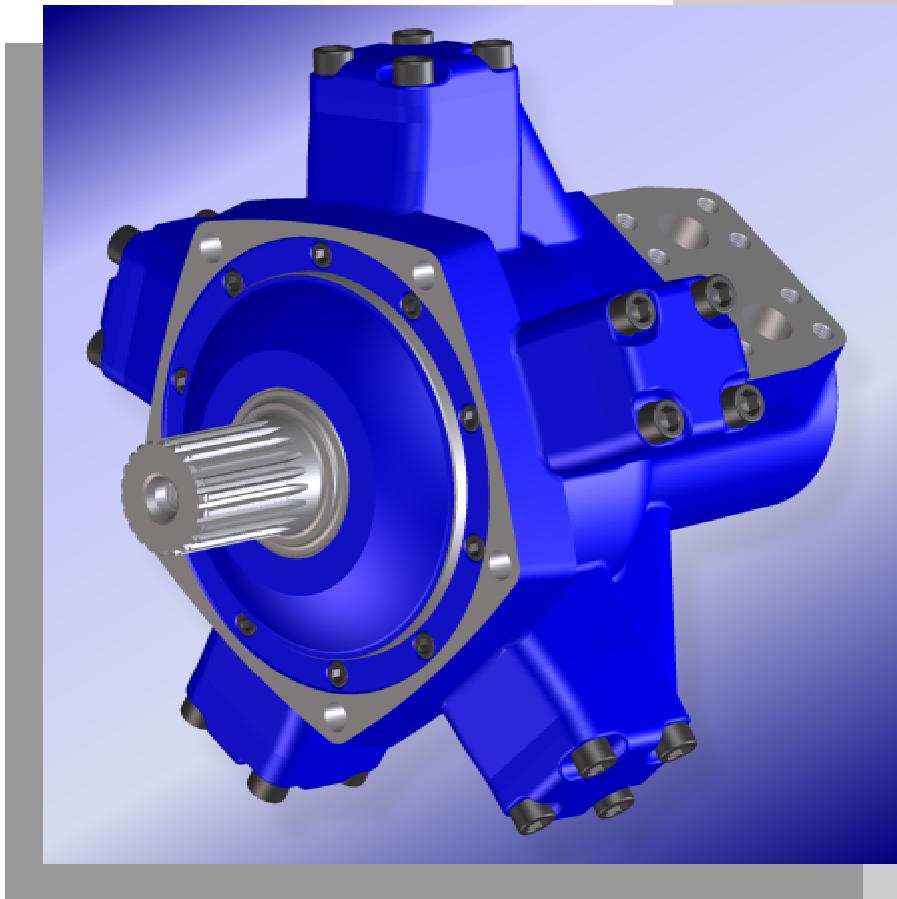


HYDRAULIC-MOTORS



Radial Piston Motors

with fixed displacement

RM...X series

$V_g = 250 \text{ cm}^3/\text{rev} - 900 \text{ cm}^3/\text{rev}$

Features:

- many displacements for all applications
- very high starting torque
- high efficiencies, high constant power
- smooth running at all speeds
- high resistance to temperature shock
- reversible
- suitable for automatic control engineering
- suitable for inflammable and biologically degradable liquids
special design - type "S18" with environmentally sealed, grease lubricated bearings, especially for operating with hardly combustible fluids containing water or glycol (HFA, HFB or HFC) available
- bearings for very long life
- quiet running properties
- design with:
 - instrument shaft
 - brake and / or gearbox
 - valve assembly

Contents

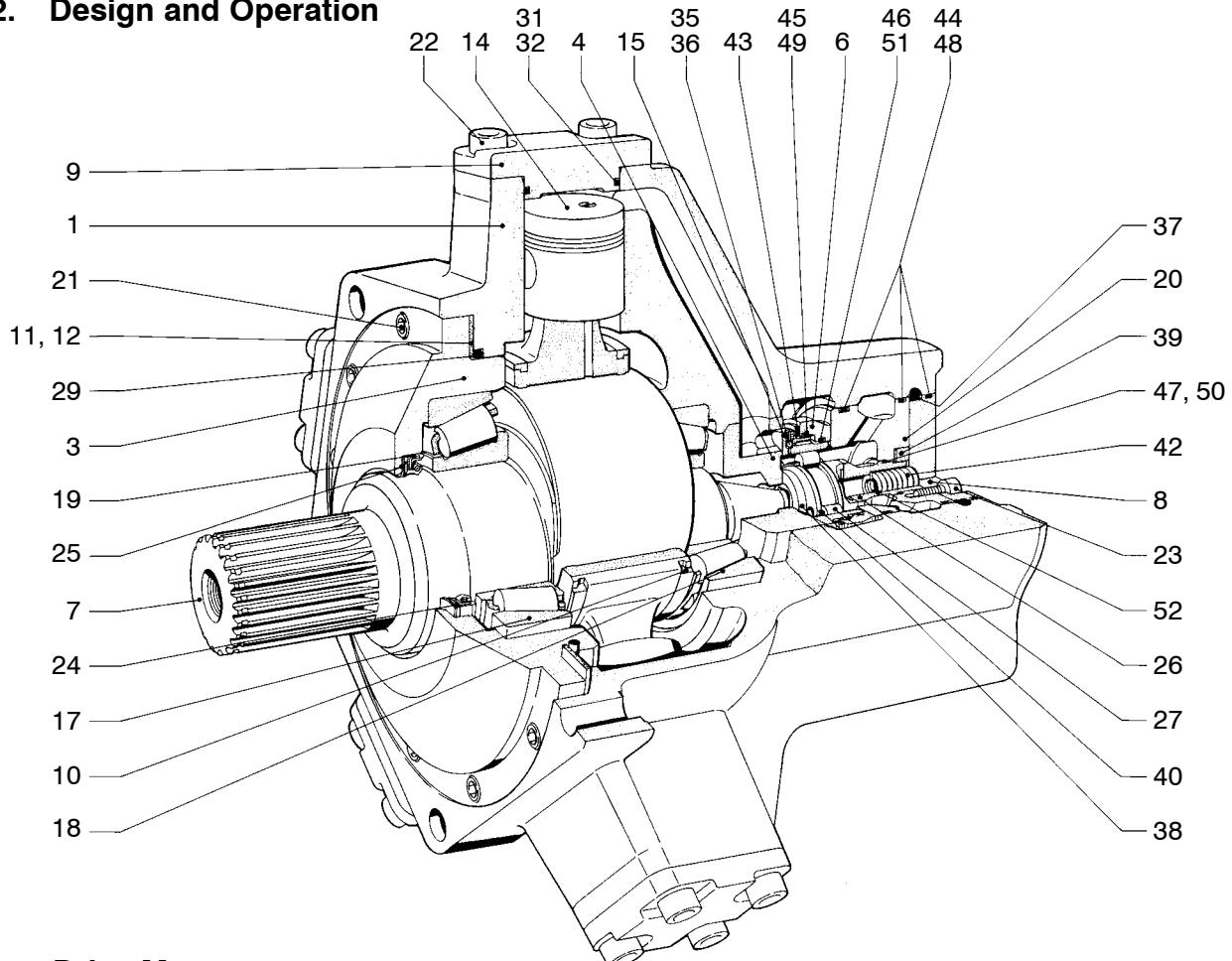
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1. General Characteristics and Features

Design:

The radial piston hydraulic motor has been designed with a high load capacity. It is efficient, has a low moment of inertia, and is capable of very low speeds and has excellent reversing properties. The concept features make it extremely quiet, being suitable for servo control systems with facility to work either as a motor or pump in both directions.

2. Design and Operation



2.1 Drive Motor

Consists of a close grain, high strength, cast iron cylinder block. Eccentric crankshaft concept.

Operating characteristics:

Five radial piston/connecting rod assemblies (14) bear on the crankshaft (7) which is located by heavy duty tapered roller bearings.

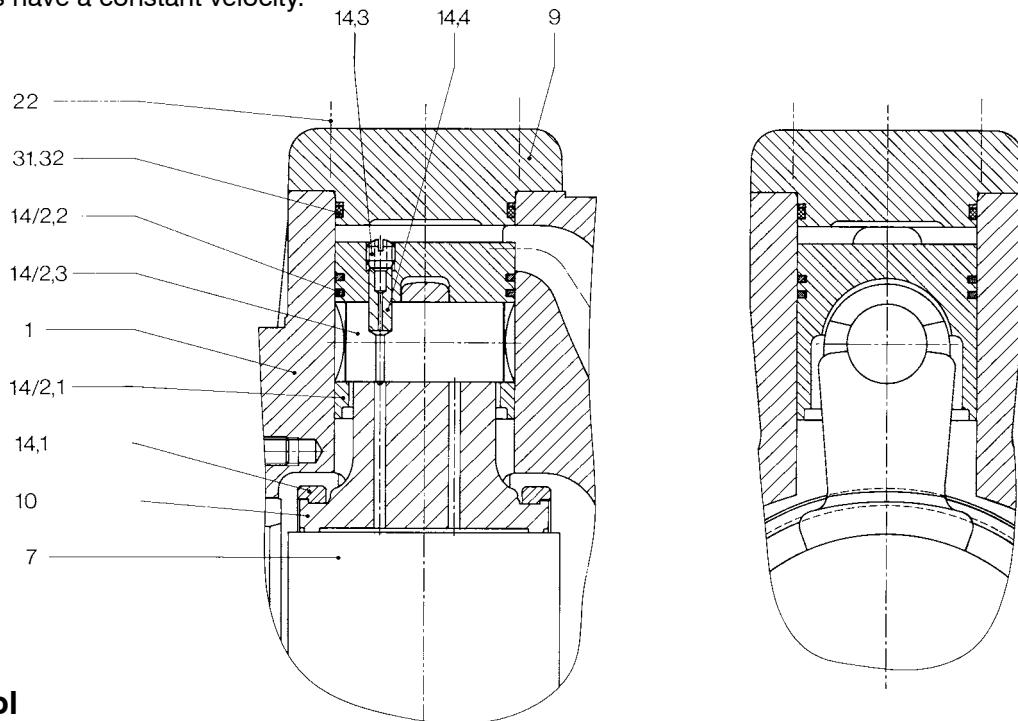
Crankshaft bearings (17 & 18):

Pre-loaded to take the thrust in both axial directions, ensures silent running and allows heavy radial and axial loading on the output shaft (e.g. gear drives).

Connecting Rod (14.1):

The computer optimised design is hydrostatically balanced on the crankshaft with sufficient leakage to ensure lubrication and cooling. Friction losses are reduced to a minimum and, stick slip action is avoided at low speeds. High starting torque and running torque combined with high speeds are important features of the design. Long service life is assured since con-rod slippers are unaffected by contamination and self-adjustable. Non-inflammable fluids have been used with success. Noise generation is also reduced by the cushioning effect of the hydrostatic bearing design.

The force is transmitted from the piston (14) to the connecting rod (14.1) via cylindrical, pressure-lubricated reciprocating bearing. A special design feature is the bending stress relieved gudgeon pin. This design is superior to a ball connection since friction losses are lower and all moving contact surfaces have a constant velocity.



2.2 Control

Design:

The oil flow to and from the cylinders is arranged through a flat faced distributor (4) which operates in the following manner:

Control rings (6 & 15) are mounted on eccentric (38) over roller bearings (27) and, together with the body (1) form two annular passages. When oil pressure is supplied to the motor, the crankshaft (7) and eccentric (38) rotate together, allowing the control rings (6 & 15) to open the inner and outer annular passages to the oil flow. Control rings (6 & 15) are axially loaded by means of wave springs (43) to maintain constant clearance across the face of the distributor block (4) under pressure. The eccentric (38) is also axially loaded by means of the hydraulic compensator (26) and spring (42). The design ensures low friction losses, self cleaning across the distributor face, immunity from the effects of contamination and a low leakage loss. The sinusoidal opening characteristics of the distributor results in smooth and quiet running at all speeds. A twoway shuttle valve (35 & 36) ensures that the inner and outer annular spaces between control rings (6 & 15) are always at the higher pressure applied to the motor.

3. Available Options:

The range is comprehensive, and the following features can be provided:

1. Choice of shafts
2. Double shaft extension
3. Motor and brake combinations
4. Geared motors; gear motor and brake combinations
5. Tachometer and other measuring attachments
6. Couplings, flanges
7. Viton seals
8. Special models for HFB and HFC non-flammable fluids
9. Direct valve assembly possible
10. Connection SAE J 518 High pressure (Typ: A1)

We are prepared to consider special designs.

Changes reserved!

