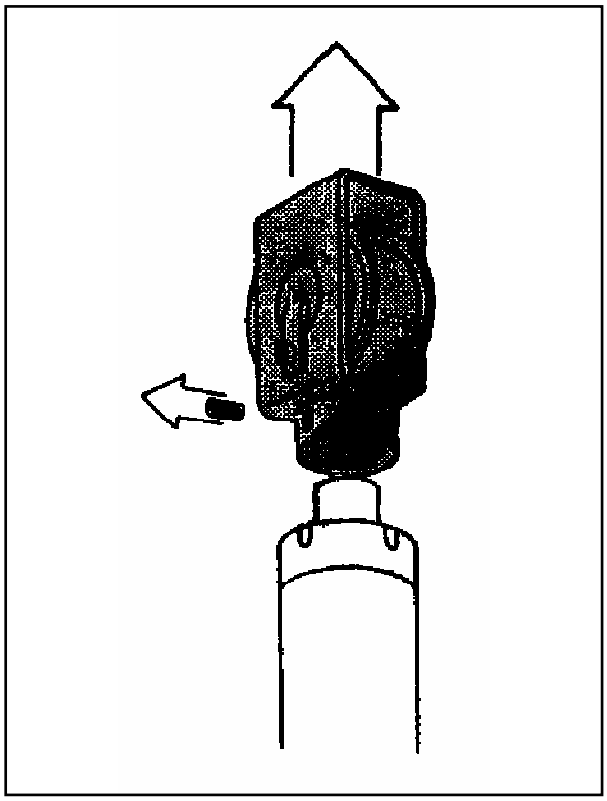


Figure J42

Note: The assembly is anchored to the rod with a screw. Remove it before attempting to unscrew.

In the lateral cylinders it is sufficient to work with the crossmember on which the rod pushes detached by 200/300mm.

Observe the following procedure.

Unscrew the cap (1) with the proper tool. Avoid hitting it with pointed objects.

Replace the seals (2, 4 and 14).

Retighten the cap (1).

Purge the air through the vent screw (15) as previously described.

Narrow Aisle Mast

Before removing mast ALWAYS ensure that the carriage is fully lowered.

Removal

1. Remove the cap head setscrew from the front of the carriage and remove forks.
2. Attach suitable lifting equipment to the mast to prevent it moving in an uncontrolled manner.
3. Disconnect mast microswitch.
4. Disconnect all hydraulic hoses.
5. Remove the two tilt cylinder pivot pins from the brackets attached to the mast.
6. Remove mast support caps, lever the bottom of mast forward to allow tilt cylinder brackets to clear mast support assembly, and lift the mast clear of the truck.

Overhauling

Instructions for overhauling the mast are given later in this section.

Refitting

Refitting the mast is the reversal of the above instructions.

When refitting the mast pivot bushes the hole in the bush **MUST** be aligned with the lubrication hole in the mast support cap to enable the pivot bushes to be greased.

If new bushes are to be fitted, they must be drilled after initial fitting by removing the grease nipple, drilling through the lubrication hole - taking care not to damage the threads, removing the bush to allow all swarf to be cleaned off and fitted finally with the drilled hole aligned with the lubrication hole.

Cylinders

Free Lift

Note: Unless the cylinder tube needs replacing it is not generally necessary to remove the entire cylinder for reseal.

Removal

1. Lift carriage sufficiently to expose the cylinder hydraulic connections and block in position using suitable block. Lower cylinder fully to remove all hydraulic fluid.
2. Remove hydraulic fittings from cylinder.
3. Remove cylinder clamp.
4. Slacken grub screws securing chain sheeve onto cylinder ram and remove sheeve complete with chain and hoses, where fitted.
5. Slacken grub screw securing cylinder in place and lift cylinder clear.

Overhaul

Overhaul cylinder by following the instructions set out in Section G Hydraulics.

Refitting

Refitting the free lift cylinder is the reverse of the removal instructions.

Main Lift Cylinders

Note: The main lift cylinders must be removed to enable service work to be carried out.

Removal

1. Raise mast sufficiently to enable the ram to clear the mast section when the ram is lowered. Slacken the grub screws securing the cylinder top and bottom.
2. Support the mast channel with a suitable support.
3. Lower the ram fully to remove all hydraulic fluid from the cylinder.
4. Disconnect the hydraulic feed to the cylinder.
5. Remove cylinder top clamp.
6. Lift the cylinder clear.

Overhaul

Overhaul cylinder by following the instructions set out in Section G Hydraulics.

Refitting

Refitting the main lift cylinder is the reverse of the removal instructions.

Bump Stops

Removal

1. Raise the mast enough to gain access to the bump stop fixings.
2. Remove the bump stop fixings.

Refitting

Refitting the bump stops is the reverse of the removal instructions.

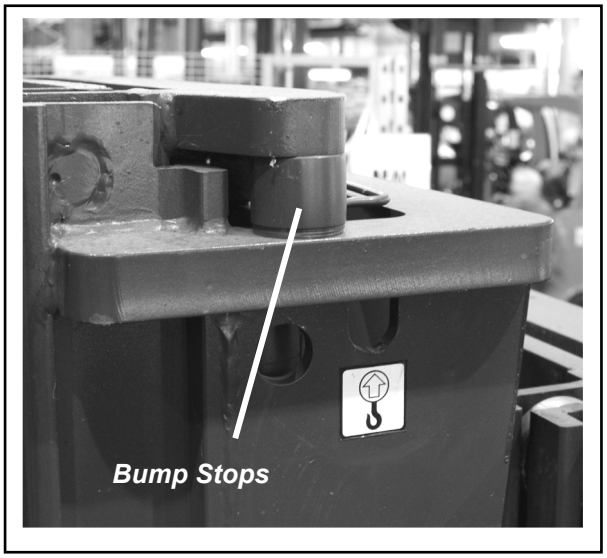


Figure J43

Integrated Sideshifter

Introduction

This section contains important information on how to operate the attachment properly, safely and efficiently.

The operating manual shall be read, understood and applied by all personnel working on or with the equipment, for example:

- Installing and operating the equipment
- Inspection, maintenance and repair
- Transport and disposal

WARNING

The illustrations in this operating manual may deviate from the actual version of the equipment.

Qualified and authorised personnel

Qualified and authorised personnel are equipped by way of their education and training to perform the tasks assigned to them in accordance with accepted practice and safety regulations. They are assigned tasks by the equipment owner.

Warranty claims based on defects

KAUP shall not be liable for any damage to the equipment resulting from:

- Improper use / operation.
- Modifications to components.
- Inappropriate installation, maintenance, inspection and servicing.
- Assignment of unqualified or non-authorised personnel.
- Claims raised by third parties.

Limits of Applicable Use

Kaup attachments are intended for use under the following climatic conditions:

- Average ambient temperature for continuous operation +25°C
- Allowable maximum ambient temperature, short term (up to 1hour) +40°C
- Allowable minimum ambient temperature for attachments intended for indoor use +5°C
- Allowable minimum ambient temperature for attachments intended for outdoor use -20°C

Standard models of Kaup attachments are **NOT** suitable for:

- Use in cold storage facilities.
- Use in explosive environments
- Use in conjunction with hydraulic systems involving biological oils.
- Use in rough environmental conditions (e.g. seawater)
- The transport of acidic liquids.

Safety Aspects

- As the user, extend the safety instructions with generally applicable, legal and other measures that ensure a safe and environmentally friendly operation of the attachment.
- Pay close attention to all safety- and danger-related signs on the attachment and in this operating manual. Failure to observe these can result in severe injury or even death.
- Pay close attention to the operating manual provided by the manufacturer of the fork lift truck.
- Keep a safe distance away from moving, reciprocating or rotating parts of the attachment to avoid danger of crushing, pinching or entanglement.
- Notify the responsible department/person immediately of changes and faults in operation of the attachment that affect safety. The attachment shall be shut down.
- Use aids to vision (e.g. mirrors, camera, etc.) where goods being transported obstruct vision.
- Only allow work on the attachment to be carried out by qualified and authorised persons. Adhere to the legal minimum age in the country of operation!
- The attachment should only be used for the purpose intended.
- Never work on or with attachments while under the influence of drugs, alcohol or medicines which affect reaction time.

Design

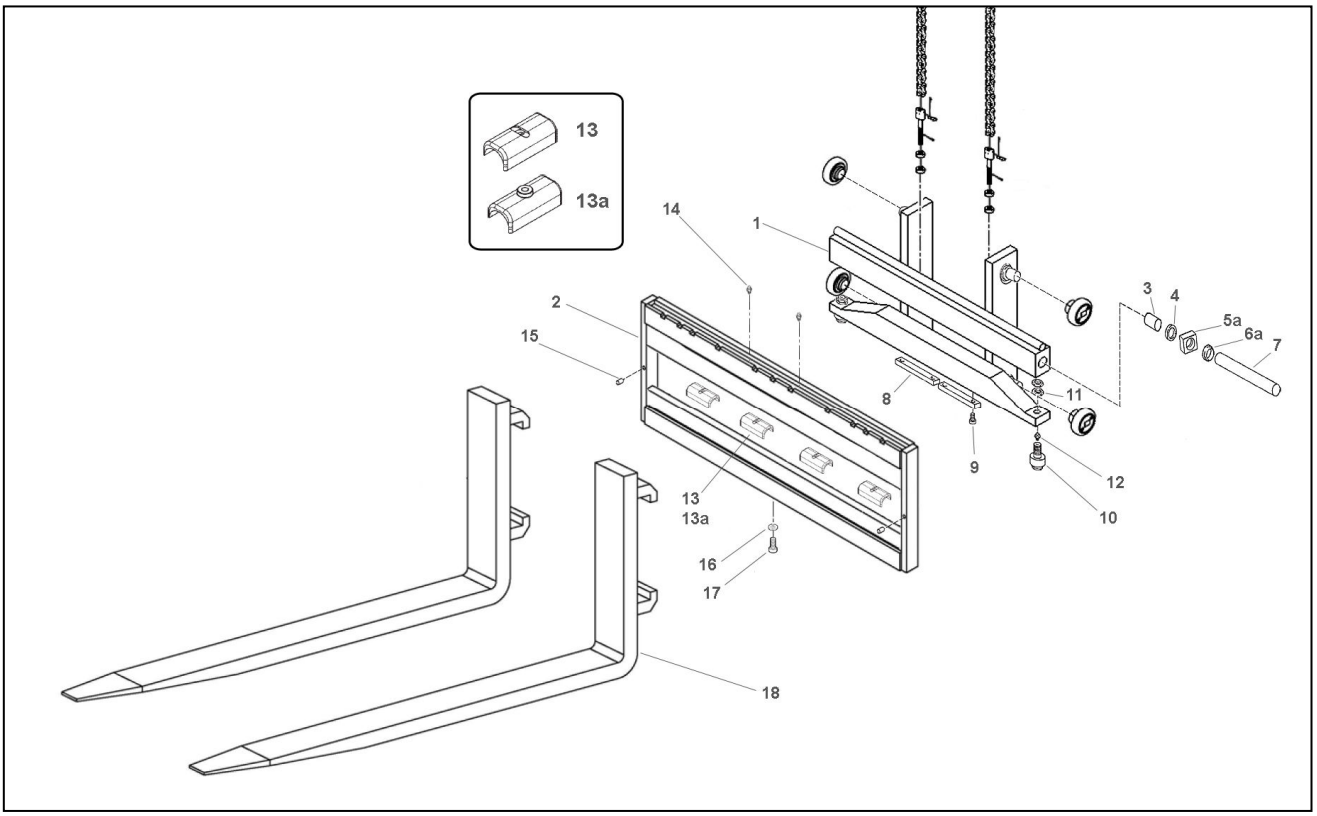


Figure J44 - Kaup Sideshifter

Ref	Description	Qty
1	Kaup standard Mast Carriage Assembly	1
2	Fork Carriage	1
3	Bush - Glacier	2
4	Groove Ring	2
5	Washer	2
6	Stripper	2
7	Piston Rod	2
8	Holder	2
9	Screw (M16 x 60)	2
10	Guide Roller	2
11	Nut (M30)	4
12	Grease Nipple (M8)	2
13 / 13a	Sliding Piece	4
14	Grease Nipple (M8)	2
15	Steel Pipe	2
16	Washer - Spring (M16)	1
17	Screw - Cap Head (M16 x 25)	1
18	Fork	2
19	Roller Bearing Assembly	4
20	Chain Anchor Assembly	2

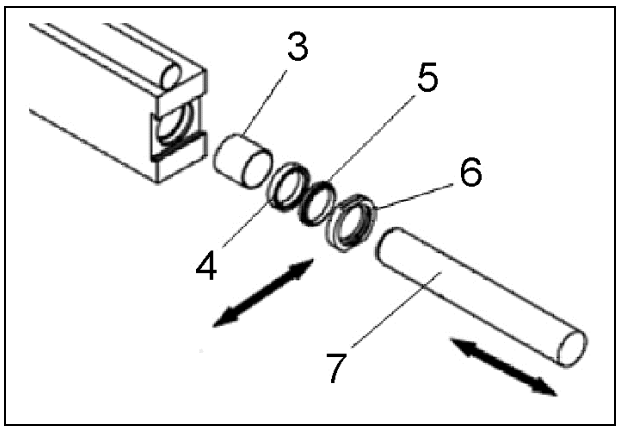


Figure J45 - Kaup Piston System

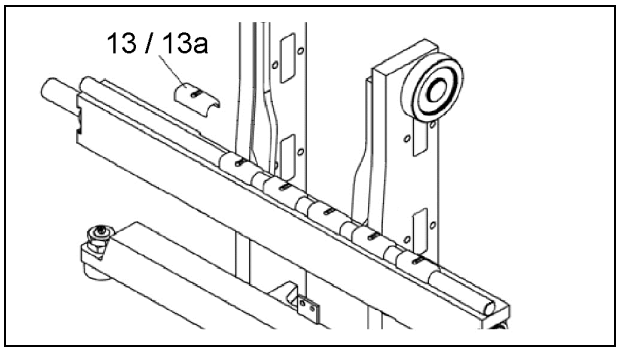


Figure J46 – Sliding Pieces

Proper Use of the Equipment

The sideshifter is intended for shifting raised (10 cm) loads sideways. This allows loads on the attached load forks to be positioned precisely in racks or on truck platforms without the need to manoeuvre the fork lift truck.

Proper use of the machine and/or equipment includes the following:

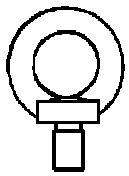
- Observance of the operating manual at all times.
- Observance of the technical data on the identification plate on the attachment.
- Adherence to the specified inspection and maintenance instructions.

Improper Use of the Equipment

- Exceeding the allowable load capacity or load centre.
- Dragging or pushing loads with the attachment.
- Moving the load while it is resting on the floor or truck platform
- Transporting persons with the load or load handling devices
- Mounting auxiliary equipment in the attachment such that the original mode of usage is changed, (e.g. fork extensions) must be authorised by the manufacturer.

Installation

- Installation and commissioning should be performed by qualified and authorised personnel only.
- Pay attention to a sufficient load-carrying capacity of the lifting means.
- The following are examples of preferred lifting means:

	Capacity (kg/ M16)	Part No.
	250	9710160008
	1200	0360010201
	2000	0360010301

- Integrated sideshifters are part of the conveyor truck and must be installed in the mast in accordance with the instructions issued by the truck manufacturer. This applies in particular to the choice of mast rollers, stops, chain attachments and hydraulic connections.

