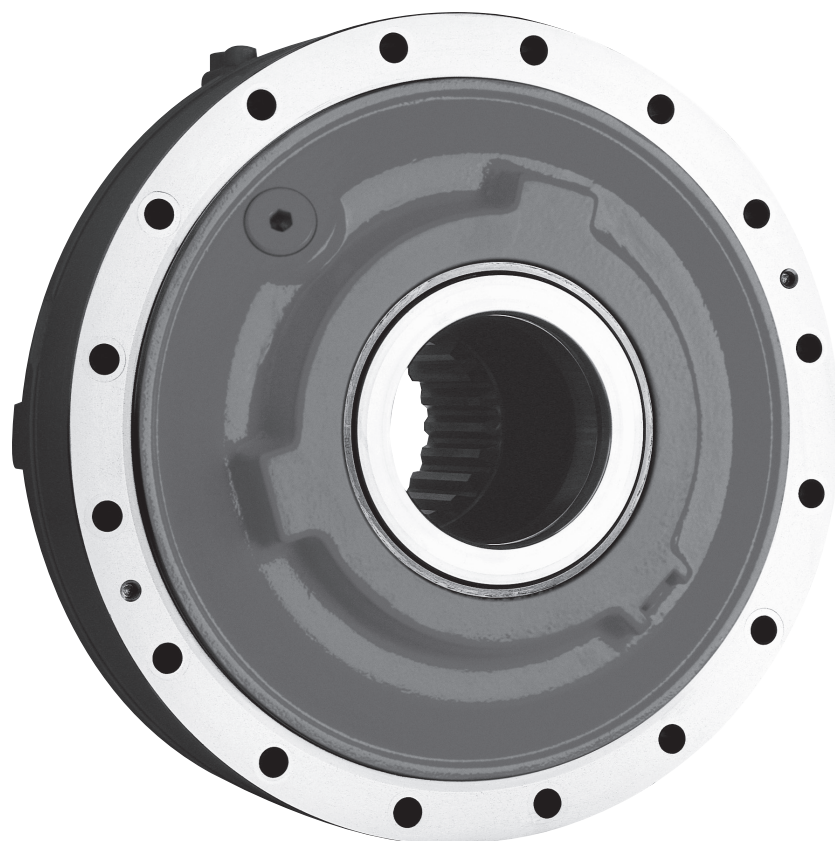


# Hägglunds CA

Radial piston hydraulic motor

**Installation and maintenance  
manual**  
RE 15305-WA/08.2018

Supersedes:  
**RE 15305-WA/10.2015**  
English



The data specified above only serve to describe the product. No statements concerning a certain condition or suitability for a certain application can be derived from our information. The information given does not release the user from the obligation of own judgment and verification. It must be remembered that our products are subject to a natural process of wear and aging.

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Changes in the equipment may occur. We therefore reserve the right to introduce amendments in the manual as we deem necessary without notice or obligations.

This Installation and Maintenance Manual is valid for motors manufactured after 2003-06-01. For older motors please contact your Bosch Rexroth representative.

The cover shows an example configuration. The product supplied may therefore differ from the figure shown.

The original operating instructions were prepared in English.

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# 1 General

## 1.1 Safety precautions

**It is of high importance that the Safety precautions are always followed, if you are unsure about something, please do not hesitate to contact your nearest Bosch Rexroth office for advice.**

- **Warning signs.** In this manual you will find the following signs which indicate a potential hazard, which can or will cause personal injury or substantial property damage. Depending on the probability of the hazard, and how serious the injury or property damage could be, there are three levels of classification.

Warning sign, signal word	Meaning
 <b>DANGER</b>	Indicates a dangerous situation which may cause death or severe personal injuries if not avoided.
 <b>WARNING</b>	Indicates a dangerous situation which may cause death or severe personal injuries if not avoided.
 <b>CAUTION</b>	Indicates a dangerous situation which may cause minor or medium personal injuries if not avoided.
<b>NOTICE</b>	Damage to property: The product or the environment could be damaged.

- **Application area.** All new and rebuild applications, should always be approved and supervised by Bosch Rexroth personnel.
- **Mounting.** Carefully follow the instructions and be aware of the high weights and forces during lifting.
- **Before starting up.** Before starting up new, rebuild or just worked on applications, all accessories and safety arrangements functions, should be controlled/tested.
- **Periodic maintenance.** Notice the intervals in maintenance chart (4.4) and keep a record.
- **Dismounting.** Carefully follow the instructions and be aware of the high weights and forces during lifting.

## 1.2 Motor data

Table 1.1

Metric	Full displacement				Max. ** pressure	Displacement shift				
	Displace- ment	Specific torque	Rated speed	Max.*** speed		Displace- ment	Specific torque	Rated speed	Max. speed	Ratio
	V <sub>i</sub> cm <sup>3</sup> /rev	T <sub>s</sub> Nm/bar	n rpm	n rpm		p bar	V <sub>i</sub> cm <sup>3</sup> /rev	T <sub>s</sub> Nm/bar	n rpm	n rpm
Motor type										
CA 50 20	1 256	20	400	400	350	Not recommended to be used in reduced displacement				
CA 50 25	1 570	25	350	400	350					
CA 50 32	2 010	32	280	400	350					
CA 50 40	2 512	40	230	350	350					
CA 50	3 140	50	200	280	350	1 570	25	200	280	1:2
CA 70 40	2 512	40	270	400	350					
CA 70 50	3 140	50	225	320	350	1 570	25	225	320	1:2
CA 70 60	3 771	60	195	275	350	1 886	30	195	275	1:2
CA 70	4 400	70	180	240	350	2 200	35	180	240	1:2
CA 100 40	2 512	40	390	400	350					
CA 100 50	3 140	50	320	400	350					
CA 100 64	4 020	64	260	390	350					
CA 100 80	5 024	80	220	310	350	2 512	40	220	310	1:2
CA 100	6 280	100	190	270	350	3 140	50	190	270	1:2
CA 140 80	5 024	80	245	340	350					
CA 140 100	6 280	100	205	275	350	3 140	50	205	275	1:2
CA 140 120	7 543	120	180	245	350	3 771	60	180	245	1:2
CA 140	8 800	140	170	220	350	4 400	70	170	220	1:2
CA 210 160	10 051	160	105	150	350	5 026	80	105	150	1:2
CA 210 180	11 314	180	100	135	350	5 657	90	100	135	1:2
CA 210	13 200	210	85	115	350	6 600	105	85	115	1:2

\* Related to a required charge pressure of 12 bar/175 psi for motors in braking mode. (Special considerations regarding charge pressure, cooling and choice of hydraulic system for speeds above rated, 4 ports must be used).

\*\* The motors are designed according to DNV-rules. Test pressure 420 bar/6000 psi. Peak/transient pressure 420 bar/6000 psi maximum, allowed to occur 10000 times.

\*\*\* Speed above 280 rpm requires viton seals. Max permitted continuous case pressure is 2 bar.

Table 1.1

US Motor type	Full displacement				Max. ** pressure	Displacement shift				
	Displace- ment	Specific torque	Rated speed	Max.*** speed		Displace- ment	Specific torque	Rated speed	Max. speed	Ratio
	V <sub>i</sub> in <sup>3</sup> /rev	T <sub>s</sub> lbf•ft/ 1 000 psi	n rpm	n rpm	p bar	V <sub>i</sub> in <sup>3</sup> /rev	T <sub>s</sub> lbf•ft/ 1 000 psi	n rpm	n rpm	
CA 50 20	76.6	1 017	400	400	5 000	Not recommended to be used in reduced displacement				
CA 50 25	95.8	1 271	350	400	5 000					
CA 50 32	122.6	1 627	280	400	5 000					
CA 50 40	153.3	2 034	230	350	5 000					
CA 50	191.6	2 543	200	280	5 000	95.8	1 271	200	280	1:2
CA 70 40	153.3	2 034	270	400	5 000					
CA 70 50	191.6	2 543	225	320	5 000					
CA 70 60	230.1	3 051	195	275	5 000	115.1	1 526	195	275	1:2
CA 70	268.5	3 560	180	240	5 000	134.3	1 780	180	240	1:2
CA 100 40	153.3	2 034	390	400	5 000					
CA 100 50	191.6	2 543	320	400	5 000					
CA 100 64	245.3	3 254	260	390	5 000					
CA 100 80	306.6	4 068	220	310	5 000	153.3	2 034	220	310	1:2
CA 100	383.2	5 085	190	270	5 000	191.6	2 543	190	270	1:2
CA 140 80	306.6	4 068	245	340	5 000					
CA 140 100	383.2	5 085	205	275	5 000					
CA 140 120	460.3	6 102	180	245	5 000					
CA 140	537	7 119	170	220	5 000	268.5	3 560	170	220	1:2
CA 210 160	613.2	8 136	105	150	5 000	306.7	4 068	105	150	1:2
CA 210 180	690.4	9 154	100	135	5 000	345.2	4 577	100	135	1:2
CA210	805.5	10 678	85	115	5 000	402.8	5 339	85	115	1:2

\* Related to a required charge pressure of 12 bar/175 psi for motors in braking mode. (Special considerations regarding charge pressure, cooling and choice of hydraulic system for speeds above rated, 4 ports must be used).

\*\* The motors are designed according to DNV-rules. Test pressure 420 bar/6000 psi. Peak/transient pressure 420 bar/6000 psi maximum, allowed to occur 10000 times.

\*\*\* Speed above 280 rpm requires viton seals. Max permitted continuous case pressure is 2 bar.

### 1.3 Functional description

The hydraulic industrial motor Hägglunds CA is of the radial-piston type with a rotating cylinder block/hollow shaft and a stationary housing. The cylinder block is mounted in fixed roller bearings in the housing. An even number of pistons are radially located in bores inside the cylinder block, and the valve plate directs the incoming and outgoing oil to and from the working pistons. Each piston is working against a cam roller.

When the hydraulic pressure is acting on the pistons, the cam rollers are pushed against the slope on the cam ring that is rigidly connected to the housing, thereby producing a torque. The cam rollers transfer the reaction force to the piston which are guided in the rotating cylinder block. Rotation therefore occurs, and the torque available is proportional to the pressure in the system.

Oil main lines are connected to ports A and C in the connection block and drain lines to ports D1, D2 or D3 in the motor housing.

The motor is connected to the shaft of the driven machine through the hollow shaft of the cylinder block. The torque is transmitted by using a mechanical shaft coupling, or alternatively by splines.

The symmetrical design of the motor has made it possible to design it as a two displacement motor. This means that two different speeds can be obtained for a given flow. The simplest way of performing displacement change is by connecting a special valve, direct to the flange face on the connection block.

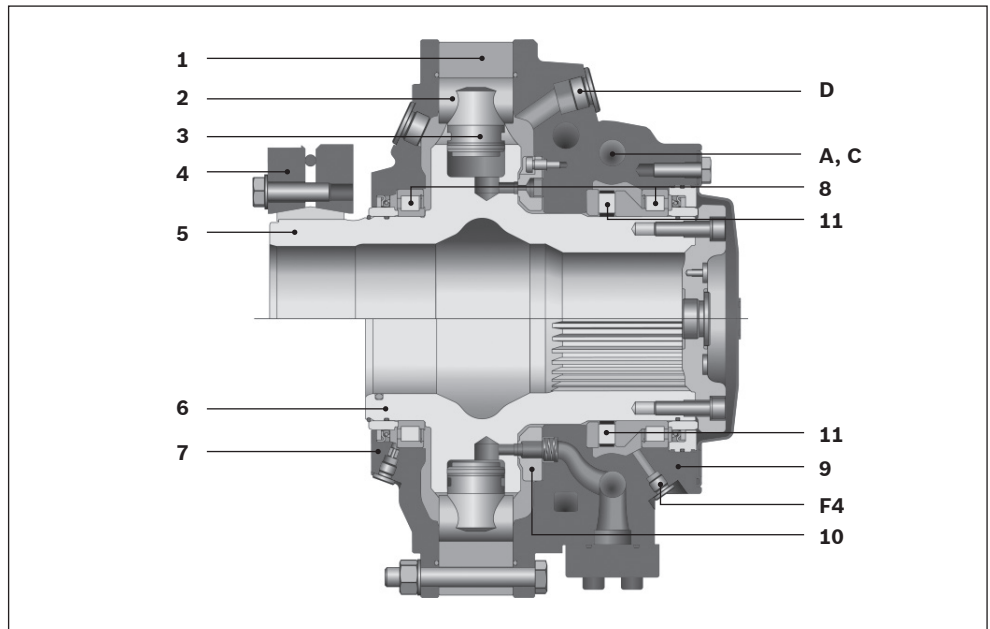
#### Valid patents

US 4522110, US 005979295A, SE 9101950-5, EP 0102915, JP 83162704, GB 1524437, EP NL 0524437, EP:DE 69211238.3.

#### Quality

To assure our quality we maintain a Quality Assurance system, certified to standard ISO 9001





**Fig 1: The Compact CA Motor**

- |                                      |                                   |
|--------------------------------------|-----------------------------------|
| <b>1</b> Cam ring                    | <b>9</b> Connection block         |
| <b>2</b> Cam roller                  | <b>10</b> Valve plate             |
| <b>3</b> Piston                      | <b>11</b> Axial bearing           |
| <b>4</b> Shaft coupling              | <b>A</b> Inlet or outlet port »A« |
| <b>5</b> Cylinder block/hollow shaft | <b>C</b> Inlet or outlet port »C« |
| <b>6</b> Cylinder block/spline       | <b>D</b> Drain port               |
| <b>7</b> Front end cover             | <b>F4</b> Flushing                |
| <b>8</b> Cylindrical roller bearing  |                                   |

## 2 Technical data

### 2.1 Recommended charge pressure

The hydraulic system must be such that the motor will receive sufficient charge pressure at the low-pressure port. This applies to all types of installations.

There are three distinct cases:

**Case 1:**

The motor works in braking mode. Required charge pressure at the inlet port is according to diagram below.

**Case 2:**

The motor works in driving mode only. Required back pressure at the outlet port corresponds to 30% of value given in diagram below, but may not be lower than 2 bar (29 psi).

**Case 3:**

The motor is used with 2-speed valve. Required charge pressure at inlet port for valve is according to AC-3.1 Accessories.

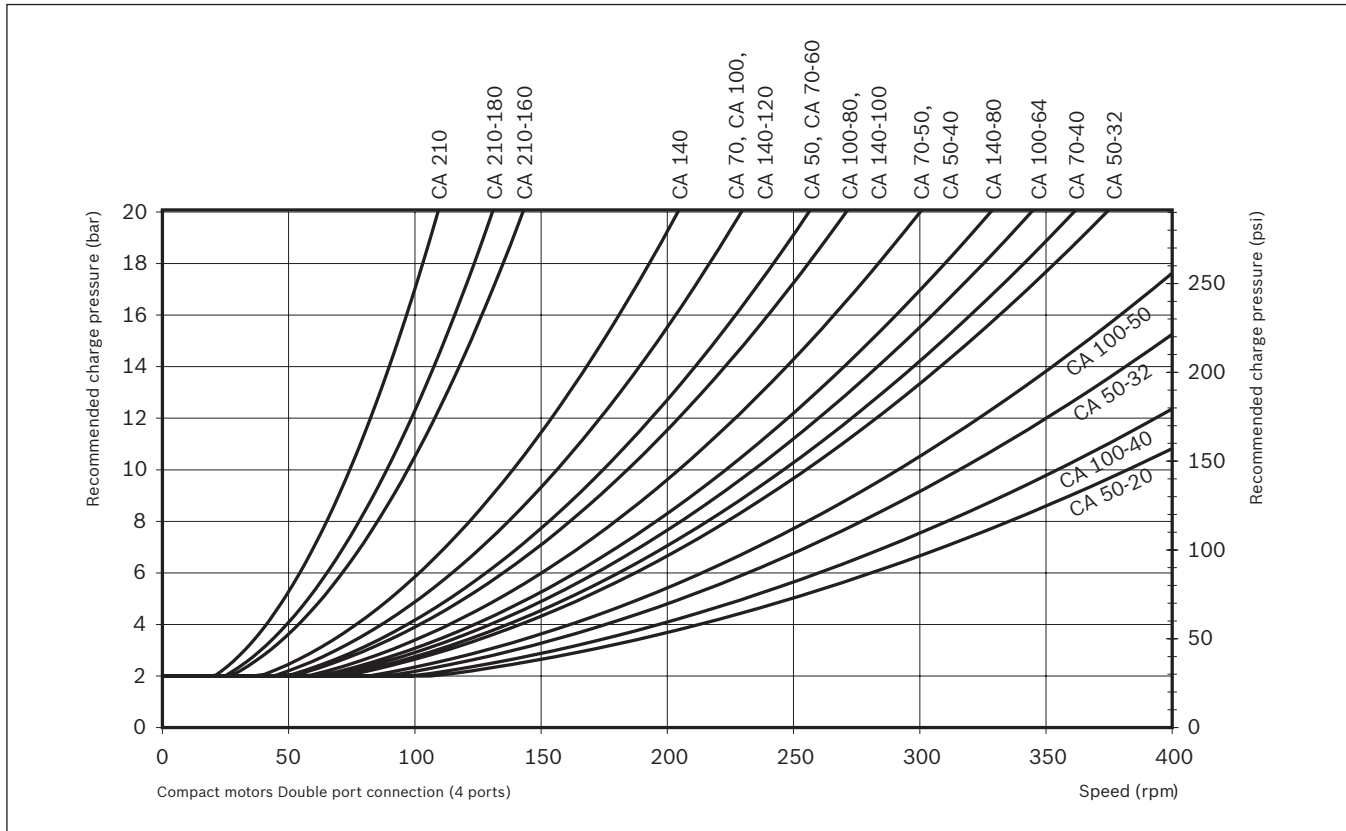
## ! WARNING

In hanging load applications, charge pressure at motors connection must be according to graph below under all conditions.

**Table 2.1 Charge pressure**

**Recommended charge pressure – Compact CA Motors**

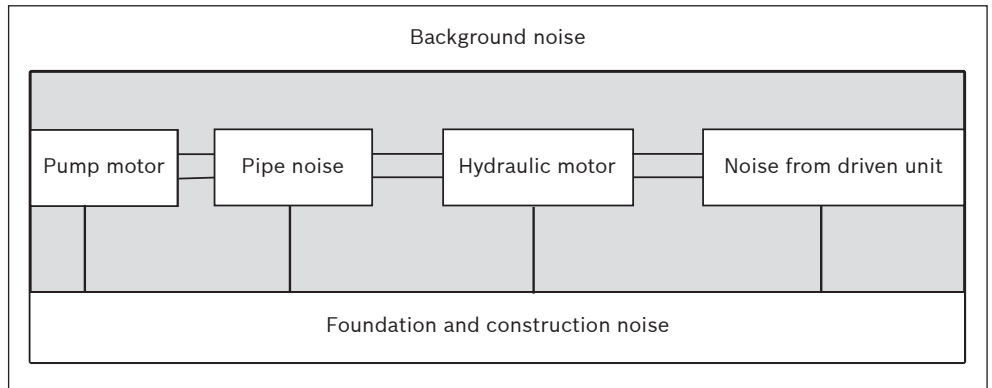
Double port connection (4 ports) oil viscosity 40 cSt / 187 SSU



**NOTICE!**

The diagram is valid for 1 bar (15 psi) case pressure. With increasing case pressure the charge pressure must be increased accordingly. The graph is valid when 4 ports are used. Max casing pressure is 3 bar (43.5 psi) (for 1% of the operation time evenly divided, pressure peaks of max 5 seconds up to 8 bar (116 psi) is allowed). Max permitted case pressure at stand-still is 8 bar (116 psi).

## 2.2 Sound from a complete installation



### 2.2.1. Remarks:

#### **Background noise**

The background noise can not normally be influenced but is usually known or easy to measure.

#### **Pump unit**

The pump unit is a known noise level.

#### **Pipe noise**

The pipe noise is probably the source of the majority of mistakes in installations: all pipe clamps should be of vibration insulating type secured to concrete ceiling, wall or floor. Securing to non-rigid metal structures or structures is likely to give resonance and should be avoided.

#### **Hydraulic motor**

The hydraulic motor is a known noise level. (Tables of sound data - see subsection 4.9 in the Engineering Manual).

#### **Driven unit**

The driven unit is an unknown sound source (for us) but can through certain information probably be obtained from the supplier. When securing the torque arm of a hydraulic motor to the foundation or casing of a driven machine, it is highly important to study the construction of the foundation or casing. This may well be the most important factor to consider, since many structures may give rise to resonance, resulting in severe noise problems.

## 2.3 Choice of hydraulic fluid

The Hägglunds hydraulic motors are primarily designed to operate on conventional petroleum based hydraulic oils. The hydraulic oil can be chosen in consultation with the oil supplier of your local sales office, bearing the following requirements in mind:

### 2.3.1. General

The oil shall have FZG (90) fail stage minimum 11 described in IP 334 (DIN 51354). The oil must also contain inhibitors to prevent oxidation, corrosion and foaming. The viscosity of mineral oil is highly dependent of the temperature. The final choice of oil must depend on the operating temperature that can be expected or that has been established in the system and not in the hydraulic tank. High temperatures in the system greatly reduce the service life of oil and rubber seals, as well as resulting in low viscosity, which in turn provides poor lubrication. Content of water shall be less than 0.1%. In Industrial applications with high demands for service life, the content of water shall be less than 0.05%.

Viscosity index = 100 is recommended. Viscosity index = 150 can be used for operation with large temperature difference, however many hydraulic fluids are subject to temporary and permanent reductions of the viscosity. Hägglunds recommendation is always to use the base oil viscosity when calculating the rated life and max allowed power. For heavy-duty applications we recommend synthetic oils.

Recommended viscosity in motor case at operating temperature 40-150 cSt/187-720 SSU. For speed below 5 rpm, coated pistons shall be used, please contact your Hägglunds representative.

#### Temperature limits

Normal operating temperature should be less than +50 °C (122 °F)

Nitrile seals (std motor)	-35 °C to +70 °C
Viton seals	-20 °C to +100 °C
Nitrile seals (std motor)	-31 °F to +158 °F
Viton seals	-4 °F to +212 °F

#### Minimum viscosity limits at operating temperature in motor case

Standard motors with uncoated pistons and uncoated cam rollers	20 cSt/98 SSU*
Motors type C (coated pistons and coated cam rollers) for speed below 5 rpm or when charge pressure exceeds 50 bar (725 psi) at speed above 100 rpm	10 cSt/59 SSU*

\* Low viscosity gives reduced service life for the motors.  
Max permitted viscosity is 10000 cSt/48000 SSU

### 2.3.2. Fire resistant fluids

#### Operating with fire resistant fluids

The following fluids are tested for Häggglunds motors: (ISO/DP 6071)

Fluid	Approved	Seals	Internal paint
HFA: Oil (3-5%) in water emulsion	No	–	–
HFB: Inverted emulsion 40-45% water in oil	Yes	Nitrile (std motor)	Not painted*
HFC: Water-glycol	Yes	Nitrile (std motor)	Not painted*
<b>HFD synthetic fluids</b>			
HFD:R – Phosphate esters	Yes	Viton	Not painted*
HFD:S – Chlorinated hydrocarbons	Yes	Viton	Not painted*
HFD:T – Mixture of the above	Yes	Viton	Not painted*
HFD:U – Other compositions	Yes	Viton	Not painted*

\* Must be specified in the order.

#### IMPORTANT!

Down rating of pressure data and service life must be considered when using fire resistant fluid. The Häggglunds company or its authorised representative must always be contacted for approval in the case of these types of fluids.