Radial Piston Motor

RM		X		A1			
----	--	---	--	----	--	--	--

Displacement nominal size

255 cm³/rev = 250
360 cm³/rev = 355
442 cm³/rev = 450
490 cm³/rev = 500
708 cm³/rev = 710
904 cm³/rev = 900

Series type - motor

Actual series type = X

Drive shaft

Cylindrical with key
DIN 6885

= Z

Splined shaft
DIN 5480

= K

Involute splined shaft
DIN 5480

= H

Hydraulic ports

Flange connection radial

SAE J518C 1" - 6000 PSI for nominal size 250 - 500 = A1

SAE J518C 1 1/4" - 6000 PSI for nominal size 710 - 900 = A1

Sealing material

NBR, suitable for:

HLP - mineral oils to DIN 51524 part 2

= *

FPM (Viton), suitable for:
phosphoric acid-ester and high temperatures

= V

2nd shaft end

Without 2nd shaft end

= *

Cylindrical instrument shaft ø10_{h6} for measuring device

= M

Additional data

Brakes / gearboxes / decoder / special installation-situations / higher leakage pressures etc.

= detailed description

* = no indication in type key

Example for ordering:

RM 900 X K A1 □ M □

Additional data
Instrument shaft ø10_{h6}
Sealing material: NBR
Flange: SAE J518C 1 1/4" - 6000 PSI
Drive shaft: Splined shaft DIN 5480
Series type: X
Displacement: V_g = 904 cm³/rev
Radial Piston Motor

All characteristic quantities at $v = 36 \text{ mm}^2/\text{s}$; $\Theta = 50^\circ\text{C}$; $p_{\text{outlet}} = \text{without pressure}$

Nominal size			250	355	450	500	
Displacement	V_g	cm^3/rev	255	360	442	490	
Theor. specific torque	$T_{\text{spec.theor.}}$	Nm/bar	4,1	5,7	7,0	7,8	
Average specific torque	$T_{\text{spec.aver.}}$	Nm/bar	3,7	5,3	6,5	7,2	
Min. starting torque / theor. torque	%		89,5	90	90,5	91	
Inlet pressure, max. continuous	$p_{\text{cont.}}$	bar		250			
	intermittent	$p_{\text{interm.}}$			315		
	peak	p_{peak}				400	
Total pressure, max. in port A+B	p_{total}	bar			400		
Leakage pressure, max.	p_{Leak}	bar				1,5	
Operating speed range	n	rpm	5-600	5-550	5-500	5-450	
Continuous power, max.	$P_{\text{cont.}}$	kW	28	36	40	40	
Intermittent power, max.	$P_{\text{interm.}}$	kW	35	45	50	50	
Moment of inertia	J	kgm^2	0,0082	0,0089	0,0096	0,0101	
Weight	m	kg	75	75	75	75	
Temperature range of pressure medium	Θ	$^\circ\text{C}$			-30 up to +80		
Viscosity range	v	mm^2/s	18 up to 1000, recommended: 30 up to 50				

Nominal size			710	900			
Displacement	V_g	cm^3/rev	704	904			
Theor. specific torque	$T_{\text{spec.theor.}}$	Nm/bar	11,2	14,4			
Average specific torque	$T_{\text{spec.aver.}}$	Nm/bar	10,3	13,2			
Min. starting torque / theor. torque	%		89,5	91			
Inlet pressure, max. continuous	$p_{\text{cont.}}$	bar	250				
	intermittent	$p_{\text{interm.}}$		315			
	peak	p_{peak}			400		
Total pressure, max. in port A+B	p_{total}	bar		400			
Leakage pressure, max.	p_{Leak}	bar		1,5			
Operating speed range	n	rpm	5-550	5-450			
Continuous power, max.	$P_{\text{cont.}}$	kW	63	63			
Intermittent power, max.	$P_{\text{interm.}}$	kW	80	80			
Moment of inertia	J	kgm^2	0,0273	0,0298			
Weight	m	kg	132	132			
Temperature range of pressure medium	Θ	$^\circ\text{C}$	30 up to +80				
Viscosity range	v	mm^2/s	18 up to 1000, recommended: 30 up to 50				

$p_{\text{cont.}}$ = admissible continuous pressure at limitation to $P_{\text{cont.}}$.

p_{max} = maximal admissible operating pressure at limitation to $P_{\text{interm.}}$.

p_{peak} = peak pressure, where the components remain safe in function.

$P_{\text{cont.}}$ = Continuous power (at maximal 10 bar outlet pressure).

Motor flushing must be carried out above $P_{\text{cont.}}$.

$P_{\text{interm.}}$ = Power, which may be demanded temporarily (max. 10% duty cycle / hour).

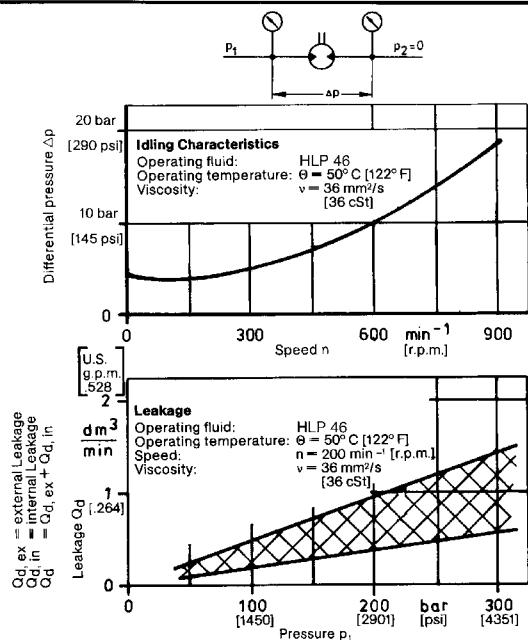
Power, speed and bearing life may be increased when flushing with 3 - 6 liters flushing oil.

For queries, please look at page 22.

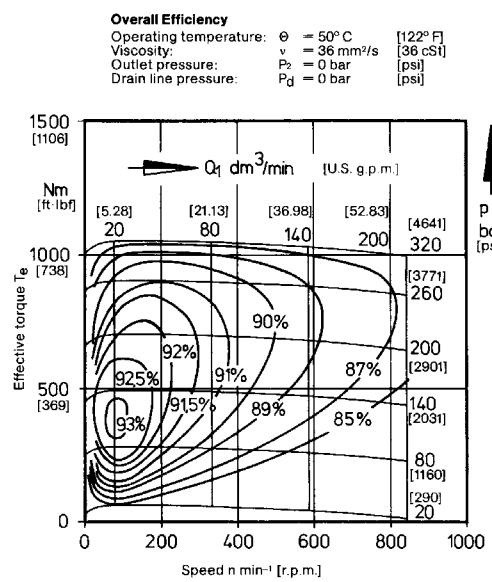
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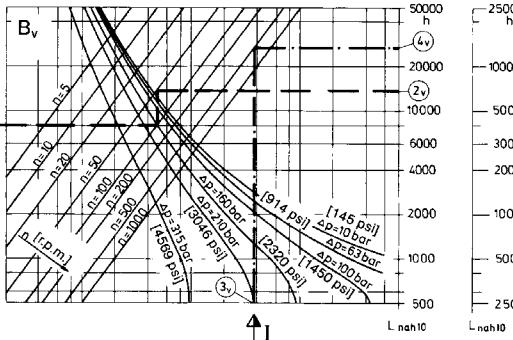
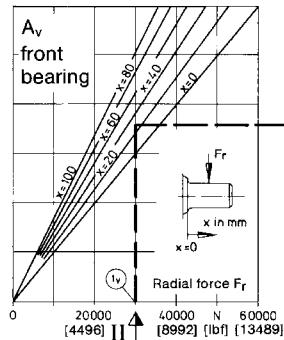
Characteristics



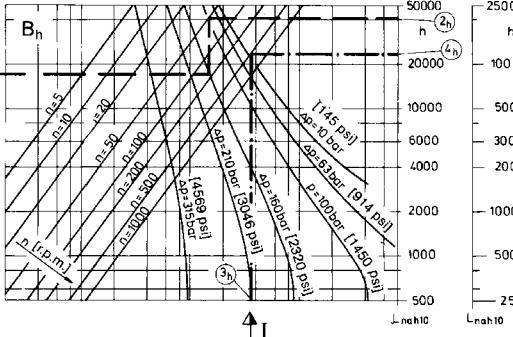
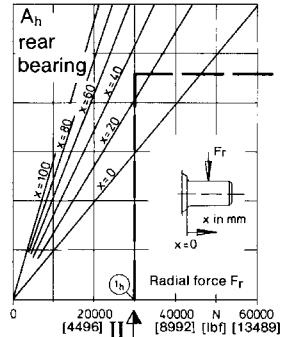
Performance



Determination of Bearing Life



I Given: $F_r = 0 \text{ N}$ [0 lbf], $\Delta p = 210 \text{ bar}$ [3046 psi]; $n = 500 \text{ min}^{-1}$ [r.p.m.]
Duration of life of bearing.
Points of intersection of $\Delta p = 210 \text{ bar}$ [3046 psi] (3v) and (3h) with the absciss vertically to the speed line $n = 500 \text{ min}^{-1}$ [r.p.m.] then horizontally to the duration of life of bearing (4v) $L_{nah10} = 26000$ hours resp. $L_{nah50} = 130000$ hours and (4h) $L_{nah10} = 23000$ hours resp. (4h) $L_{nah50} = 115000$ hours.



L_{nah10} is the modified nominal duration of life of bearing in operating hours at a viscosity $v = 36 \text{ mm}^2/\text{s}$ [36 cSt] at which 10% of the bearings can fail, 90% reach a higher duration of life. The average middle duration of life of bearing L_{nah50} is five times L_{nah10} .

Shaft strength

Example:

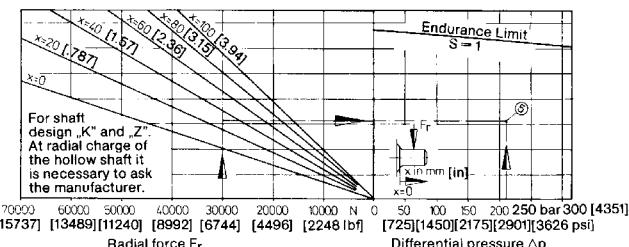
Given values: $F_r = 30000 \text{ N}$ [6744 lbf] $x = 30 \text{ mm}$ [1.181 in]
 $\Delta p = 210 \text{ bar}$ [3046 psi]

Required value: Shaft strength

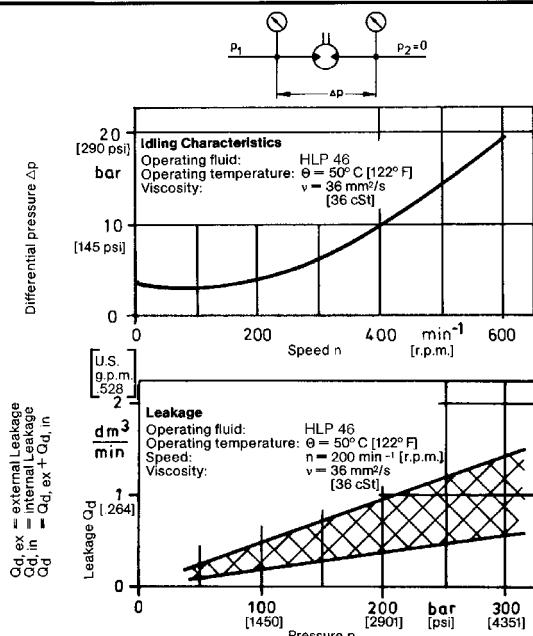
Draw a vertical line from $F_r = 30000 \text{ N}$ [6744 lbf] to distance $x = 30 \text{ mm}$ [1.181 in] and a straight horizontal line from there.

If the intersection \odot of the horizontal with the vertical line of $\Delta p = 210 \text{ bar}$ [3046 psi] is below curve the shaft has sufficient fatigue strength.

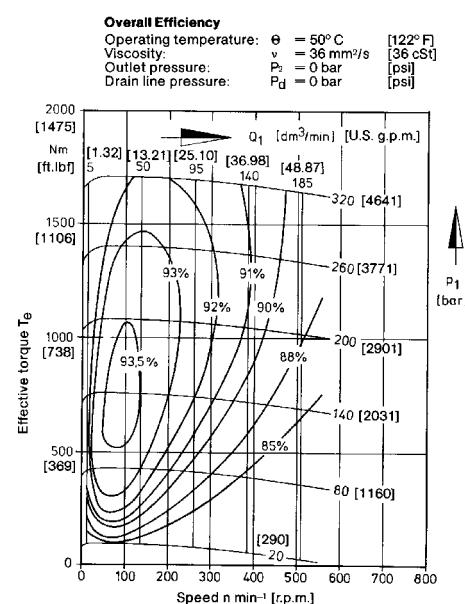
Allowable axial forces will be provided on request.