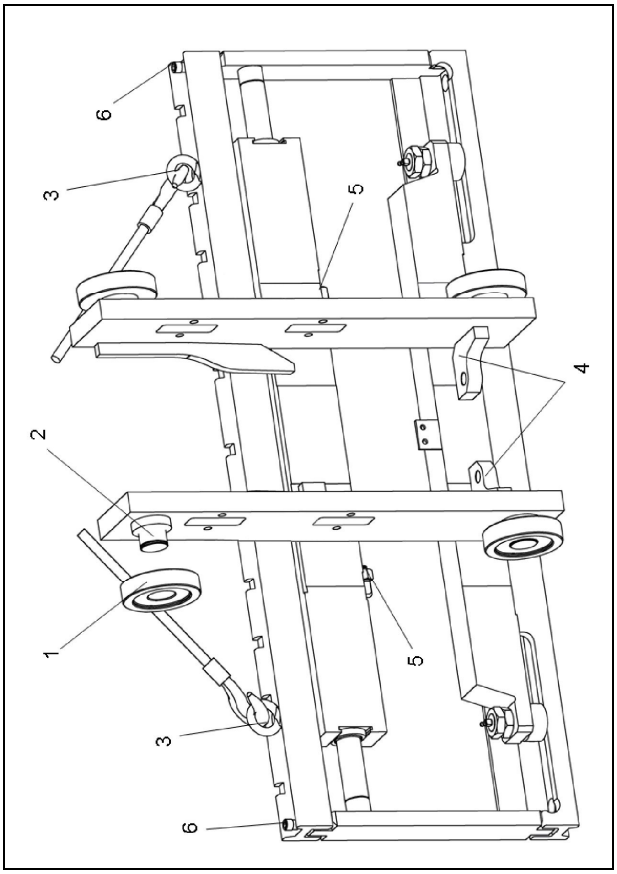


Figure J47 – Sideshifter Installation

- Mount the mast rollers (1) on the sideshifter's roller pins (2).
- Install additional stops to prevent the rollers from coming out of the mast.
- Using suitable lifting means (3), lift the sideshifter and ease it into position in the mast.
- Connect the mast chain to the eyes (4) on the carriage and secure the chain.
- Install the stops necessary to limit lift on the mast.
- Connect the hydraulics (5) to the truck's hydraulic system.
- **Mast designs vary, so the procedure for installation might not necessarily be as described here. Always comply with the specifications and instructions issued by the manufacturer of the mast.**
- Remove the safety retaining stops (6) and slide the fork arms onto the fork carrier from the side.
- Make sure that all safety retaining stops (6) have been correctly reinstalled.
- Before initial operation, check the functions and the identification of the attachment with the movement directions of the operating elements (operating lever, joystick, etc.).
- Mount the residual carrying capacity notice and identification of the operating elements (if not already present) of the combination of lift truck/attached equipment on the lift truck

KAUP-attachments are delivered pre-lubricated. If the attachment has been in storage for a longer period, we recommend that it be lubricated again before being placed in service. See Maintenance (page J27)

CAUTION

Failure of the safety devices (e.g. the pressure relief valve and the non-return valve) and incorrect connection of the controls to the actuators can cause malfunctioning of the attachment and damage to it.

After mounting and before initial operation, check the functions and the identification of the attached equipment with the movement directions of the operating elements (operating lever, joystick, etc.).

Bleeding the Hydraulic system

- Start the truck.
- Move the sideshifter repeatedly in both directions to maximum extent.
- Inspect the hydraulic connections for leakage.

Adjustment after putting into service

The hydraulic system is under pressure. During work on hydraulic components, oil spurting out can cause injuries. Unload the system in accordance with the operating instructions of the lift truck manufacturer. In the case of injuries caused by high pressure oil, inform the works physician and seek out a specialist immediately.

Operation

General Operation

- At least once per working shift, the machine and equipment must be inspected for visible damage and defects. Repeat faults to your superior and have them rectified without delay.
- Be aware of persons present in the area where you are working or driving and ensure that they are not endangered.
- Do not transport any load exceeding that specified on the residual load plate for the particular combination of lift truck and attachment.
- The nominal capacity of the forks must exceed the load.

Load Handling

- Set the forks as wide apart as possible for the load to be carried.
- Position the mast vertically and take up the load parallel to the floor.
- Always transport pallets, boxes and containers using both forks.
- Drive the attachment up to the load to maximum extent.
- Raise the load about 300 mm and tilt the mast backwards.
- Centre the load to the middle of the lift truck during take-up and transport.

Driving

- Ensure that pallets, boxes, containers and packaging are in good condition.
- Do not drive with the mast tilted forward.
- Take care when driving that neither the attachment nor the load comes into contact with the ground.
- Ensure that multiple items stacked on top of one another are securely fastened.

Maintenance and Servicing

General

Regular maintenance is essential to ensure reliable operation and long service life of the KAUP attachment.

- Ensure that maintenance and servicing are performed by qualified and authorised personnel only.

- Lubrication and cleaning work on the attachment may also be performed by the lift truck operator.

- Perform maintenance and servicing work only when the attachment is parked securely on a stable, level foundation. For installing and removing, it is recommended to use a pallet to take the attachment. The attachment can thus be securely placed and transported.

- Pay attention to a sufficient load-carrying capacity of the stop device.

- Replace missing or defective warning signs on the attachment.

WARNING

Do not use third party spare parts. Through poor quality or incorrect matching they can result in a risk of accident. The EC Declaration of Conformity by the manufacturer becomes invalid and you assume full responsibility in the case of accident. Use only original spare parts from the manufacturer.

CAUTION

The hydraulic system is under pressure. During work on hydraulic components oil spurting out can cause injuries. Unload the system in accordance with the operating instructions of the lift truck manufacturer. In the case of injuries caused by high pressure oil, inform the works physician and seek out a specialist immediately.

WARNING

Screw connections can loosen due to vibration of the attachment. During routine maintenance check that screw connections are correctly torqued and replace screws which are visibly damaged.

Note the following tightening torques which are valid for screws with connecting surfaces according to ISO 4762, ISO 4014, ISO 4032 etc.:

Screw/bolt Rating	8.8	10.9	12.9
M6	9.3Nm	14Nm	16Nm
M8	23Nm	33Nm	39Nm
M10	45Nm	66Nm	77Nm
M12	77Nm	115Nm	135Nm
M16	190Nm	280Nm	330Nm
M20	385Nm	550Nm	640Nm

WARNING

Failure of the safety devices (e.g. the pressure relief valve and the non-return valve) and incorrect connection of the controls to the actuators can cause malfunctioning of the attachment and damage to it.

After mounting and before initial operation, check the functions and the identification of the attached equipment with the movement directions of the operating elements (operating lever, joystick, etc.).

Significant Modification

Significant modifications are, for example, those which affect the stability, performance, speed and strength of components.

Modifications to the attachment may only be made with prior approval by the manufacturer.

Lubricants and Schedule for Routine Maintenance

Approved and recommended Lubricants

Greases	For example	Note
Lithium soap grease NLGI Class 2	Avialith 2	Designation DIN51825 K 2 K-30
Complex soap grease NLGI Class 2	Turmogrease Gel M 5	Foundry quality
Teflon spray	Wieds or Rivolta	Only for plastic sections

The specified maintenance schedules can change as a result of the operating conditions such as extreme cold, heat and dust or poor ground conditions and this must be taken into account by the owner.

With other loads, such as fork arms with a length of over 2,400 mm or raised load centres, amended/shorter maintenance intervals should be agreed by the user with the manufacturer.

Check Daily

- all lines, hoses and connections for leakage and damage.
- Ensure that all fork safety retaining stops are present and undamaged.

After 50 hours and every 500 hours thereafter

Check Screws:

- Retaining System
- On the hooks, model 8 – 10T
- On the fork safety retaining stops

Replace loose or damaged screw. Torque the screws as specified above.

Weekly

Grease

- Sliding pieces by way of the greasing nipples
- Supporting rollers by way of the greasing nipples

Every 200 hours

Check wear on:
- Sliding pieces
- Piston rod
- Supporting Rollers

As Necessary

Supporting Roller 1 – 6 T
Replace defective support rollers by removing the screws and the retaining system. Use suitable lifting gear to lift the complete fork carrier off the carriage. Remove the nuts and replace the support rollers. Install and tighten the first nut and lock it by installing and tightening the second nut. Reinstall the fork carrier; installation is the reverse of the removal procedure.

Sliding Pieces
Replace worn sliding pieces by removing screws and hooks, model 8 – 10T or the retaining system. Use suitable lifting gear to lift the complete fork carrier off the carriage. Replace the sliding pieces. During installation pay close attention that the sliding pieces are seated correctly. Remount the fork carriage in the reverse order.

Piston System A, 1 – 6 T
Piston rod, bushing, seal kit; renew defective parts by removing the bolts and the retaining system. Use suitable lifting gear to lift the complete fork carriage off the lift truck. Pull out the piston rod to the side with unpressurised hydraulic system. Slide the washer out of the upper rail. Replace the defective parts and mount the parts in the reverse sequence

Identification Plate and Caution Board

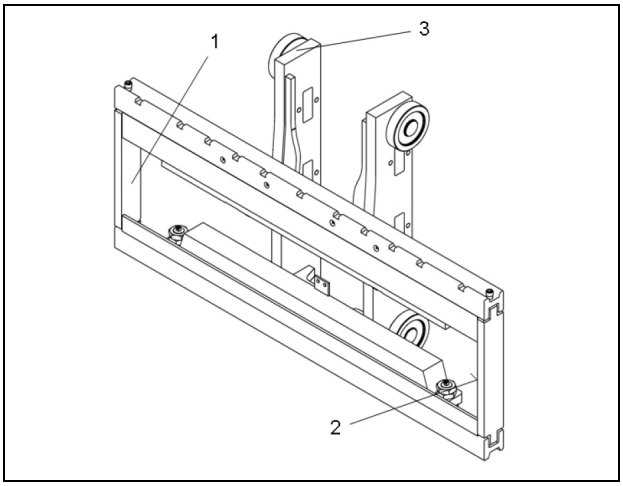


Figure J47 – Plate Locations

1. **Identification Plate** without CE-Mark, from quality department

Figure J49 – Identification Plate

2. **Caution Board,** before putting into operation carefully read and take note of the operating and security instructions.

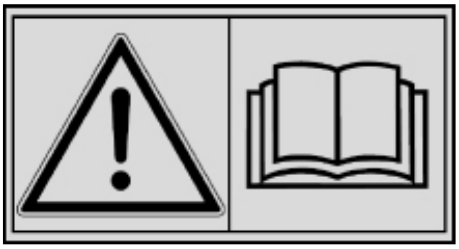


Figure J50 – Caution Board

3. **Serial Number,** engraved into material

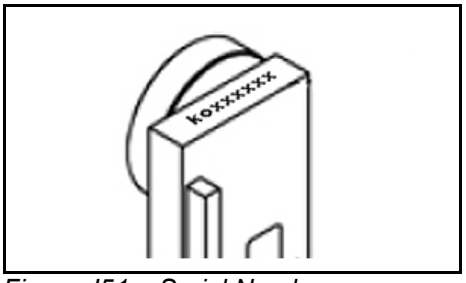


Figure J51 – Serial Number

Transport

During transport of the attachment, car should be given to using appropriate means of support (e.g. pallets). These must not be damaged. The attachment must be secured against slipping or tipping over on the support.

Decommissioning and Storage

If the attachment is to be stored for an extended period, the hydraulic connectors must be sealed against contamination and damage. Store the attachment in a clean, dry environment.

Disposal

Prevent environmental damage by disposing of the following items properly in accordance with relevant national regulations:

- Hydraulic fluids, greases, lubricants and soiled working materials (cleaning rags etc)
- Packing materials (Pallets, straps, cartons and plastic sheeting)

After decommissioning, the attachment should be disposed of in accordance with local legislation and regulations.

Troubleshooting

Troubleshooting should only be performed by qualified and authorised personnel.

Fault	Possible Cause	Correction
When Shifting		
Too Slow	Pressure supplied by the lift truck too low.	Increase pressure at the lift truck.
	Bore of the throttle valve is too small	Re-bore the throttle valve or replace it with a larger one.
Jerky Shifting Action	Sliding pieces not properly lubricated.	Lubricate the sliding pieces.
Too Much Clearance in Sliding Guides	Sliding piece is worn.	Replace the sliding piece.
Oil Leakage		
Cylinder is Leaking	Screw fitting is leaking.	Tighten / seal screw fitting.
	Sealing kit defective.	Replace sealing kit.
	Piston rod scored.	Replace piston rod and sealing kit.

Seat and Covers

This Page is Intentionally Left Blank

Contents

This Page is Intentionally Left Blank

Battery Cover

The battery cover is removed by lifting and turning the two latches. The battery cover now comes straight off the top of the battery compartment.

Spool Valve Fascia Panel

Removal

1. Remove the spool valve levers.
2. Undo the four M4 screws securing the fascia panel to the front electrical cover and lift off.

Refitting

Refitting is the reversal of the above instructions.

Note: After re-fitting the spool valve levers, ensure that the symbols indicating the control lever function are the correct way round (as seen by the operator).

Front Electrical Cover

Removal

1. Disconnect battery plug.
2. Remove spool valve fascia panel.
3. Lift seat pan and remove the two M8 hex head screws securing the cover to the electrical mounting plate.
4. Lift the cover, tilting it forward in order to allow it to clear the handbrake lever as you do so, and remove.

Refitting

Refitting the front electrical cover is the reversal of the removal instructions.

Seat Pan

NB: Remove battery cover before lifting seat pan.

Removal

1. Disconnect battery plug and withdraw plug through hole in rear of seat pan.
2. Remove seat by unscrewing four M8 hex. head screws through seat pan into seat runners. **Note:** Heavy
3. Remove seat latch bolt from seat pan retaining bracket and move latch out of the way. Flip seat pan over onto its back.
4. Undo the two M8 cap head bolts and lift the seat pan from truck.

Refitting

Refitting is the reversal of the removal instructions.

Seat Pan Gas Strut

Removal

1. Remove top cover.
2. Disconnect battery plug.
3. Lift seat pan to remove pressure on strut and support seat pan.
4. Unscrew both ball-joints from pre-drilled holes in chassis and seat pan and remove gas strut.

Refitting

Refitting is the reversal of the removal instructions.

Front Nose Cone Cover

Removal

Remove the four M6 screws securing the cover to the chassis and lift off.

Refitting

Refitting is the reversal of the above.

Steering Column Cowl

Removal

1. Remove the front nose cone cover as detailed above.
2. Remove steering wheel boss.
3. Remove steering wheel.
4. Disconnect Zapi dash display wiring.
5. Undo the two M8 hex. head screws and withdraw the cowl over the steering column.

Refitting

Refitting is the reversal of the above instructions.

Traction Lever Fascia

Removal

1. Remove spool valve fascia panel as detailed above.
2. Remove front electrical cover as detailed above.
3. Remove the traction lever, the fascia can then be removed.

Refitting

Refitting is the reversal of the above instructions.

Document Holder

Removal

Undo the two nyloc nuts securing the document holder to the rear of the seat and remove.