## 2.4 Environmentally acceptable fluids

Fluid	Approved	Seals	Internal paint
Vegetable */** Fluid HTG	Yes	Nitrile (std motor)	–
Synthetic **/*** Esters HE	Yes	Nitrile (std motor)	–

\* Vegetable fluids give good lubrication and small change of viscosity with different temperature. Vegetable fluids must be controlled every 3 months and temperature shall be less than +45 °C (113 °F) to give good service life for the fluid.

\*\* Environmental acceptable fluid gives the same service life for the drive, as mineral oil.

\*\*\* The fluid shall have less than 10g/100g according to ASTM D 1958-97/DIN 53241

### 2.4.1. Filtration

The oil in a hydraulic system must always be filtered and also the oil from your supplier has to be filtered when adding it to the system. The grade of filtration in a hydraulic system is a question of service life v.s. money spent on filtration.

In order to obtain stated service life it is important to follow our recommendations concerning contamination level.

When choosing the filter it is important to consider the amount of dirt particles that the filter can absorb and still operate satisfactory. For that reason we recommend a filter with an indicator that gives a signal when it is time to change the filter cartridge.

### 2.4.2. Filtering recommendations

Before start-up, check that the system is thoroughly cleaned.

1. For industrial applications the contamination level should not exceed ISO 4406:1999 18/16/13 (NAS 1638, class 7).

2. When filling the tank and motor case, we recommend the use of a filter with the grade of filtration  $\beta_{10}=75$ .

#### 2.4.3. Explanation of “GRADE OF FILTRATION”

Grade of filtration  $\beta_{10}=75$  indicates the following:

- $\beta_{10}$  means the size of particle  $\geq 10 \mu\text{m}$  that will be removed by filtration.
- $=75$  means the grade of filtration of above mentioned size of particle. The grade of filtration is defined as number of particles in the oil before filtration in relation to number of particles in the oil after filtration.
- Ex. Grade of filtration is  $\beta_{10}=75$ .
- Before the filtration the oil contains  $N$  number of particles  $\geq 10 \mu\text{m}$  and after passing the filter once the oil contains  $\frac{N}{75}$  number of particles  $\geq 10 \mu\text{m}$ .
- This means that  $N - \frac{N}{75} = \frac{74 \cdot N}{75}$  number of particles have been filtered (=98.6%).

## 3 Installation

### 3.1 Mounting instructions

If the motor is to work properly it must be installed with the greatest possible precision. Every item connected to the motor that does not meet the requirements of the following instructions may result in stresses that adversely affect the service life of the motor.

Normally the motor must be completely filled with oil. When the motor is installed with the shaft in the horizontal plane, the drain ports must be positioned vertically. The higher of the two drain ports must be used: see figure 3.25.

When the motor is mounted with the shaft in the vertical plane, drain outlet D1 or D2 must be connected to the drain hole on the shaft end housing or end cover. A preloaded check valve must be connected in the drain line to ensure that the motor is filled with oil; see 3.2.2 “Draining and venting the motor”.

The drain line must be dimensioned so that maximum 3 bar (43.5 psi) motor housing pressure is not exceeded.

The maximum housing pressure is 3 bar (43.5 psi). Brief peaks during operation up to 8 bar (116 psi) are permissible. The permitted housing pressure when the motor is stationary is 8 bar (116 psi).

The motor must always be connected in such a way as to give a sufficient boost, make-up flow at the low pressure connection. This is particularly important at high speeds and with rapid reversing, see 2.1 “Recommended charge pressure”.

**Table 3.1 Valid for couplings**

Dim		CA50/70		CA100/140		CA210	
A	mm	$\begin{matrix} 0 \\ -0.025 \end{matrix}$	120	$\begin{matrix} 0 \\ -0.025 \end{matrix}$	140	$\begin{matrix} 0 \\ -0.025 \end{matrix}$	160
	in	$\begin{matrix} 0 \\ -0.00098 \end{matrix}$	4.7244	$\begin{matrix} 0 \\ -0.00098 \end{matrix}$	5.5118	$\begin{matrix} 0 \\ -0.00098 \end{matrix}$	6.2992

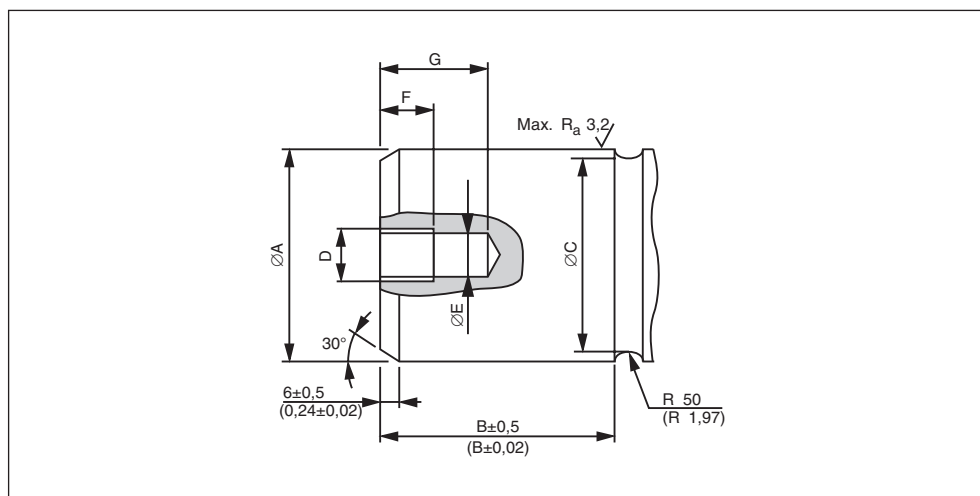
**Notice!** The dimensions are valid for +20 °C (68 °F)

Dim	CA50/70	CA100/140	CA210
B mm	71.5	84.5	105
in	2.81	3.33	4.13
C mm	116	133	153
in	4.57	5.24	6.02

**Notice!** The dimensions are valid for +20 °C (68 °F)

**Design of driven shaft end on heavily-loaded shaft**

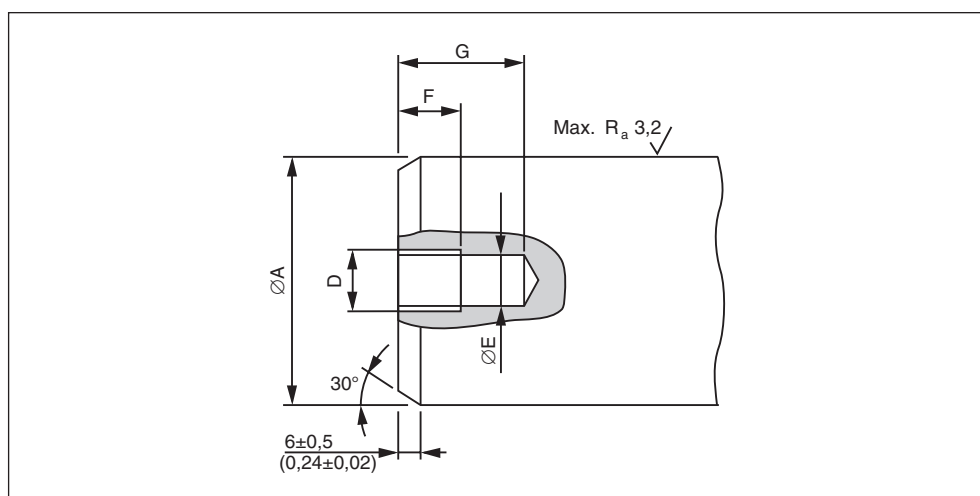
Where the driven shaft is heavily loaded and is subject to high stresses, for example on changes in the direction of rotation, it is recommended that the driven shaft should have a stress relieving groove; see figure 3.1 and tables 3.1 and 3.4.



**Figure 3.1**

**Normally-loaded shaft**

In drives with only one direction of rotation where the stresses in the shaft are moderate, the shaft can be plain, see figure 3.2 and tables 3.1 and 3.4



**Figure 3.2**

**Table 3.2**

**Unidirectional drives**Steel with yield strength  $Re_l = 300 \text{ N/mm}$ **Bidirectional drives**Steel with yield strength  $Re_l = 450 \text{ N/mm}$ **Spline**

The splines shall be lubricated with hydraulic oil, or filled with transmission oil from the connected gearbox. To avoid wear in the splines, the installation must be within the specified tolerances in table 3.3. If there is no radial or axial force on the shaft, the shaft can be oiled only.

For production of the shaft, see 278 2230, 278 2231, 278 2232, 278 2233, 278 2234, 278 2235, 278 2236, 278 2238 and 278 2239. For control of spline see table 3.3.

**Unidirectional drives**Steel with yield strength  $Re_{l_{mm}} = 450 \text{ N/mm}^2$ **Bidirectional drives**Steel with yield strength  $Re_{l_{mm}} = 700 \text{ N/mm}^2$ **Table 3.3**

Motor	CA50/70	CA100/140	CA210
Tooth profile and bottom form	DIN 5480	DIN 5480	DIN 5480
Tolerance	8f	8f	8f
Guide	Back	Back	Back
Pressure angle	30°	30°	30°
Module	5	5	5
Number of teeth	22	26	28
Pitch diameter	Ø 110	Ø 130	Ø 140
Minor diameter	$\begin{matrix} 0 \\ -1.62 \end{matrix}$ Ø 109	$\begin{matrix} 0 \\ -1.62 \end{matrix}$ Ø 129	$\begin{matrix} 0 \\ -1.62 \end{matrix}$ Ø 139
Major diameter	$\begin{matrix} 0 \\ -0.220 \end{matrix}$ Ø 119	$\begin{matrix} 0 \\ -0.250 \end{matrix}$ Ø 139	$\begin{matrix} 0 \\ -0.250 \end{matrix}$ Ø 149
Measure over measuring pins	$\begin{matrix} -0.083 \\ -0.147 \end{matrix}$ 129.781	$\begin{matrix} -0.085 \\ -0.150 \end{matrix}$ 149.908	$\begin{matrix} -0.085 \\ -0.150 \end{matrix}$ 159.961
Diameter of measuring pins	Ø 10	Ø 10	Ø 10
Addendum modification X M	+2.25	+2.25	+2.25

**Thread for mounting tool**

To make it easier to mount the motor on the driven shaft end or to remove the motor from the shaft it is recommended that a hole (table 3.4) should be drilled and tapped in the centre of the shaft for a mounting tool; see 3.1.4 “Mounting the motor onto the driven shaft”, and 3.1.5 “Removing the motor from the driven shaft”.

The tool has both a UNC thread and a metric thread, so that the hole can be drilled and tapped to conform to one of the two alternatives given in table 3.4.



Table 3.4 Alternative thread (figure 3.1 and 3.2)

CA 50-210		
D	M20	UNC 5/8"
E	>17 (0.67)	>13.5 (0.53)
F	25 (0.98)	22 (0.87)
G	50 (1.97)	30 (1.18)

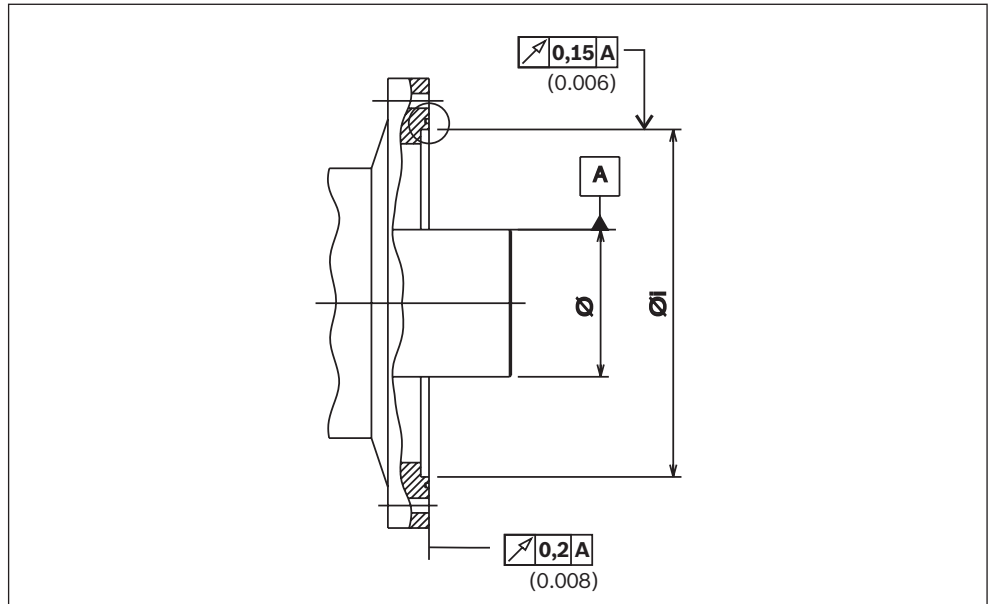


Fig. 3.3

### 3.1.1. Lifting methods

Always make sure where the centre of gravity is before any lifting.

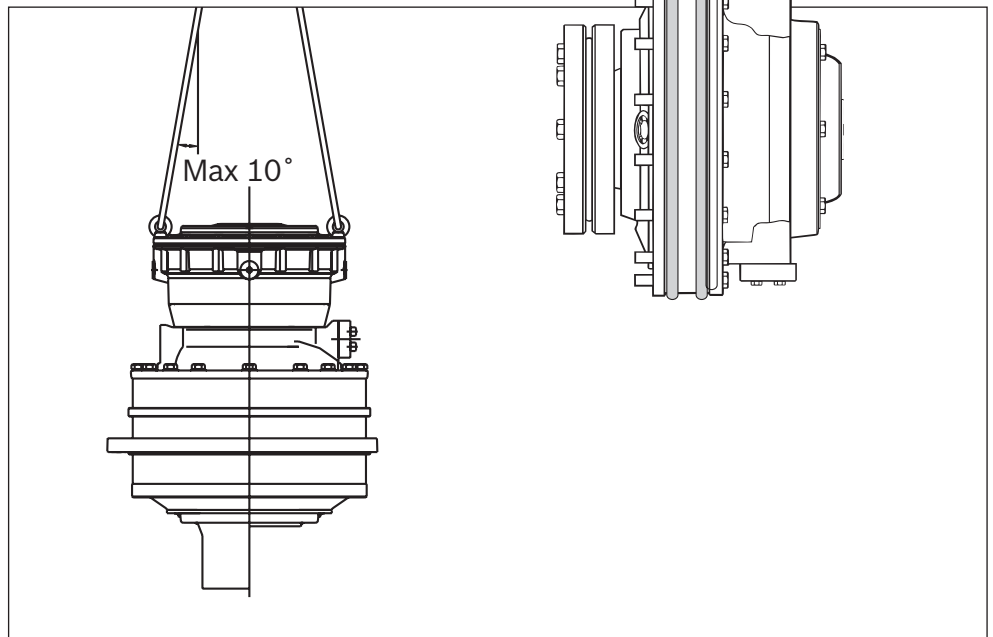


Fig. 3.4a Fig. 3.4b

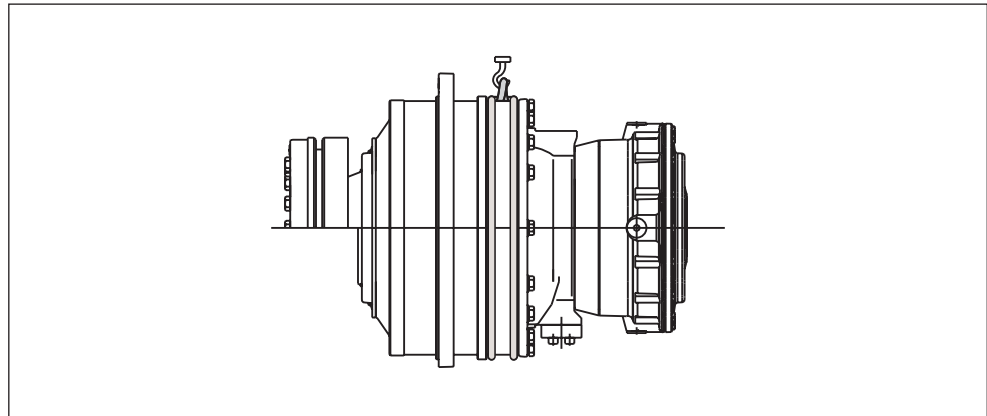


Fig. 3.4c

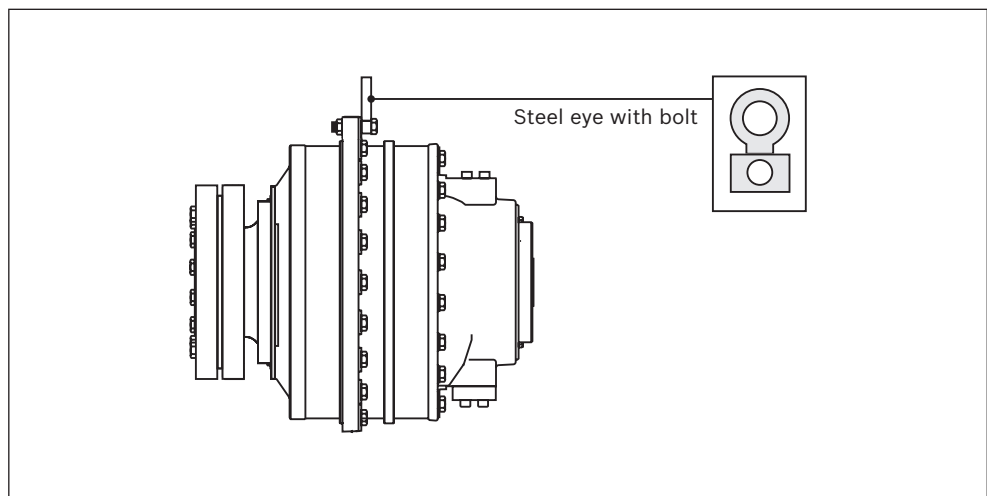
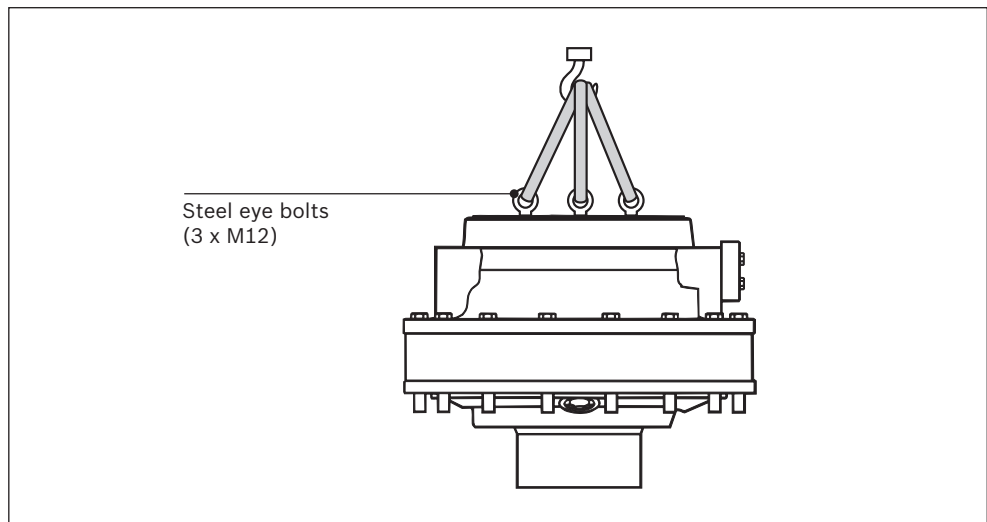


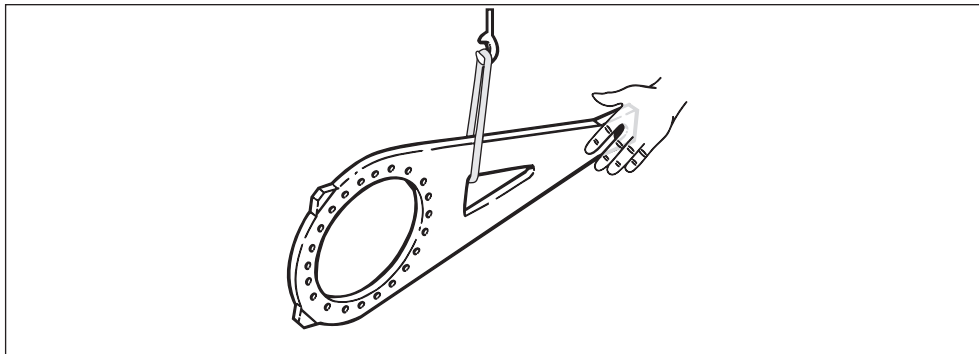
Fig. 4d (CA 210)

**Notice!** Motor lifted without coupling fitted, danger of slipping off.



**Notice!** The end cover and screws must be removed before mounting the steel eye bolts. After the lift; refit the end cover and screws with torque 81 Nm (59 lbf.ft).

**Lifting the torque arm**

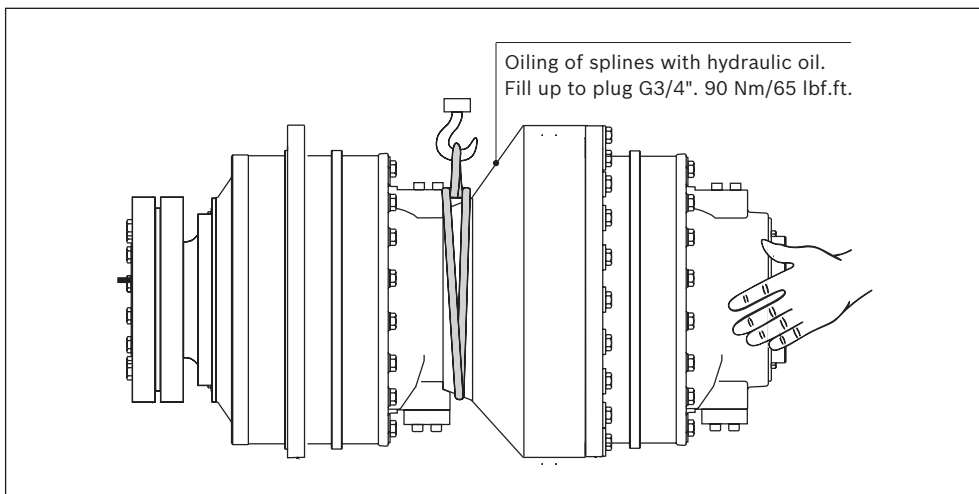


**Fig. 3.5**

**! DANGER**

Always make sure where the centre of gravity is before any lifting. Never stand below a hanging motor or torque arm.

**Lifting Compact Tandem motor**



**Fig. 3.5b: Lifting method**

**! DANGER**

Always make sure where centre of gravity is before any lifting. Never stand below the motor during lifting.

## Installation

See 3.1 Mounting instructions.