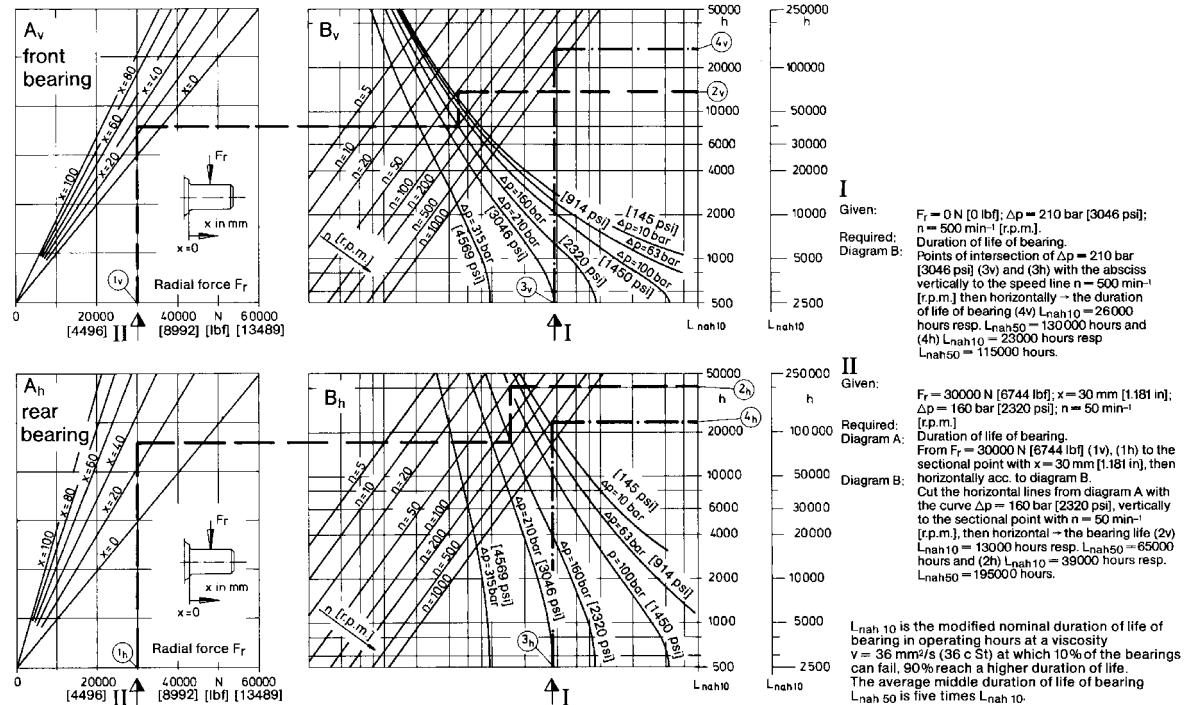
Characteristics



Performance



Determination of Bearing Life



Shaft strength

Example:

Given values: $F_r = 30000 \text{ N}$ [6744 lbf] $x = 30 \text{ mm}$ [1.181 in]

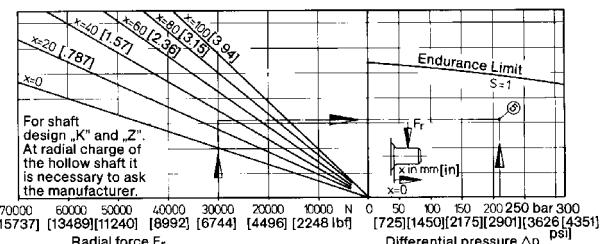
$\Delta p = 210 \text{ bar}$ [3046 psi]

Required value: Shaft strength

Draw a vertical line from $F_r = 30000 \text{ N}$ [6744 lbf] to distance $x = 30 \text{ mm}$ [1.181 in] and a straight horizontal line from there.

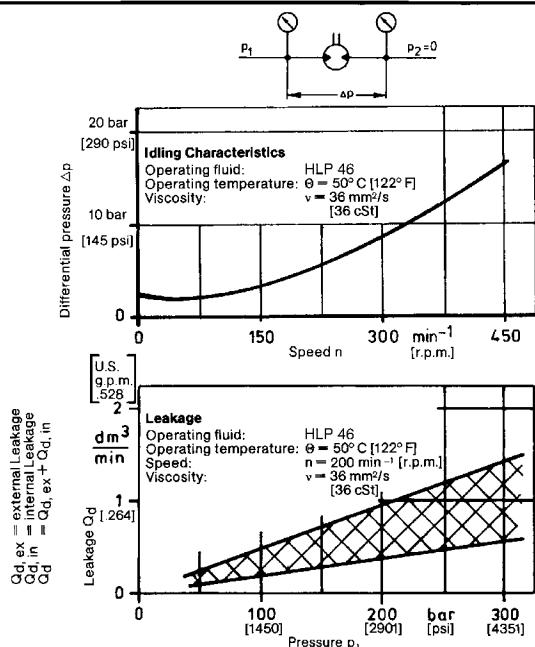
If the intersection \odot of the horizontal with the vertical line of $\Delta p = 210 \text{ bar}$ [3046 psi] is below curve the shaft has sufficient fatigue strength.

Allowable axial forces will be provided on request.

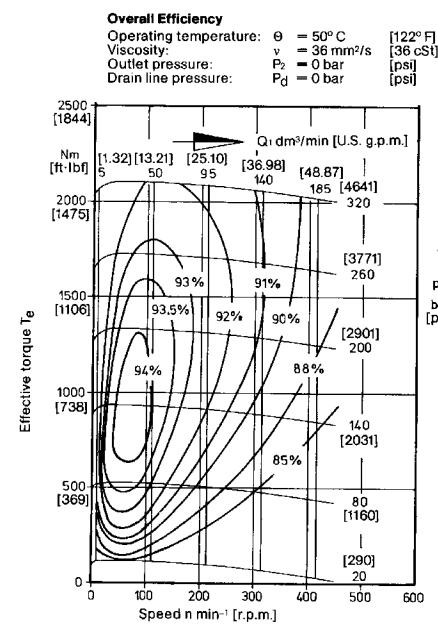


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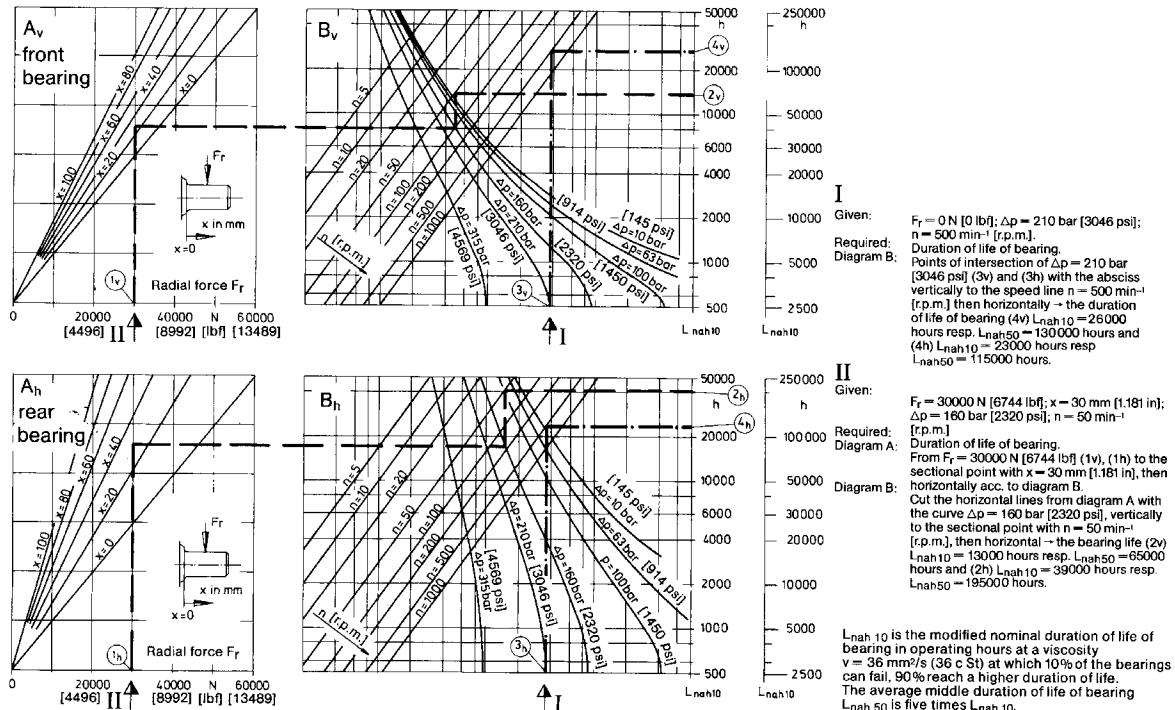
Characteristics



Performance



Determination of Bearing Life



Shaft strength

Example:

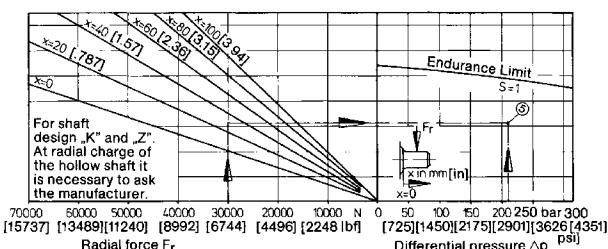
Given values: $F_r = 30000 \text{ N}$ [6744 lbf] $x = 30 \text{ mm}$ [1.181 in]
 $\Delta p = 210 \text{ bar}$ [3046 psi]

Required value: Shaft strength

Draw a vertical line from $F_r = 30000 \text{ N}$ [6744 lbf] to distance $x = 30 \text{ mm}$ [1.181 in] and a straight horizontal line from there.

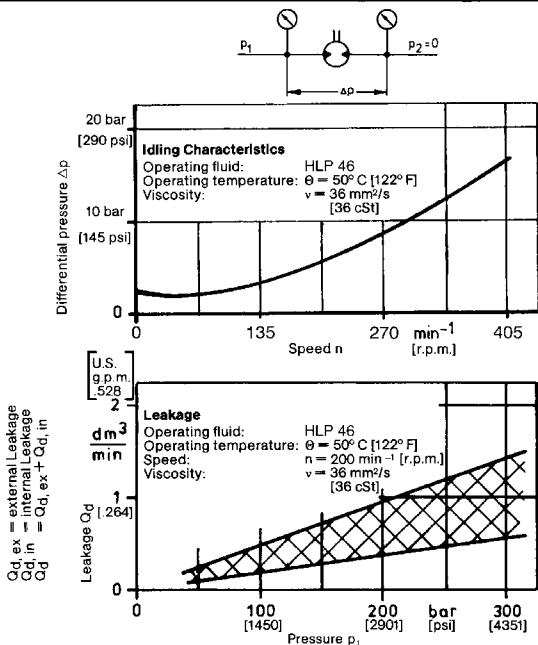
If the intersection ⑤ of the horizontal with the vertical line of $\Delta p = 210 \text{ bar}$ [3046 psi] is below curve the shaft has sufficient fatigue strength.

Allowable axial forces will be provided on request.

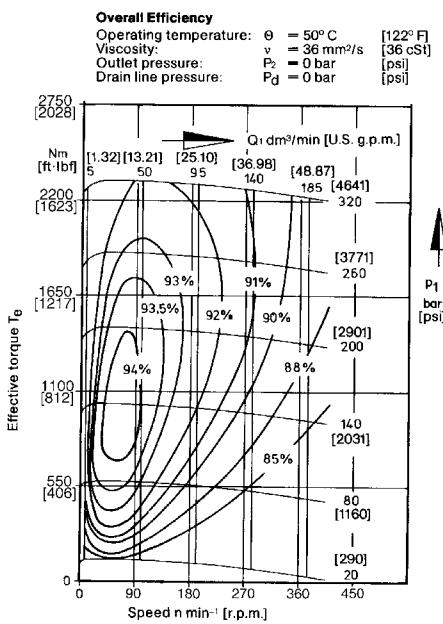


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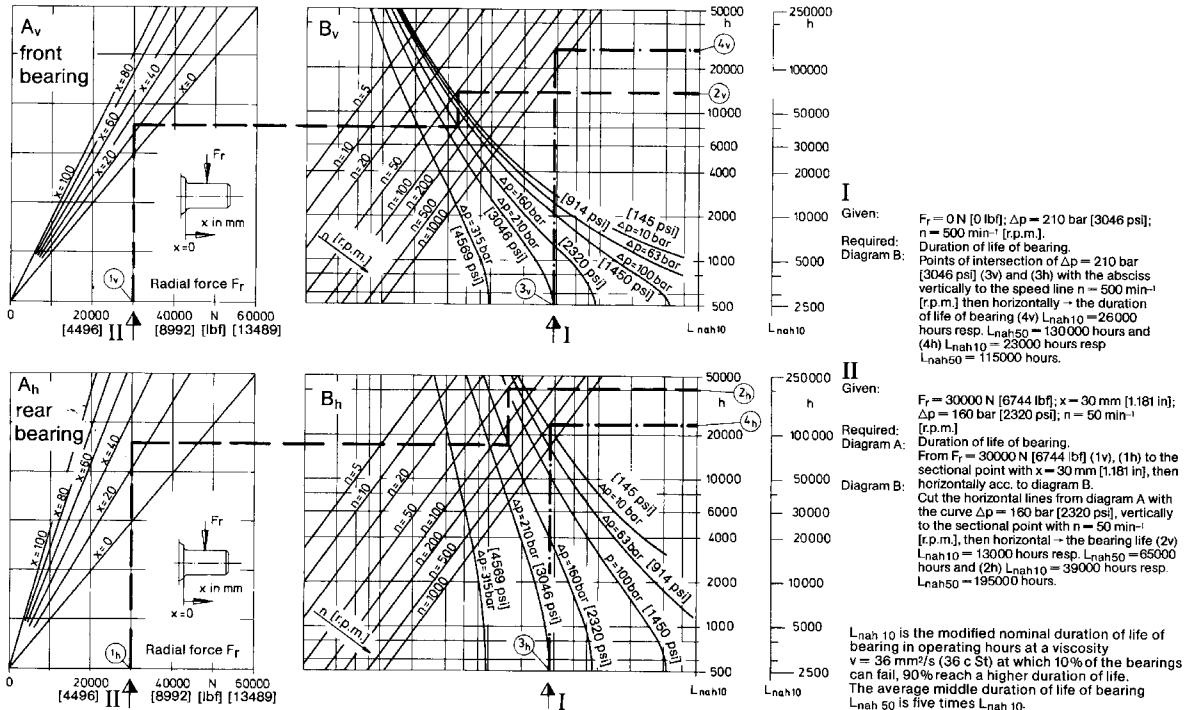
Characteristics