Refitting

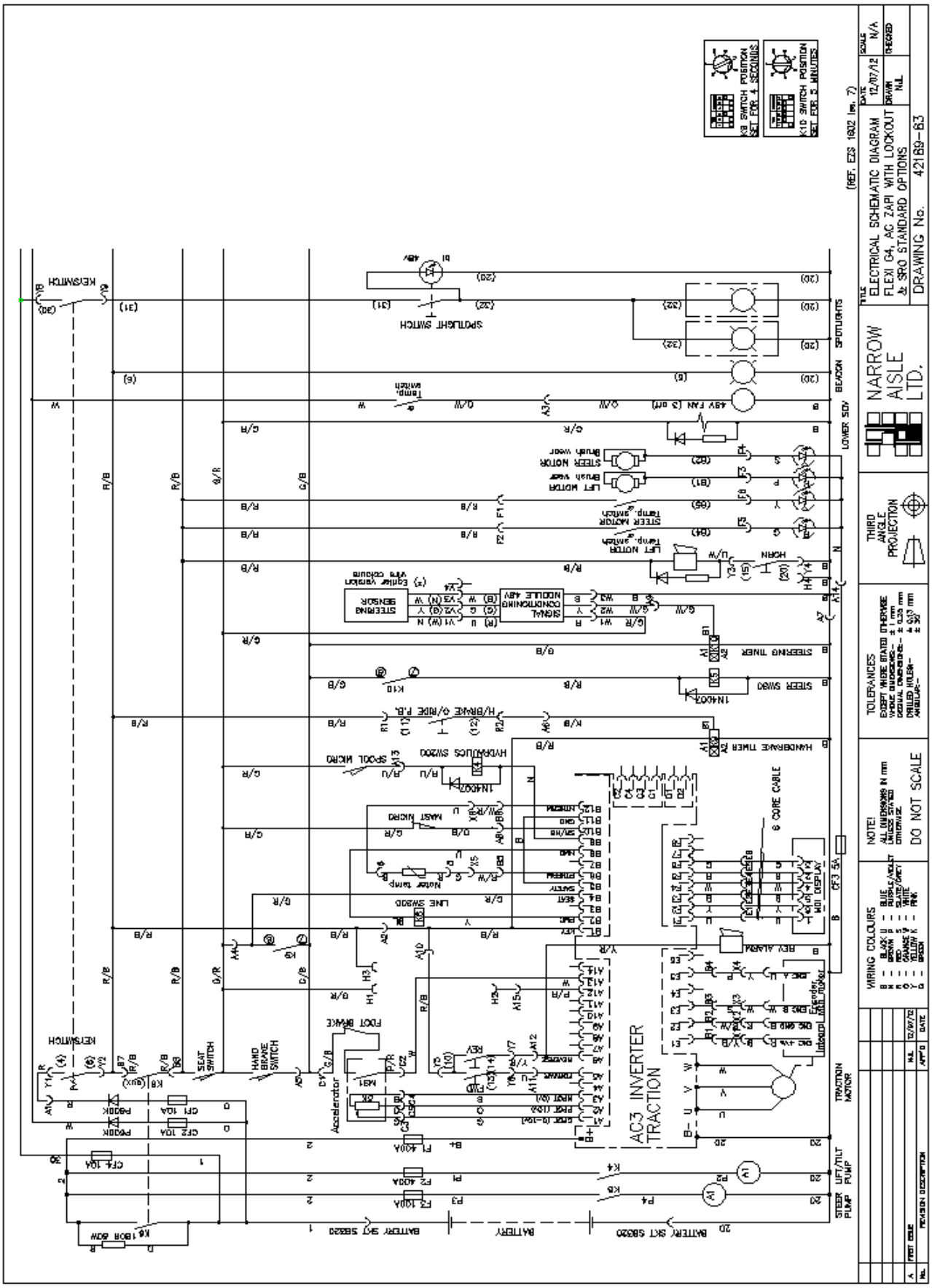
Refitting is the reversal of the above instructions.|

Electrical System

ZAPI AC3 Flash Inverter

This Page is Intentionally Left Blank

Contents


NARROW AISLE LTD.
ELECTRICAL SCHEMATIC DIAGRAM
FLEXI G4, AC ZAPI WITH LOCKOUT
& SRO STANDARD OPTIONS
DRAWING No. 42189-83
(REF. EZS 1802 Iss. 7)
AC3 INVERTER TRACTION
TRACTION MOTOR
STEER PUMP
LIFT/TILT PUMP
BATTERY
HORN
SPOTLIGHT SWITCH
LOWER SIDE BEACON
SPOTLIGHTS
STEERING TIMER
HANDBRAKE TIMER
STEER SW&D
LINE SW&D
MAST MICRO
SPOOL MICRO
HYDRAULICS SW&D
FOOT BRAKE
HAND BRAKE SWITCH
SEAT SWITCH
KEYSWITCH
Accelerator
6 CORE CABLE
REV ALARM
THIRD ANGLE PROJECTION
TOLERANCES
NOTE!
DO NOT SCALE
WIRING COLOURS

Introduction

Within the ZAPIMOS family, the AC-3 FLASH inverter is the model suitable for control of 7÷12 kW motors. It has been expressly designed for battery electric traction.

It is fit for electric truck, electric cars, tractors and buses.

Figure L1

Specification

Technical Specification

- Inverter for AC asynchronous 3-phase motors
- Regenerative braking functions
- Can-bus interface
- Flash memory (256 Kbytes On-Chip Program Memory) Digital control based upon a microcontroller
- Voltage = 36 - 48 - 72 - 80 – 96 V
- Maximum current (36 V, 48 V) = 600 A (RMS) for 3'
- Maximum current (72 V, 80 V) = 600 A (RMS) for 3'
- Maximum current (96 V) = 450 A (RMS) for 3'
- Booster (all versions) = 10% of maximum current for some seconds
- Operating frequency = 8 kHz
- External temperature range = -30 °C to 40 °C
- Maximum inverter temperature (at full power) = 75 °C

Block Diagram

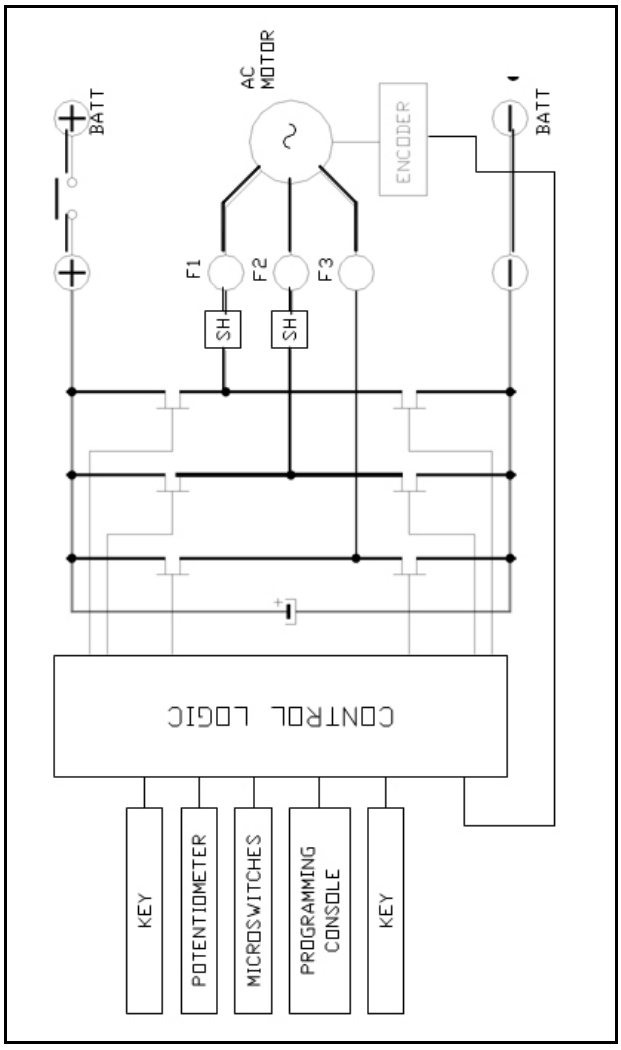


Figure L2

Specification for the Input Devices Filling Up the Installation Kit

The AC-3 FLASH inverters need some external parts in order to work. The following devices complete the kit for the AC-3 FLASH installation.

Microswitches

- The microswitches must have a contact resistance lower than 0.1 ohm and a leakage current lower than 100 µA.
- When full load connected, the voltage drop between the key switch contacts must be lower than 0.1 V.
- The microswitches send a voltage signal to the microprocessor when a function request is made (for e.g. a running request).

Accelerator Unit

The accelerator unit can consist of a potentiometer or a Hall effect device. It should be in a 3-wire configuration.

CPOT (A16 Ampseal connector version; A11 Amp Saab 29 poles connector version; A15 Amp Saab 42 poles connector version; A1 Molex Minifit version) signal ranges from 0 to 10 V.

Potentiometer value should be in the 0.5 – 10 kΩ range; generally, the load should be in the 1.5 mA to 30 mA range. Faults can occur if it is outside this range.

The Procedure for automatic potentiometer signal acquisition is carried out using the Console. This enables adjustment of the minimum and maximum useful signal level (PROGRAM VACC function), in either direction. This function is unique when it is necessary to compensate for asymmetry with the mechanical elements associated with the potentiometer, especially relating to the minimum level. The sequence of procedure is described in the programming console manual.

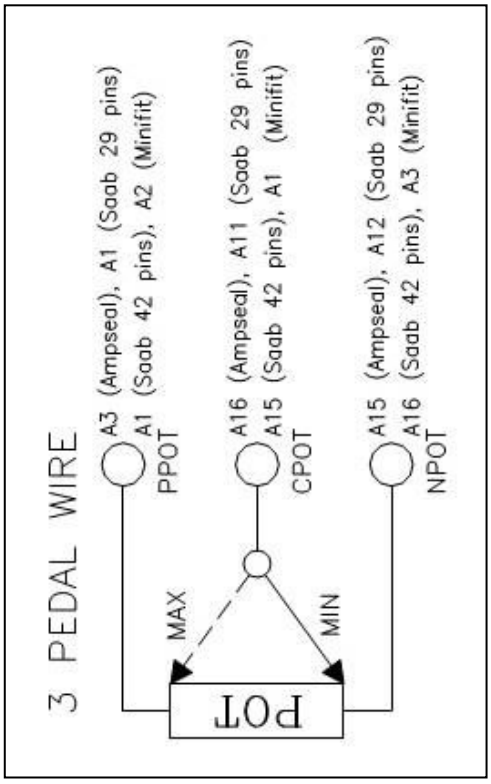


Figure L3

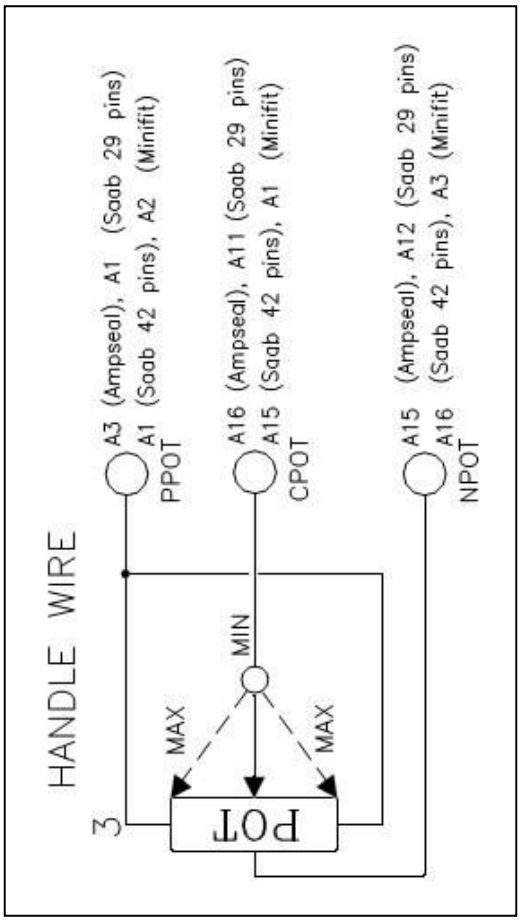


Figure L4

The graphs L5 & L6 show the output voltage from a non-calibrated potentiometer with respect to the mechanical “zero” of the control lever. MI and MA indicate the point where the direction switches close. 0 represents the mechanical zero of the rotation.

L5 shows the relationship of the motor voltage without signal acquisition being made. L6 shows the same relationship after signal acquisition of the potentiometer.

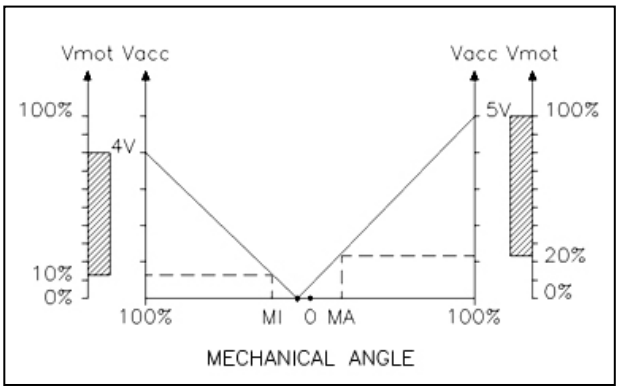


Figure L5

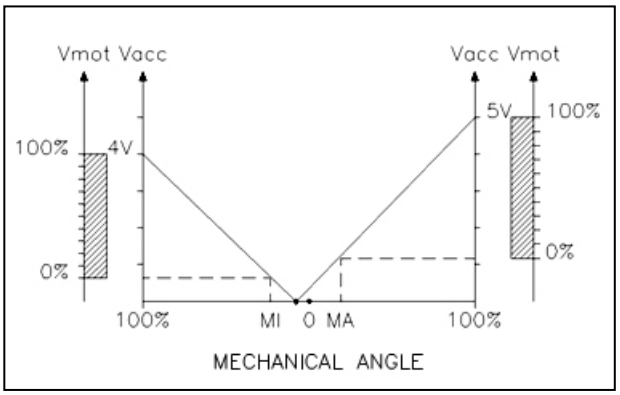


Figure L6

Speed Feedback

The motor control is based upon the motor speed feedback. The speed transducer is an incremental encoder, with two phases shifted at 90°. The encoder can be of different types:

- power supply: +5 V or +12 V
- electric output: open collector (NPN or PNP), push-pull, line driver
- standard (A and B) or differential (A, A, B, B) output

Note: The encoder resolution and the motor poles pair (the controller can handle), is specified in the home page display of the handset showing following headline:

AC3T2C F CNR1.07

The definitions of which are as follows:

AC3T = AC-3 traction controller

2 = motor’s poles pair number

C = 80 pulses/rev encoder

F = flash

CNR1.07 = software version number

Installation Hints

In the description of these installation suggestions you will find;

- **Information**, useful for anyone who is working on the installation, or a deeper examination of the content
- **Warnings**, describing operations that can lead to a failure of the electronic device, can be dangerous / harmful for the operator or are important to guarantee system performance and safety.

Material Overview

Prior to the start of the installation it is necessary to have the required materials. The wrong choice of cables or other parts could lead to failures, misbehaviour and/or poor performance.

Contactors

The main contactor must be installed.

Depending on the position of a jumper installed in the logic board:

- The output which drives the main contactor coil is on/off (the coil is driven with the full battery voltage).
- The output which drives the main contactor coil is switched at high frequency (1 kHz) with a duty cycle of 70%; this feature is useful to

decrease the power dissipation of the contactor coil.

Fuses

Use a 6.3A Fuse for protection of the auxiliary circuits.

For protection of the power unit, refer to diagrams. The Fuse value shown is the maximum allowable. For special applications or requirements these values can be reduced.

For Safety reasons, we recommend the use of protected fuses in order to prevent the spread of fused particles should the fuse blow.

Installation of the Hardware

Before performing any operations, ensure that the battery is disconnected. When the installation is complete, start the machine with the drive wheels raised from the floor to ensure that any potential installation errors do not compromise safety.

After operation, even with the Key Switch open, the internal capacitors may remain charged for some time. For safe operation, we recommend that the battery is disconnected, and a short circuit is made between Battery Positive and Battery Negative power terminals of the inverter using a Resistor between 10 ohm and 100 ohm.

Positioning and Cooling of the Controller

Install the inverter with the base-plate on a flat metallic surface that is clean and unpainted.

Apply a light layer of thermo-conductive grease between the two surfaces to permit better heat dissipation.

Ensure that the wiring of the cable terminals and connectors is carried out correctly.

Fit transient suppression devices to the horn, solenoid valves, and contactors not connected to the controller.

The heat generated by the power block must be dissipated. For this to be possible the compartment must be ventilated and the heat sink material ample.

The heat sink material and system should be sized on the performance requirement of the machine. Abnormal ambient air temperatures should be considered. In situations where ventilation is poor or heat exchange is difficult, forced air ventilation should be used.

The thermal energy dissipated by the power block module varies and is dependent on the current drawn and the duty cycle.

Wirings: Power Cables

The power cables must be as short as possible to minimize power losses. They must be tightened on controller power posts with a Torque of 13-15Nm.

The AC-3 FLASH module should only be connected to a traction battery. Do not use converters, outputs or power supplies. For special applications please contact the nearest Zapi Service Centre.

CAUTION

Do not connect the controller to a battery with a nominal voltage different than the value indicated on the controller label. A higher battery voltage may cause power section failure. A lower voltage may prevent the logic operating.

Wirings: I/O Connections

After crimping the cable, verify that all strands are entrapped in the wire barrel.

Verify that all the crimped contacts are completely inserted in the connector cavities.

WARNING

A cable connected to the wrong pin can lead to short circuits and failure; before turning on the truck for the first time, verify with a multimeter the continuity between the starting point and the end of a signal wire.

For information about mating connector pins, see “Description of Connectors”, page L11

Main Contactor and Key Connection

The connection of the battery line switches must be carried out following ZAPI instructions.

If a mechanical battery line switch is installed, it is necessary that the key supply to the inverter is open together with power battery line; if not, the inverter may be damaged if the switch is opened during a regenerative braking.