### Data for the Tandem motor

Tandem motor	Max. pressure bar (psi)	Max. speed rpm	Total weight Spline version kg (lb)	Total weight Shaft version kg (lb)	Max. torque to driven shaft* Nm (lbf-ft)
CA50 XBONH + TA5 + CA50 SA0N	245 (3 552)	280	399 (878)	427 (936)	24 500 (18 000)
CA70 XBONH + TA5 + CA50 SA0N	205 (2 972)	240	429 (944)	456 (1 003)	
CA70 XBONH + TA7 + CA70 SA0N	175 (2 538)		462 (1 016)	489 (1 076)	
CA100 XBONH + TA5 + CA50 SA0N	325 (4 712)	270	489 (1 076)	534 (1 175)	49 000 (36 100)
CA100 XBONH + TA7 + CA70 SA0N	290 (4 205)		522 (1 148)	567 (1 247)	
CA100 XBONH + TA10 + CA100 SA0N	245 (3 552)		638 (1 404)	683 (1 503)	
CA140 XBONH + TA5 + CA50 SA0N	260 (3 770)	220	529 (1 164)	571 (1 256)	
CA140 XBONH + TA7 + CA70 SA0N	235 (3 408)		562 (1 236)	604 (1 329)	
CA140 XBONH + TA10 + CA100 SA0N	205 (2 972)		678 (1 492)	720 (1 584)	
CA140 XBONH + TA14 + CA140 SA0N	175 (2 538)	115	718 (1 578)	760 (1 672)	73 500 (54 200)
CA210 XBONH + TA5 + CA50 SA0N	280 (4 060)		619 (1 362)	680 (1 496)	
CA210 XBONH + TA7 + CA70 SA0N	260 (3 770)		652 (1 434)	713 (1 569)	
CA210 XBONH + TA10 + CA100 SA0N	235 (3 408)		768 (1 690)	829 (1 824)	
CA210 XBONH + TA14 + CA140 SA0N	210 (3 045)		808 (1 778)	869 (1 912)	
CA210 XBONH + TA21 + CA210 180 SA0N	190 (2 755)		898 (1 976)	959 (2 110)	
CA210 XBONH + TA21 + CA210 SA0N	175 (2 538)	898 (1 976)	959 (2 110)		

\* See Engineering Manual AC-3.5

**Table 3.5**

Motor	Motor with shaft coupling		Motor with splines	
	kg	lb	kg	lb
CA 50	203	447	175	385
CA 70	232	510	205	451
CA 100	310	682	265	583
CA 140	347	763	305	671
CA 210	456	1003	395	869

**Table 3.6a**

Torque arm	Weight	
	kg	lb
TCA 5	21	46
TCA 7	24	53
TCA 10	75	165
TCA 14	65	143

**Table 3.6b**

Brake	Weight	
	kg	lb
MDA 5-10	100	220
MDA 14-21	230	506
BICA 13	87	191
BICA 24	175	385
BICA 37	210	462

## ! WARNING

Lifting straps must be chosen with reliable safety margin over the total weight of the lifted object.

### Standing the motor on a flat surface

When the motor is placed on a flat surface such as a floor, it must stand either on its outer diameter or on the suitably protected end face of the hollow shaft (see figure 3.6 and 3.7).

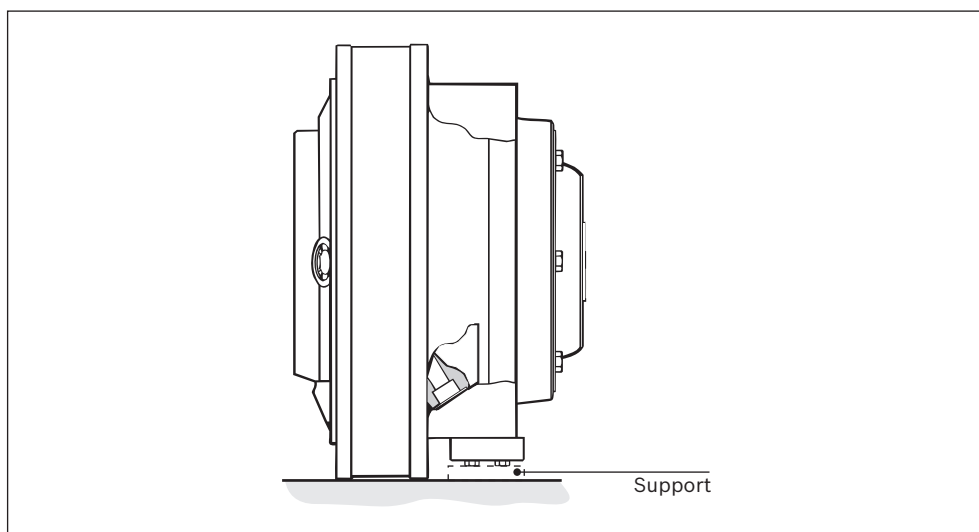


Fig. 3.6

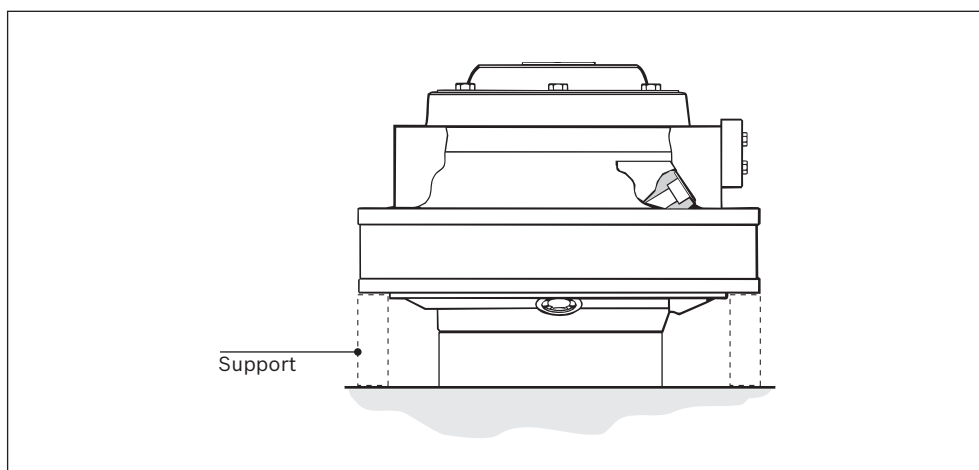


Fig. 3.7

**Notice!** The motor must not be placed on the end face of the hollow shaft when the coupling is fitted, since this may cause damage to the coupling.

When in storage, the motor must always be placed on the end face to the hollow shaft. It is also advisable to provide supports at the mounting surface of the motor; see figure 3.7.

### 3.1.2. Mounting the coupling onto the motor shaft

Instruction to follow when mounting the Hägglunds CA motor on a driven shaft.

Before the motor is mounted there are some preconditions which must be fulfilled:

- The shaft material for the driven shaft must be of a quality which meets the minimum requirements specified by Bosch Rexroth. (See our recommendations, table 3.2.
- The shaft must have the dimensions as recommended in the section 3.1.
- You should note that the couplings are from the factory lubricated with MoS<sub>2</sub> (Molykote) on the conical surfaces and the bolts. This lubricants shall remain on those surfaces but:

## CAUTION

Molykote must under no circumstances be transferred to the surfaces between the driven shaft and the motor.

It is therefore important that you clean your hands free from Molykote.

If those conditions are fulfilled you may start the mounting.

- Clean the driven shaft and the out- and inside of the Hägglunds CA motor hollow shaft. Use acetone or similar.
- Remove the spacers between the two clamping rings of the coupling.
- Mount the coupling on the hollow shaft of the motor. The coupling must be pushed right up to the stop of the shaft.
- Mount the motor onto the driven shaft by following the instruction in the section 3.1.4 “Mounting the motor onto the driven shaft”. (With or without using the mounting tool).

## CAUTION

Never tighten the coupling screws until the motor has been mounted onto the driven shaft.

However for the tightening of the coupling screws the following must be observed: Keep tension in your lifting wires to avoid a skew setting of the motor on the shaft during the tightening of the screws. Wobbling caused by a skew setting of the motor gives extra forces on the main bearings.

In order to avoid the misalignment of the two clamping rings during the screw tightening, the gap between the rings must be measured in several places during the process, see figure 3.14. The difference between the measured gaps must never vary more than 1 mm (0.04”) during any stage of the tightening process.

Pre-set the coupling screws in opposite pairs (12-6-3-9 o'clock) until you reach maximum 50% of the torque specified for the screws. It is very important that when you reach this stage the misalignment is controlled as described above.

Mark the screw head (at 12 o'clock) with a pen or paint so that you can follow the turning sequence of the screws.

Set the torque wrench for the specified maximum torque. Tightening torque of the coupling screws; see the sign on the coupling, or table 3.9.

Now start tightening the screws in sequence shown in figure 3.14a.

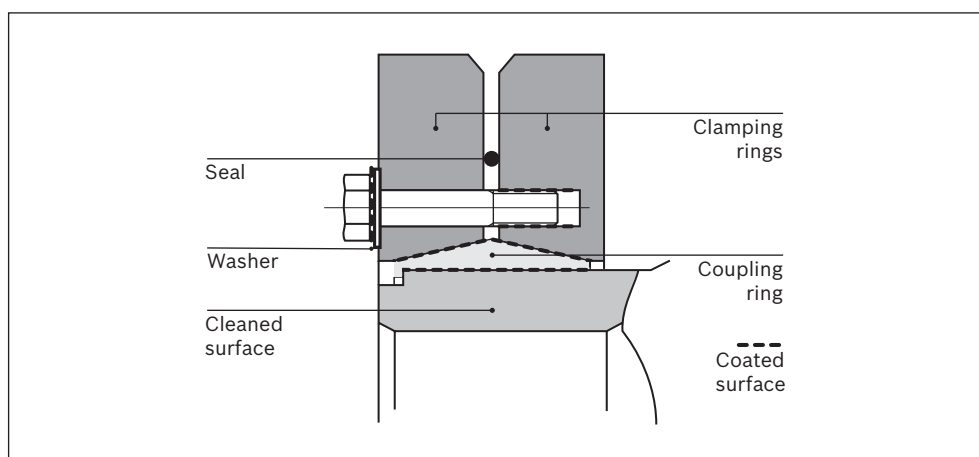
Keep on doing this until you have reached the stated torque. Several passes are required before the screws are tightened to specified torque. Keep checking the alignment of the coupling. (15-20 passes may be necessary).

When the specified torque is reached it is important that all screws are tightened with specified torque and that no further movement can be observed.

**Remember:**

The following factors are important for successful mounting:

- Right material and dimension on the driven shaft.
- The conical surface between the coupling ring and the clamping rings + the bolts shall be coated with MoS<sub>2</sub> (Molykote), see figure 3.8. This is done from the factory at delivery. When a motor has been in for overhaul or service and shall be reassembled it may be necessary to lubricate those surfaces with Molykote again but remember: only the specified surfaces!
- Absolutely no Molykote on the surfaces between shaft-motor. Clean the driven shaft and the inside of the motor hollow shaft.
- Alignment of the motor on the shaft. (Dimensional check).
- Minimum variation in the gap between the clamping rings. (Dimensional check).
- Right torque on the bolts. (Use torque wrench).



**Fig. 3.8**

**! CAUTION**

Before starting the motor, check that the rotating coupling can not cause damage.

### 3.1.3a Fitting the torque arm to the motor

The torque arm is fitted to the motor before the motor is mounted on the driven shaft.

- Open the nuts M16 screws for CA 50-70.
- Clean the spigot surface on the torque arm and motor.
- Oil the screws.
- Make sure that the torque arm will be pointing in the right direction when the motor is mounted in place on the machine. To achieve the highest possible oil level in the motor housing, the motor must be turned until the drain outlets are positioned according to figure 3.12.
- Line up the torque arm on the motor by using the screws with washers.
- Mount screws and washers according to figure 3.9 and screws according to figure 3.9a.
- Tighten the screws to the torque stated in the table below.

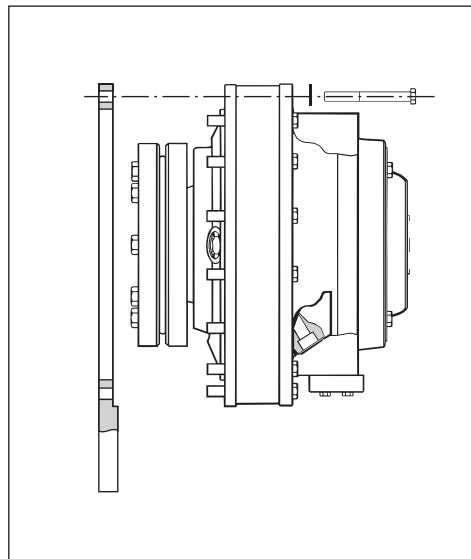
## CAUTION

Do not weld, drill, grind or carry out any similar work on the torque arm without Hägglunds approval.

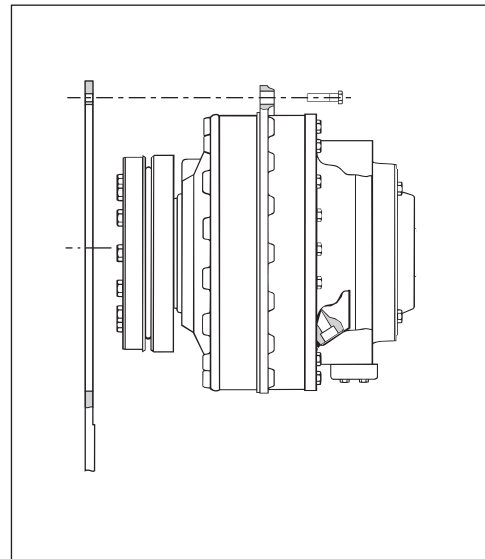
**Table 3.7a**

Motor	Screw dimension	Number of screws	Tightening torque	
			Nm	lbf-ft
CA 50	M16 Strength class 10.9	16	280	205
CA 70	M16 Strength class 10.9	20	280	205
CA 100	M20 Strength class 10.9	17	540	400
CA 140/210	M20 Strength class 10.9	21	540	400

Notice! Use torque wrench and oiled screws!



**Fig. 3.9 CA 50/70**



**Fig. 3.9a CA 100/140/210**



**3.1.3b Fitting the double ended torque arm**

The torque arm is fitted to the motor before the motor is mounted on to the driven shaft. See 3.1.3a “Fitting the torque arm to the motor”.

Check and adjust the rod end (pos 1) according to the drawing. Mount the rod to the torque arm, use the shaft (pos 2) and lock them with circlips. Tighten the 4 pcs of screw (pos 3) on the rod end, torque according to table 3.7b.

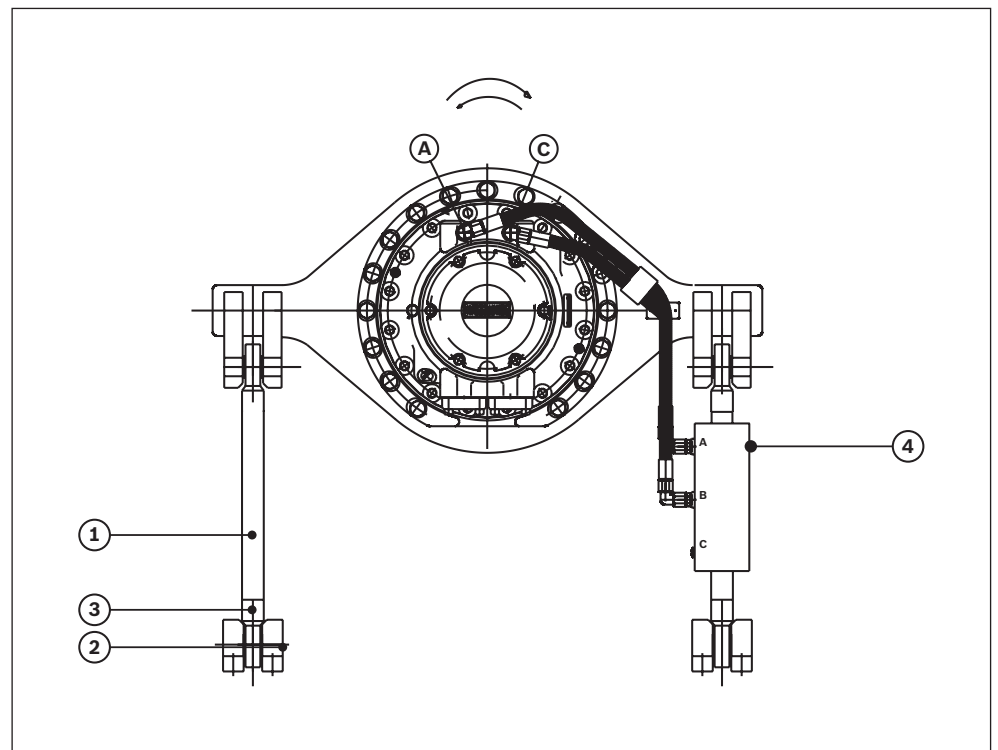
Mount the hydraulic cylinder. The piston rod has to be mounted upwards, and on the right hand viewed from the motors main connection side. Cylinders oil connection A, B and C must point in the direction to the motor. Mount the hoses. The hose mounted to the high pressure connection (C) has to be mounted to the hydraulic cylinders connection B, and the hose from connection (A) has to be mounted to the cylinders connection A.

This is valid with the cylinder on the right side hand-side of the motor, and a single speed motor.

**Table 3.7b**

Cylinder	Screw dimension	Tightening torque	
		Nm	lbf·ft
50/36	M8x25	25	15
80/56	M10x30	49	36
100/70	M12x40	86	63
125/90	M16x30	210	155

**Remark!** Start the system and run it for some minutes. Vent the cylinder from air. Use the vent screws on the cylinder (pos 4).



**Fig. 3.9b**

### 3.1.4a Mounting the motor onto the driven shaft – shaft coupling

The motor can be mounted onto the driven shaft with or without a mounting tool, but the use of a mounting tool is recommended since it makes the work easier.

It is important to arrive at the correct clamping length between the driven shaft and the hollow shaft of the motor.

Ensure that the full clamping length is used by, for example, measuring and marking the driven shaft. This is of particular importance if the duty is so severe that a stress relieving groove has been made on the driven shaft. See figure 3.11, 3.11a and the table 3.8.

Mounting the motor with a mounting tool (figure 3.10)

- Remove the End cover together with screws and washers.
- Align the motor with the driven shaft.
- Locate the existing plastic washer between the nut on the mounting tool and the bearing retainer. Pass the mounting tool through the centre of the motor, and screw it into the driven shaft to stated depth by using the key handle in the end of the tool.
- Pull the motor onto the shaft by turning the nut on the mounting tool until the length stated in the table 3.8, is obtained; see figure 3.11.
- Tightening the shaft coupling see table 3.9
- Remove the mounting tool.
- Refit the plug.
- Refit the end cover and tighten the screws together with washers. Torque 81 Nm (59 lbf·ft).

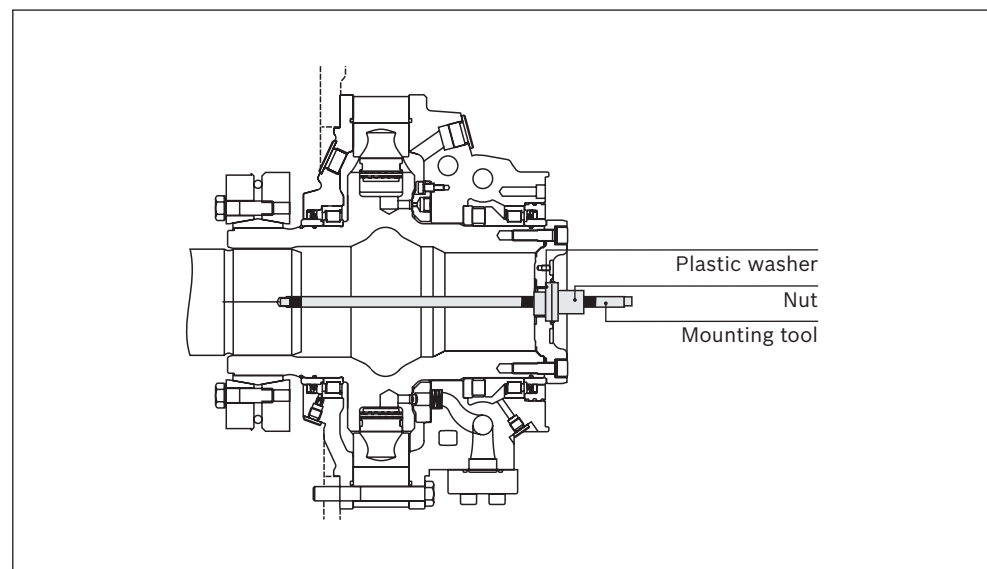


Fig. 3.10 Mounting the CA 50...210

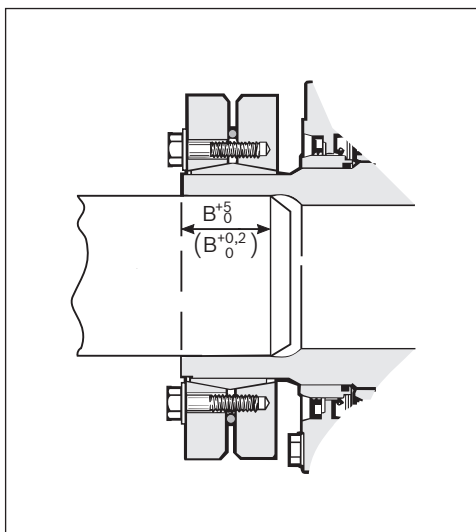


Fig. 3.11 Without stress relieving groove

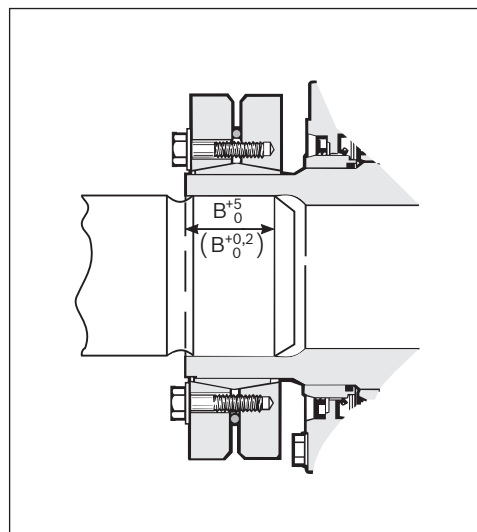


Fig. 3.11a With stress relieving groove

Table 3.8

Motor	Length B mm	Length B in
CA 50	71.5	2.81
CA 70	71.5	2.81
CA 100	84.5	3.33
CA 140	84.5	3.33
CA 210	105	4.13

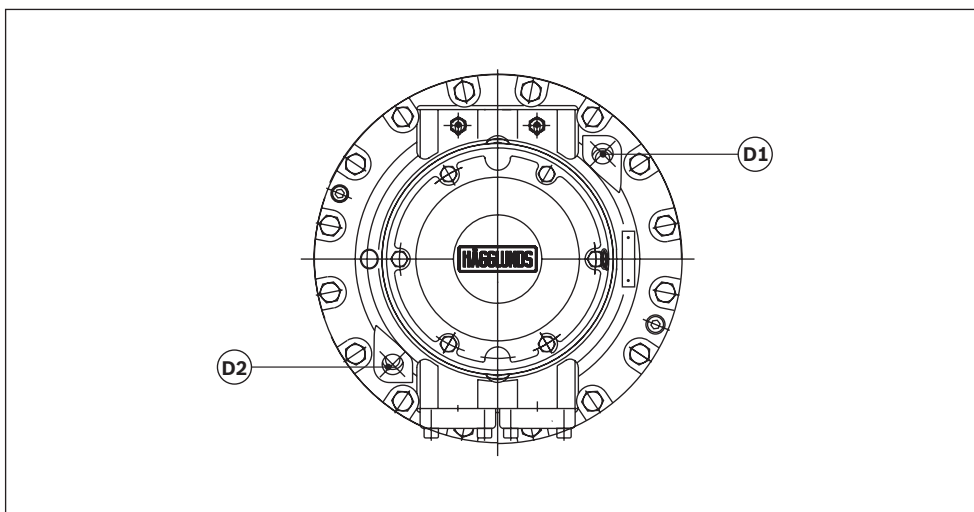


Fig. 3.12: Vertical line

**Mounting the motor without a mounting tool**

The motor can be mounted onto the driven shaft without using a mounting tool, though this is more difficult and takes longer time. However, it is easier to mount the motor if during mounting the compressed air trapped within the hollow shaft is evacuated. To do this, remove the End cover as described in “Mounting the motor with a mounting tool”

Align the motor with the driven shaft using an overhead crane or lifting truck and press it carefully onto the shaft so that the length stated in the table beside is obtained, see figure 3.11.

To achieve the highest possible oil level in the motor housing, the motor must be turned until the drain outlets are positioned according to figure 3.12.