Performance



Determination of Bearing Life

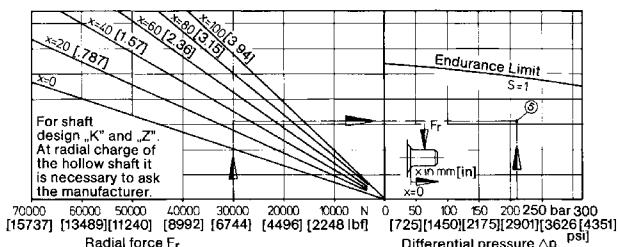


Shaft strength

Example:
Given values: $F_r = 30000 \text{ N}$ [6744 lbf] $x = 30 \text{ mm}$ [1.181 in]
 $\Delta p = 210 \text{ bar}$ [3046 psi]

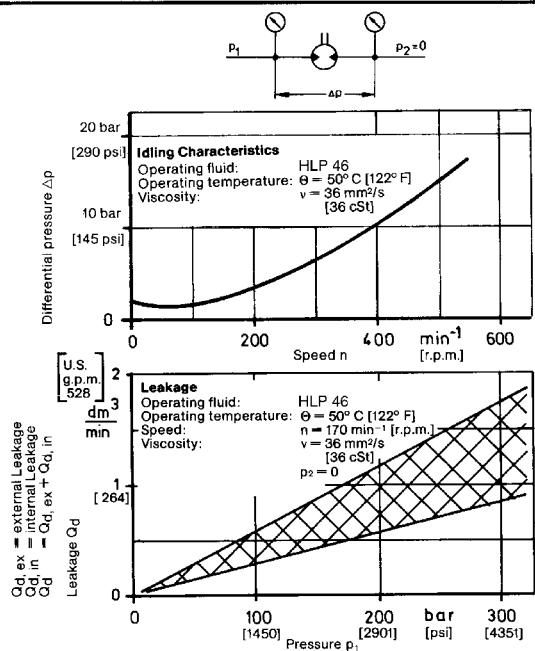
Required value: Shaft strength
Draw a vertical line from $F_r = 30000 \text{ N}$ [6744 lbf] to distance $x = 30 \text{ mm}$ [1.181 in] and a straight horizontal line from there.

If the intersection \odot of the horizontal with the vertical line of $\Delta p = 210 \text{ bar}$ [3046 psi] is below curve the shaft has sufficient fatigue strength.
Allowable axial forces will be provided on request.

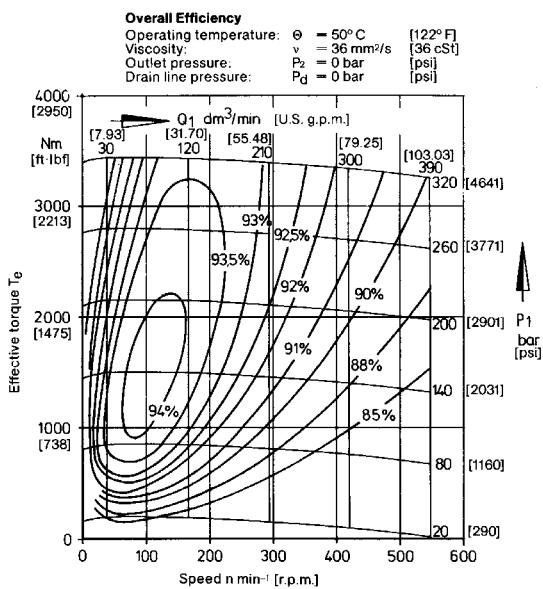


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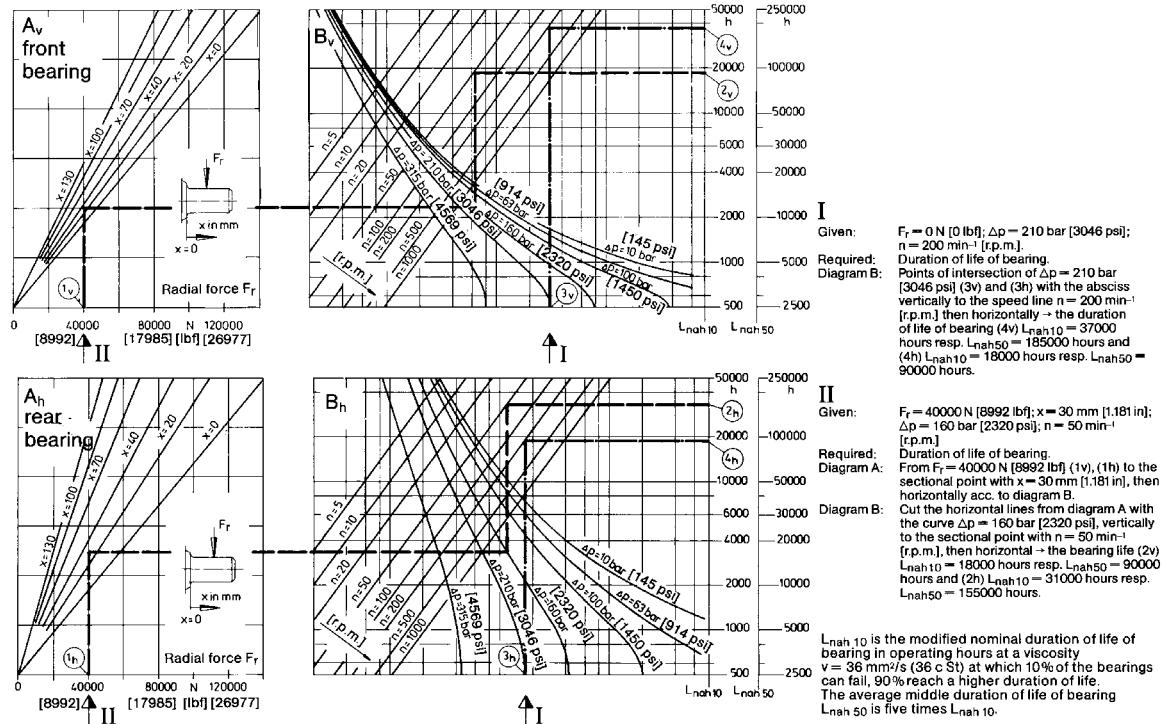
Characteristics



Performance



Determination of Bearing Life



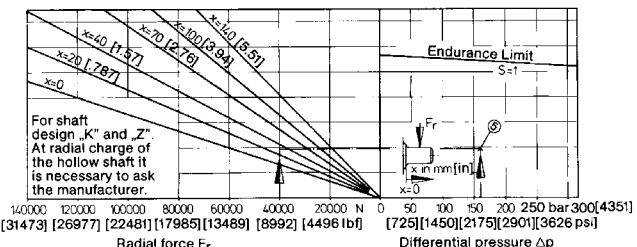
Shaft strength

Example:
Given values: $F_r = 40000 \text{ N}$ [8992 lbf] $x = 30 \text{ mm}$ [1.181 in]
 $\Delta p = 160 \text{ bar}$ [2321 psi]

Required value: Shaft strength

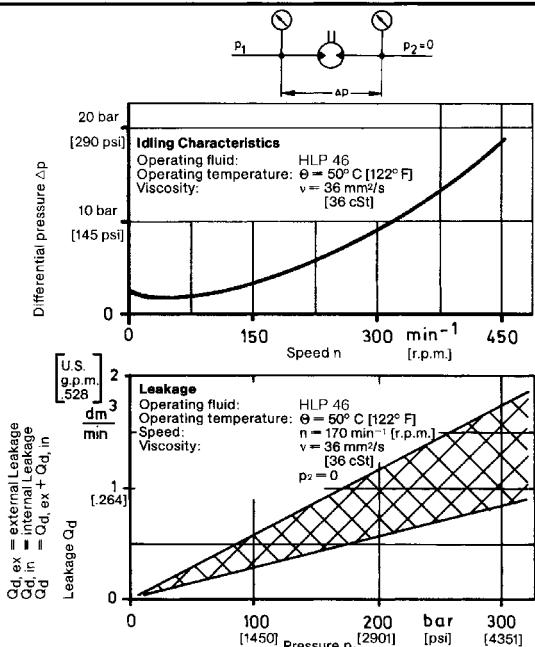
Draw a vertical line from $F_r = 40000 \text{ N}$ [8992 lbf] to distance $x = 30 \text{ mm}$ [1.181 in] and a straight horizontal line from there.

If the intersection \odot of the horizontal with the vertical line of $\Delta p = 160 \text{ bar}$ [2321 psi] is below curve the shaft has sufficient fatigue strength.
 Allowing axial forces will be provided on request.

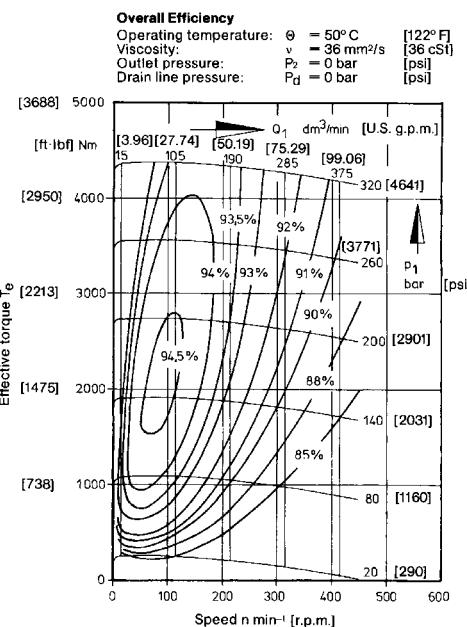


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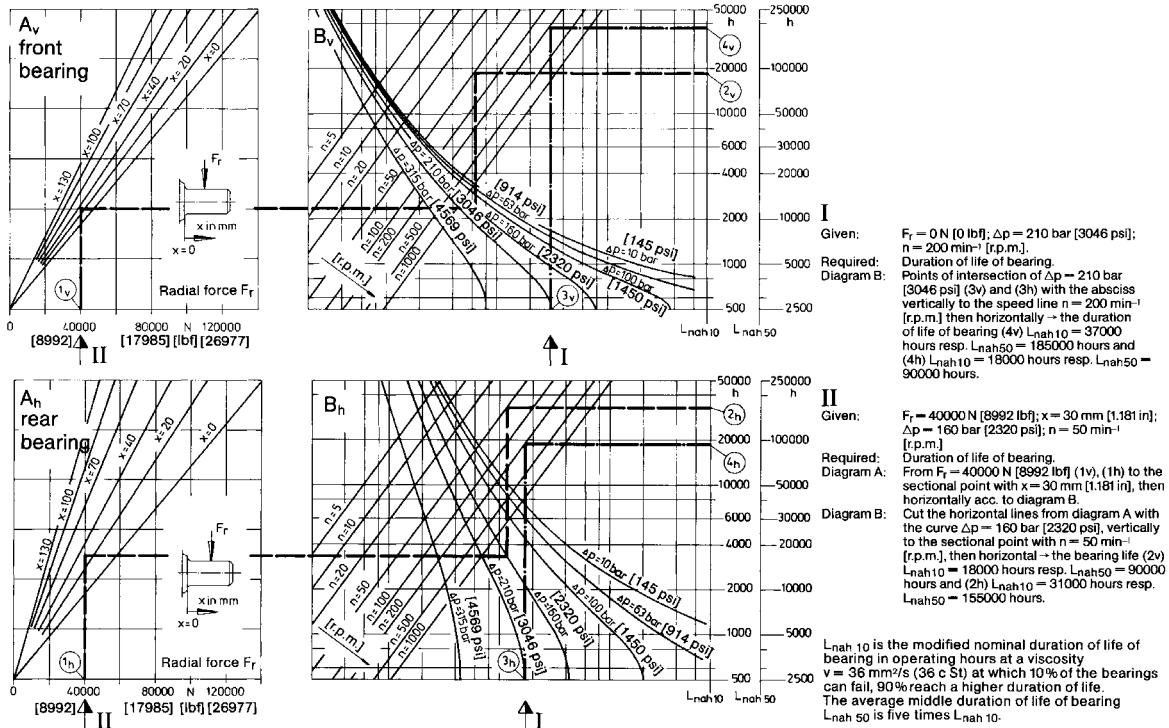
Characteristics