An intrinsic protection is present inside the logic

when the voltage on the battery power connection overtakes 40% more than the battery nominal voltage or if the key is switched off before the battery power line is disconnected.

Insulation of Truck Frame

CAUTION

The truck frame must be isolated from all electrical potential of the truck power line, in accordance with EN-1175 "Safety of machinery – Industrial truck", chapter 5.7

Protection and Safety Features

Protection Features

The AC-3 FLASH is protected against some controller injuries and malfunctions:

Battery Polarity Inversion

It is necessary to fit a MAIN CONTACTOR to protect the inverter against reverse battery polarity and for safety reasons.

Connection Errors

All inputs are protected against connection errors.

Thermal Protection

If the controller temperature exceeds 75 °C, the maximum current is reduced in proportion to the thermal increase. The temperature can never exceed 100°C.

External Agents

The inverter is protected against dust and the spray of liquid to a degree of protection meeting IP54 (Molex Minifit connectors), IP65 (Ampseal and Amp Saab connectors).

Protection Against Uncontrolled Movements

The main contactor will not close if:

- The Power unit is not functioning.
- The Logic is not functioning perfectly.
- The output voltage of the accelerator does not fall below the minimum voltage value stored, with 1 V added.
- Running microswitch in closed position.

Low Battery Charge

When the battery charge is low, the maximum current is reduced to half of the maximum current programmed.

Protection Against Accidental Start-up

A precise sequence of operations is necessary before the machine will start.

Operation cannot begin if these operations are not carried out correctly.

Requests for drive must be made after closing the key switch.

Operational Features

- Speed control.
- Optimum behaviour on a slope due to the speed feedback:
- Regenerative braking when the accelerator pedal is partially released (deceleration).
- The motor speed follows the accelerator, starting regenerative braking if the speed overtakes the speed set-point.
- Stable speed in every position of the accelerator.
- Regenerative release braking based upon deceleration ramps.
- Direction inversion with regenerative braking based upon deceleration ramp.
- Regenerative braking and direction inversion without contactors: only the main contactor is present.
- The release braking ramp can be modulated by an analogue input, so that a proportional brake feature is obtained.
- Optimum sensitivity at low speeds.
- Voltage boost at the start and with overload to obtain more torque (with current control).
- High efficiency of motor and battery due to high frequency commutations.
- Self diagnosis with indication of the fault shown by MDI fault codes.
- Modification of parameters through the programming console.

- Internal hour-meter with values that can be displayed on the console.
- Memory of the last five alarms with relative hour-meter and temperature displayed on the console.
- Test function within console for checking main parameters.

Diagnosis

The microcontroller continually monitors the inverter and carries out a diagnostic procedure on the main functions. The diagnosis is made in 4 points:

1. Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drives, can-bus interface, that the switch sequence for operation is correct and that the output of accelerator unit is correct.
2. Standby diagnosis in stby that checks: watchdog circuit, phase's voltages, contactor driver, current sensor and can-bus interface.
3. Diagnosis during operation that checks: watchdog circuits, contactor driver, current sensors and can-bus interface.
4. Continuous diagnosis that checks: temperature of the inverter, motor temperature.

Diagnosis is provided in two ways. The digital console can be used, which gives detailed information about the failure; the failure code is also displayed on the MDI.

Description of Connectors

Connectors of the Logic Traction Configuration

The AC-3 FLASH has been designed to be produced with six Molex Minifit connectors.

Molex Minifit Connectors

A1	CPOT	Accelerator potentiometer wiper.
A2	PPOT	Potentiometer positive: 10 V output; keep load > 1 kΩ.
A3	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
A4	CM	Common of FW / BW / BACK. FW / BACK. BW / EXCLUSIVE HYDRO / ENABLE microswitches.
A5	FORW	Forward direction request input. It must be connected to the forward direction microswitch, active high.
A6	BW	Backward direction request input. It must be connected to the backward direction microswitch, active high.
A7	PB	Brake request input. It must be connected to the brake pedal switch, active high.
A8	CPOTB	Brake potentiometer wiper.
A9	PPOTB	Brake potentiometer positive. 10 V output; keep load > 1 kΩ
A10	NPOTB	-Batt.
A11	-BATT	-Batt.
A12	BACK. FORW	Inching function, forward direction input. It must be connected to the inching forward switch. Active high.
A13	BACK. BACK	Inching function, backward direction input. It must be connected to the inching backward switch. Active high.
A14	EX HYDRO / ENABLE	Exclusive hydro or accelerator enable function input. It must be connected to the exclusive hydro microswitch or to the accelerator enable switch. Active high (see also OPTION chapter).
B1	KEY	Connected to the power supply through a microswitch (CH) with a 6.3 A fuse in series.
B2	PLC	Positive of main contactor coil.

B3	PBRAKE	Positive of the electromechanical brake coil.
B4	SEAT	SEAT input; it must be connected to the SEAT microswitch; it is active high.
B5	SAFETY	If not connected to -Batt the MC coil power output will be disabled. It can also be used as a general purpose input.
B6	PTHERM	Input for motor temperature sensor.
B7	CM	Common of SR / PB / SEAT microswitches.
B8	NLC	Negative of main contactor coil.
B9	NBRAKE	Output for driving a brake or an hydraulic steering contactor coil; it drives the load to -Batt maximum current: 3 A.
B10	SR / HB	Speed reduction (handbrake) input. Active low (switch opened). See also OPTION chapter.
B11	GND	-Batt.
B12	NTHERM	-Batt.
C1	CAN-L	Low level CAN-BUS voltage I/O.
C2	CAN-L-OUT	Low level CAN-BUS voltage I/O.
C3	CAN-H	High level CAN-BUS voltage I/O.
C4	CAN-H-OUT	High level CAN-BUS voltage I/O.
D1	-BATT	-Batt.
D2	MODE	This input allows the customer to select the software for traction or lifting application. Configuration: MODE: Open (not connected) Traction inverter MODE: Close (connected with A5) Pump inverter
E1 – E6		Incremental ENCODER connector (see chapter 4.2.5).
F1	PCLRXD	Positive serial reception.
F2	NCLRXD	Negative serial reception.
F3	PCLTXD	Positive serial transmission.
F4	NCLTXD	Negative serial transmission.
F5	GND	Negative console power supply.
F6	+12	Positive console power supply.
F7	FLASH	It must be connected to F8 for the Flash memory programming.
F8	FLASH	It must be connected to F7 for the Flash memory programming.

Description of Power Connections

View of the power bars:

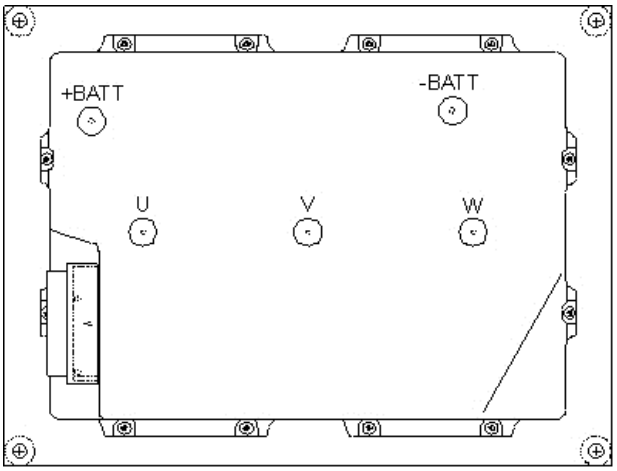


Figure L7

-BATT	Negative of the battery.
+BATT	Positive of the battery.
U; V; W	Connection bars of the three motor phases; follow this sequence and the indication on the motor.

Drawings

Mechanical Drawing

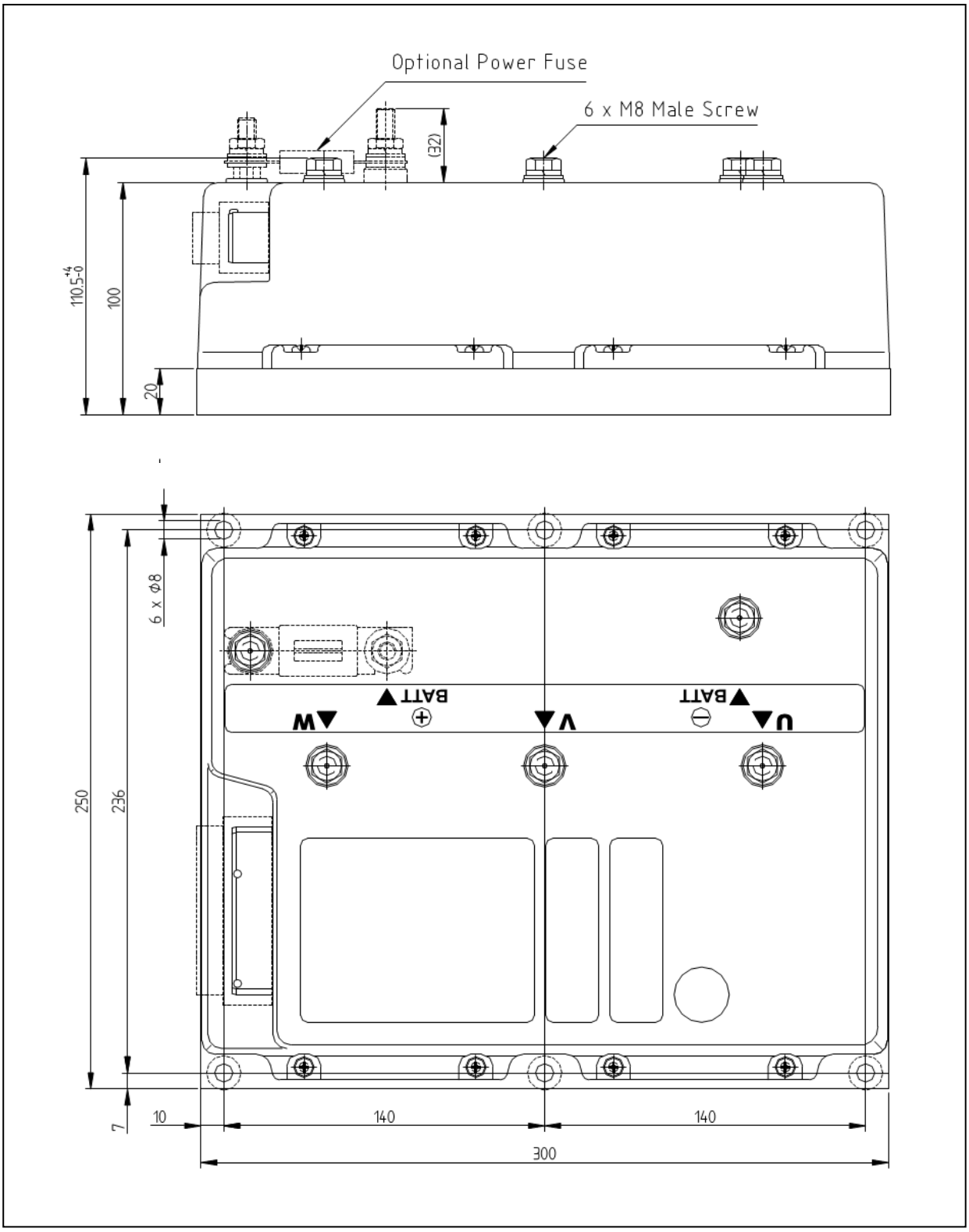


Figure L8

Molex Minifit Connectors

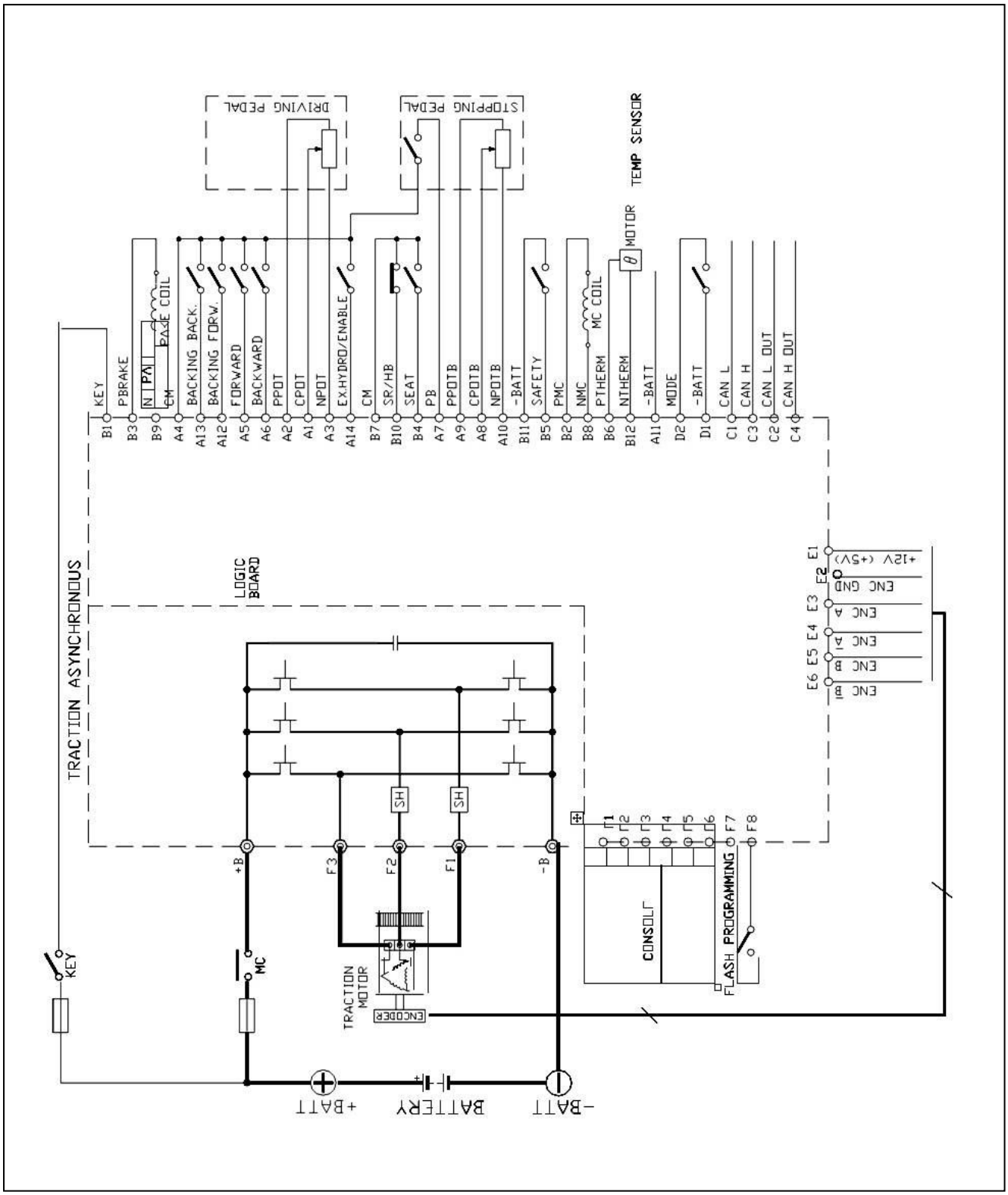


Figure L9

Programming and Adjustments Using the Digital Console

Adjustments via Console

Adjustment of Parameters and changes to the inverter's configuration are made using the Digital Console.

In the Ampseal connector version the Console is connected to the "B" Molex Spox connector of the inverter.
.

Description of the Console and Connection

Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release Number 3.02".