**! CAUTION**

Clean the driven shaft and the inside of the motor hollow shaft.

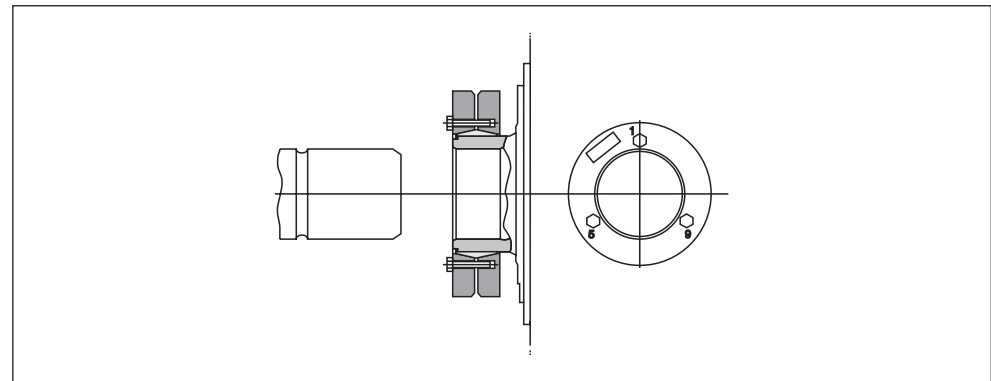


Fig. 3.13

Table 3.9

Motor type	No of screws	Screw dim	Strength class	Tightening torque		Type of head
				Nm	lbf-ft	
CA 50/70	8	M16 x 55	10.9	250	185	Hexagon
CA 100/140	12	M16 x 65	10.9	250	185	Hexagon
CA 210	15	M16 x 80	10.9	250	185	Hexagon

Note 1 Uncoated screws greased with MoS<sub>2</sub>.

Note 2 There is a metallic sign on every coupling with a tightening torque stamped on it. This torque is always to be used.

Note 3 Tightening torque value is critical. Use calibrated torque wrench.

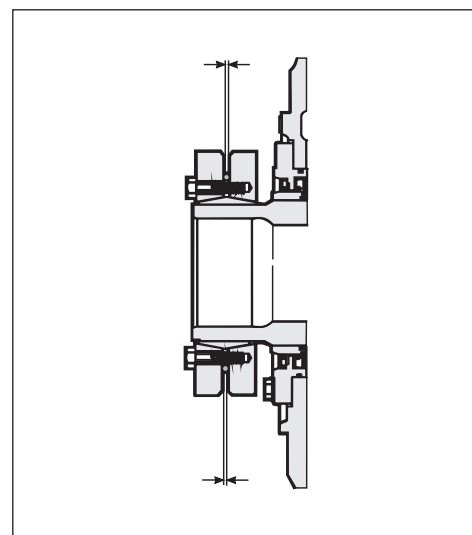


Fig. 3.14

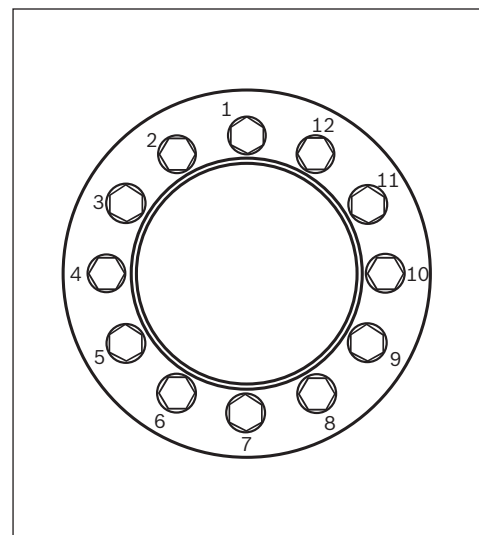


Fig. 3.14a

### 3.1.4b Mounting the motor onto the driven shaft – splines

#### Flange mounted motors

For flange mounted motors, the spline shall normally not be subject to radial load. With no radial load, the spline shaft can be oiled before mounting the motor. If the motor is subject to radial load, the splines shall be filled up with oil.

- Lubricate and install O-ring at leading edge of motor bore.
- Check shaft/splines for burrs and lubricate shaft/splines.
- Mark spline tooth location on outside of motor bore to assist alignment during installation.
- Mount the motor on to the shaft.
- Bolt the motor to the flange.
- Fill up hydraulic oil to the G1 plug.
- Torque the G1 plug.  $M_v=125 \text{ Nm}/90 \text{ lbf}\cdot\text{ft}$ .
- Mount the cover.  $M_v=81 \text{ Nm}/59 \text{ lbf}\cdot\text{ft}$ .

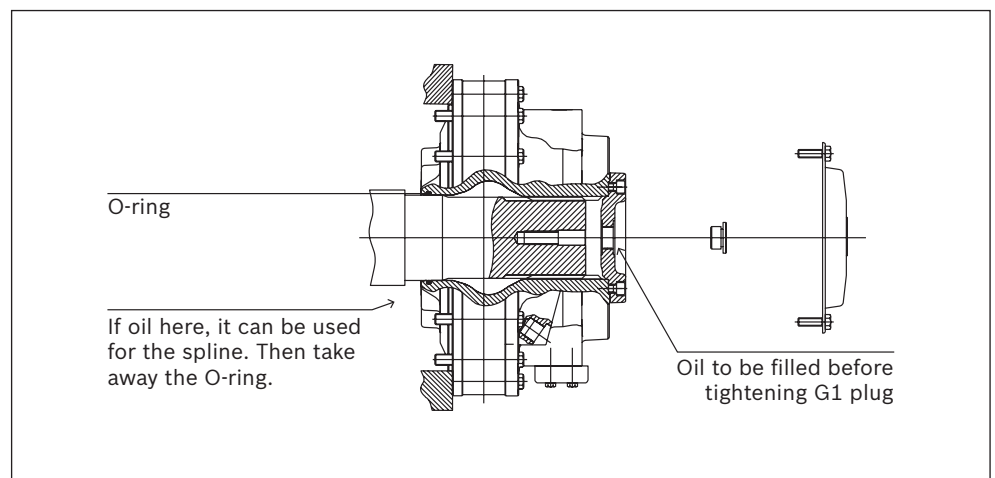
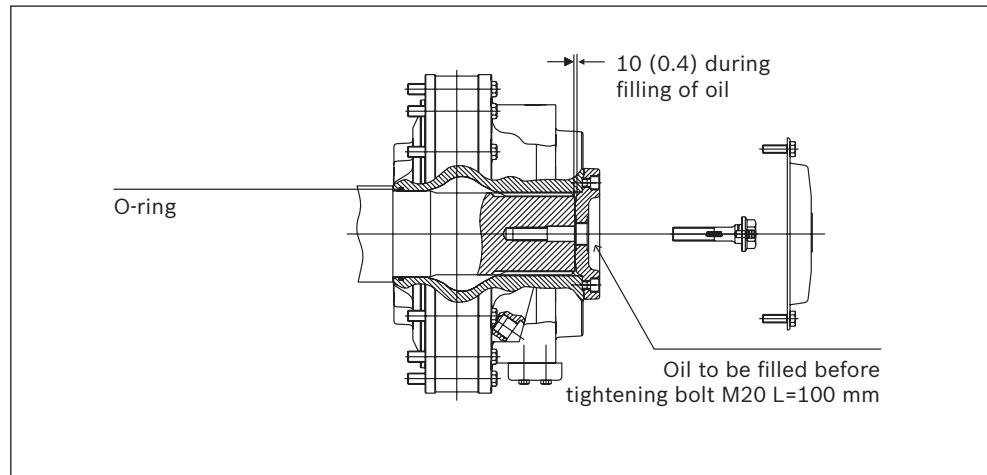


Fig. 3.15 Mounting kit 478 3629-801

#### Torque arm mounted motors

Motors that carry radial load, must have the splines oiled. The motor can be used for horizontal mounting and mounting with motor shaft pointing downwards.

- Mount torque arm to motor with bolts supplied. Align with oil connection ports as required.
- Lubricate and install O-ring at leading edge of motor bore.
- Check shaft/splines for burrs and lubricate shaft/splines.
- Mark spline tooth location on outside of motor bore to assist alignment during installation.
- Mount the motor on to the shaft.
- Fill up hydraulic oil to the G1 plug.
- Mount special designed bolt.
- Torque the bolt.  $M_v=385 \text{ Nm}/280 \text{ lbf}\cdot\text{ft}$ .
- Mount the cover.  $M_v=81 \text{ Nm}/59 \text{ lbf}\cdot\text{ft}$ .

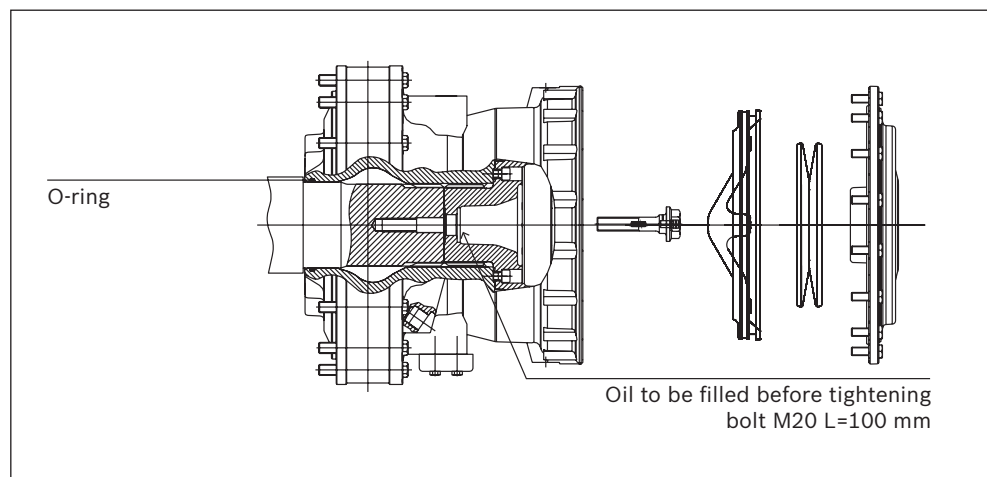


**Fig. 3.16 Mounting kit 478 3629-801**

**Torque arm mounted motors with brake MDA**

Motors with brake MDA, must have the brake disassembled. See 3.1.11.

- Mount torque arm to motor with bolts supplied. Align with oil connection ports as required.
- Lubricate and install O-ring at leading edge of motor bore.
- Check shaft/splines for burrs and lubricate shaft/splines.
- Mark spline tooth location on outside of motor bore to assist alignment during installation.
- Mount motor with brake housing on the shaft.
- Fill up hydraulic oil to the G1 plug.
- Mount special designed bolt.
- Torque the bolt.  $M_v=385 \text{ Nm}/280 \text{ lbf-ft}$ .
- Mount the brake according to 3.1.9.



**Fig. 3.17 Mounting kit 478 3629-801**

**! DANGER****Wrong position of disc set!**

Danger to life or risk of injury, damage to equipment!

- ▶ When reassembly of brake parts, be aware of correct position of disc set.  
See fig.3.17a

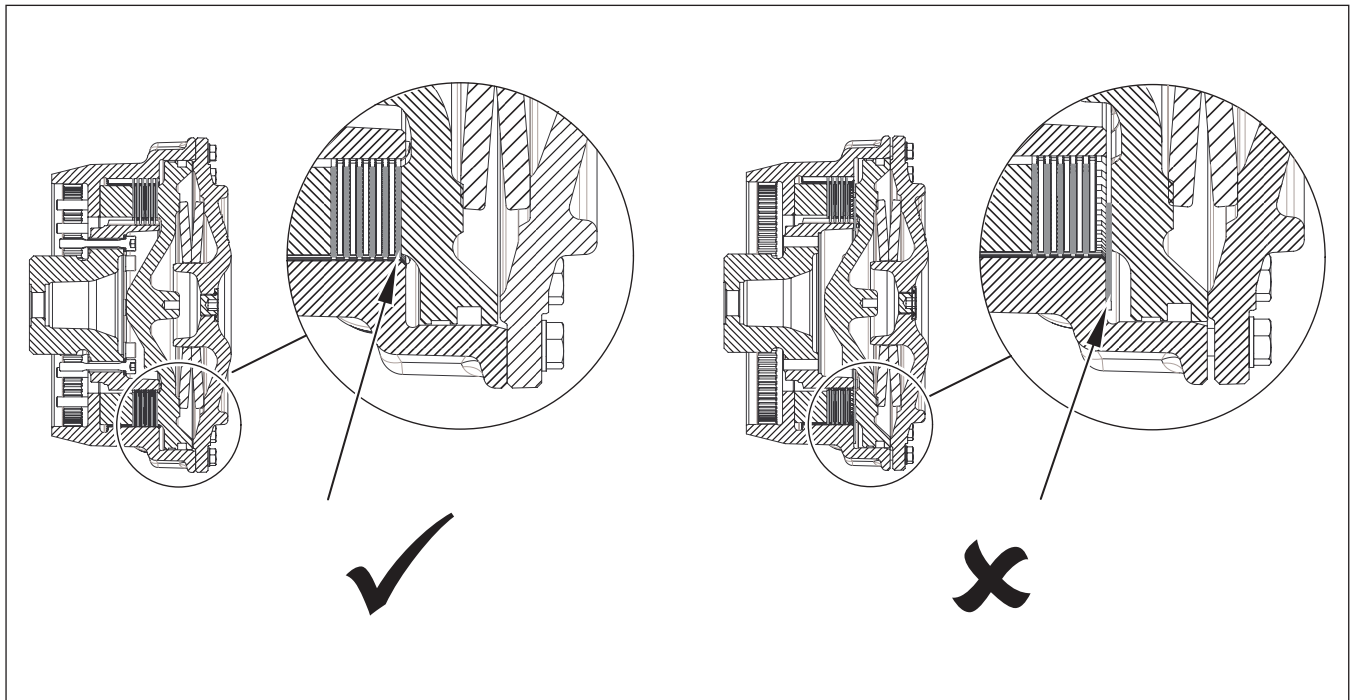
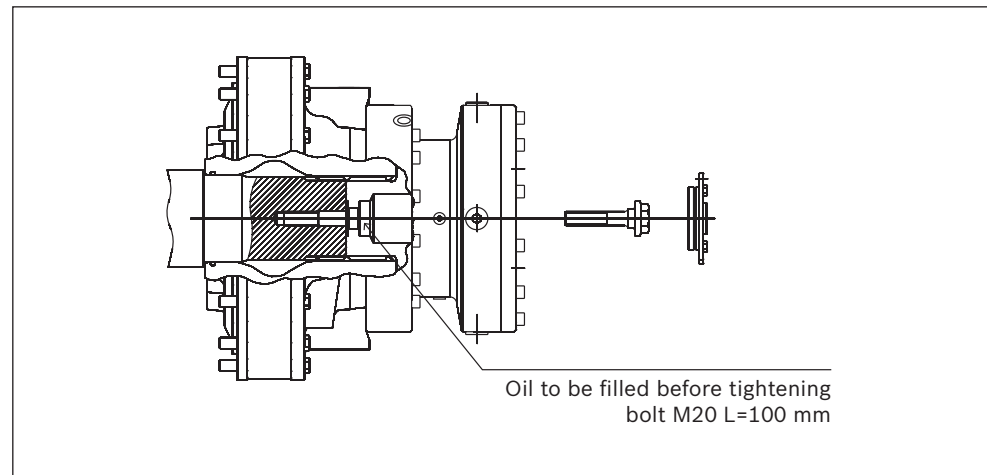


Fig. 3.17a Correct position of disc set

**Torque arm mounted motors with brake BICA**

Motors with brake BICA, must have the screwed centre cover disassembled. See Installation and Maintenance Manual for BICA

- Mount torque arm to motor with bolts supplied. Align with oil connection ports as required.
- Lubricate and install O-ring at leading edge of motor bore.
- Check shaft/splines for burrs and lubricate shaft/splines.
- Mark tooth location on outside of motor bore to assist alignment during installation.
- Mount motor with brake on the shaft.
- Fill up hydraulic oil to the plug G1”.
- Mount special designed bolt.
- Torque the bolt.  $M_v=385 \text{ Nm}/280 \text{ lbf-ft}$ .
- Mount the screwed centre cover and torque the bolts.  $M_v=24 \text{ Nm}/18 \text{ lbf-ft}$ .



**Fig. 3.18** Mounting kit 478 3629-801

**3.1.5. Removing the motor from the driven shaft**

Before dismounting the motor from the driven shaft the oil in the motor housing must be drained through the lower draining hole.

The motor can be removed from the shaft with or without the mounting tool. The operation is easier if the tool is used.

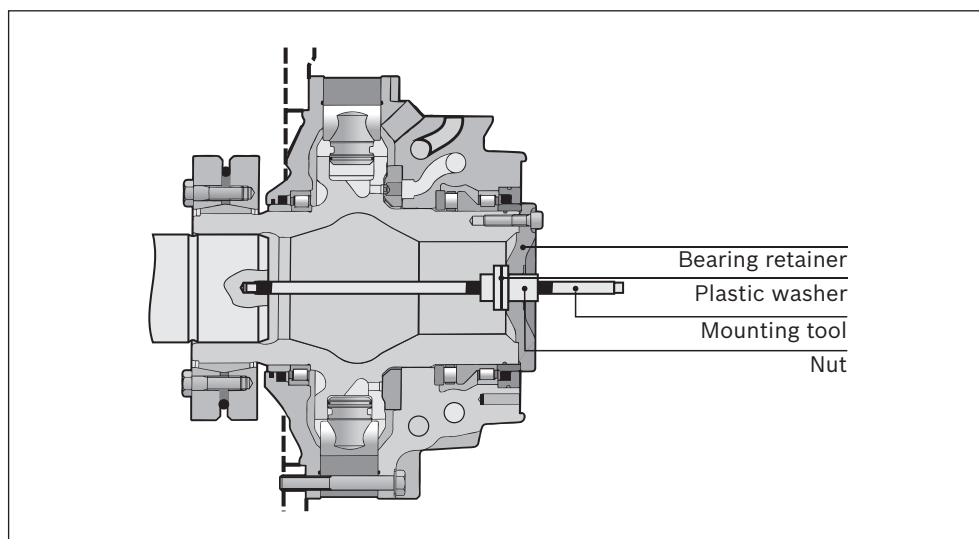
**! DANGER**

Never stay below the motor during disassembly.

**! WARNING**

Always make sure that the lifting equipment is strong enough to handle the weight of the motor.





**Fig 3.19 Removal of Compact 50...210**

#### **Removal by using the mounting tool**

- Slacken the shaft coupling screws gradually; see figure 3.14 and 3.14a. Each screw should be slacked only about a quarter of a turn each time. Thus tilting and jamming of the collars or thread stretching will be avoided. The screws must be slacked until the coupling ring is fully released.
- Remove the End cover and Bearing retainer together with screws and washers; see figure 3.19.
- Locate the existing plastic washer outside the mounting tool nut. Then pass the tool through the centre shaft, and screw it into the driven shaft to stated depth.
- Screw in the nut of the tool until the Bearing retainer can be refitted.
- Remove the motor from the driven shaft by unscrewing the nut of the mounting tool.
- Remove the Bearing retainer and mounting tool. Finally, refit the removed Bearing retainer, torque 136 Nm (100 lbf·ft) and End cover, torque 81 Nm (59 lbf·ft) as before.

#### **Removing the motor without using the mounting tool**

- Slacken the screws of the shaft coupling, see above “Removal of motors by using the mounting tool”.
- Remove end cover and plug to allow air to enter the space in the hollow shaft of the motor; see “Mounting the motor without a mounting tool“. After removal of the motor, refit the removed components as before.
- Carefully pull the motor off the driven shaft supported by an overhead crane or a lifting truck.

### 3.1.6. Mounting the reaction point

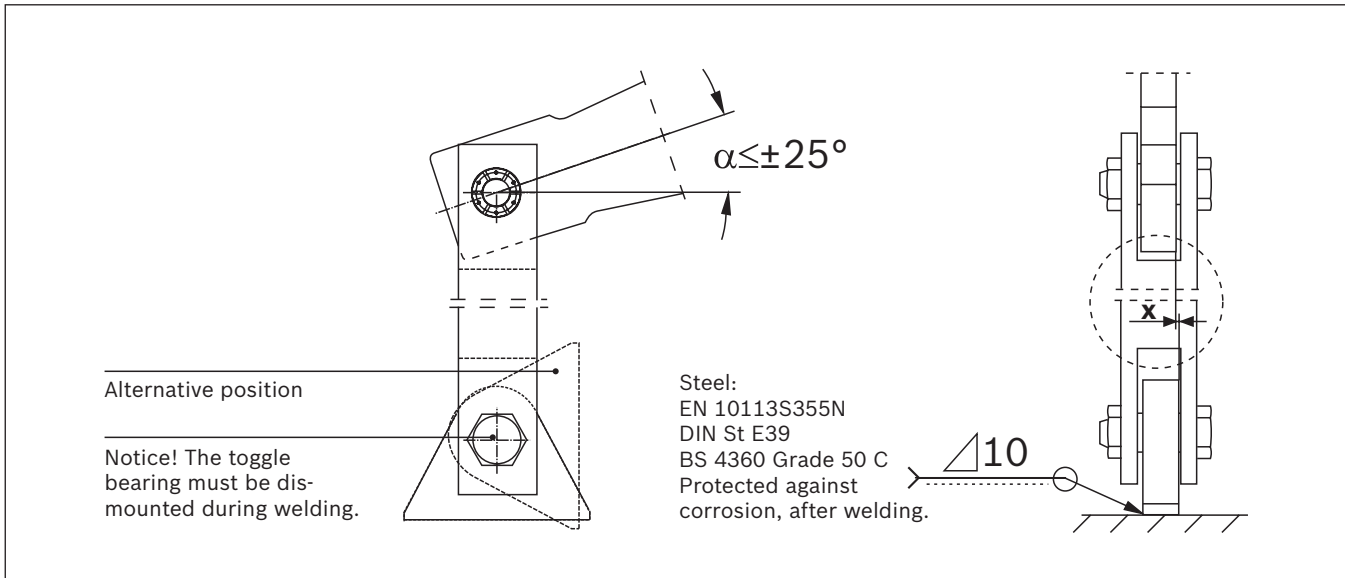


Fig. 3.20 Mounting of pivoted attachment

$x = \pm 2 \text{ mm}$  (0.079) misalignment in installation.

$x \leq \pm 15 \text{ mm}$  (0.59) movement when in use.