Performance

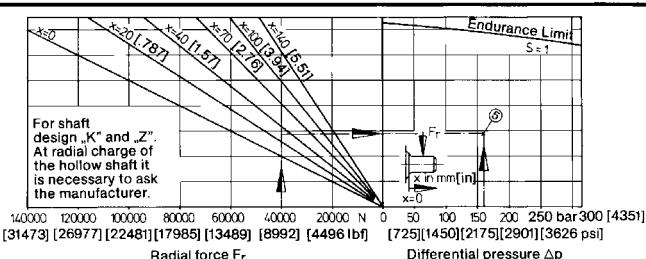


Determination of Bearing Life



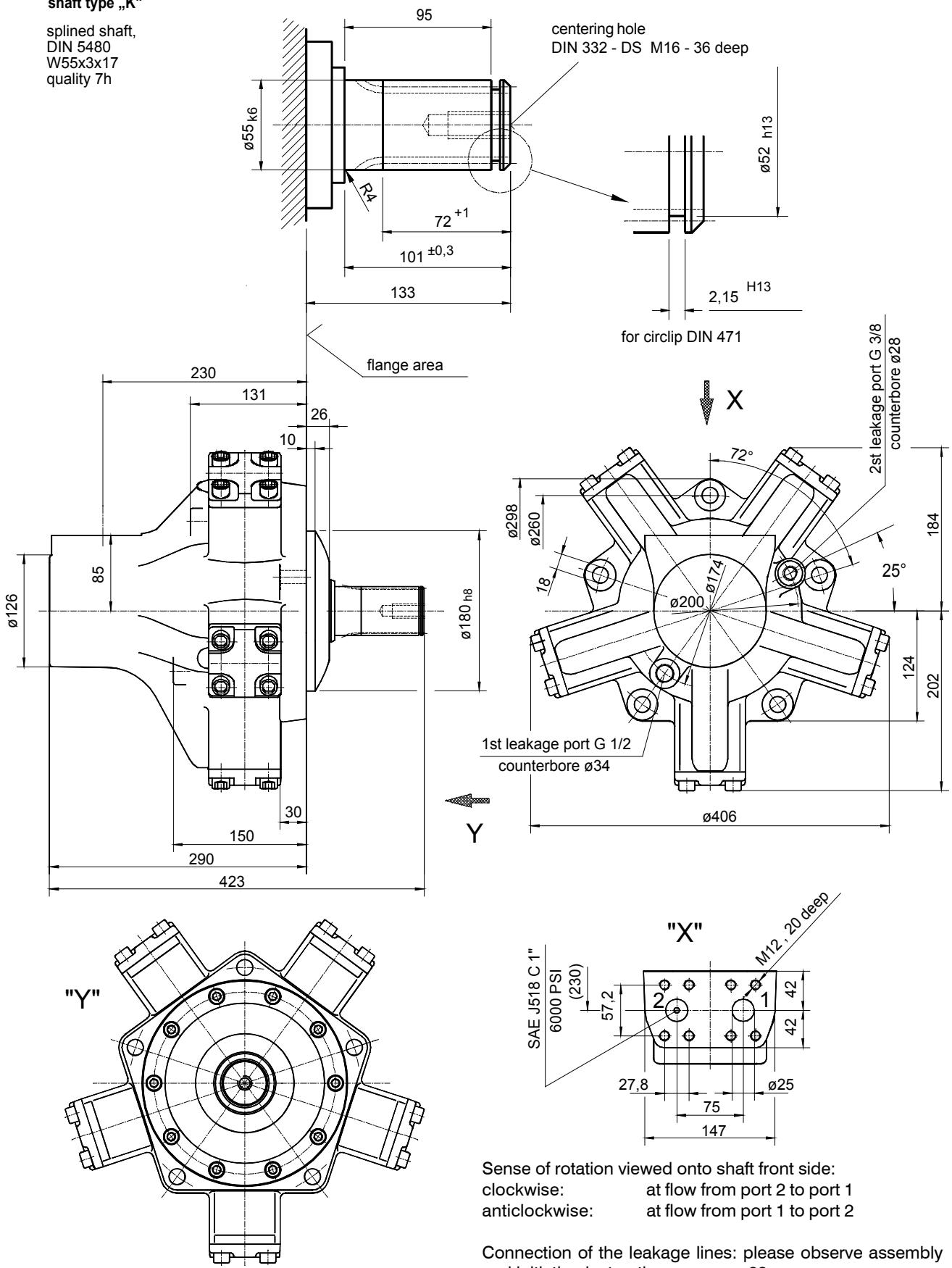
Shaft strength

Example:
Given values: $F_r = 40000 \text{ N}$ [8992 lbf] $x = 30 \text{ mm}$ [1.181 in]
 $\Delta p = 160 \text{ bar}$ [2321 psi]
Required value: Shaft strength
Draw a vertical line from $F_r = 40000 \text{ N}$ [8992 lbf] to distance $x = 30 \text{ mm}$ [1.181 in] and a straight horizontal line from there.
If the intersection (5) of the horizontal with the vertical line of $\Delta p = 160 \text{ bar}$ [2321 psi] is below curve the shaft has sufficient fatigue strength.
Allowable axial forces will be provided on request.



shaft type „K“

splined shaft,
DIN 5480
W55x3x17
quality 7h



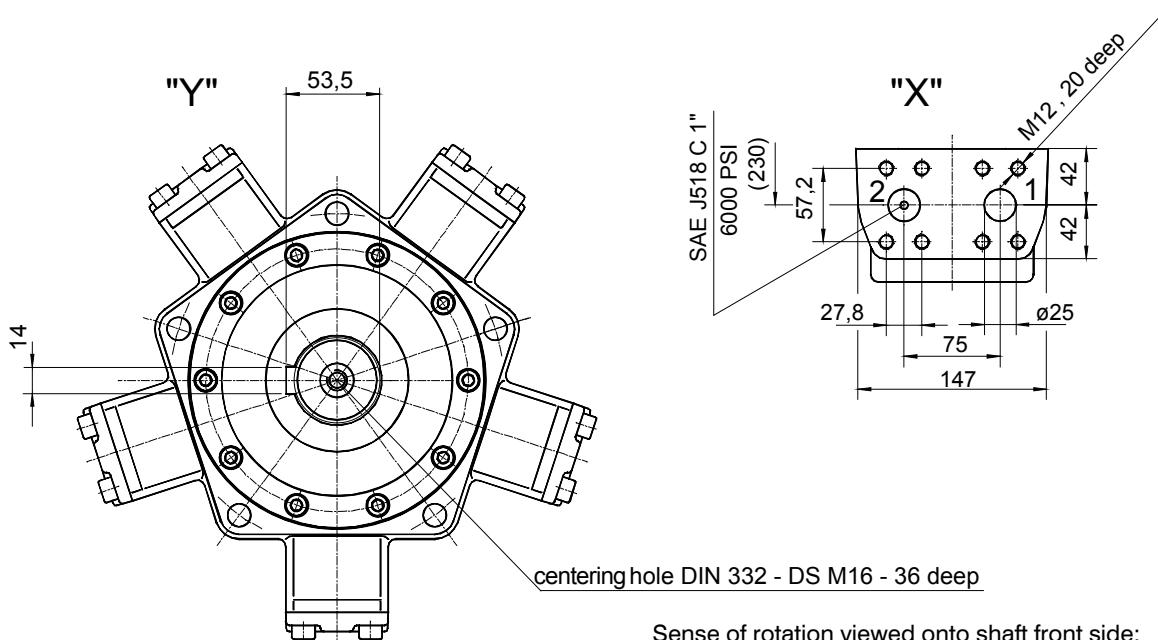
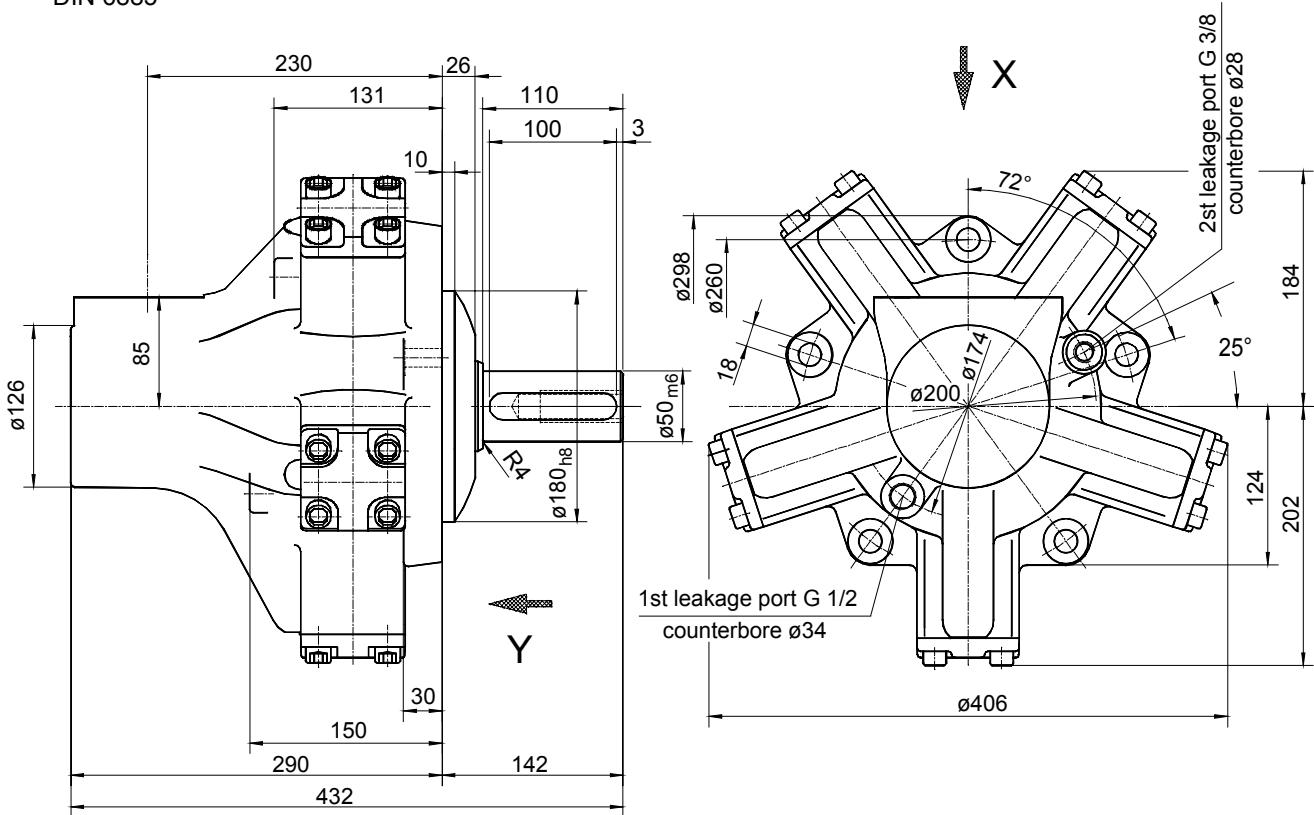
Sense of rotation viewed onto shaft front side:
 clockwise: at flow from port 2 to port 1
 anticlockwise: at flow from port 1 to port 2

Connection of the leakage lines: please observe assembly and initiation instructions on page 23.

Changes reserved!