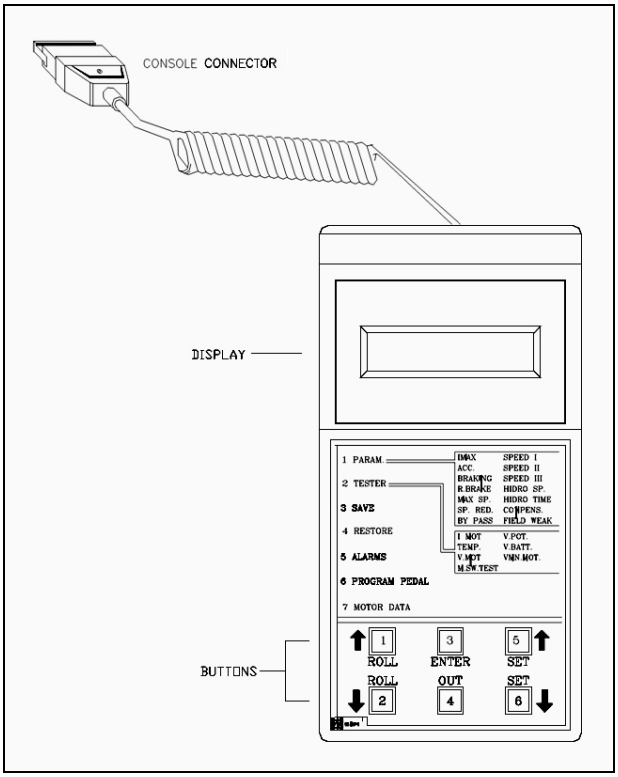


Figure L10

Description of Standard Console Menu

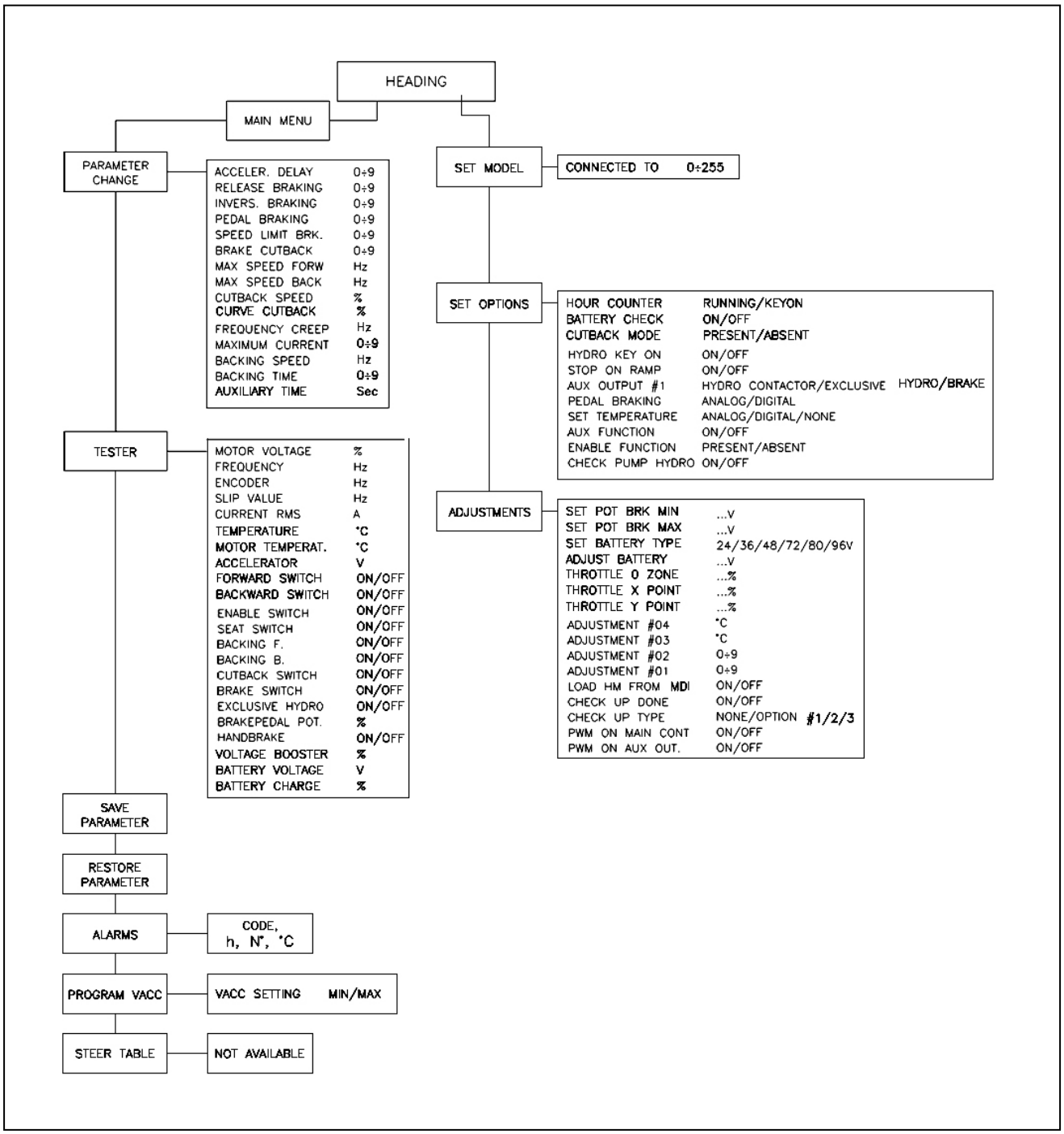


Figure L11

Function Configuration

Using the CONFIG MENU of the programming console, the user can configure the following functions (see "OPERATIONAL FEATURE" chapter for an explanation of "hydraulic steering function"):

SUBMENU "SET OPTIONS"

1. HOUR COUNTER

- RUNNING: the counter registers travel time only.
- KEY ON: the counter registers when the "key" switch is closed.

2. BATTERY CHECK

- ON: the battery discharge level check is carried out; when the battery level reaches 10%, an alarm is signalled and the maximum current is reduced to half of the programmed value.
- OFF: the battery discharge level check is carried out but no alarm is signalled.

3. CUTBACK MODE

- PRESENT: B10 (Minifit), A28 (Amp Saab 29 and 42 poles), A9 (Ampseal) input is managed as a cutback speed input.
- ABSENT: B10 (Minifit), A28 (Amp Saab 29 and 42 poles), A9 (Ampseal) input is managed as a handbrake input.

4. HYDRO KEY ON

- ON / OFF: if this option is programmed ON the traction inverter manages a hydraulic steering function when the "key" is switched ON (only if the "aux output #1" option is programmed as "hydro contactor" or as "exclusive hydro").

5. STOP ON RAMP

- ON: the stop on ramp feature (truck electrically hold on a ramp) is managed for a time established by "auxiliary time" parameter. After this time, the behaviour depends on the "aux output #1" option programming (see also the following table).
- OFF: the stop on ramp feature is not performed.

6. AUX OUTPUT #1

- BRAKE: B9 (Minifit), A7 (Amp Saab 29 poles), A9 (Amp Saab 42 poles), A28 (Ampseal) output drives an electromagnetic brake coil (see also the table below).
- HYDRO CONT.: the inverter manages a hydraulic steering function when the direction input or brake pedal input are active or a movement of the truck is detected.
- EX. HYDRO: the inverter manages a hydraulic steering function when the exclusive hydro input is active.

7. PEDAL BRAKING

- ANALOG: The mechanical brake pedal has a switch and a potentiometer installed. When the accelerator is released and the pedal brake is pushed the inverter performs electrical braking whose intensity is proportional to the brake pedal potentiometer. The minimum intensity is established by the "Release braking" parameter, when the brake pedal is slightly pressed (brake switch close but brake potentiometer at the minimum). The maximum intensity is established by the "Pedal braking" parameter when the brake pedal is fully pressed (brake potentiometer at the maximum). In the middle positions, the electrical braking intensity is a linear function between minimum and maximum intensity.
- DIGITAL: The truck does not have a potentiometer installed on the mechanical brake pedal, but only a microswitch; when the accelerator pedal is released and the brake pedal is pushed (brake switch closed), the inverter performs electrical braking following "Pedal braking" parameter.

8. SET TEMPERATURE

- DIGITAL: a digital (ON/OFF) motor thermal sensor is connected to B6 (Minifit), A3 (Amp Saab 29 poles), A4 (Amp Saab 29 poles), A25 (Ampseal) input.
- ANALOG: an analogue motor thermal sensor (KTY-84) is connected between B6 and B12 (Minifit), A3 and A4 (Amp Saab 29 poles), A4 and A5 (Amp Saab 42 poles), A24 and A25 (Ampseal) (the curve can be customized on a customer request).
- NONE: no motor thermal sensor switch is connected.

9. AUX FUNCTION

- ON/OFF: if this option is programmed ON the traction inverter applies maximum braking and traction torque.

10. ENABLE FUNCTION

- PRESENT: A14 (Minifit), A27 (Amp Saab 29 poles), A26 (Amp Saab 42 poles), A7 (Ampseal) input is managed as accelerator enable input.

- ABSENT: A14 (Minifit), A27 (Amp Saab 29 poles), A26 (Amp Saab 42 poles), A7 (Ampseal) input is managed as exclusive hydro input.

11. CHECK PUMP HYDRO

- ON/OFF: if this option is programmed ON, the traction inverter doesn't receive any messages by the pump inverter from the CAN-BUS line, the "CAN BUS KO" warning appears on the traction and the maximum speed is reduced down to 10%. The traction also checks via CAN that there aren't alarms on pump. If pump is in alarm, the maximum speed is reduced down to 10%, but in this case any alarm or warning appears.

SUBMENU "ADJUSTMENTS"

1. SET POT BRK MIN

It records the minimum value of braking pedal potentiometer when the braking pedal switch is closed; the procedure is similar to the "Program Vacc" function (see page L32). This procedure must be carried out only if the "Pedal braking" option is programmed as "Analog".

2. SET POT BRK MAX

It records the maximum value of braking pedal potentiometer when the braking pedal is fully pressed; the procedure is similar to the "Program Vacc" function (see page L32). This procedure must be carried out only if the "Pedal braking" option is programmed as "Analog".

3. SET BATTERY TYPE

It selects the nominal battery voltage.

4. ADJUST BATTERY

Fine adjustment of the battery voltage measured by the controller.

5. THROTTLE 0 ZONE

It establishes a deadband in the accelerator input curve (see Figure L12)

6. THROTTLE X POINT

This parameter changes the characteristic of the accelerator input curve.

7. THROTTLE Y POINT

This parameter changes the characteristic of the accelerator input curve.

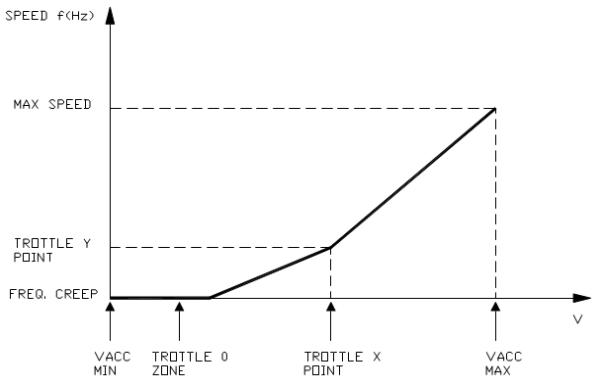


Figure L12

VACC MIN and VACC MAX are values programmable by the "Program Vacc" function.

8. ADJUSTMENT #04

This parameter determines the motor temperature level at which the "Motor temperature" alarm is signalled. The range is from 70 °C to 160 °C with 10 °C steps. This parameter must be adjusted only if the "Set temperature" (menu "Set option") parameter is programmed "Analog".

9. ADJUSTMENT #03

This parameter isn't used.

10. ADJUSTMENT #02

It adjusts the lower level of the battery discharge table.

11. ADJUSTMENT #01

It adjusts the upper level of the battery discharge table.

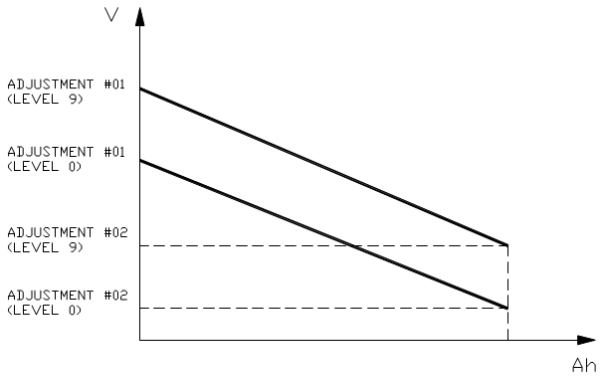


Figure L13

12. LOAD HM FROM MDI

For an explanation of this point see the MDI instrument handbook.

13. CHECK UP DONE

Turn it On when the asked Maintenance service has been executed to cancel the CHECK UP NEEDED warning.

14. CHECK UP TYPE

It specifies the handling of the CHECK UP NEEDED warning:

- NONE: No CHECK UP NEEDED warning.
- OPTION #1: CHECK UP NEEDED warning on the hand set after 300 hours.
- OPTION #2: Equal to OPTION#1 but performances are reduced down to 50% after 340 hours.
- OPTION #3: Equal to OPTION#2 but the truck definitively stops after 380 hours.

15. PWM ON MAIN CONT

- OFF: the inverter applies the battery voltage to the loads on the main contactor coil.
- ON: the PWM reduces the voltage at the loads on the main contactor coil down to 62% of the battery voltage.

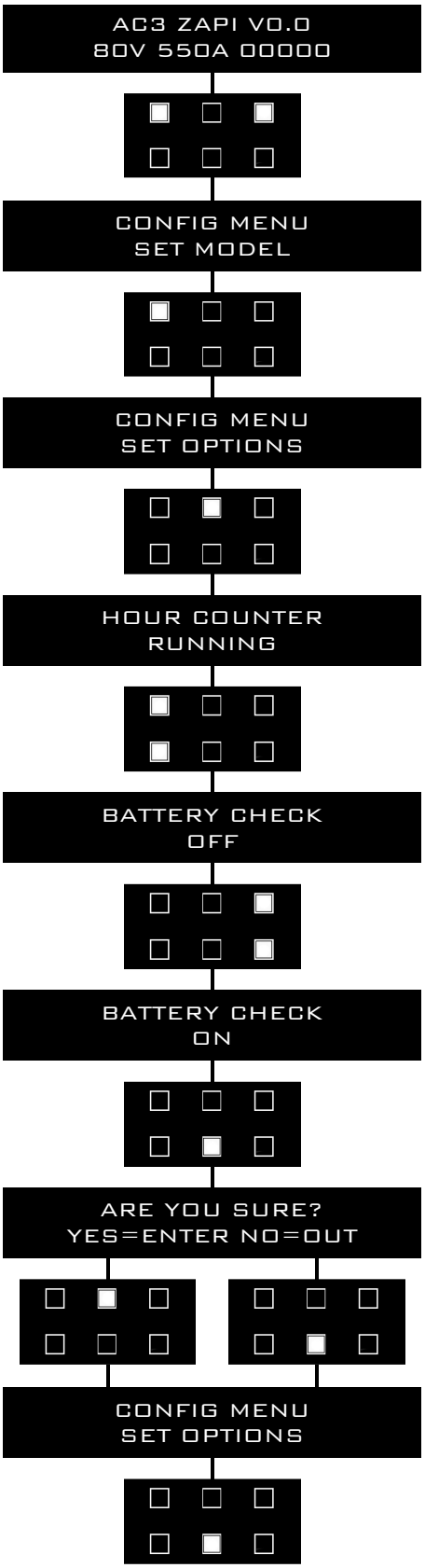
16. PWM ON AUX OUT.

- OFF: the inverter applies the battery voltage to the loads on the auxiliary output.
- ON: the PWM reduces the voltage at the loads on the auxiliary output down to 62% of the battery voltage.

AUX OUTPUT	STOP ON RAMP	A7 (Amp Saab 29 poles) A9 (Amp Saab 42 poles) B9 (Minifit), A28 (Ampseal) OUTPUT	BEHAVIOUR ON A SLOPE
BRAKE	**ON**	- It drives the coil of an electromagnetic brake. - The hydraulic steering function request is sent to the pump inverter by the can-bus link.	The truck is electrically held on a slope; when the time set by "auxiliary time" parameter is elapsed the brake is applied and the 3-phase bridge is released. **Do not use this combination if the negative brake is not installed.**
BRAKE	**OFF**	- It drives the coil of a electromagnetic brake. - The hydraulic steering function request is sent to the pump inverter by the can-bus link.	The truck is not electrically hold on a slope, but comes down very slowly; when the time set by "auxiliary time" parameter is elapsed, the brake is applied and the 3-phase bridge is opened. **Do not use this combination if the negative brake is not installed.**
HYDRO CONT.	**ON**	- It drives the coil of a hydraulic steering contactor. - The hydraulic steering function request is also sent to the pump inverter by the can-bus link.	The truck is electrically hold on a slope; when the time set by "auxiliary time" parameter is elapsed, the truck comes down very slowly, till the flat is reached.
HYDRO CONT.	**OFF**	- It drives the coil of a hydraulic steering contactor. - The hydraulic steering function request is also sent to the pump inverter by the can-bus link.	The truck is not electrically hold on a slope, but comes down very slowly till the flat is reached.
EXCL. HYDRO	**ON**	- It drives the coil of a hydraulic steering contactor. - The hydraulic steering function request is also sent to the pump inverter by the can-bus link.	The truck is electrically hold on a slope; when the time set by "auxiliary time" parameter is elapsed, the truck comes down very slowly, till the flat is reached.
EXCL. HYDRO	**OFF**	- It drives the coil of a hydraulic steering contactor. - The hydraulic steering function request is also sent to the pump inverter by the can-bus link.	The truck is not electrically hold on a slope, but comes down very slowly till the flat is reached.