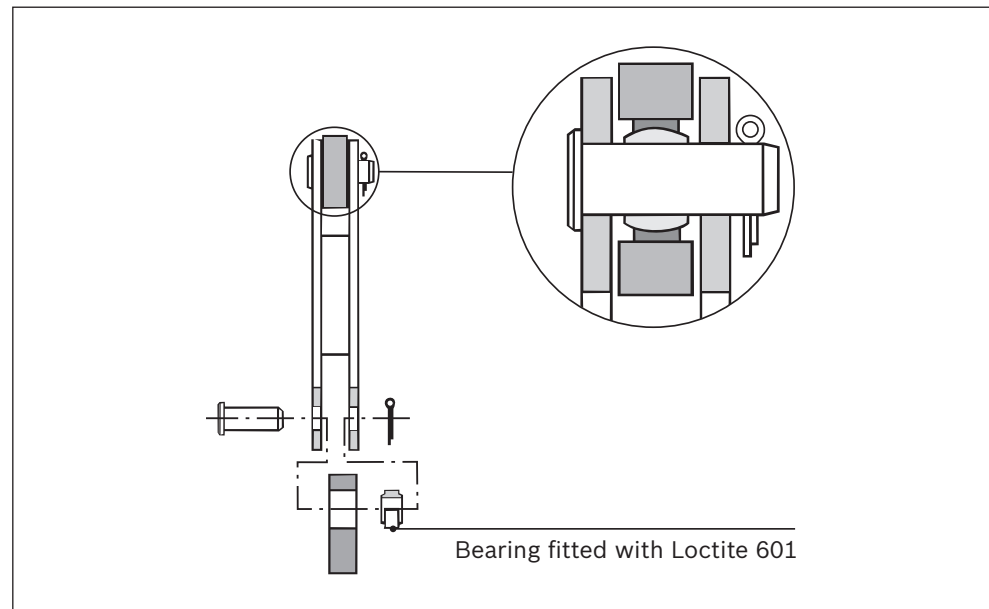


Fig. 3.21

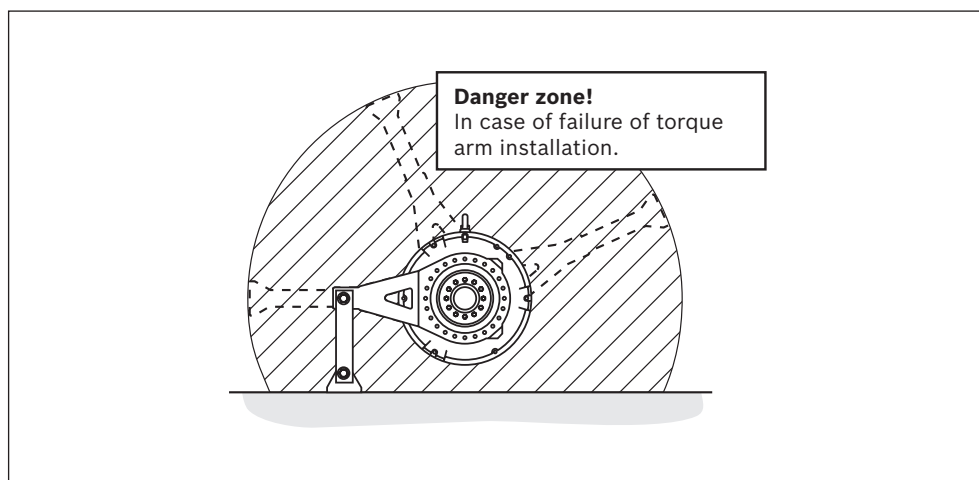


Fig. 3.22

## ! DANGER

Make sure that the foundation can withstand the forces from the torque arm.

### 3.1.7. Brake MDA

#### Functional description

MDA brake is of multi disc type with a rotating disc-centre (brake discs) and a stationary housing (steel discs). It is a wet brake which means discs are running in oil-bath. The brake is actuated by spring force and released by hydraulic pressure. Brake torque builds up in disc set between rotating disc-centre (brake discs) and stationary housing (steel discs) by a spring force acting on disc set through a piston. The brake is normally activated giving brake torque. When pressurizing brake the piston will move against cover and stop, giving zero brake torque. Intended use is as parking brake! The brake can also serve as security brake and emergency brake.

**Oils:** Conventional petroleum based hydraulic oils.

Be aware of high water content in oil, levels above 2% are not allowed due to use of water based glue in disc set. Minimum viscosity limit: 20 cSt

Torque levels in tech data is based on above mentioned oil. Other type of oils can give different torques due to different friction coefficient (different additives in oil).

### 3.1.8. Control of braking torque

The motor can be used for controlling the torque for the brake. Start to drain the brake to tank, and increase pressure for the motor until it starts to rotate. Pressure drop over the motor x  $T_s$  for the motor gives braking torque for the brake. If the motor can not rotate the brake, increase back pressure in the brake cylinder until the motor can rotate the brake.

Braking torque =  $(\text{Pressure drop over the motor} \times \text{motor torque } T_s \times 100) / (\% \text{ Braking torque in diagram 3.1 or 3.2.})$  With full torque and 10 rpm, the brake must not rotate more than max 10 seconds.

### 3.1.9. Installation of MDA hydraulics

#### Activation time of brake.

Flushing of brake cylinder lines before start up of system is necessary to have a quick action of the brake especially when used as a emergency brake, see example of flushing below. For winch applications, hanging loads and other applications where quick activating times are necessary sizing of return lines becomes important. Higher viscosity, cold outside temperature, long drain lines and smaller tube diameters affects the activation time of brake. This must be taken in to account when designing systems and where multi disc brake MDA will be used. Please see figure 3.24.

#### Opening pressure

To secure correct opening pressure: Use hydraulic scheduling according to figure 3.23 when using external pressure (system pressure) as control pressure to open and close the brake. Pressure reduce valve (set at 20 bar) and pressure relief valve (set at 25 bar) in line. Air in the brake results in slow function. Vertical installation with motor shaft pointing upwards not allowed. The hydraulic connection must be on top of the brake, to avoid air. Air gives a slow function for the brake.

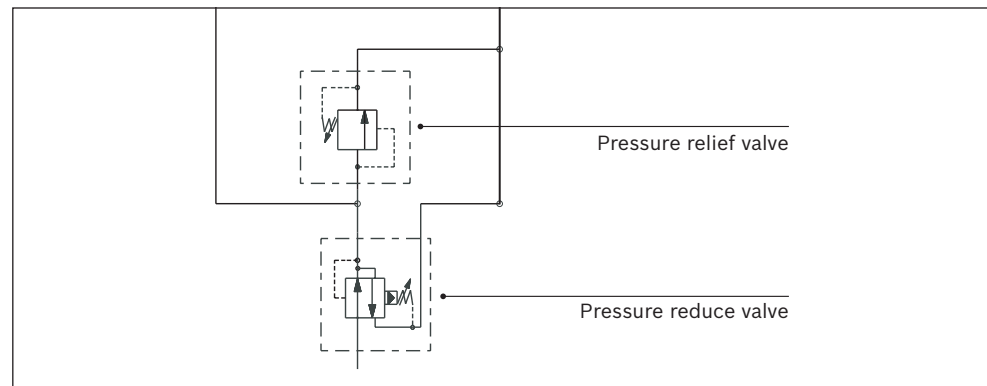


Fig. 3.23

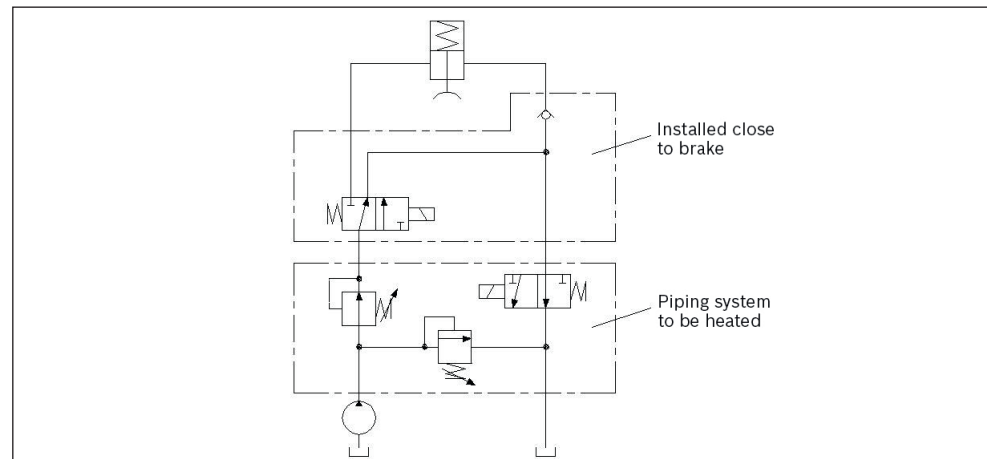


Fig. 3.24

## WARNING

If the brake is used in cold environment as emergency brake, it must be flushed.

3.1.10. Brake MDA 5, 7 and 10

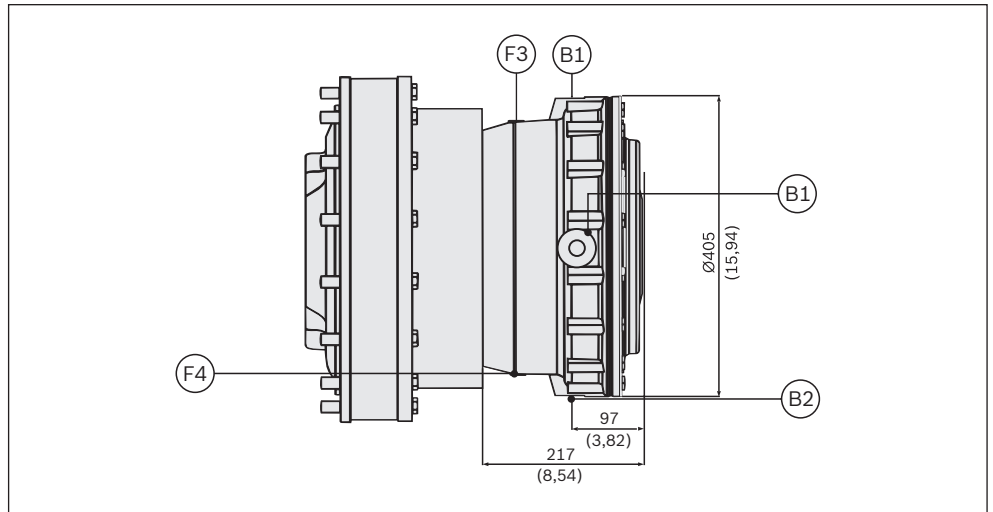


Fig. 3.25

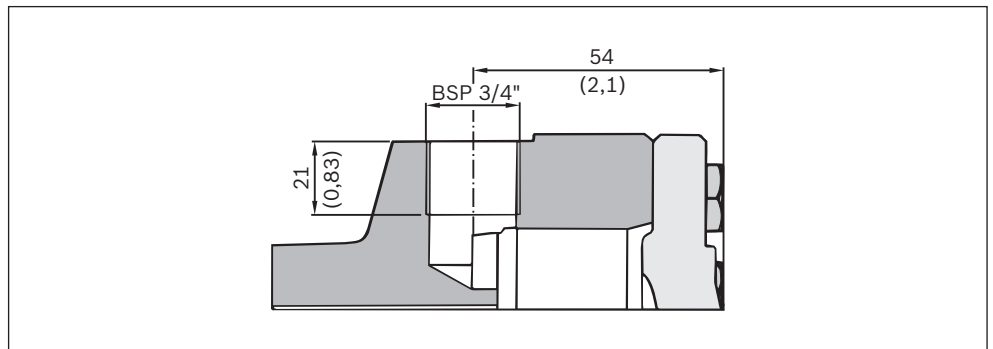


Fig. 3.26 B1 and B2

Table 3.10

Connection	Description	Port connection
B1	Brake connection	G 3/4"
B2	Alt. brake connection	G 3/4"
F3, F4	Flushing connection (For flushing of motor axial bearing)	G 1/4"

Table 3.11

Brake	Torque*	Begins to open at**	Fully open at**	Opening pressure (min-max)	Displacement. max	Weight	Oil volume
	Nm (lbf·ft)	bar (psi)	bar (psi)	bar (psi)	cm <sup>3</sup> (in <sup>3</sup> )	kg (lbs)	l (US gal)
MDA 5-16	13600 ± 400 (10000 ± 295)	16 (232)	19 (276)	20-25 (290-363)	155 (9.5)	100 (220)	1.7 (0.45)
MDA 5-26	22600 ± 700 (16700 ± 520)	16 (232)	19 (276)	20-25 (290-363)	195 (11.9)	100 (220)	1.7 (0.45)
MDA 7-34	30400 ± 900 (22400 ± 660)	16 (232)	19 (276)	20-25 (290-363)	256 (15.6)	100 (220)	1.7 (0.45)
MDA 10-48	41500 ± 2000 (30600 ± 1480)	16 (232)	19 (276)	20-25 (290-363)			

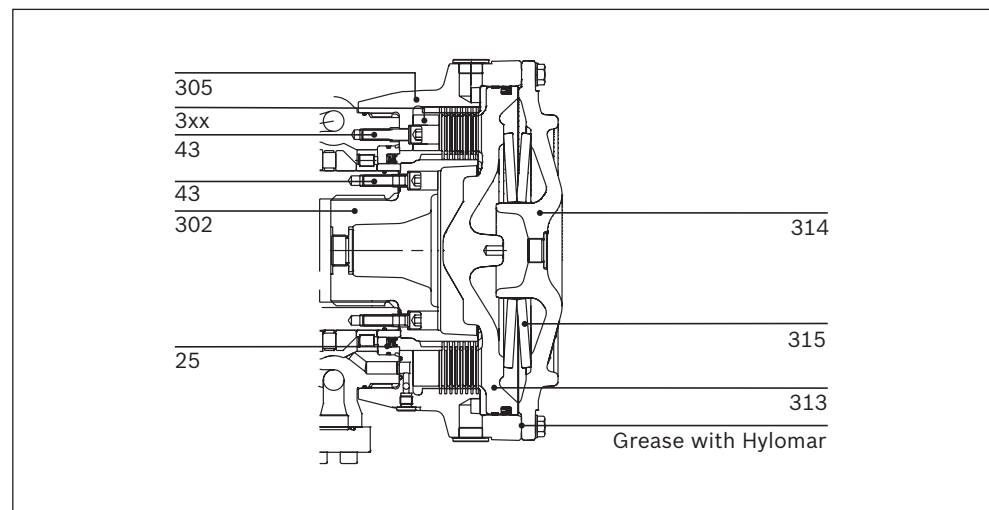
\* Pressure in brake cylinder = 0 bar.

\*\* See diagram 3.1. High pressure reduce service life for seals and axial bearing.

**3.1.11. Mounting MDA 5, 7 and 10**

The brake is normally mounted on the motor at the factory. If the brake is disassembled and shall be mounted on a motor, it must be done according to following.

1. Control that seal and Seal retainer (25) is mounted according to figure 3.27.
2. Mount Disc centre (302) on the cylinder block. Oil the screws (43) and assemble with torque 136 Nm (100 lbf·ft).
3. Put the Brake housing (305) on the motor, and mount the right spacer (3xx). Oil the screws and mount them with tightening torque 136 Nm (100 lbf·ft). See table 3.12.
4. Mount first one outer disc. Then mount inner disc, outer disc until all discs are mounted.
5. MDA5 has 6 outer discs and 5 inner discs.
6. MDA7 has 8 outer discs and 7 inner discs.  
MDA10 has 11 outer discs and 10 inner discs.
7. Grease the seals with Texaco multifak or an equivalent grease without solid additives and mount the piston (313).
8. Grease the springs (315) with MoS2 Molykote or an equivalent grease. Put the springs on the Brake cover (314). The springs shall be mounted against each other on the inner diameter.
9. Grease Brake cover, contact surface between Brake cover and Brake housing with a thin layer of Hylomar. Mount Brake cover (314) on the brake. Oil the screws and assemble the screws. Start mounting by slightly tightening the screws, no more than 1 turn each. Continue with one turn of each screw around the cover. Tightening torque is 114 Nm (84 lbf·ft).



**Fig. 3.27**

**Table 3.12**

Brake	Screws (ISO 89811)	Spacer
MDA 5	MC6S 12x50 12.9	t=54 (2.13)
MDA 7	MC6S 12x50 12.9	t=42.4 (1.67)
MDA 10	MC6S 12x50 12.9	t=25 (0.98)

### 3.1.12. Reduction of brake torque

The diagram 3.1 below shows the falling braking torque  $M_{\max}$  for increasing pressure in the brake cylinder drain.

Example: MDA 10 has a dynamic braking torque of  $41\,500 \pm 2\,000$  Nm ( $30\,600 \pm 1\,480$  lbf·ft), when the brake is not under pressure.

Assume that the pressure in brake cylinder drain is 1.5 bar / 21.75 psi. The diagram shows that the actual brake torque ( $M_{\text{act}}$ ) corresponds to only 90 % of  $M_{\max}$ .

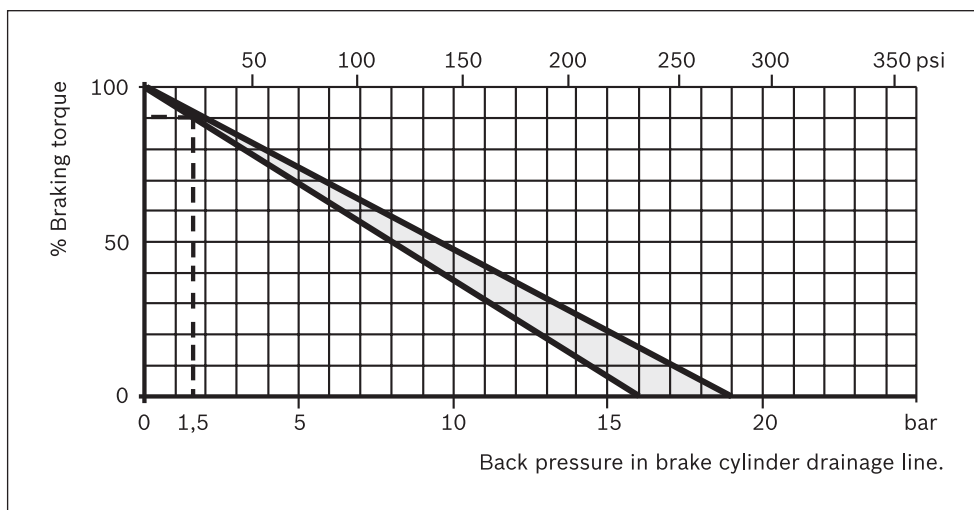
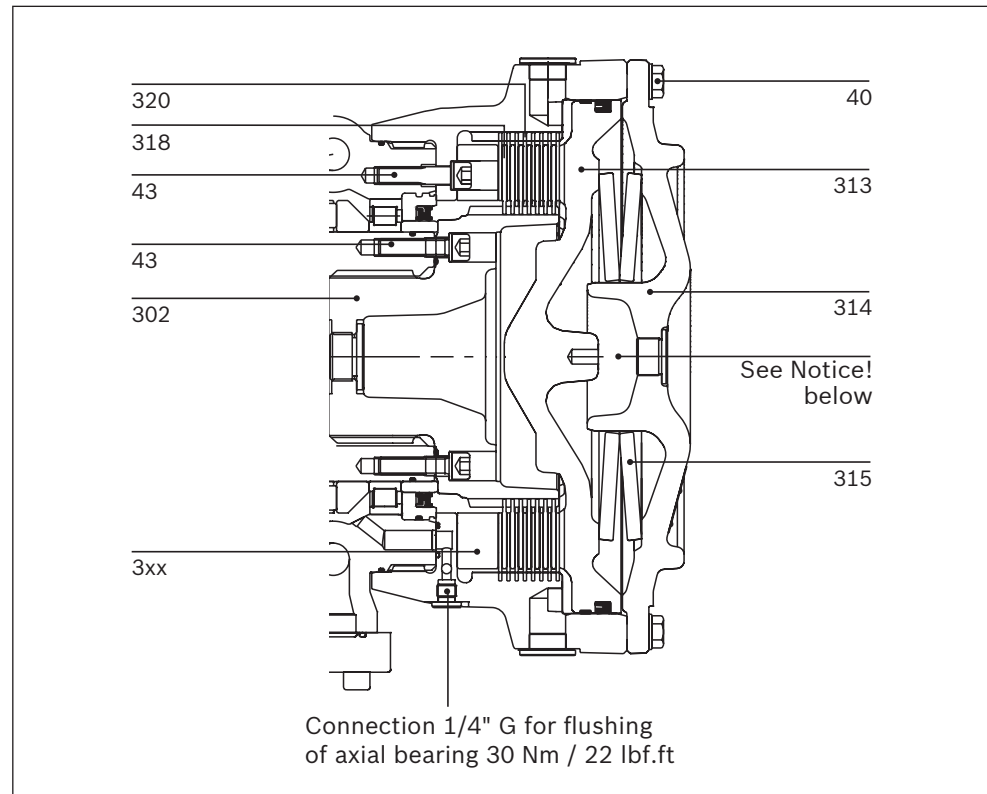


Diagram. 3.1

## ! WARNING

Motors with SPECIAL brakes may have different working operation. Please make sure that you check the ordering code on your brake.

**Disassembly of MDA 5, 7 and 10****Fig. 3.28**

## ⚠ DANGER

Please read this instruction carefully before starting the disassembly!

1. Start the disassembly by slightly loosening the screws (40). Not more than 1 turn each. Continue with 1 turn of each screw around the cover until the preload of the Belleville springs (315) (Cup springs) is zero. After that the screws can be removed and the Brake cover (314) lifted off.
2. The Brake piston (313) can be removed by installing an M12 screw in the centre hole and lifted off by using the screw.

**Notice!** The M12 screw can not be used to hold the brake cover (314) while removing the screws (40). There is a risk that the threaded part in the brake piston (313) can fail due to big forces when removing the screws.

3. Inner and outer discs (318, 320) can be removed and the screws (43) holding the spacer (3xx) in place can be removed.
4. Loosen the screws (43) holding the disc centre (302) in place.

Please note that the motor cannot be pressurized when the brake assembly is removed.