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shaft type „Z“
feather key
DIN 6885



Sense of rotation viewed onto shaft front side:
clockwise: at flow from port 2 to port 1
anticlockwise: at flow from port 1 to port 2

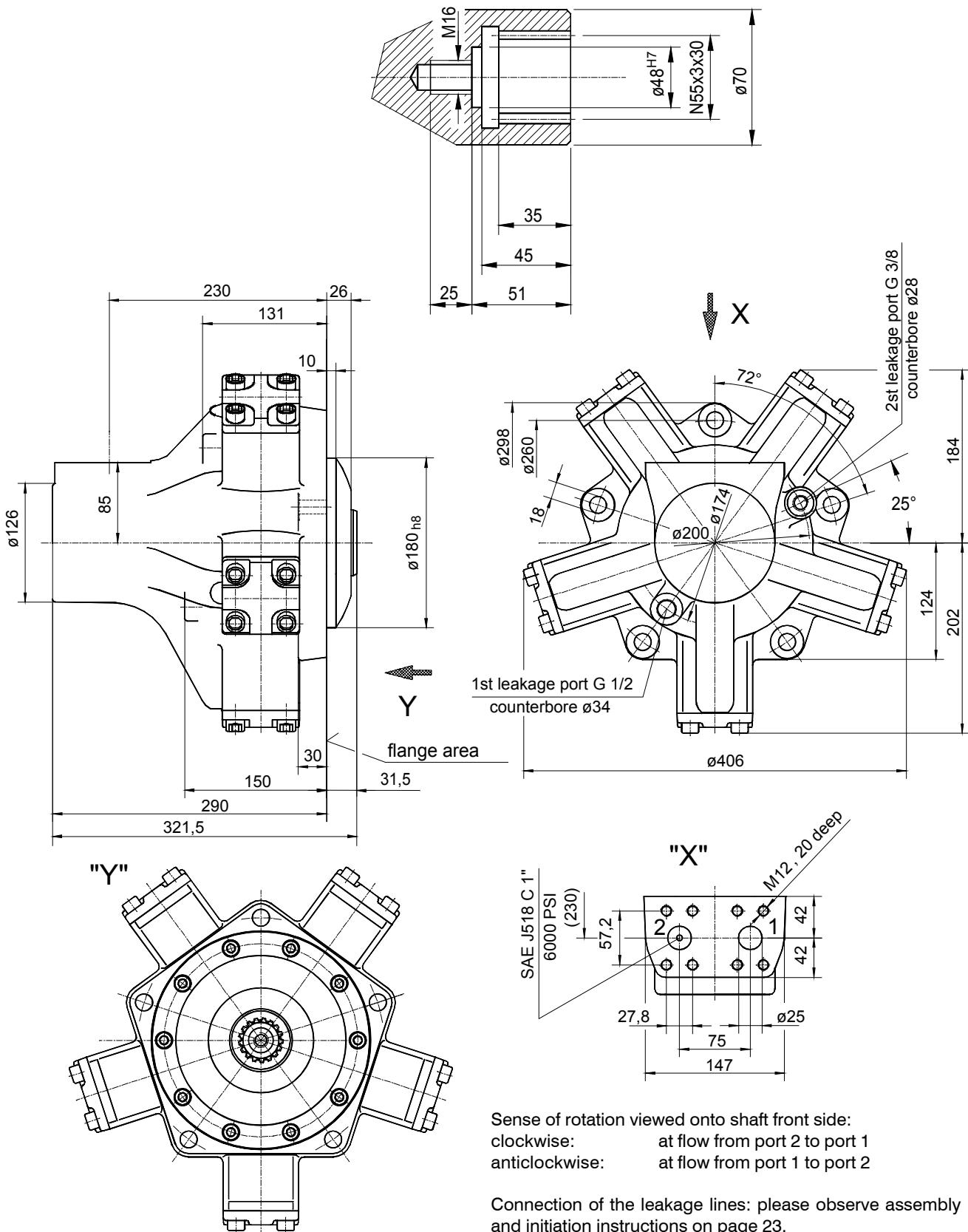
Connection of the leakage lines: please observe assembly and initiation instructions on page 23.

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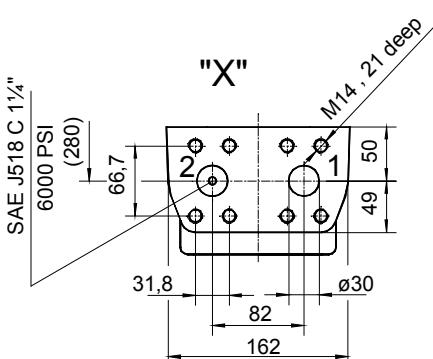
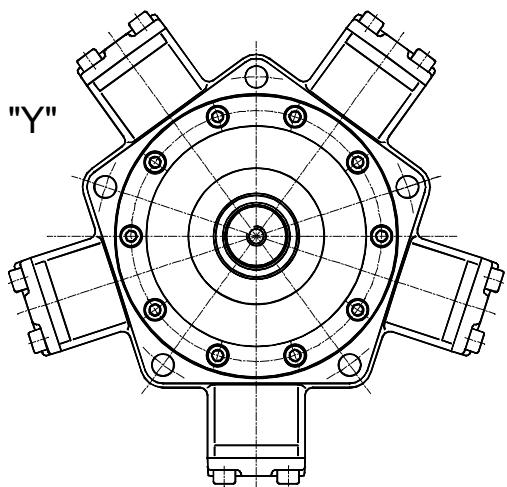
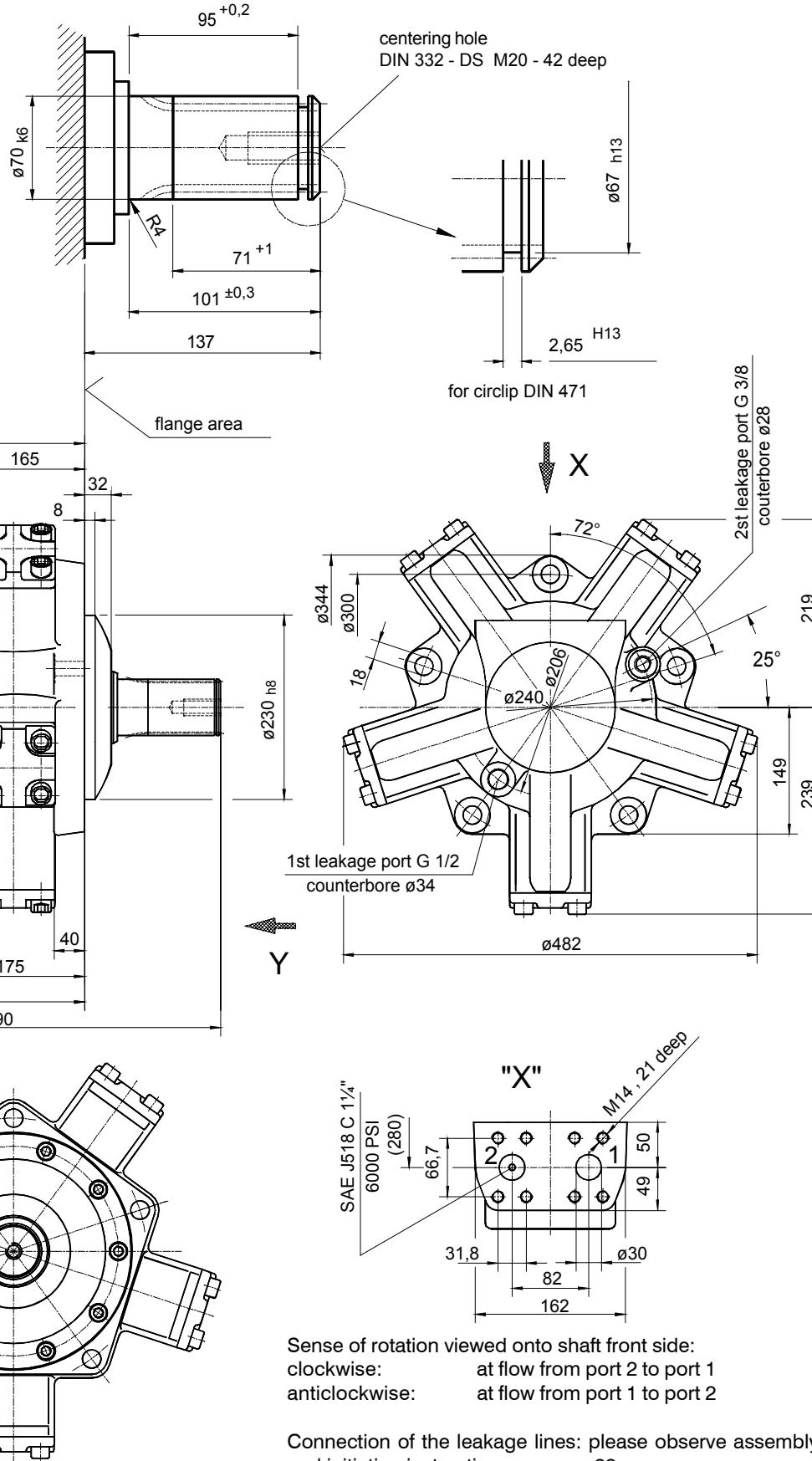
shaft type „H“

involute splined shaft, DIN 5480 quality 9H



shaft type „K“

splined shaft,
DIN 5480,
W70x3x30x22
quality 7h



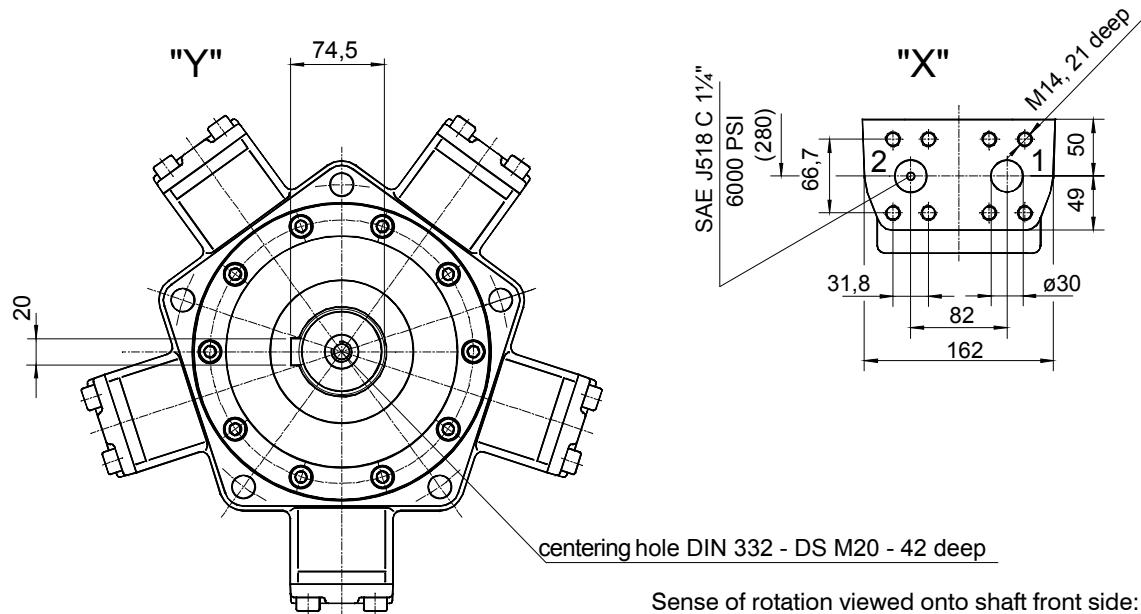
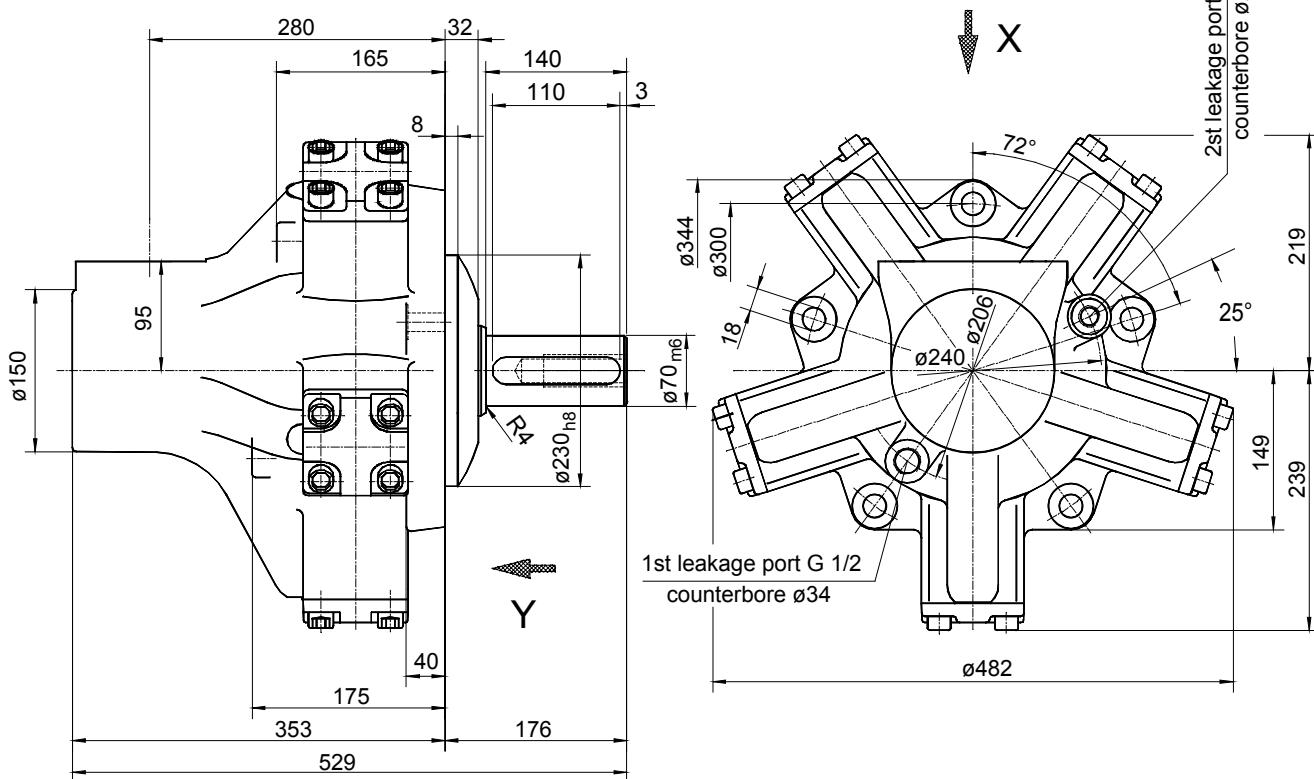
Sense of rotation viewed onto shaft front side:
clockwise: at flow from port 2 to port 1
anticlockwise: at flow from port 1 to port 2

Connection of the leakage lines: please observe assembly and initiation instructions on page 23.