Flow chart showing how to make changes to OPTION Menu.

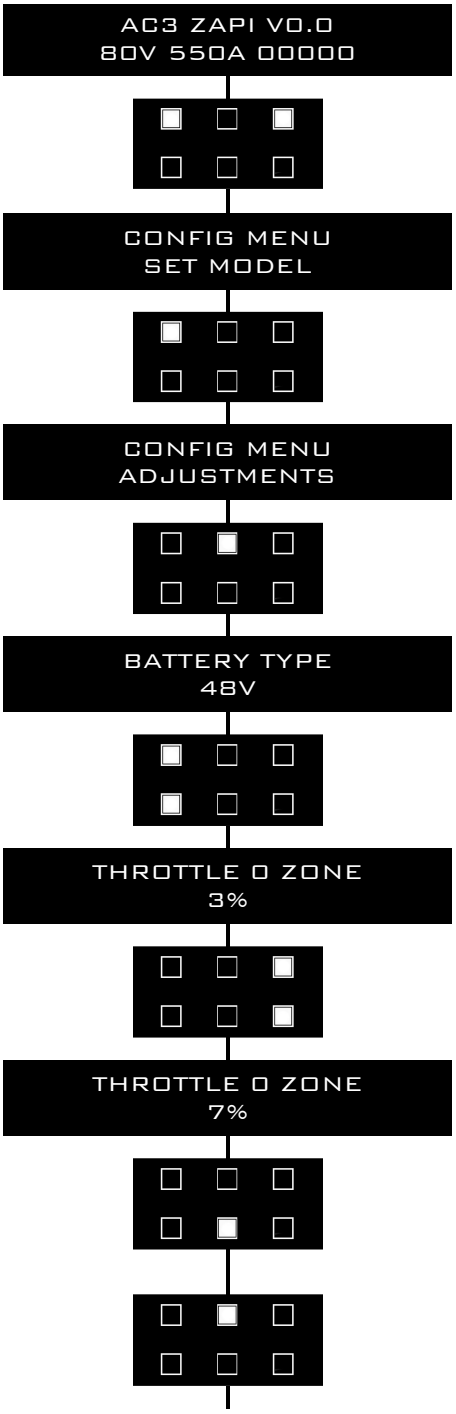
1. Opening Zapi Display.
2. Press Top Left and Top Right Buttons to enter SET Menu.
3. The Display will show: SET MODEL.
4. Press ROLL UP or ROLL DOWN button until SET MODEL Menu appears.
5. SET OPTIONS appears on the display.
6. Press ENTER to go into the SET MODEL Menu.
7. The display will show the first OPTION.
8. Press ROLL UP or ROLL DOWN button until the desired OPTION appears.
9. Desired OPTION appears.
10. Press SET UP or SET DOWN button in order to modify the changes.
11. New OPTION appears.
12. Press OUT to exit the Menu.
13. Confirmation request appears.
14. Press ENTER to accept the changes, or press OUT if you wish not to.
15. SET OPTIONS Menu appears.
16. Press OUT again. Display now shows the Opening Zapi Menu



17.

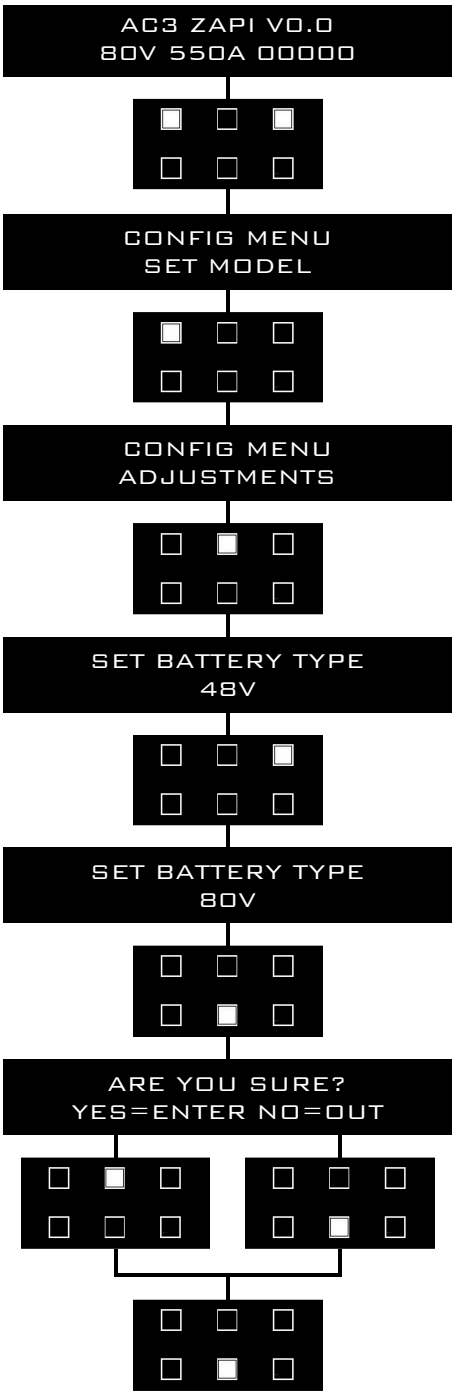
Flow chart showing how to make changes to ADJUSTMENT Menu.

1. Opening Zapi Display.
2. Press Top Left and Top Right Buttons to enter CONFIG Menu.
3. The Display will show: SET MODEL.
4. Press ROLL UP or ROLL DOWN button until ADJUSTMENTS Menu appears.
5. ADJUSTMENTS appears on the display.
6. Press ENTER to go into the ADJUSTMENTS Menu.
7. The display will show SET BATTERY TYPE.
8. Press ROLL UP or ROLL DOWN button until the desired parameter is reached.
9. Desired parameter appears.
10. Press SET UP or SET DOWN button in order to modify the changes.
11. Press OUT.
12. Press ENTER to confirm.
13. Repeat steps 5 to 12 for the other adjustments.



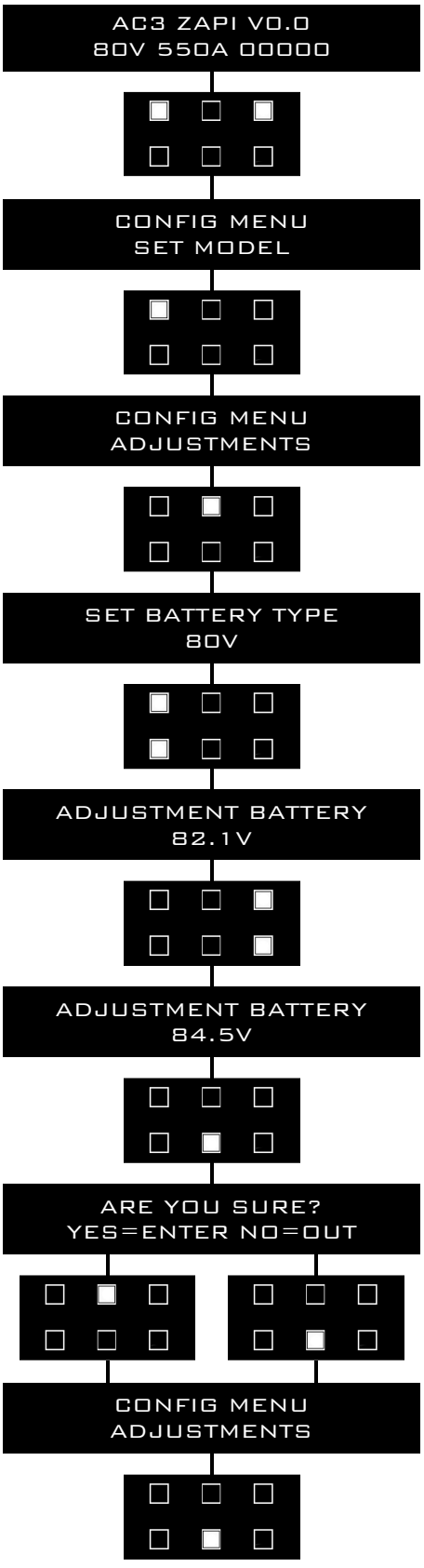
Flow chart showing how to use the SET BATTERY TYPE adjustment

1. Opening Zapi Display.
2. Press Top Left and Top Right Buttons to enter CONFIG Menu.
3. The Display will show: SET MODEL.
4. Press ROLL UP or ROLL DOWN button until ADJUSTMENTS Menu appears.
5. ADJUSTMENTS appears on the display.
6. Press ENTER to go into the ADJUSTMENTS Menu.
7. The display will show: SET BATTERY TYPE.
8. Press SET UP to choose nominal value of the battery.
9. New battery value appears
10. Press OUT.
11. Confirmation request appears.
12. Press ENTER to accept the changes, or press OUT if you wish not to.
13. Press OUT again. Display now shows the Opening Zapi Menu



Flow chart showing how to carry out ADJUSTMENT BATTERY operation by console.

1. Opening Zapi Display.
2. Press Top Left and Top Right Buttons to enter CONFIG Menu.
3. The Display will show: SET MODEL.
4. Press ROLL UP or ROLL DOWN button until ADJUSTMENTS Menu appears.
5. ADJUSTMENTS appears on the display.
6. Press ENTER to go into the ADJUSTMENTS Menu.
7. The display will show the first OPTION.
8. Press ROLL UP or ROLL DOWN button until the desired OPTION appears.
9. ADJUST BATTERY appears.
10. Press SET UP or SET DOWN button in order to increase or decrease respectively. Set the value read by an external meter.
11. Battery value appears on the display.
12. Press OUT to exit the Menu.
13. Confirmation request appears.
14. Press ENTER to accept the changes, or press OUT if you wish not to.
15. ADJUSTMENTS Menu appears.
16. Press OUT again. Display now shows the Opening Zapi Menu



Parameter Regulation

In addition to the input configuration, parameter, modification is made directly by ZAPI on customer specifications, or by the customer, making the adjustments using the programming console.

The following parameters can be modified:

1. ACCELERATION DELAY
It determines the acceleration ramp.

2. RELEASE BRAKING
It controls the deceleration ramp when the travel request is released.

3. INVERS. BRAKING
It controls the deceleration ramp when the direction switch is inverted during travel.

4. PEDAL BRAKING
It determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.

5. SPEED LIMIT BRK.
Deceleration ramp when the pedal position is changed but not completely released.

6. BRAKE CUTBACK
It determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.

7. MAX SPEED FORW
It determines the maximum speed in forward direction.

8. MAX SPEED BACK
It determines the maximum speed in backward direction.

9. CUTBACK SPEED
Speed reduction when the cutback switch is active.

10. CURVE CUTBACK
Determines the speed reduction in curve (only if the eps is present).

11. FREQUENCY CREEP
Minimum speed when the forward or reverse switch is closed, but the accelerator is on a minimum position.

12. MAXIMUM CURRENT
This parameter changes the maximum current of the inverter.

13. BACKING SPEED
It determines the speed in inching function.

14. BACKING TIME
It determines the time of the inching function.

15. AUXILIARY TIME
It determines the time that the truck is held on the ramp if the "stop on ramp" option is ON.

The following table shows the different values at which the parameters can be set.

PARAMETER	UNIT	PROGRAMMED LEVEL									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
ACCELERATION DELAY (*)	Sec.	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0
RELEASE BRAKING (**)	Sec.	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
INVERS. BRAKING (**)	Sec.	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
PEDAL BRAKING (**)	Sec.	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
SPEED LIMIT BRK. (**)	Sec.	8.9	8.3	7.7	7.1	6.6	6.0	5.5	4.9	4.4	3.8
BRAKE CUTBACK (**)	Sec.	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0
MAX SPEED FORW	Hz	65	80	95	110	125	140	155	170	185	200
MAX SPEED BACK	Hz	65	80	95	110	125	140	155	170	185	200
CUTBACK SPEED	%Max Sp	10	20	30	40	50	60	70	80	90	100
CURVE CUTBACK	%Max Sp	0	10	21	33	44	55	66	78	89	100
FREQUENCY CREEP	Hz	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
MAXIMUM CURRENT	%IMAX	47	53	58	64	70	76	82	88	94	100
BACKING SPEED	Hz	0	2	4	6	8	10	12	14	16	18
BACKING TIME	Sec.	0. 2	0.5	1.0	1.4	1.8	2.3	2.7	3.1	3.6	4.0
AUXILIARY TIME	Sec.	0	1	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5

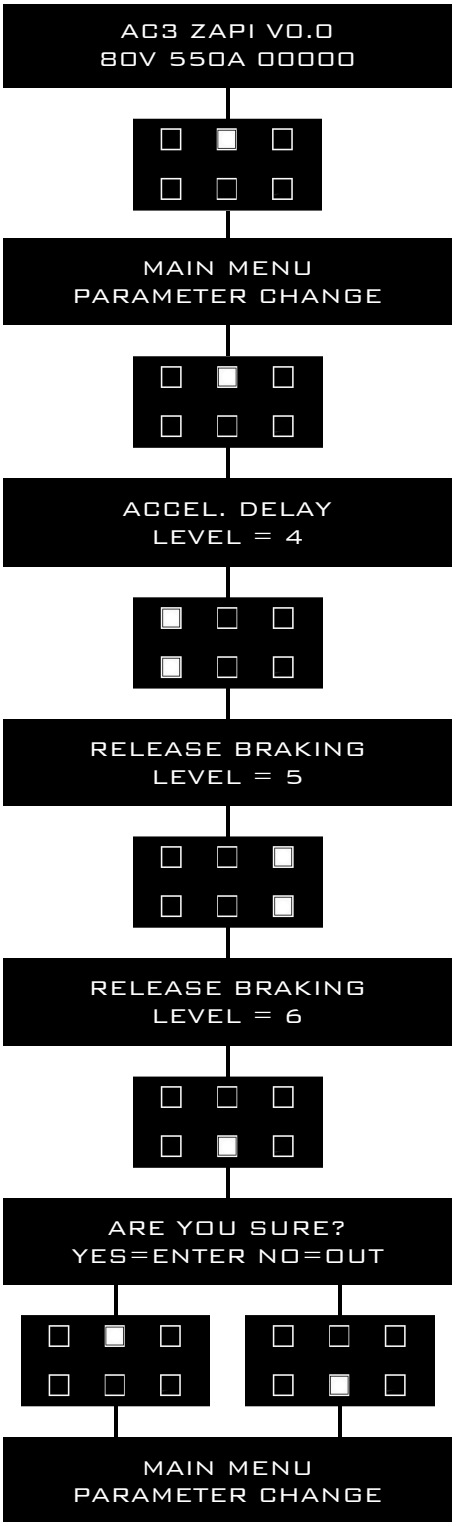
(*) The acceleration time shown is the time from 0 Hz to 100 Hz. This is the ideal ramp calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, as a function of the load.

(**) The braking feature is based upon deceleration ramps. The value shown in the table is the time to decrease the speed from 100 Hz to 0 Hz. This is the ideal ramps calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, as a function of the load.

After changing a parameter, press ENTER to confirm data when requested by the message on the console. Parameters modified and optimized on one unit can be stored by the console (SAVE) and then released (RESTORE) on another inverter, thus allowing fast and standardized settings (see console manual for details).

Flow Chart showing how to make Programme changes using Digital Console fitted with Eprom CK ULTRA.