3.1.13. Brake MDA 14 and 21

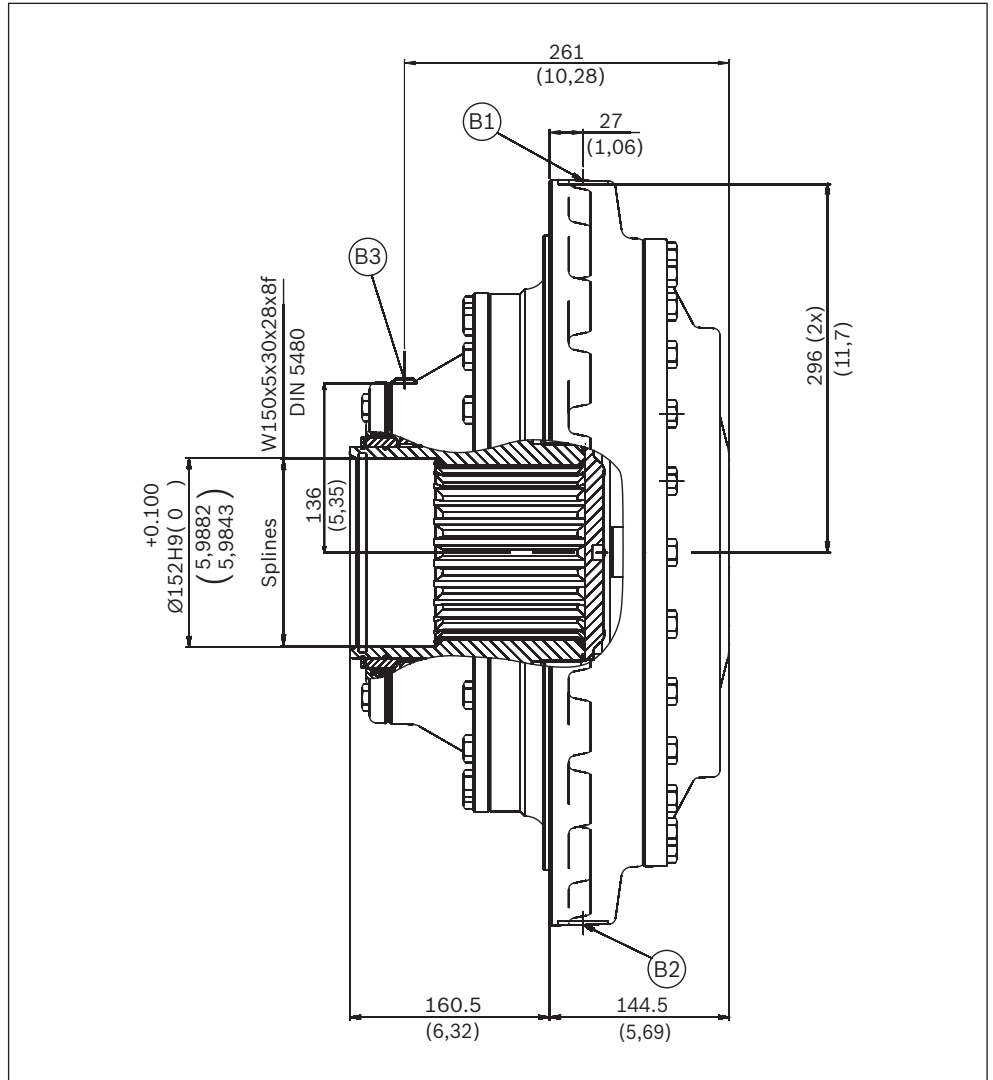


Fig. 3.29

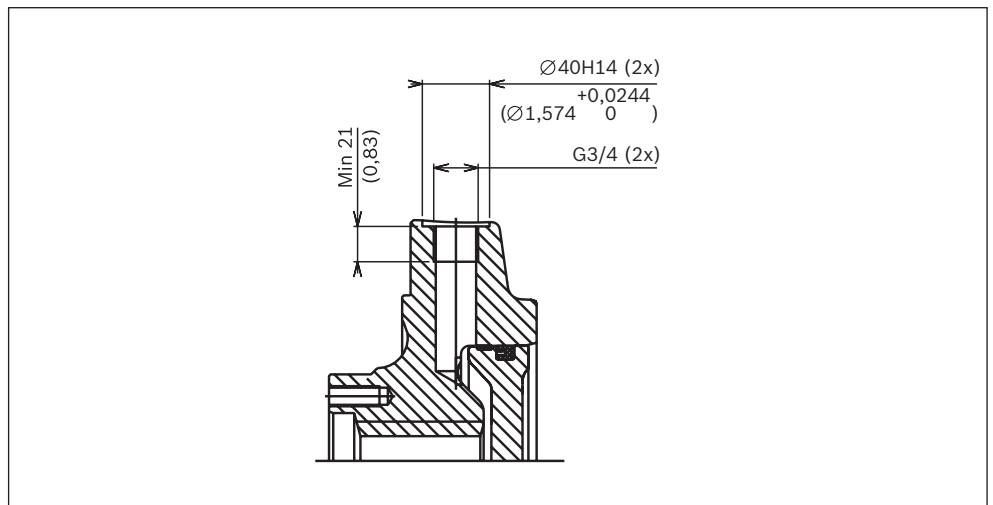


Fig. 3.30 B1 and B2

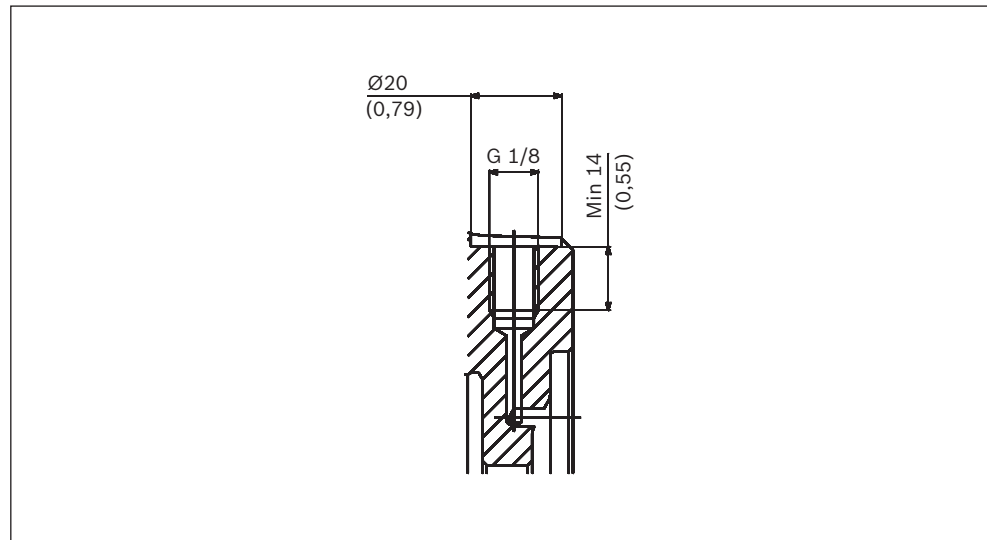


Fig. 3.31 B3

Table 3.13

Connection	Description	Port connection
B1	Brake connection	G 3/4"
B2	Alt. brake connection	G 3/4"
B3	Flushing connection	G 1/8"

Table 3.14

Brake	Torque*	Begins to open at**	Fully open at**	Opening pressure (min-max)	Displacement. max	Weight	Oil volume
	Nm (lbf-ft)	bar (psi)	bar (psi)	bar (psi)	cm <sup>3</sup> (in <sup>3</sup> )	kg (lbs)	l (US gal)
MDA 14-19	16300 ± 900 (12000 ± 660)						
MDA 14-38	32700 ± 1800 (24100 ± 1330)	15 (220)	20 (290)	20-25 (275-350)	318 (19.14)	230 (510)	2.0 (0.53)
MDA 14-67	57000 ± 3000 (42000 ± 2200)						
MDA 21-95	81800 ± 4300 (60300 ± 3170)	15 (220)	20 (290)	20-25 (275-350)	318 (19.14)	230 (510)	2.0 (0.53)

\* Pressure in Brake cylinder = 0 bar (0 psi).

\*\* See diagram 3.2.

**3.1.14. Mounting MDA 14 & 21**

**Flange mounted brakes**

The brakes, MDA 14 and MDA 21 are normally mounted to a bearing bracket or winch (see figure 3.31) with M20 screws. The spline shaft shall be greased with Texaco Multifak EP2 or equivalent.

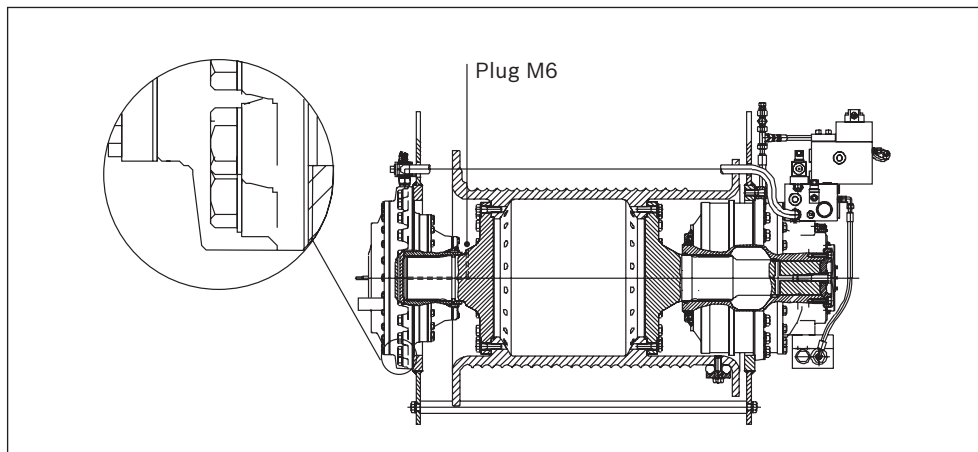


Fig. 3.32

Screw dimension	Number of screws	Tightening torque	
		Nm	lbf-ft
M20 Strength class 10.9	22	540	398

**Torque arm mounted brakes**

Disassemble the brakes according to page 38. Note: Remove cover (pos 312).

- Mount torque arm on the brake with M20 screws.
- Lubricate and install o-ring at leading edge of brakes shaft
- Check shaft/splines for burrs and lubricate shaft/splines with Texaco Multifak EP2.
- Mount the brake on the shaft.
- Mount the mounting kit, 078 1700-801, bolt and cover.
- Torque the bolt.  $M_v=385 \text{ Nm}/280 \text{ lbf-ft}$ .

Assemble the brakes according to page 38.

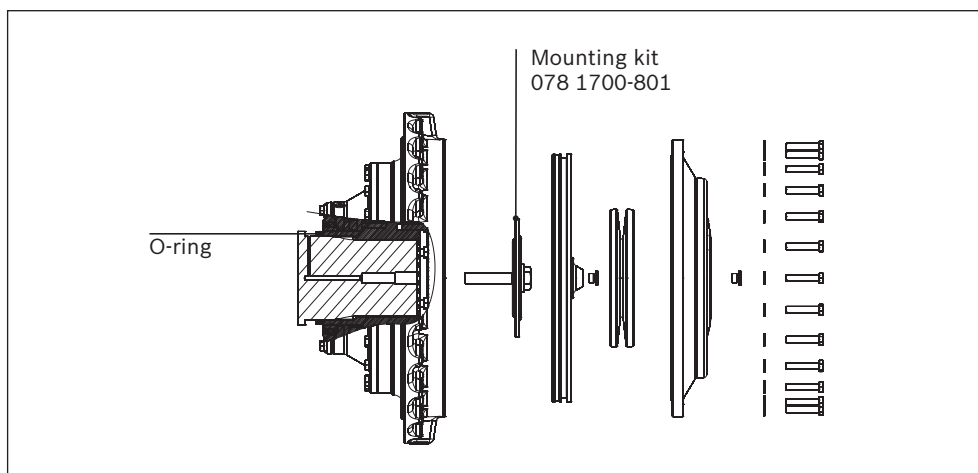


Fig. 3.32b

**Tandem mounting of motor CA and brake MDA 14**

CA motor type B and tandem kit 278 2339-606 must be used.

Fill splines and shaft with hydraulic oil.

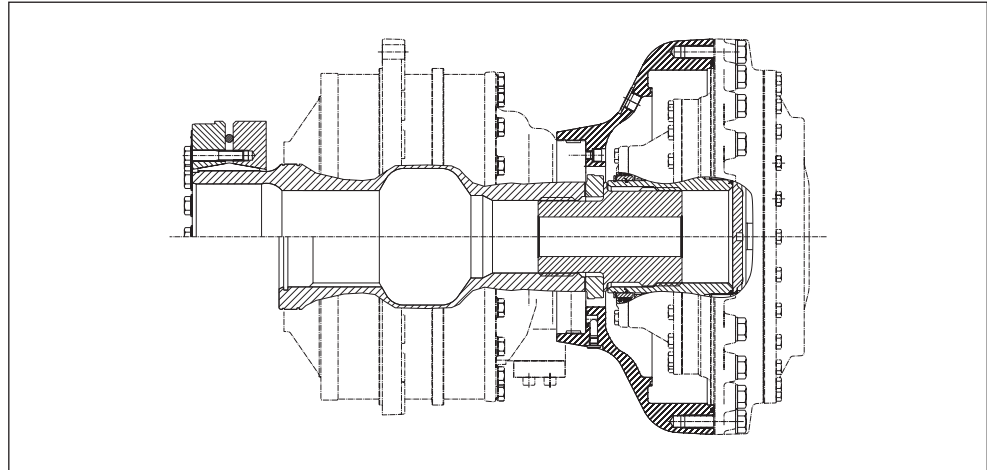


Fig. 3.32c

**Lifting the MDA 14 & 21 brake**

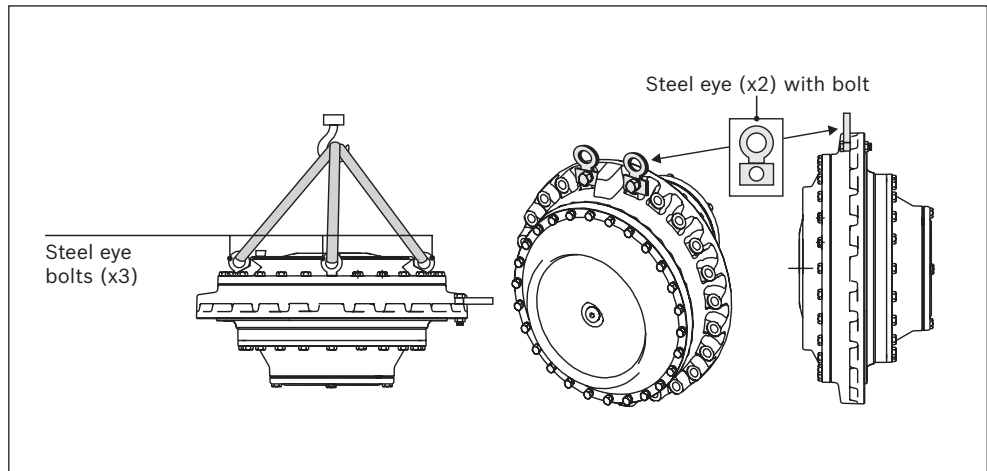


Fig. 3.33

**Spline**

The splines shall be grease with Texaco Multifak EP2 or equivalent. This is with exception for tandem mounted MDA14, where spline shall be lubricated with hydraulic oil.

To avoid wear in the splines the installation must be within the specified tolerances in table 3.15.

For production of the shaft, see 178 2571 regarding flange mounting and 078 1516 regarding torque arm mounting.

**Table 3.15**

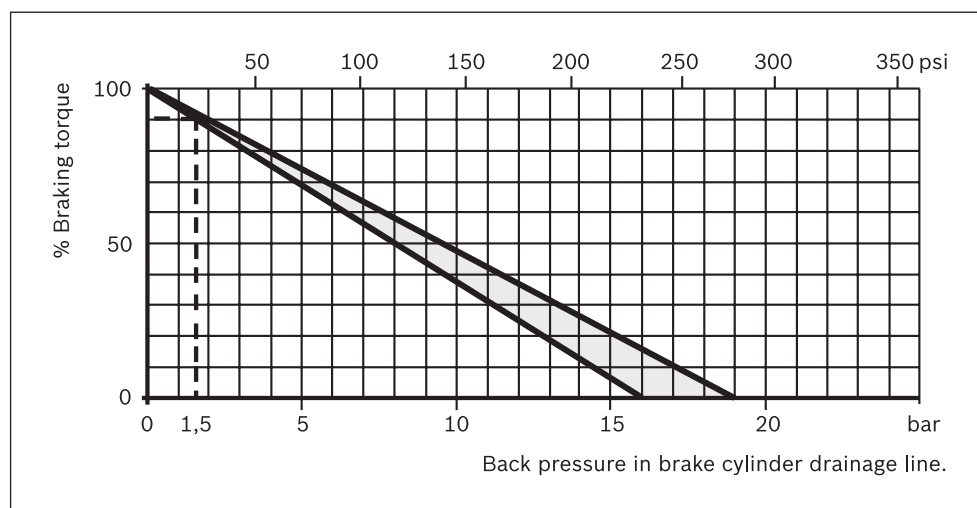
Tooth data		W150
Tooth profile and bottom form		DIN 5480
Tolerance		8f
Guide		Back
Pressure angle		30°
Module		5
Number of teeth		28
Pitch diameter		Ø 140
Minor diameter	$\begin{matrix} 0 \\ -1.62 \end{matrix}$	Ø 139
Major diameter	$\begin{matrix} 0 \\ -0.250 \end{matrix}$	Ø 149
Measure over measuring pins	$\begin{matrix} -0.085 \\ -0.150 \end{matrix}$	159.961
Diameter of measuring pins		Ø 10
Addendum modification X M		+2.25

**Unidirectional drives**Steel with yield strength  $R_{elmm} = 450 \text{ N/mm}^2$ **Bidirectional drives**Steel with yield strength  $R_{elmm} = 700 \text{ N/mm}^2$ **3.1.15. Reduction of brake torque**

The diagram 3.2, shows the falling braking torque  $M_{max}$  for increasing pressure in the brake cylinder drain.

Example: MDA 21 has a dynamic braking torque of  $81\,800 \pm 4\,300 \text{ Nm}$ , when the brake is not under pressure.

Assume that the pressure in brake cylinder drain is 1.5 bar/21.75 psi. The diagram shows that the actual brake torque ( $M_{act}$ ) corresponds to only 90% of  $M_{max}$ .

**Diagram. 3.2**

## ! WARNING

Motors with SPECIAL brakes may have different working operation. Please make sure that you check the ordering code on your brake.

### Disassembly and assembly of MDA 14 and 21

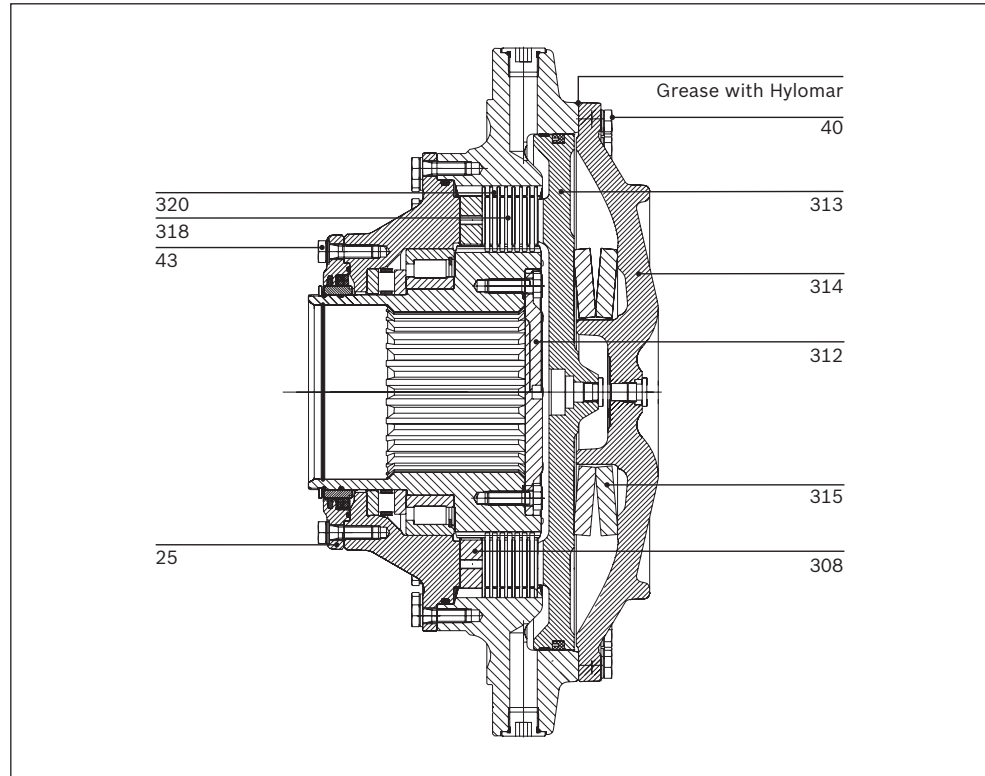


Fig. 3.28

## ! DANGER

Please read this instruction carefully before starting the disassembly!

1. Start the disassembly by slightly loosening the screws (40). Not more than 1 turn each. Continue with 1 turn of each screw around the cover until the preload of the Belleville springs (315)(Cup springs) is zero. After that the screws can be removed and the Brake cover (314) lifted off.
2. The Brake piston (313) can be removed by installing 3 screws (M8) and be lifted off by using the screws.
3. Inner and outer discs (318, 320) can be removed and the spacer (308) in place can be removed.
4. Loosen the screws (43), and take off the seal retainer (25).
5. Control the seal and mount seal retainer (25) as figure. Oil the screws (43) and assembly with torque 114 Nm (84 lbf-ft).

6. Mount spacer for MDA 14 (308). Mount first one outer disc, then inner disc, outer disc until all discs are mounted.

**Notice!** Matched disc set.

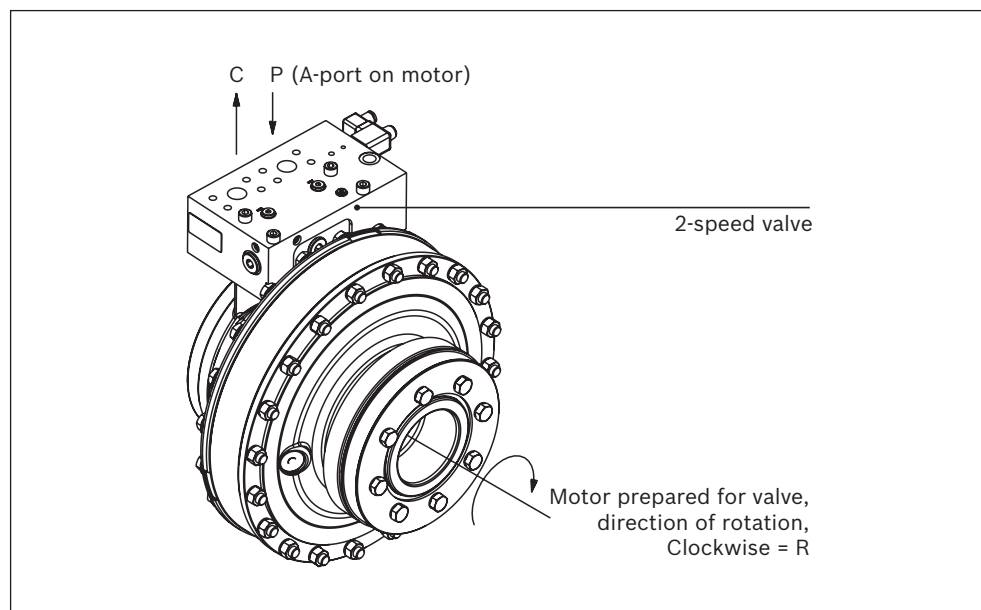
MDA 14 has 8 outer discs and 7 inner discs

MDA 21 has 11 outer discs and 10 inner discs.

7. Grease the seals with Texaco Multifak or equivalent grease without solid additives and mount the piston (313).
8. Grease the springs (315) with MoS2 Molykote or an equivalent grease, put the springs on the Brake cover (314). The springs shall be mounted against each other in the inner diameter.
9. Grease Brake cover, contact surface between Brake cover and Brake housing with a thin layer of Hylomar. Mount the Brake cover (314) on the brake, oil the screws and assembly the screws. Start mounting by slightly tightening the screws, no more than one turn each. Continue with one turn of each screw around the cover, tightening torque is 114 Nm (84 lbf·ft)

### 3.1.16. Motors with 2-speed valve

Motors with 2-speed function must be ordered with correct direction of rotation. With wrong direction, load on the piston will be increased 3 times, which can give overheating of the pistons. With the high pressure supply connected to A-port, the motor shaft rotates in the directions shown by arrows. R-motor rotates clockwise, and L-motor counter-clockwise, viewed from the motor shaft side. If the motor is working in half displacement, and in not preferred “direction of rotation”, allowed pressure is maximum 210 bar (3 000 psi).



**Fig. 3.35**

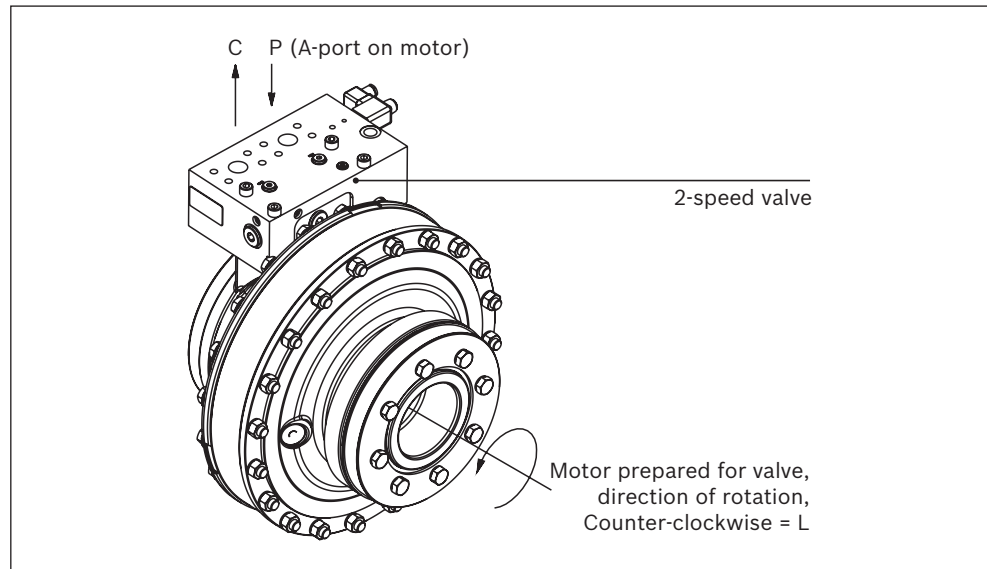


Fig. 3.35a

**Mounting of 2-speed valve on CA 50-210**

Remove the protective cover from motor mounting surface, place the O-rings (included in delivery) in their proper position on the valve mounting surface. Use grease to keep O-ring fixed. Mount valve against the motor with the ports in corresponding position.