Changes reserved!

shaft type „Z“

feather key
DIN 6885



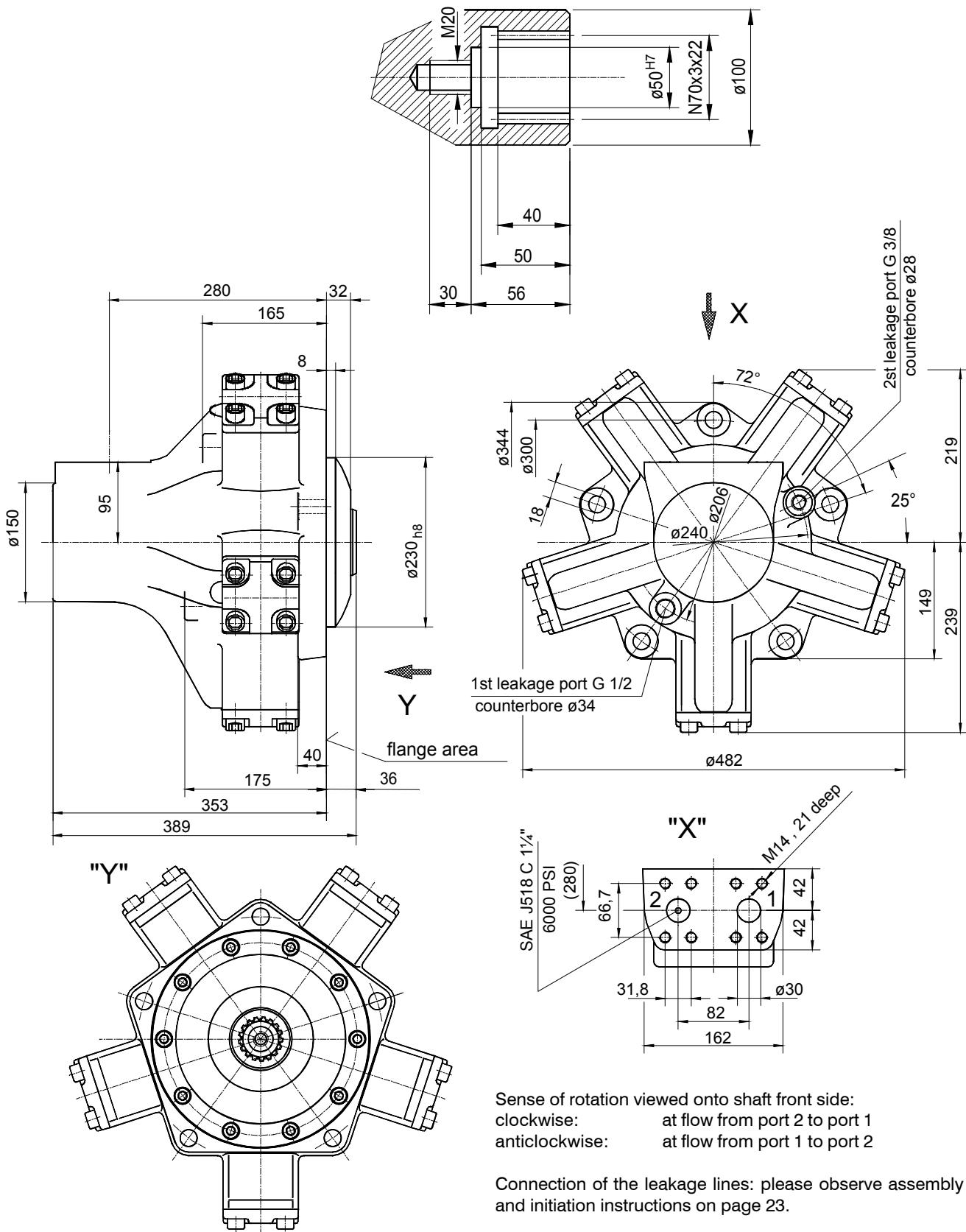
Sense of rotation viewed onto shaft front side:
 clockwise: at flow from port 2 to port 1
 anticlockwise: at flow from port 1 to port 2

Connection of the leakage lines: please observe assembly and initiation instructions on page 23.

Changes reserved!

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shaft type „H“
involute spline shaft, DIN 5480 quality 9H



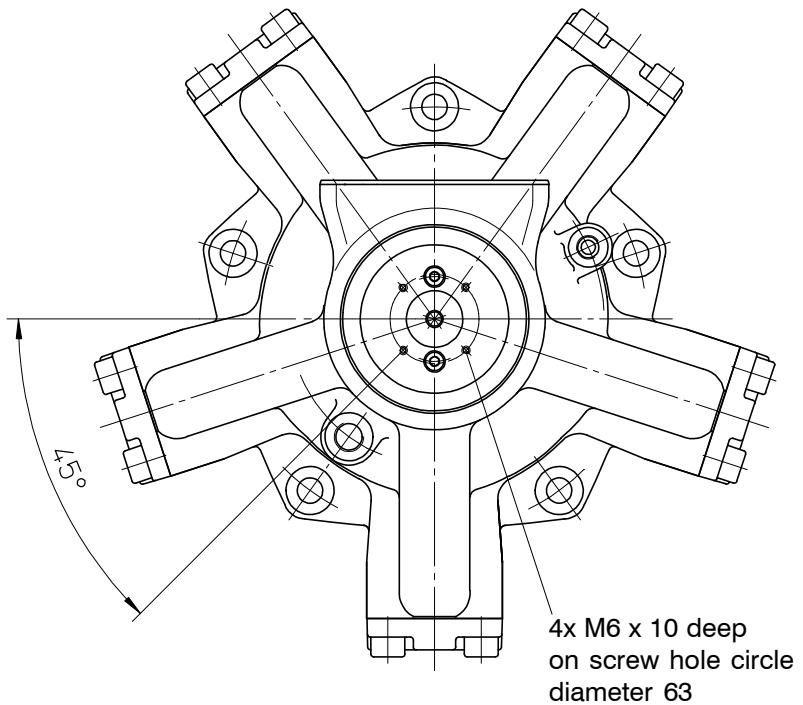
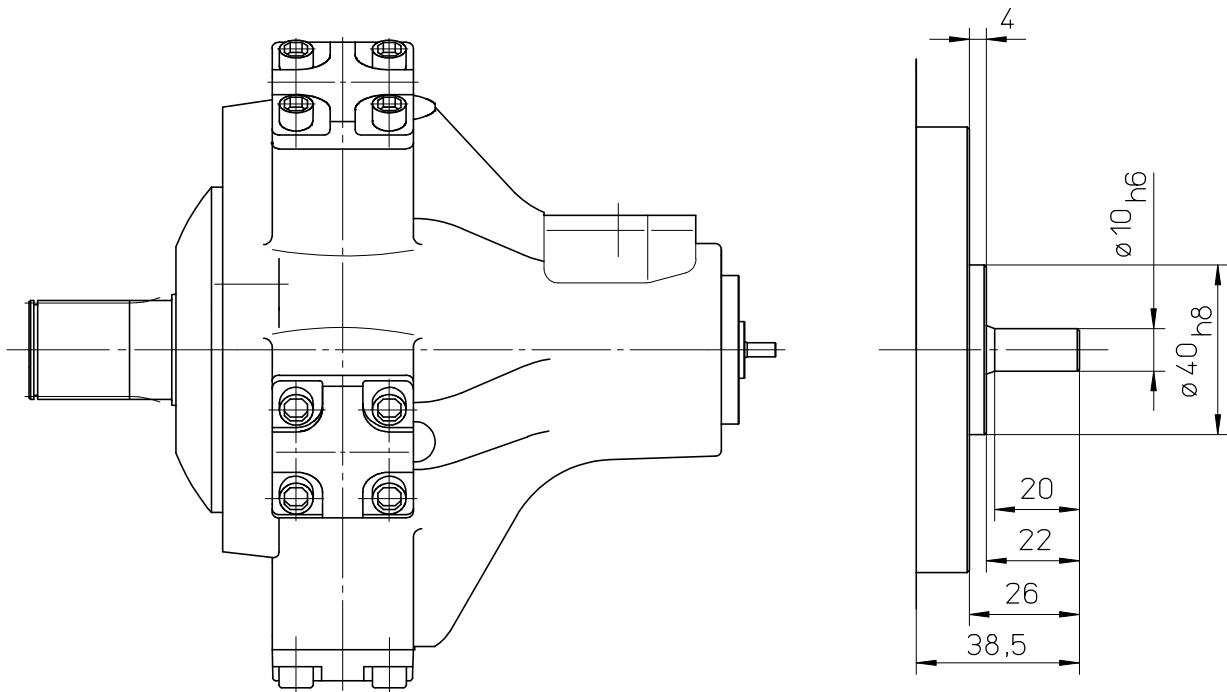
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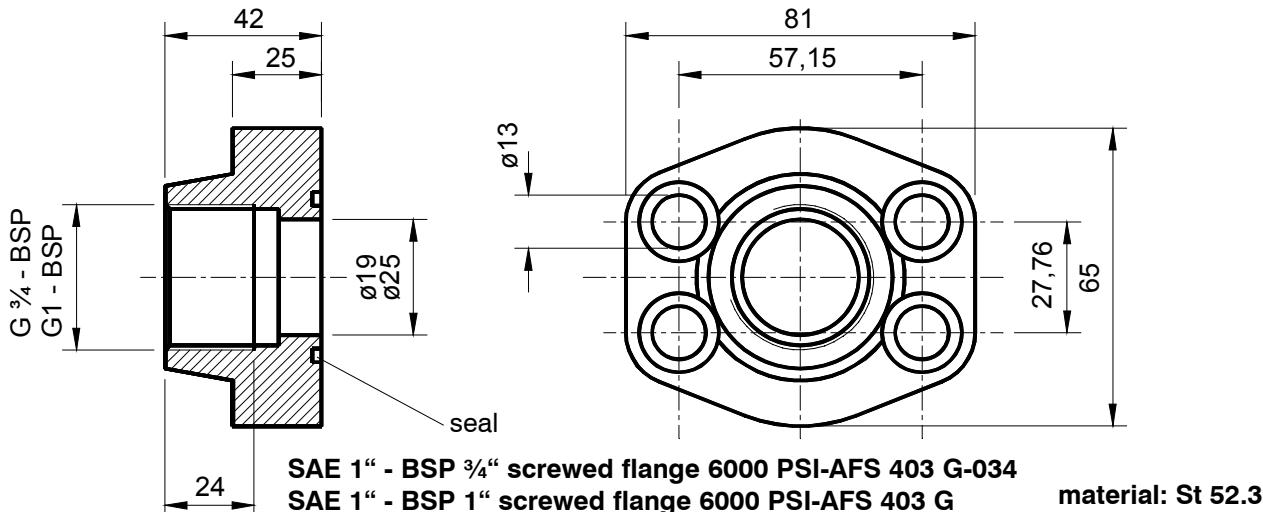
All radial piston motors with type mark „M“ are equipped with an instrument shaft.

The instrument shaft transmits a maximal torque of 5 Nm.