1. Opening Zapi Display.
2. Press ENTER to go into the General Menu.
3. The Display will show:
4. Press ENTER to go into the Parameter Change facility.
5. The Display will show the first parameter.
6. Press either ROLL UP or ROLL DOWN to display the next parameter.
7. The names of the Parameters appear on the Display.
8. Stop when the desired Parameter appears. The Display will show a Level Number that will be between 0 and 9. Press either PARAM (top right) or SET (bottom right) to change the Level value.
9. The Display will show the Next Level.
10. When you are satisfies with the changes you have made, press OUT.
11. The Display asks “ARE YOU SURE?”
12. Press ENTER to accept the changes, or press OUT if you wish not to and/or to make further modifications to the parameters
13. The Display will show:



Programming Console Functions

Functional configuration (see pages L15 - L17), Parameter programming (see pages L24 - L26).

Tester: the user can verify the state of the following parameters:

- motor voltage (%)
- frequency (Hz)
- encoder (Hz)
- slip value (Hz)
- current rms (A)
- temperature (°C)
- motor temperat. (°C)
- accelerator (V)
- forward switch (ON/OFF)
- backward switch (ON/OFF)
- enable switch (ON/OFF)
- seat switch (ON/OFF)
- backing f. (ON/OFF)
- backing b. (ON/OFF)
- cutback switch (ON/OFF)
- brake switch (ON/OFF)
- exclusive hydro (ON/OFF)
- brakepedal pot. (%)
- hand brake (ON/OFF)
- battery voltage (V)

- Save function (for storing data).
- Restore function (for loading parameters on another inverter).
- Display of the last 5 alarms including hour-meter value and temperature at the moment of the alarm.
- Accelerator range programming: records the minimum and maximum useful accelerator stroke values for both direction of running.
- See the console manual for a detailed description of function and parameters.

Sequence for AC Inverter Traction Setting

When the "Key Switch" is closed, if no alarms or errors are present, the Console Display will be showing the Standard Zapi Opening Display. If the controller is not configured to your requirements, follow the sequence detailed here. Remember to re-cycle the Key Switch if you make any changes to the controller's configuration.

1. Select the Options required. See pages L15 - L17

2. Select and set the Battery Voltage. See page L17

3. Confirm correct installation of all wires. Use the Console's TESTER function to assist.

4. Perform the accelerator signal acquisition procedure using the Console "PROGRAM VACC". Procedure as detailed on page L32

5. Set the "MAXIMUM CURRENT" Current, using the table on page L24.

6. Set the Acceleration Delay requirements for the machine. Test the parameters in both directions.

7. Set the FREQUENCY CREEP level starting from level 0.6 Hz. The machine should just move when the accelerator microswitch is closed. Increase the Level accordingly.

8. Set the Speed Reductions as required. Make adjustments to "CUTBACK SPEED" Check the performance with the accelerator pedal totally depressed. If the machine is a forklift, check the performance with and without load.

9. RELEASE BRAKING. Operate the machine at full speed. Release the accelerator pedal. Adjust the level to your requirements. If the machine is a forklift, check the performance with and without load.

10. INVERSION BRAKING. Operate the machine at 25% full speed. Whilst travelling INVERT the Direction Switch. Set a soft Level of Inversion Braking. When satisfactory, operate the machine at Full Speed and repeat. If the machine is a Forklift, repeat the tests and make adjustments with and without load. The unladen full speed condition should be the most representative condition.

11. PEDAL BRAKING (If used). Operate the machine at full Speed. Release the accelerator pedal and press the Pedal Brake. Set braking level to your requirements.

12. Set "MAX SPEED FORW".

13. Set "MAX SPEED BACK" (Reverse).

14. Make the choice for the truck behaviour on a slope (see page L17) If the "Stop on ramp" option is ON, set the desired value of "auxiliary time" parameter.

15. Set “SET TEMPERATURE”, setting the motor thermal sensor type used.

CAUTION

Depending on the motor used it is necessary to set some parameters: giving Zapi the motor curves it is possible to know the optimal setting in order to the motor runs efficiently.

Tester: Description of the Functions

1. MOTOR VOLTAGE

This is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

2. FREQUENCY

This is the frequency of the voltage and current supplied to the motor.

3. ENCODER

This is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

4. SLIP VALUE

This is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

5. CURRENT RMS

Root Mean Square value of the motor current.

6. TEMPERATURE

The temperature measured on the aluminium heat sink holding the MOSFET devices.

7. MOTOR TEMPERAT.

This is the temperature of the motor; if the option is programmed "None" (see page L17) it shows 0°.

8. ACCELERATOR

The voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the Left Hand Side of the Console Display and the value in percentage is shown on the Right Hand Side.

9. FORWARD SWITCH

The level of the Forward direction digital entry FW.

- ON / +VB = active entry of closed switch.
- OFF / GND = non active entry of open switch.

10. BACKWARD SWITCH

The level of the Reverse direction digital entry BW.

- ON / +VB = active entry of closed switch.
- OFF / GND = non active entry of open switch.

11. ENABLE SWITCH

Status of the accelerator enable input.

- ON / +VB = active entry of closed switch.
- OFF / GND = non active entry of open switch.

12. SEAT SWITCH

The level of the Seat Microswitch digital entry.

- ON / +VB = active entry of closed switch.
- OFF / GND = non active entry of open switch.

13. BACKING F.

Status of the inching function (forward direction) input.

- ON / +VB = active entry of closed switch.
- OFF / GND = non active entry of open switch.

14. BACKING B.

Status of the inching function (backward direction) input.

- ON / +VB = active entry of closed switch.
- OFF / GND = non active entry of open switch.

15. CUTBACK SWITCH

The level of the Speed Reduction Microswitch.

- ON / GND = active entry of speed reduction microswitch.
- OFF / +VB = non active entry of microswitch.
-

16. BRAKE SWITCH

The level of the Pedal Brake Microswitch.

- ON / +VB = active entry of Brake pedal Microswitch.
- OFF / GND = non active entry of microswitch.

17. EXCLUSIVE HYDRO

Status of the exclusive hydro input.

- ON / +VB = active entry of closed switch.
- OFF / GND = non active entry of open switch.

18. BRAKEPEDAL POT.

The percentage of the pressure on the brake pedal (100% if the pedal is totally pressed, 0% if the pedal is released).

19. HAND BRAKE

The level of the Handbrake Microswitch.

- ON / GND = active entry of Handbrake Switch (open switch).
- OFF/ +VB = non active entry of microswitch (closed switch).

20. VOLTAGE BOOSTER

This is the booster of the voltage supplied to the motor in load condition; it is expressed as a percentage of the full voltage.

21. BATTERY VOLTAGE

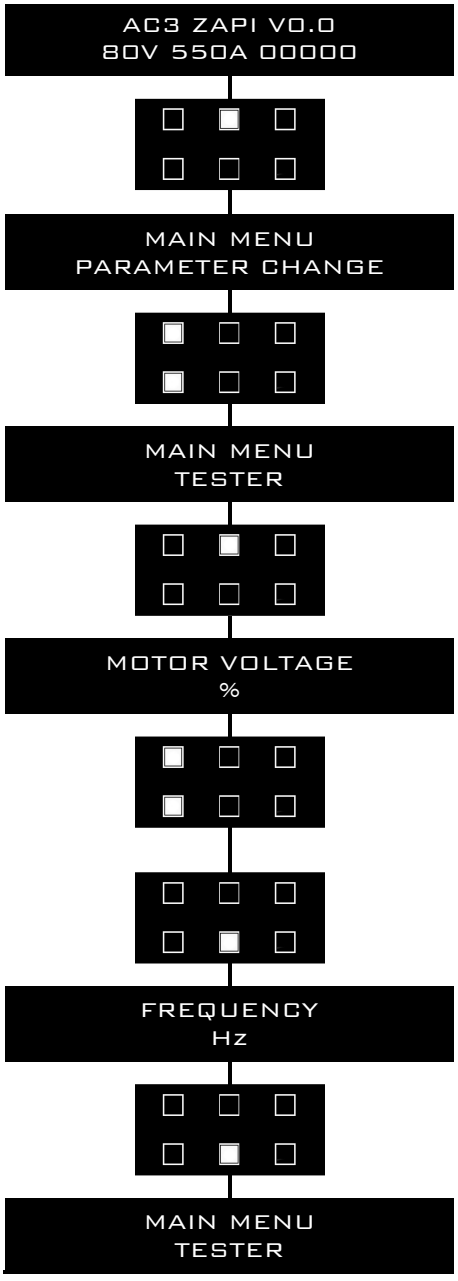
Level of battery voltage measured at the input to the key switch.

22. BATTERY CHARGE

The percentage Charge level of the battery.

Flow Chart showing how to use the TESTER function of the Digital Console.

1. Opening Zapi Display.
2. Press ENTER to go into the General menu
3. The Display will show:
4. Press ROLL UP or ROLL DOWN button until TESTER MENU appears.
5. The Display will show:
6. Press ENTER to go into the TESTER function.
7. The first variable to be tested is shown on the Display
8. Press ROLL UP or ROLL DOWN button until the desired variable for measurement appears on the Display.
9. When you have finished, press OUT
10. The Display will show:
11. Press OUT again to return to Opening Zapi Display



Other Functions

Description of the Console "SAVE" Function

The SAVE function allows the operator to transmit the Parameter values and Configuration data of the controller into the Console memory. It is possible to load 16 different programmes.

The information saved in the Console memory can then be reloaded into another inverter using the RESTORE function.

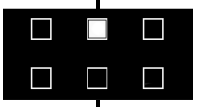
The data that is available via the SAVE function is as follows:

- All Parameter Values (PARAMETER CHANGE).
- Options (SET OPTIONS).
- The Level of the Battery (ADJUST BATTERY).

Flow Chart showing how to use the SAVE function of the Digital Console.

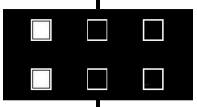
1. Opening Zapi Display.

2. Press ENTER to go into the General menu



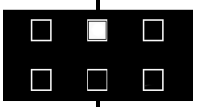
3. The Display will show:

4. Press ROLL UP or ROLL DOWN button until SAVE PARAM. appears on the display



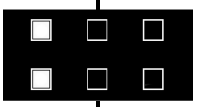
5. The Display will show:

6. Press ENTER to go into the SAVE function.

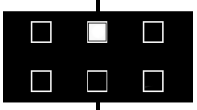


7. If this facility has been used before, the type of inverter data stored appears on the top main with a 2 digit reference

8. Keep pressing either ROLL UP or ROLL DOWN button until the second main indicates a FREE storage facility



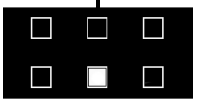
9. Press ENTER to commence SAVE routine.



10. You can see the items that are being stored whilst the SAVE routine is happening.

11. When finished, the Console shows:

12. Press OUT again to return to Opening Zapi Display



Description of the Console "RESTORE" Function

The RESTORE PARAM function allows transfer of the Console's stored data into the memory of the inverter. This is achieved in a fast and easy way using the method previously used with the SAVE PARAM. function.

The data that is available via the RESTORE PARAM. function is as follows:

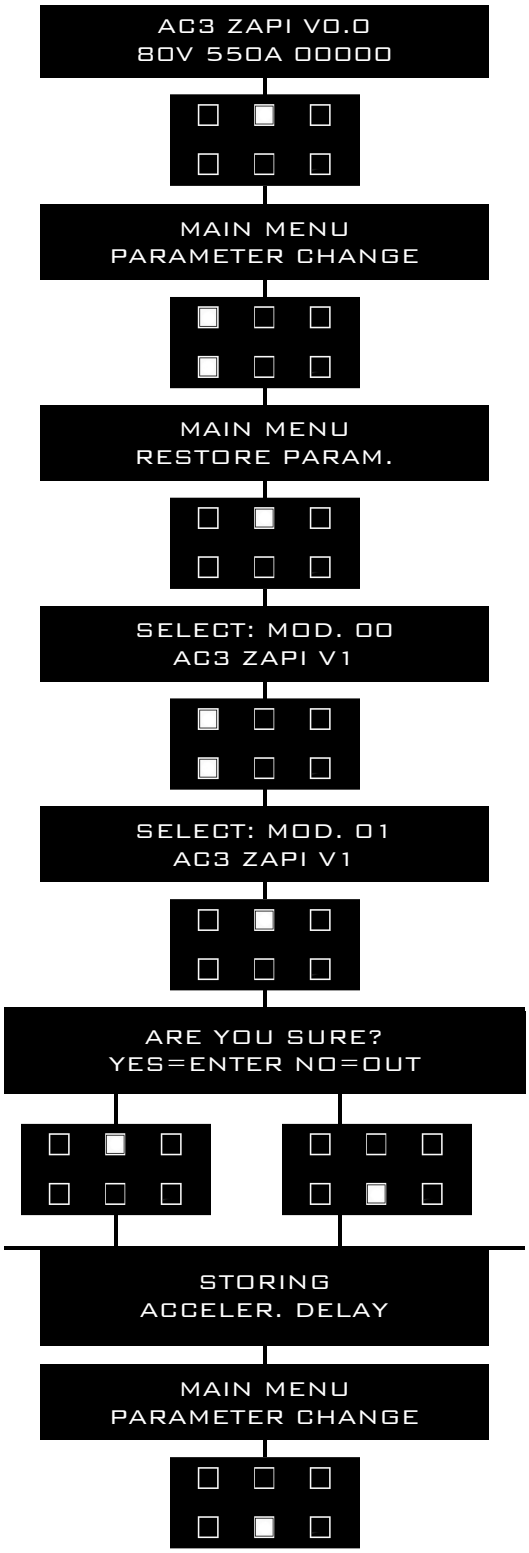
- All Parameter Values (PARAMETER CHANGE).
- Options (SET OPTIONS).
- The level of the Battery (ADJUST BATTERY).

WARNING

When the RESTORE operation is made, all data in the inverter memory will be written over and replace with data being restored.

Flow Chart showing how to use the RESTORE function of the Digital Console.

1. Opening Zapi Display.
2. Press ENTER to go into the General menu
3. The Display will show:
4. Press ROLL UP or ROLL DOWN button until RESTORE PARAM. appears on the display.
5. The Display will show:
6. Press ENTER to go into the RESTORE PARAM function.
7. The Display shows the type of Model stored, with a Code Number.
8. Keep pressing either ROLL UP or ROLL DOWN button until the desired model appears on the Display
9. Press ENTER to commence the RESTORE operation
10. The Display asks “ARE YOU SURE?”
11. Press ENTER for YES or OUT for NO.
12. You can see the items that are being stored in the inverter memory whilst the RESTORE routine is happening.
13. When finished, the Console shows:
13. Press OUT again to return to Opening Zapi Display



Description of Alarms Menu

The microprocessor in the controller remembers the last five Alarms that have occurred. Items remembered relative to each Alarm are:

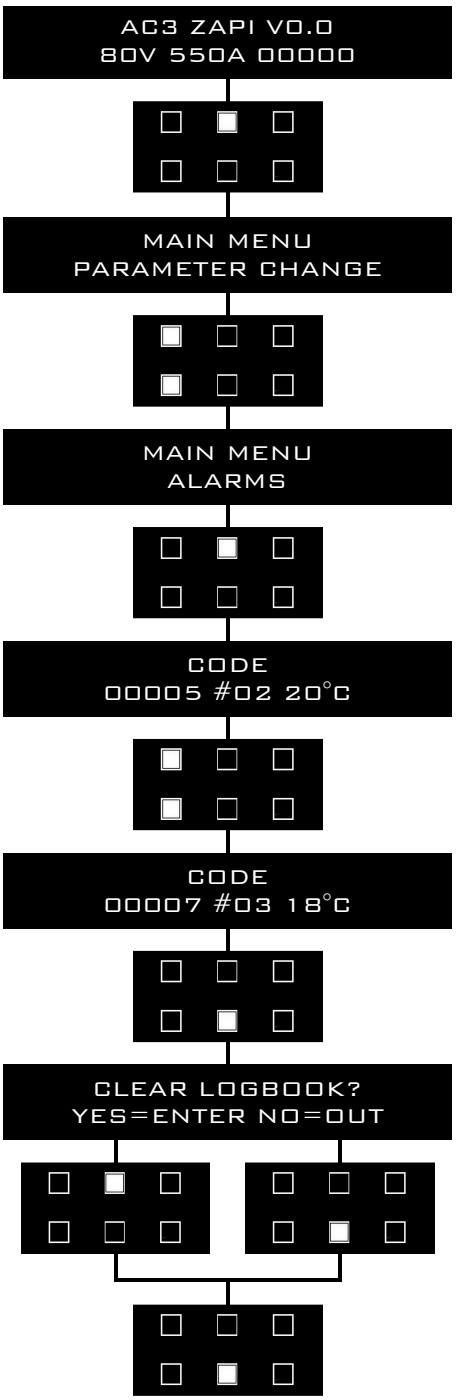
- The code of the alarm
- The number of times the particular Alarm occurred,

- The Hour Meter count
- The controller temperature.