4 pcs 1/2 UNC x 127 (5") included in delivery, strength class 12.9 (ISO 898/1)  
Tightening torque: 131 Nm (97 lbf·ft).

\*For Marine applications, use Sikaflex or similar for corrosion protection.

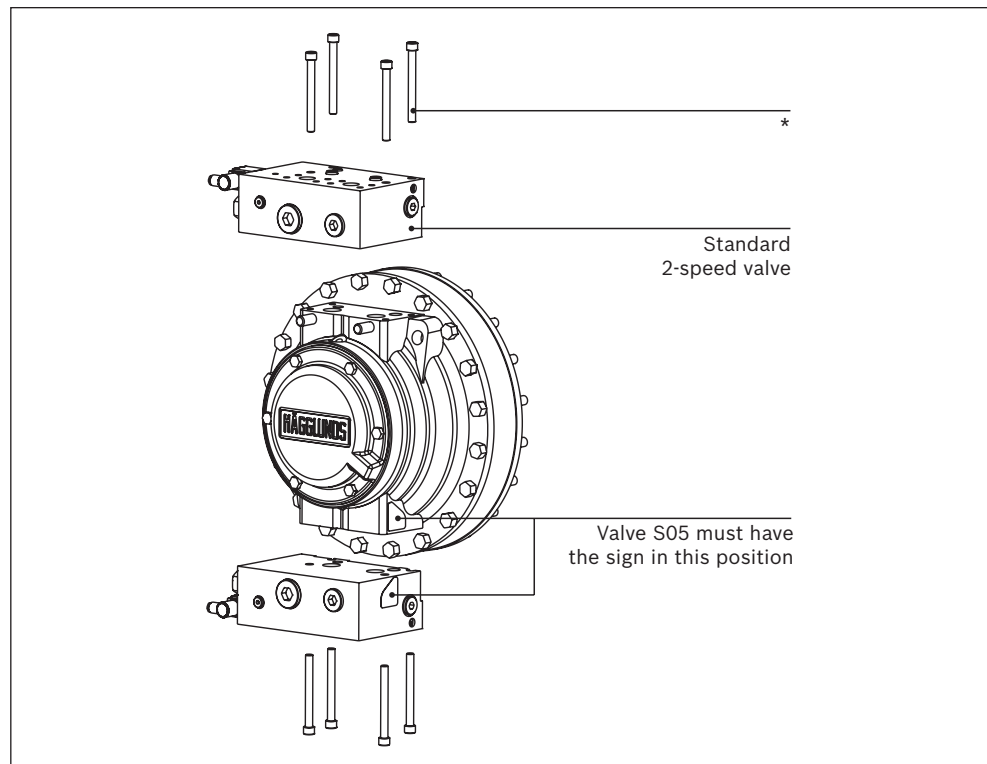


Fig. 3.36



**! WARNING**

VTCA 600 will not automatically shift from half to full displacement at overload.

**! CAUTION**

Direction of rotation see also page 40.

**! WARNING**

Valve S05 is not allowed with hanging load

**3.2 Oil connections**

When using (heavy wall) piping and in frequent reversal drives, it is recommended to fit flexible hoses between the motor and piping to avoid damage due to vibration and to simplify installation of the motor. The length of the hoses should be kept fairly short.

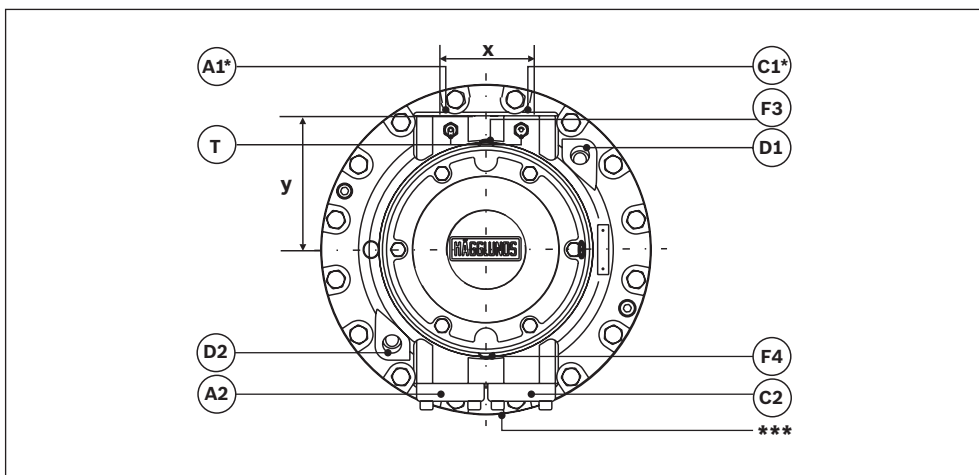


Fig. 3.37

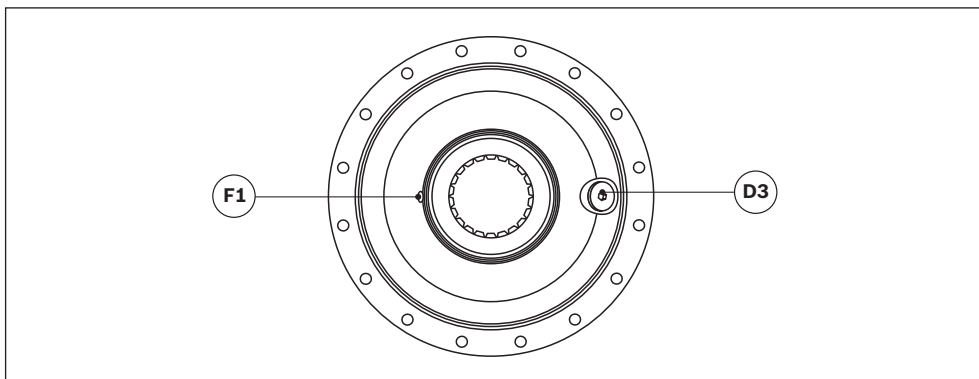


Fig. 3.37a

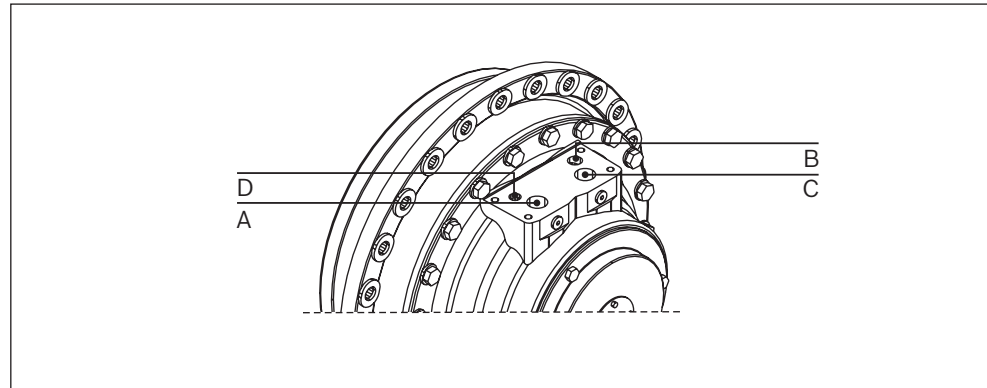


Fig. 3.37b

Table 3.16

Connection	Description	Remarks
C1*, C2	Main connection	If C is used as the inlet, the motor shaft rotates clockwise, viewed from the motor shaft side*.
A1*, A2	Main connection	If A is used as the inlet, the motor shaft rotates counterclockwise, viewed from the motor shaft side*.
D1	Drain outlet	Normally plugged at delivery.
D2, D3	Alternative drain outlets	Normally plugged at delivery.
F1	Flushing connection	For flushing of radial lip seal. Normally plugged.
F3, F4	Flushing connection	For flushing of axial bearing and motor case.
T	Test connections	Used to measure pressure and/or temperature at the main connections.

A, B, C and D: Connections for 2-speed valve. See figure 3.37b

Table 3.17

Motor	A**	C**	D1, D2	D3	F1, F3, F4	T	y mm	y in	x mm	x in
CA 50...210	1 1/4"	1 1/4"	G 3/4"	G 3/4"	G 1/4"	G 1/4"	188	7.40	99	3.90

\* Not valid for motors prepared for displacement shift.

\*\* SAE coupling J 518 C, code 62, 414 bar (6000 psi).

\*\*\* A2-connection and C2-connection is blocked at delivery. They are able to withstand maximum pressure.

**Main connection A, C**

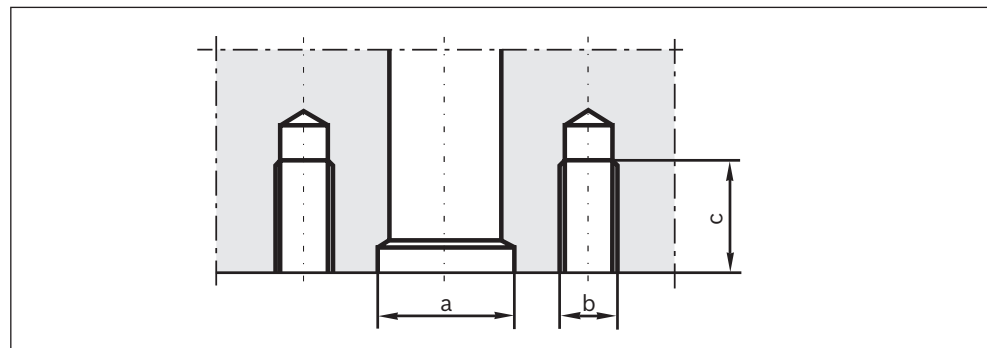
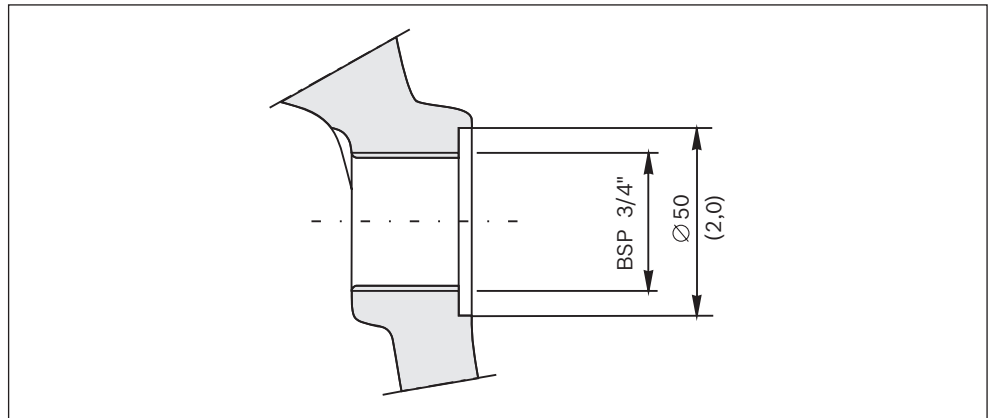


Fig. 3.38

Table 3.18

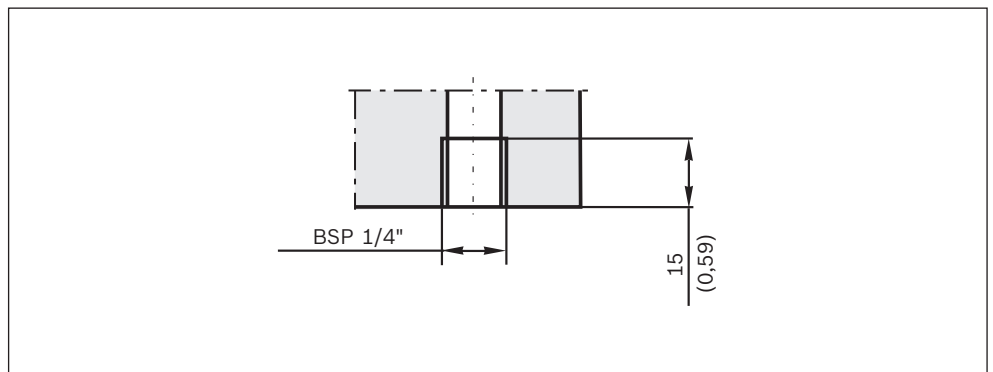
Motor	a mm (in)	b	c mm (in)
CA 50...210	31 (1.22)	1/2 UNC	25 (0.98)

**Drain connection D1, D2**



**Fig. 3.39**

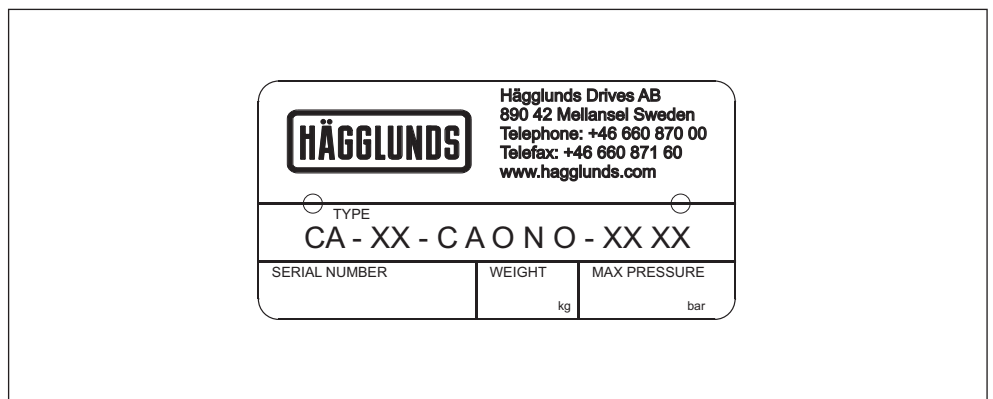
**Test connection T**



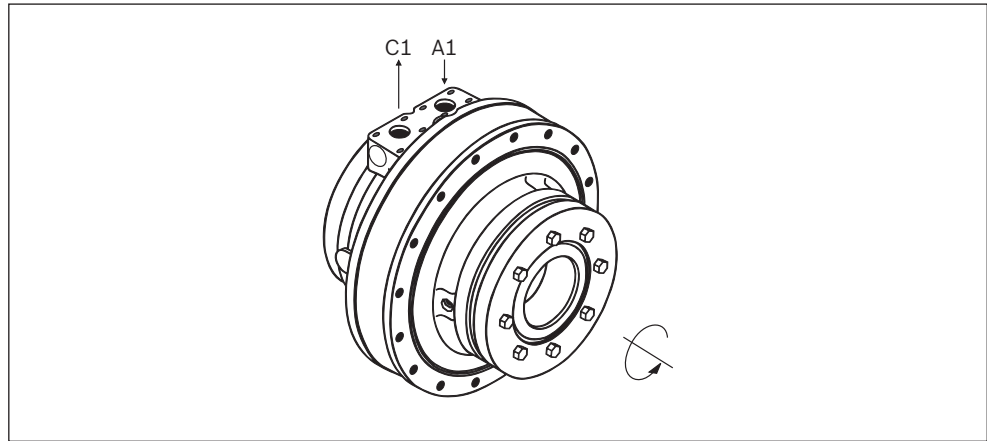
**Fig. 3.40**

**3.2.1. Direction of rotation of motor shaft**

With the inlet pressure supply connected to A port, the motor shaft rotates in the direction shown by the arrow, anti-clockwise viewed from the motor shaft side.  
 With the inlet pressure supply connected to C port, the motor shaft rotates clockwise viewed from the motor shaft side.



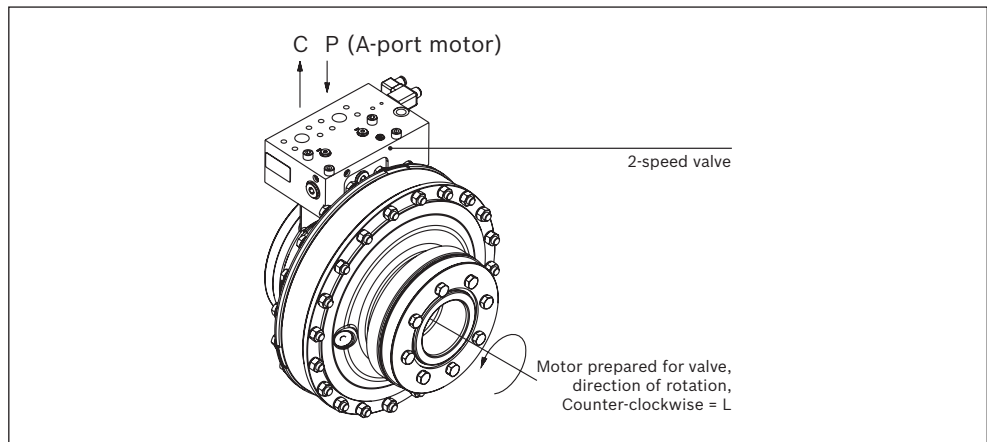
**Fig. 3.40b Motor sign single speed motor**



**Fig. 3.41 Note: Single speed motor**

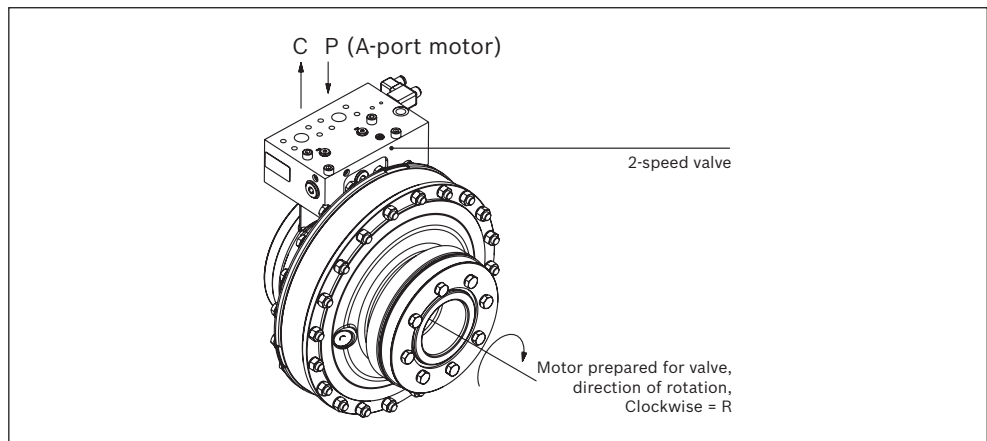
**Motor with displacement shift valve**

With a two-speed valve mounted on the motor and the oil supply connected to P give a counter clockwise rotation direction on a motor sign marked “L” as shown at figure 3.42 and figure 3.42b.



**Fig. 3.42**

If the motor sign is marked “R” the motor rotation direction is clockwise, see figure 3.40a.



**Fig. 3.42a**

The motor sign has to show “R” or “L” the specific motor rotation direction. Example of motor sign with two speed motor:

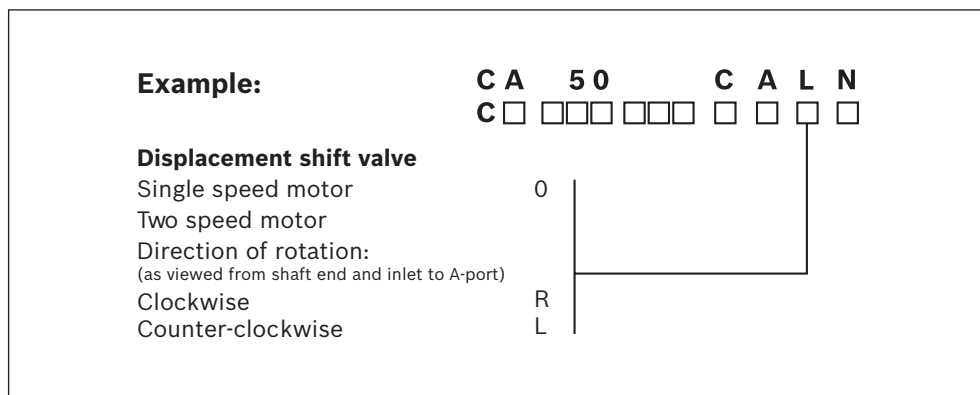


Fig. 3.42a

**! CAUTION**

Check direction of rotation.

### 3.2.2. Draining and venting the motor

#### Horizontal mounting

When the motor is installed with the shaft in the horizontal plane, it can be drained without special provisions for venting. The highest of the three drain outlets D1, D2 or D3 must always be used; see figure 3.43.

Drain line must be connected direct to the tank with a minimum of restrictions, to ensure that the maximum housing pressure is not exceeded.

#### Vertical mounting

When the motor is mounted vertically, one or the other of the vent holes must be connected to the drain line. Which of the holes that is to be used depends on whether the motor shaft is pointing upwards or downwards.

#### Motor shaft pointing downwards

The motor must be connected to the drain connection in D1 or D2 and F3 or F4. See figure 3.44.

#### Motor shaft pointing upwards

The motor must be connected to the drain line connection on the shaft end housing; see figure 3.45.

The flushing connection F on the shaft end housing should be connected to the low pressure connection. With bidirectional drives, use the connection with lowest average pressure. (Connection to high pressure will increase the motor drain flow). This gives flushing of the radial lip seal. It is advisable to fit the nipple and the hose to the motor before fitting the torque arm.