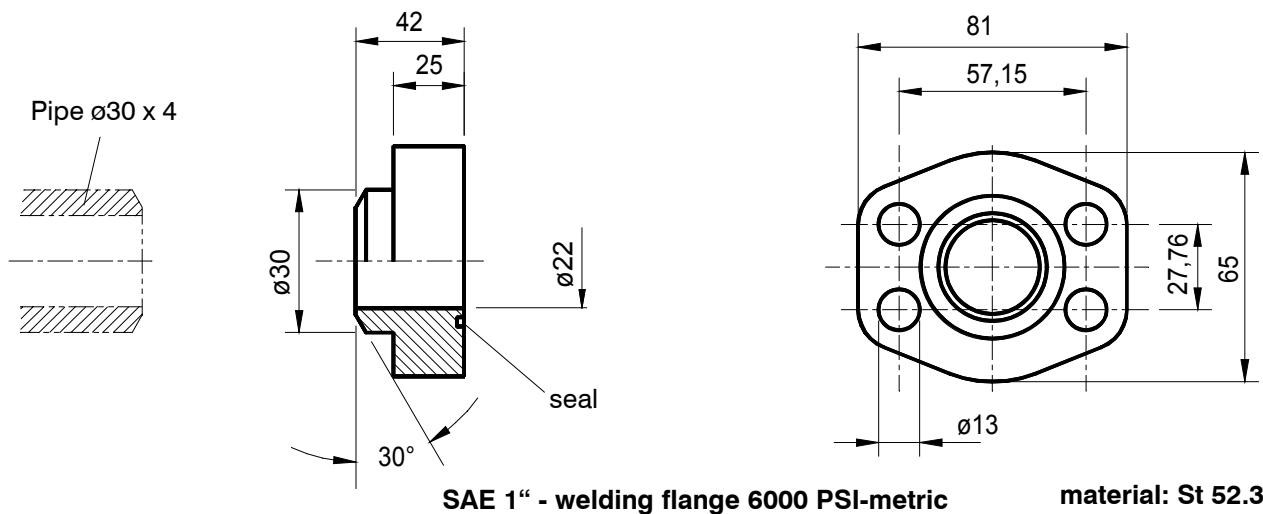
On request further documentation is available relating to installation of tacho-generators for registration of speed and incremental encoders for registration of turning angle up to 3600 impulses per revolution.



For every radial piston motor 2 flanges, 2 o-ring seals and 8 bolts are required.



Designation	Seal-material	Thread DIN ISO 228/1	Order-No.
1 piece SAE 1"- screwed flange complete, metric 6000 PSI with BSP-thread, with 4 bolts M12 x 45 DIN 912 - 8.8 and 1 o-ring 32,92 x 3,53	NBR FPM NBR FPM	G 3/4 G 3/4 G 1 G 1	59.0000.31 59.0000.32 59.0000.33 59.0000.34

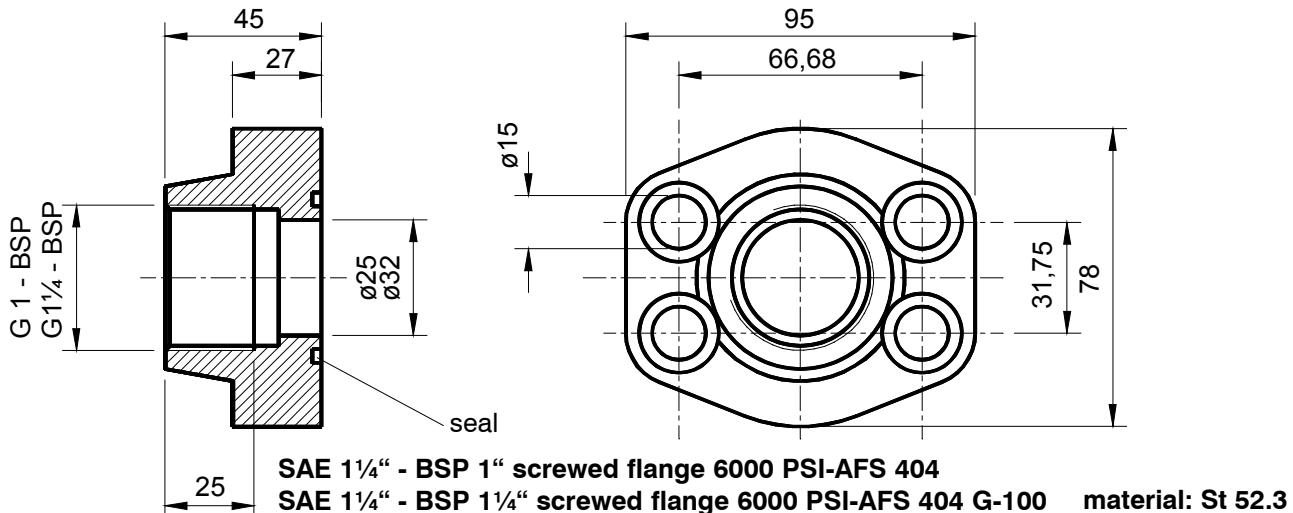


Designation	Seal-material	Pipe	Order-No.
1 piece SAE 1"- welding flange complete, metric 6000 PSI with 4 bolts M12 x 45 DIN 912 - 8.8 and 1 o-ring 32,92 x 3,53	NBR FPM	30 x 4 30 x 4	59.0000.35 59.0000.36

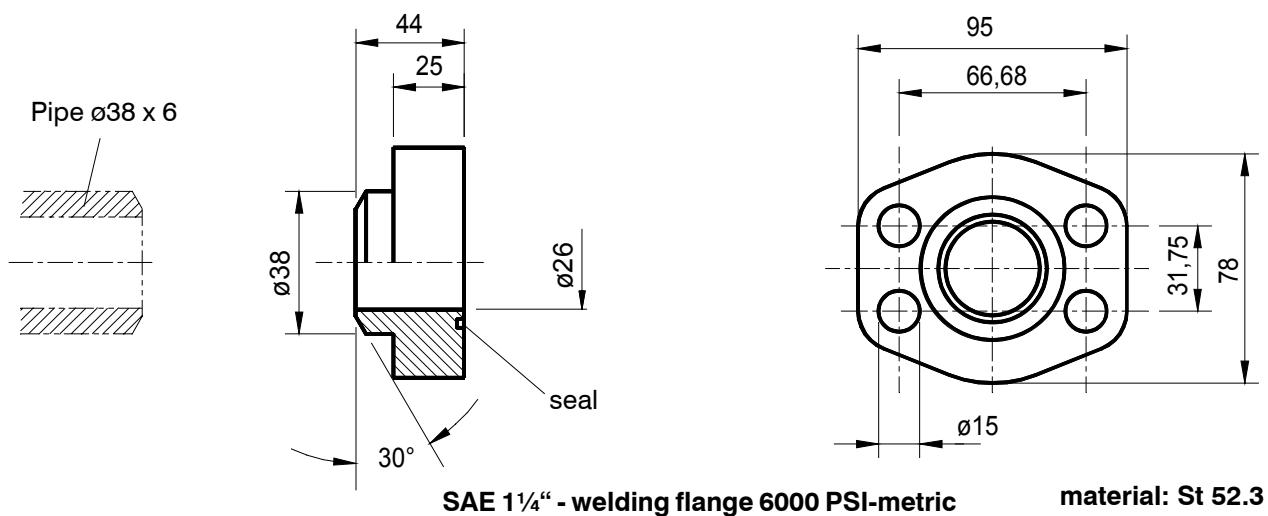
Changes reserved!

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For every radial piston motor 2 flanges, 2 o-ring seals and 8 bolts are required.



Designation	Seal-material	Thread DIN ISO 228/1	Order-No.
1 piece SAE 1 1/4" - screwed flange complete, metric 6000 PSI with BSP-thread, with 4 bolts M14 x 45 DIN 912 - 8.8 and 1 o-ring 37,7 x 3,53	NBR FPM NBR FPM	G 1 G 1 G 1 1/4 G 1 1/4	59.0000.21 59.0000.22 59.0000.23 59.0000.24



Designation	Seal-material	Pipe	Order-No.
1 piece SAE 1 1/4" - welding flange complete, metric 6000 PSI with 4 bolts M14 x 45 DIN 912 - 8.8 and 1 o-ring 37,7 x 3,53	NBR FPM	38 x 6 38 x 6	59.0000.25 59.0000.26

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You know your product, we know our radial piston motors! Give us your conditions, we will calculate all important data for the suitable drive.

1. **Company** _____

For attention of _____

Street / P.O.Box _____

Department _____

Postal code / City _____

Phone No. _____

Country _____

Fax No. _____

2. **Operating data: secondary drive**

2.1 Machine type: _____ project: _____

2.2 Machine operating factor at gearboxes k = _____

2.3 Installation position: horizontal vertical
 drive shaft upwards drive shaft downwards

2.4 Forces onto drive shaft: pressure tension

radial: _____ N axial: _____ N

2.5 Nominal torque T_N = _____ Nm speed n _____ min⁻¹ time _____ min

2.6 Continuous torque T_{cont} = _____ Nm speed n _____ min⁻¹ time _____ min

2.7 Maximum torque T_{max} = _____ Nm speed n _____ min⁻¹ time _____ min

2.8 Minimum torque T_{min} = _____ Nm speed n _____ min⁻¹ time _____ min

2.9 Maximum speed n_{max} = _____ min⁻¹ time t _____ min

2.10 Minimum speed n_{min} = _____ min⁻¹ time t _____ min

2.11 Information about working cycle: _____

2.12 Secondary drive with valve assembly on the motor

2.13 Control drive with proportional- / servo valve

2.14 Maximum power: P_{max} = _____ kW continuous power: P_{cont} = _____ kW

2.15 one-shift-operation two-shift-operation three-shift-operation

2.16 Desired bearing life: L_{h10} = _____ hours

2.17 Remarks: _____

3. **Operating data: primary drive**

Hydraulic fluid: _____ operating temperature: Θ = _____ °C

Delivery volume of pump Q_P = _____ l/min

opened circuit closed circuit

Feeding pressure p_F = _____ bar

System pressure p_{Sys} = _____ bar

Desired operating pressure at T_N p_N ~ _____ bar

Pressure liquid:

HLP mineral oil to DIN 51524 part 2.

Biologically degradable fluids (gaskets NBR / FPM to clarify with supplier of fluid).

HFC Reduce pressure to about 70%, re-calculate bearing life.

HFD phosphoric acid-ester, FPM-seals (Viton) are necessary.

Filtering:

Max. admissible contamination degree of the fluid to NAS 1638 class 9,
filter recommendation with a minimum retaining value of $\beta_{10} \geq 100$.

For a long life NAS 1638 class 8, filter recommendation with a minimum retaining value of $\beta_5 \geq 100$.

Assembly / attachment:

Installation position optional, leakage oil outlet see below.

Motor align exactly, fastening screws min. 10.9.

For frequent reversing, 2 fastening screws to be used as dowel screws.

Coupling:

Install the coupling with a screw (not with a hammer).

Pipelines:

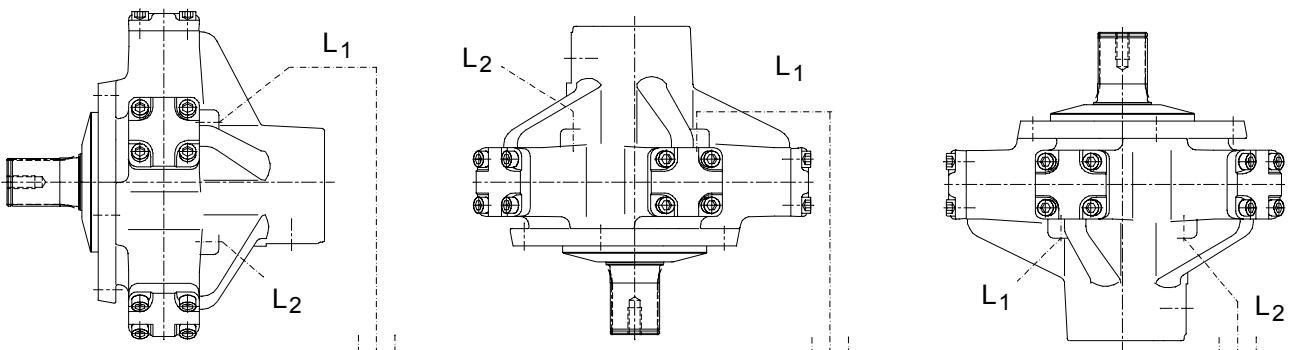
The motor has flange connections SAE J518C 1" - 6000 PSI (RM 250X to RM 500X).

The motor has flange connections SAE J518C 1 1/4" - 6000 PSI (RM 710X to RM 900X)

Use flange acc. to page 20 and 21.

Leakage line:

Before starting fill the motor with hydraulic fluid. Lay the leakage line in a way that the motor cannot drain off and no big air bubble builds up within the housing.



Flushing:

Connect the flushing line (with about 3 - 6 liters/minute, 1,5 bar maximum) in that way that the oil inlet enters at the lowest leakage connection L₁ / L₂.



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