This function permits a deeper diagnosis of problems as the recent history can now be accessed.

Flow Chart showing how to use the ALARMS function via the Digital Console.

1. Opening Zapi Display.
2. Press ENTER to go into the General Menu
3. The Display will show:
4. Press ROLL UP or ROLL DOWN button until PARAMETER CHANGE appears.
5. The Display will show:
6. Press ENTER to go into the ALARMS function.
7. The display will show: THE MOST RECENT ALARM.
8. Each press of the ROLL UP button brings up following Alarms. Pressing ROLL DOWN returns to the most recent.
9. If an Alarm has not occurred, the Display will show: ALARM NULL.
10. When you have finished with the Alarms, press OUT to exit the ALARMS menu.
11. The Display will ask “CLEAR LOGBOOK?”
12. Press ENTER for yes, or OUT for no.
13. Press OUT again. Display now shows the Opening Zapi Menu



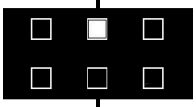
Description of the Console “PROGRAM VACC” Function

This function looks for and remembers the minimum and maximum potentiometer wiper voltage over the full mechanical range of the pedal. It enables compensation for non symmetry of the mechanical system between directions. The operation is performed by operating the pedal after entering the PROGRAM VACC function.

Flow Chart showing how to use the PROGRAM VACC function of the Digital Console.

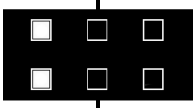
1. Opening Zapi Display.

2. Press ENTER to go into the General Menu.



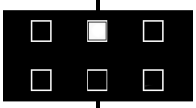
3. The Display will show:

4. Press ROLL UP or ROLL DOWN button until PROGRAM VACC appears.



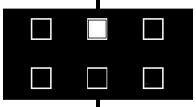
5. The Display will show:

6. Press ENTER to go into the PROGRAM VACC routine.



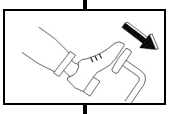
7. The display will show the minimum and maximum values of potentiometer wiper output. Both directions can be shown.

8. Press ENTER to clear these values. The Display will show 0.0



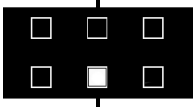
9. Select Forward Direction, close any interlock switches that may be in the system.

10. Slowly depress the accelerator pedal (or tiller butterfly) to its maximum value. The new minimum and maximum voltages will be displayed on the Console plus an arrow indicating the direction.



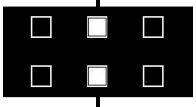
11. Select the Reverse Direction and repeat item 10.

12. When finished, press OUT.



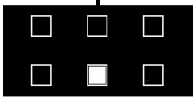
13. The display will ask “ARE YOU SURE?”

14. Press ENTER for yes, OUT for no.



15. When finished the Console shows:

16. Press OUT again. Display now shows the Opening Zapi Menu



AC3 ALARMS DISPLAYED ON THE DIGITAL CONSOLE

(AL 8) WATCHDOG.
The test is made in both standby and running conditions. It is a self-diagnosing test within the logic. If this Alarm occurs, replace the logic.

(AL 13) EEPROM KO.
There is a fault in the area of memory in which the Adjustment Parameters are stored. This Alarm disables the truck. Re-cycle the key switch. If the fault remains at key on, replace the logic. If the Alarm disappears, the parameters and settings previously stored will have been replaced by default values. The controller will require re-programming.

(AL 16) AUX OUTPUT KO (See Additional)

(AL 17) LOGIC FAILURE #3.
Fault in the hardware section of the logic board that monitors the hardware current protection. Replace the controller.

(AL 18) LOGIC FAILURE #2.
Fault in the hardware section of the logic board that monitors the phase's voltage feedback. Replace the controller.

(AL 19) LOGIC FAILURE #1.
This Alarm indicates that either an under voltage or an over voltage has occurred. There are two possible reasons.

a) A real under voltage / over voltage has occurred.
b) There is a fault in the hardware section of the logic board that monitors the over voltage protection. Replace the controller.
c)

(AL 30) - (AL 31) VNM LOW-VMN HIGH.
This check is carried out during initial diagnosis, and in standby. Possible causes:

a) Problem with the motor power connections / cables
b) Motor has a frame rate
c) Failure of the inverter

(AL 37) CONTACTOR CLOSED.
The logic checks that the Line Contactor contacts are not closed when the coil is not energised. It is possible for the capacitor bank to cause this problem if the capacitors are not discharged in a given time period. Check that the contacts are not welded and are free to move

(AL 38) CONTACTOR OPEN.
This alarm is generated when the line contactor driver has turned on, but the contactor does not close. Possible causes:

a) The wiring to the contactor coil is open circuit or not connected properly
b) There are problems within the contactor (contacts / mechanical).

(AL 53) STBY 1 HIGH.
This check is carried out in standby. Logic checks that the current is zero. If not, this alarm generated and the truck disabled. Possible causes

a) Current Sensor failure
b) Logic failure

Replace the controller

(AL 60) CAPACITOR CHARGE.
Circuit shows the capacitor charging system. When the key switch is closed, the Capacitor charges via the Pre-Charge Resistor. If the Capacitor does not reach a pre-determined charge level in a pre-determined time, this Alarm is generated and the Line Contactor is disabled. Possible reasons:

a) The pre-charge resistor is open circuit due to the charging circuit failure, or failure of the power module(s).

See L36

(AL 61) HIGH TEMPERATURE
The invertor temperature >75 Deg C. Maximum current is reduced in proportion to the temperature increase. The Inverter stops working @ 100 Deg C. If the alarm is generated when the inverter is cold

a) Check the wiring of the thermal sensor
b) Thermal sensor failure
c) Logic failure

(AL 65) MOTOR TEMPERATURE
This alarm is generated if the motor temperature switch has opened, or the analogue signal > than a cut off level. If this occurs when the motor is cold, check the wiring. If all is ok, replace the logic board.

(AL 66) BATTERY LOW
If the BATTERY CHECK option is ON, a battery discharge algorithm is carried out. When the battery is discharged, this alarm is generated, and the maximum current is reduced to 50% of the programmed value Lift lockout occurs plus traction speed is reduced. Charge the battery.

(AL 68) SAFETY
This alarm is generated when the “Safety” input is open This circuit becomes active and opens the drivers for the Line Contactor and stops the machine. Check the safety input connections. Black wire link B5 to B11.

(AL 71) HANDBRAKE.
The truck does not start because the handbrake switch is open. Possible causes are:

a) Defective wiring
b) Failure of the handbrake microswitch
c) Incorrect operator operation
d) Logic Failure

AL 74) DRIVER SHORTED.
At Key On, the microprocessor checks that the Line Contactor coil driver. is not short circuit. If it is, this alarm is generated. Replace the logic.

(AL 75) CONTACTOR DRIVER.
When the initial diagnosis is completed, the logic closes the line contactor and verifies the voltage on the drain of the driver. If it is not low, this alarm is generated.

(AL 76) COIL SHORTED.
At Key on, the microprocessor checks the Line (Main) contactor driver. If it does not produce the correct result from a pre-determined stimulus, this alarm is generated. Possible causes:

a) Coil current is too high
b) Possible external short circuit
c) Logic failure

(AL 78)VACC NOT OK.
This test is made in standby. The Alarm is generated when the accelerator wiper voltage is >1v of the minimum value programmed by the PROGRAM VACC function. Possible causes:

a) The potentiometer is not correctly calibrated.
b) The potentiometer is defective
c) Acceleration is partly depressed

(AL 79) INCORRECT START.
This Alarm signals an incorrect starting sequence. Possible causes:

a) Failure of a running microswitch,
b) Error in the starting sequence made by the operator,
c) Incorrect wiring,
d) Logic failure.

(AL 80) FORW + BACK.
This test is carried out continuously. The Alarm is generated when both forward and reverse running requests are made simultaneously. Possible causes :

a) Defective wiring
b) Running microswitch failure
c) Incorrect operation
d) Logic failure.

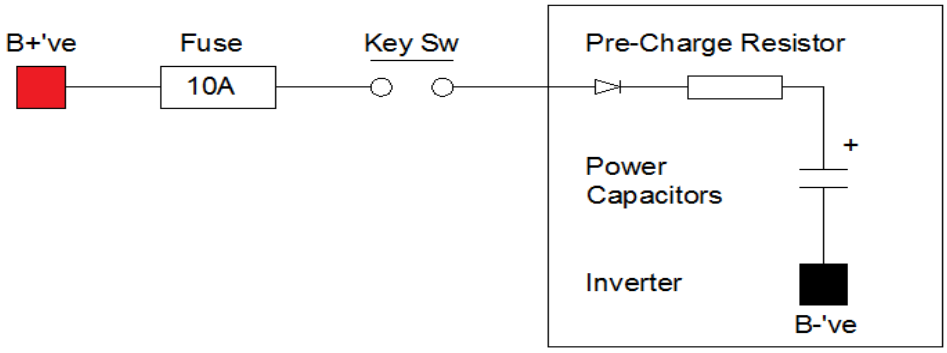
(AL 82) ENCODER ERROR.
Two consecutive readings of the encoder speed are too different. Due to the inertia of the system it is not possible for the encoder to change **it’s speed considerably in a short time** frame. It is more likely to be an encoder problem. Eg. One or both of the encoder channels are corrupted or are disconnected. Check both the electrical and mechanical functions of the encoder. Also remember that Electro Magnetic Noise on the sensor bearing can be a cause for this Alarm. Check the encoder wiring for damage or bad connection.

(AL 86) PEDAL WIRE KO.
This alarm is generated if a fault is detected in the accelerator potentiometer wiring. (Either Positive or Negative is open circuit)

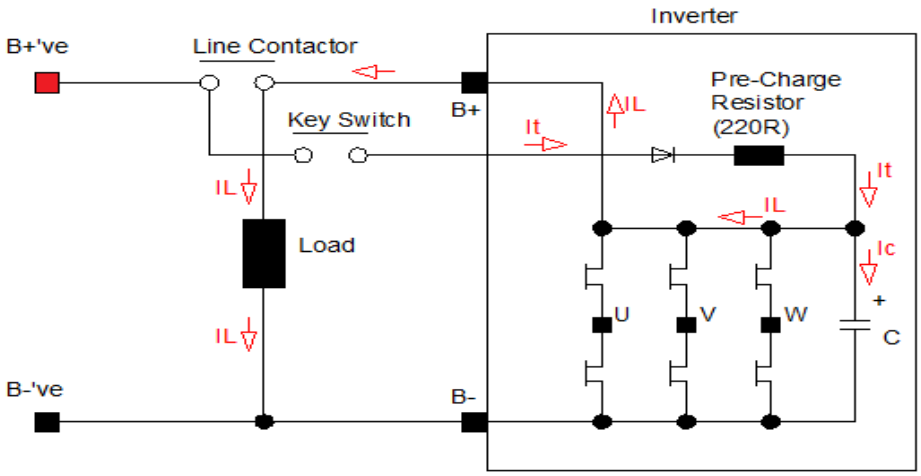
(AL 87) PEDAL FAILURE.
This alarm can be activated on request and is generated if the accelerator signal is out of range. Possible causes are Hardware logic board problem, or pedal potentiometer problem.

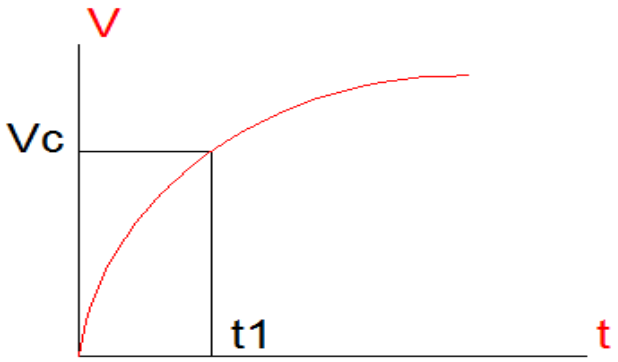
(AL 94) DATA ACQUISITION.
This Alarm is generated in the current gain acquisition phase. Wait until end of the acquisition activity.

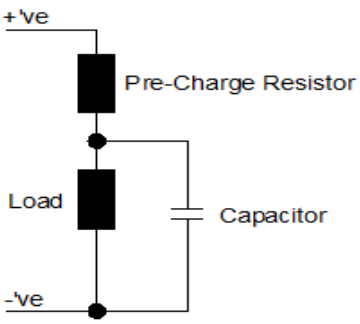
CAPACITOR CHARGE



Effect of connecting an External Load







Additional

(AL 16) Aux Output KO:
The microprocessor checks the driver of the hydraulic contactor, if the status of the driver does not correspond to the input signal, this alarm is generated.
Check for no positive input voltage on plug B pin 9 at the AC3 Inverter.

(AL 98) 00 Reload HM MDI:
Loading hour meter reading form M.D.I. (Multifunction Digital Indicator) to AC3 Inverter.

Recommended Spare Parts for Inverter

Part No.	Description
C16507	Protected 500A strip Fuse.
C16505	Protected 355A strip Fuse.
C16520	6.3A 20mm Control Circuit Fuse
C29509	SW200 80V Single Pole Contactor
C29532	SW200 48V Single Pole Contactor
C12532	Ampseal Connector 35 pins Female
C12442	Molex Minifit Connector 2 pins Female
C12358	Molex Minifit Connector 4 pins Female
C12359	Molex Minifit Connector 6 pins Female
C12414	Molex Minifit Connector 8 pins Female
C12407	Molex Minifit Connector 12 pins Female
C12403	Molex Minifit Connector 14 pins Female
C12796	Female Ampseal pin harness side
C12777	Female Molex Minifit pin harness side

Periodic Maintenance to be Repeated at Times Indicated

Check the wear and condition of the Contactors' moving and fixed contacts. Electrical Contacts should be checked every **3 months.**

Check the Foot pedal or Tiller microswitch. Using a suitable test meter, confirm that there is no electrical resistance between the contacts by measuring the volt drop between the terminals. Switches should operate with a firm click sound. Microswitches should be checked every **3 months.**

Check the Battery cables, cables to the inverter, and cables to the motor. Ensure the insulation is sound and the connections are tight. Cables should be checked every **3 months.**

Check the mechanical operation of the pedal or tiller. Are the return springs ok. Do the potentiometers wind up to their full or programmed level. Check every **3 months.**

Check the mechanical operation of the Contactor(s). Moving contacts should be free to move without restriction. Check every **3 months.**

Checks should be carried out by qualified personnel and any replacement parts used should be original. Beware of NON ORIGINAL PARTS.
The installation of this electronic controller should be made according to the diagrams included in this Manual. Any variations or special requirements should be made after consulting a Zapi Agent. The supplier is not responsible for any problem that arises from wiring methods that differ from information included in this Manual.

During periodic checks, if a technician finds any situation that could cause damage or compromise safety, the matter should be bought to the attention of a Zapi Agent immediately. The Agent will then take the decision regarding operational safety of the machine.

Remember that Battery Powered Machines feel no pain.

NEVER USE A VEHICLE WITH A FAULTY ELECTRONIC CONTROLLER.

WARNING

IMPORTANT NOTE ABOUT WASTE MANAGEMENT:

This controller has both mechanical parts and high-density electronic parts (printed circuit boards and integrated circuits). If not properly handled during waste processing, this material may become a relevant source of pollution.

The disposal and recycling of this controller has to follow the local laws for these types of waste materials.

Zapi commits itself to update its technology in order to reduce the presence of polluting substances in its product.