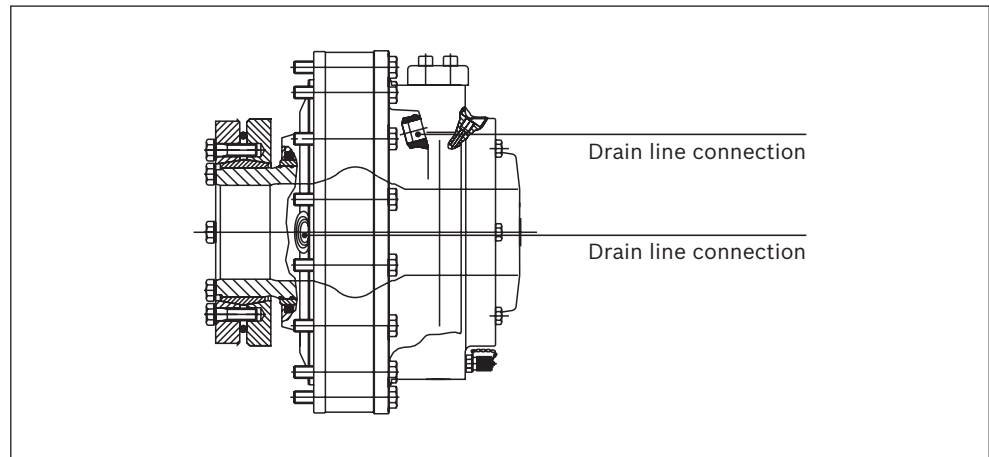


Fig. 3.43

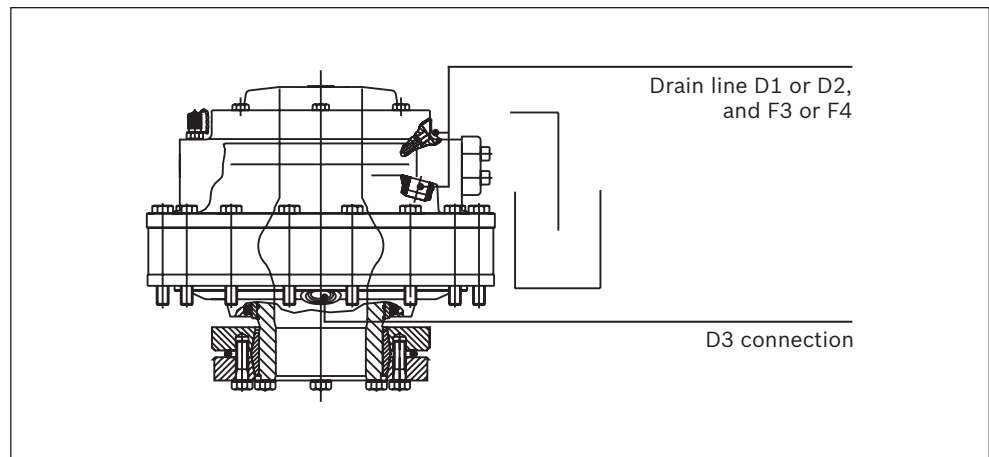


Fig. 3.44

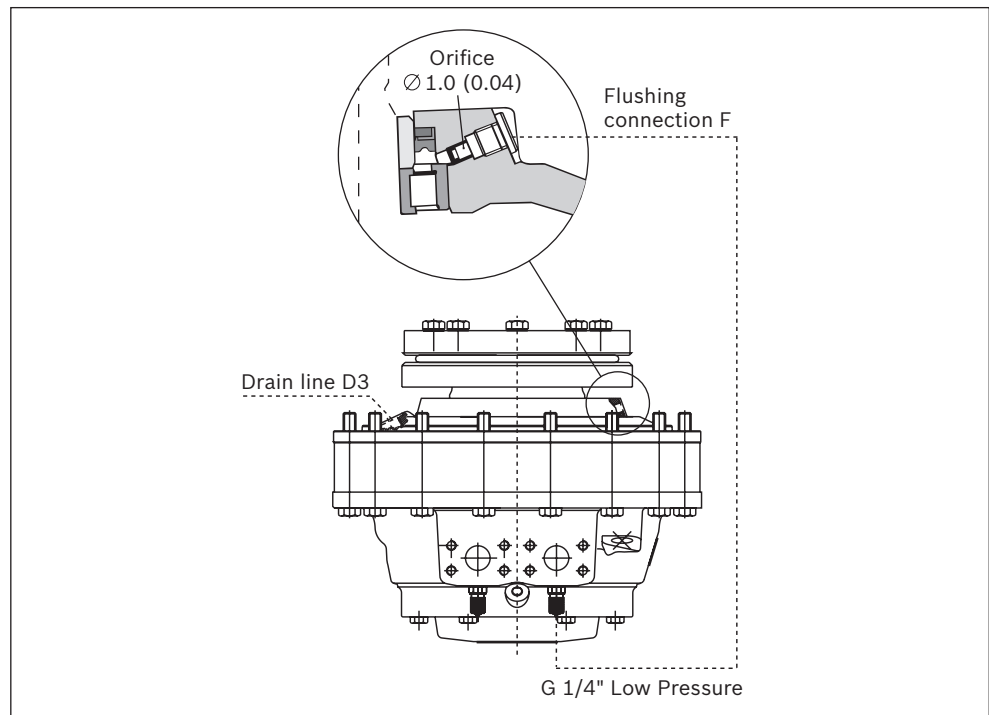


Fig. 3.45

### 3.2.3. Flushing

#### Flushing of motor case

To avoid high temperature in the motor case the heat must be removed, because high temperature gives lower viscosity and that gives reduction in basic rating life/ service life. Low viscosity also means reduced permitted output power from the motor. The motor case must be flushed when the output power exceeds the values shown beside.

Maximum power without flushing		
CA 50/70	60 kW	(80 hp)
CA 100/140/210	120 kW	(160 hp)

For calculation of required flushing, please contact your Hägglunds representative. The flushing oil shall be drained in the normal drain line. See 3.2.2.

Connect the input line for flushing in the lowest flushing F3 or F4, see figure 3.46.

For shaft pointing downwards, input line shall be D3, see figure 3.43. When there is risk for pressure spikes in motor case, input line D3 or D2 is recommended.

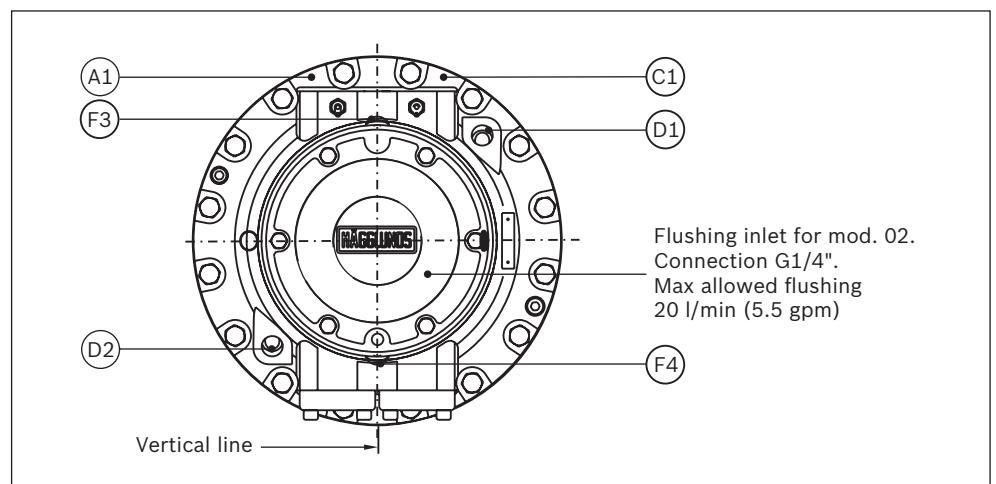


Fig. 3.46

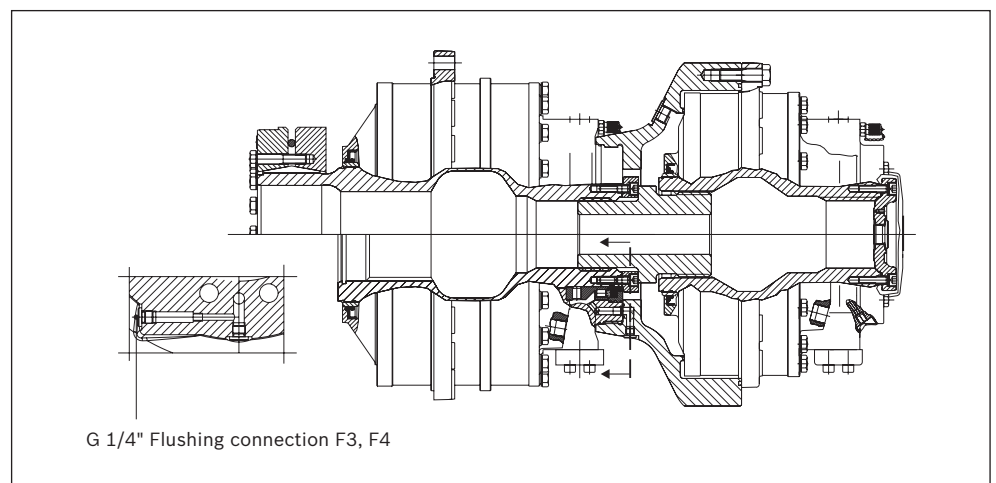


Fig. 3.46b

## 4 Operating instructions

### 4.1 Storage

The motor is delivered with internal protection in the form of an oil film and external protection in the form of an anti-rust film. This provides sufficient protection for indoor storage in normal temperatures for about 12 months.

**Notice!** The anti-rust protection must be touched-up after transport and handling. If the motor is stored for more than 3 months in uncontrolled environment or more than 12 months in controlled environment, it must be filled with oil and positioned as shown in figure 3.7.

Place the motor as shown in figure 4.1, fill the motor with filtered oil in the following order: D1, A1, B, C1. See 2.3, "Filtration".

Take extreme care to ensure that no contamination enters the motor.

Seal connections A and C with the cover plate fitted to the connection surface at delivery. Check that the O-rings or rubber seals are in position in the cover plate.

Fit the plug to D1, D2 and D3, the table below states the amount of oil needed to fill the various types of motors.

### 4.2 Before commissioning

Check the following points before commissioning the motor, i.e. before starting the first time:

- Check that the motor is connected to give the correct direction of rotation (see 3.2 "Oil connections" and 3.2.1 "Direction of rotation of motor shaft").
- Select the hydraulic fluid in accordance with the recommendations (see 2.3 "Choice of hydraulic fluid").
- Fill the motor housing with hydraulic fluid via a filter into the drain outlets D1, D2 or the vent hole (depending on how the motor is mounted).
- Check the drain line to ensure that excessive pressure does not build up in the motor housing; see 3.1 "Mounting instructions" and 3.2.2. "Draining and venting the motor".
- Check that the motor is protected from overloads (see 1.1 "Motor data").- Check that the charge pressure conforms to the charge pressure curve (see 2.1 "Recommended charge pressure").
- Check that all hydraulic couplings and plugs are properly tightened to prevent leakage.
- Make sure that the torque arm is sufficiently fastened, see 3.1.3.

**Table 4.1**

Motor	Oil volume approx.	
	Litres	US gallon
CA 50	2.0	0.53
CA 70	2.5	0.66
CA 100	3.7	0.98
CA 140	5.0	1.32
CA 210	6.8	1.80



### 4.3 Commissioning

- During initial starting and the period immediately after it, any hydraulic installation must be regularly and carefully checked at frequent intervals.
- The working pressure and charge pressure must be checked to ensure that they correspond to the contracted values.
- The pressure in the drain line measured at the motor must be less than 3 bar (43.5 psi). This pressure limit is important for the life of the motor seals.
- If leakage occurs, correct the fault and carry out new measurements.
- Check all lines, connections, screws etc and correct if necessary.
- Check other possible leakage points and replace faulty parts.
- During the start up period, dirt particles in the system are removed by the filters. The filter cartridges have to be changed after the first 100 working hours and after that according to the maintenance chart see 4.4 note to check the “filter clogged” indicators.

## **NOTICE**

It is important that the pressure is limited to 250 bar (3626 psi) when starting up the motor.

A not run-in motor in combination with dirt particles in the oil can badly affect the sliding surfaces in the motor. This is valid during the first 100 working hours.

### 4.4 Periodic maintenance

When a hydraulic system has been in service for some time, it must undergo periodic maintenance and servicing at intervals which depend on the equipment and the type of duty.

This periodic maintenance must include the following operations:

- Check the hydraulic system for leakage. Tighten the screws, replace faulty seals and keep the drive clean.
- Inspect and clean all air, oil and magnetic filters; replace all filter cartridges for which a filter clogged indication has been given; inspect tank, pump, filters etc. and clean if necessary.
- Check the pressure and temperature of the hydraulic fluid and carry out routine operations. Adjust valves etc. if necessary.
- Check the hydraulic fluid; see the Section headed “Oil”.
- Check that no dirt or other contaminations enter the system during inspection. Check that the outside of the hydraulic motor in an installation is kept free of dirt; thus leakage and faults will be detected earlier.
- We recommend that a running log be kept and that planned inspections are carried out at set intervals.
- Maintenance checks and operations are as follows:

**Maintenance chart**

In operation	Oil filters	Oil	Braking equipment	Torque arm
After the first 100 hours	Rpl.	–	Insp.	Insp.
After 3 months or 500 hours	Rpl.	–	Insp.	–
Once every 6 months	Rpl.	Insp.	Insp.	Insp.
Once every 12 months	–	–	Ctrl	–

Rpl = Replacement   Insp = Inspection   Ctrl = Control of braking torque

**4.4.1. Cleaning and care**

**CAUTION**

Damage to the surface caused by solvents and aggressive detergents!

Aggressive detergents may damage the seals on the hydraulic motor and cause them to age faster.

- Never use solvents or aggressive detergents.
- If in doubt, check the compatibility of the detergent with the seal type (Nitrile or Viton) specified in the hydraulic motor.


**CAUTION**

Damage to the hydraulic system and the seals!

Using a high-pressure cleaner could damage the speed encoder and the seals of the hydraulic motor.

- Do not point the high-pressure cleaner at sensitive components, e. g. shaft seal, seals in general, electrical connections and speed encoder.
- For cleaning and care of the hydraulic motor, observe the following:
- Plug all openings with suitable protective caps/devices.
- Check whether all plugs and plug seals are securely seated to ensure that no moisture can penetrate into the hydraulic motor during cleaning.
- Use only water and, if necessary, a mild detergent to clean the hydraulic motor.
- Remove coarse dirt from the outside of the machine and keep sensitive and important components, such as sensors and valve blocks clean.

**4.4.2. Motor**

If the motor is to be stored stationary for a longer period than about 1 month, it must be protected from internal rust. This can be done as follows:

1. Mix anti-rust additive with the hydraulic fluid of the system. Use 5% of Rust Veto Concentrate (manufactured by E F Houghton & Co, Philadelphia, USA). This additive gives rust protection for up to about 1 year, after which time the motor must be turned a few revolutions.
2. If no additives are used, the motor must be regularly turned a few revolutions.

3. If it is not possible to turn the motor, plug all connections, open drain outlet D1 or D2 on the port end housing (or if the motor is mounted vertically, flushing connection F1 on the shaft end housing) and fill the motor with hydraulic fluid. (See figure 4.1 and 4.1a).

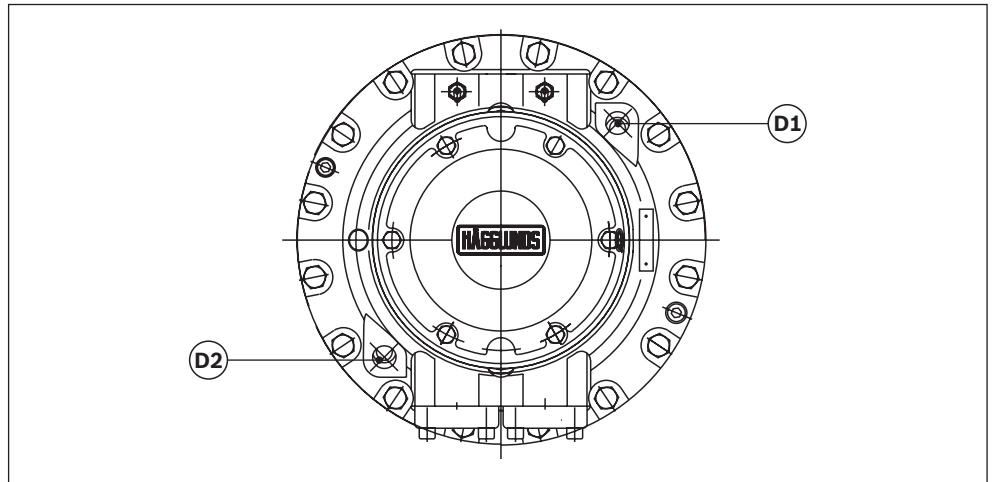


Fig. 4.1

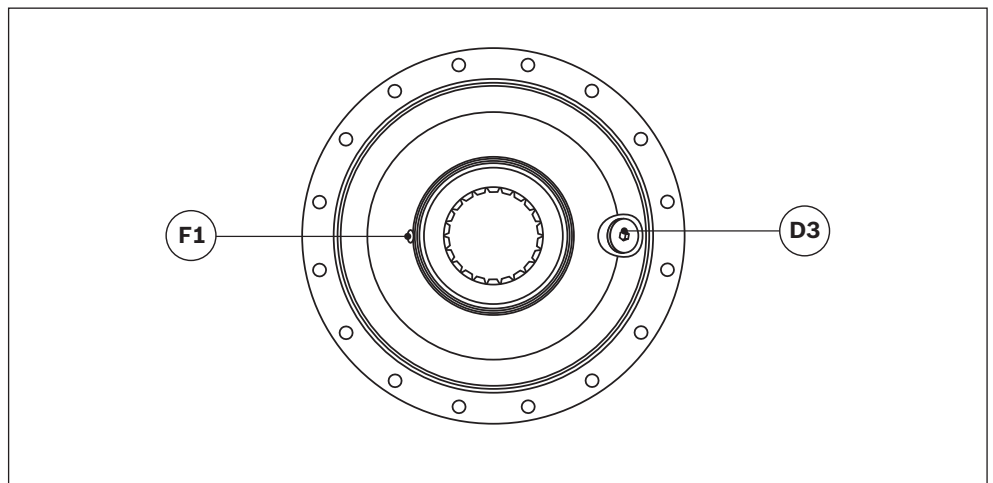


Fig. 4.1a

#### 4.4.3. Filters

Filters must be changed after the first 100 working hours and the second change is to be carried out after 3 months or 500 working hours whichever is earlier. They must then be changed at regular intervals of 6 months or 4000 working hours.

#### 4.4.4. Oil (See also 2.3)

##### Analysis

It is recommended that the oil should be analysed every 6 months. The analysis should cover viscosity, oxidation, water content, additives and contamination. Most oil suppliers are equipped to analyse the state of the oil and to recommend appropriate action. The oil must be replaced immediately if the analysis shows that it is exhausted.

### **Viscosity**

Many hydraulic oils become thinner with increasing use, and this means poorer lubrication. The viscosity of the oil in service must never fall below the minimum recommended viscosity.

### **Oxidation**

Hydraulic oil oxidizes with time of use and temperature. This is indicated by changes in colour and smell, increased acidity or the formation of sludge in the tank. The rate of oxidation increases rapidly at surface temperatures above 60 °C (140 °F), and the oil should then be checked more often.

The oxidation process increases the acidity of the fluid; the acidity is stated in terms of the “neutralisation number”. Typical oxidation is slow initially and increases rapidly later.

A sharp increase (by a factor of 2 and 3) in the neutralisation number between inspections is a signal that the oil has oxidized too much and should be replaced immediately.

### **Water content**

Contamination of the oil by water can be detected by sampling from the bottom of the tank. Most hydraulic oils repel the water, which then collects at the bottom of the tank. This water must be drained off at regular intervals. Certain types of transmission oils and engine oils emulsify the water; this can be detected by coatings on filter cartridges or a change in the colour of the oil. Obtain the advice of your oil supplier in such cases.

### **Degree of contamination**

Heavy contamination of the oil causes increased wear of the hydraulic system components. The cause of the contamination must be immediately investigated and remedied.

## **CAUTION**

All hydraulic fluids are affected differently. Obtain the advice of your oil supplier or by Hägglunds representative.

## **4.5 Oil inspection**

### **Purpose**

The purpose to take an oil sample is to check the condition of the oil.

With scheduled oil analysis, wear products can be identified and corrective action can be taken before failure occurs. Oil analysis can indicate when an oil change is required, point out shortcomings in maintenance and keep repair cost to a minimum. Using oil analysis can create a “window of opportunity”, allowing the user to schedule re-fittings or overhauls, maintenance or repairs, thus saving money on equipment repairs and downtime.

The most used method is to take samples in a special bottle and send it to a fluid laboratory for an analysis and from the laboratory you get a report, which follow a specific international standard.

You have to select what analysis the laboratory should take, but the most used analysis are particle count, water content, oxidation and viscosity.

Another method is to install an inline particle counter direct in your hydraulic system which give you the contamination level according to the international rules, the disadvantage with this method is that you only get the contamination level in the oil.

### **General**

The intention is to verify the condition of the oil during operation. The motors should be running at normal operation while the sample is taken.

- The cleanliness is extremely important during sampling.
- Always use bottles adapted to oil samples, they can be ordered from any fluid analysis laboratory.
- Never try to clean your own bottle if you want a true value of the result.
- The sample should be taken by using a mini-mess hose connected to a mini-mess coupling.
- Always clean the connections carefully before you connect the mini-mess hose to the coupling.
- Be careful when connecting the mini-mess hose because the oil beam can be dangerous and should never point against any person or other sensible object. Check and be aware of the pressure you may have on the connection before you connect.

### **How to do**

#### **Bottle samples**

The sample shall be taken at the mini-mess coupling on the charge pressure side of the motor in the closed loop system. Never out of the tank using the ball valves.

- Clean the coupling and the hose carefully.
- Connect the mini-mess hose to the coupling but be careful and be aware of the direction of the oil beam.
- Let minimum 2 litres (0.6 US gallon) of oil flush into a bucket before you fill the bottle.
- Remove the cap of the bottle as late as possible and don't let any contamination be in touch with the cap, bottle or the mini-mess hose when the sample is taken.
- In dirty air area, use a soft plastic foil (normal as protection in laboratory bottles between bottle and cap).
- Do not remove the foil, prick the end of your mini-mess hose through the foil into the bottle and fill.
- To get a reliable result the system must run without moving any valves and the mini-mess hose should not touch the bottle.
- Only  $\frac{3}{4}$  of the bottle shall be filled because the laboratory has to shake the sample to get a mixed fluid when they analyse it. Minimum 200 ml are needed for a good analysis.
- When the bottled is filled close the cap as soon as possible to prevent contamination from the air that might enter the bottle and give you a wrong result.

**Inline measure**

The sample shall be taken at the mini-mess coupling on the charge pressure side of the motor in of the closed loop system. Clean the coupling and the hose carefully.

- Connect the hoses according to the particle counters manual.
- To get a true value the contamination readings have to be stable about 10 min before you stop to measure.

## 5 Fault finding

**Hydraulic motor**

<b>Fault</b>	<b>Probable cause</b>	<b>Action</b>
The motor does not run.	Mechanical stop in the drive.	Check system pressure. If the pressure has risen to the relief valve setting, remove the load from the drive.
	The motor does not deliver enough torque because the pressure difference across the motor is not great enough for the load.	Investigate the pressure level in the system and correct the setting of the pressure limiting valve if necessary.
	Insufficient or no oil being supplied to motor.	Check the hydraulic system. Check the external leakage of the motor. (The D connection).
Motor rotates in wrong direction.	Oil supply connections to motor incorrectly connected.	Connect the oil supply correctly.
Motor runs jerkily.	Pressure or flow fluctuations in the hydraulic system.	Find the cause in the system or in the driven unit.
Noise in the motor.	The motor is being operated with the charge pressure too low.	Adjust the charge pressure to the correct level. See 2.1 "Recommended charge pressures".
	Internal faults in the motor.	Investigate the drain oil, if necessary. Put a magnetic plug in the oil flow and check the material that sticks to the magnet. Steel particles indicate damage. Note that fine material from the castings may be deposited and does not mean internal damage in the motor.
External oil leakage on the motor.	The radial lip seal is worn.	Replace the radial lip seal.

**Hydraulic motor with MDA brake**

Fault	Probable cause	Action
Insufficient braking torque.	<p>The brake cylinder is not drained in the described manner, excessive counter pressure in drainage line.</p> <p>The brake linings or the discs are worn out.</p>	<p>Remove the cause of the pressure. Concerning the maximum counter pressure, see the section dealing with draining the brake cylinder under 3.3.10/13, "Draining of brake cylinder".</p> <p>Control of braking torque according to 3.1.14. Dismantle the brake and replace the worn discs.</p>
The brake does not open.	<p>Insufficient brake opening pressure.</p> <p>Seals or piston damage.</p>	<p>For the required opening pressure see the section dealing with brake MDA under 3.1.7 "Brake MDA".</p> <p>Replace seals. Replace the piston. IMPORTANT! The spring in the brake cylinder is tensioned.</p>

**Hydraulic motor with two-speed valve, VTCA 600**

Fault	Probable cause	Action
Motor only works at one speed.	<p>Pilot pressure low.</p> <p>The valve piston has stuck in single-speed position due to impurities in the oil.</p>	<p>Suitable pilot pressure - see AC-3.1 Engineering manual.</p> <p>Inspect piston and remove impurities.</p>

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