Components

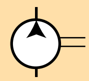
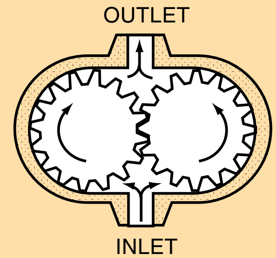
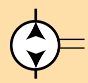
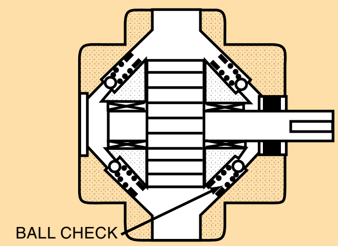
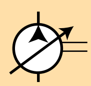
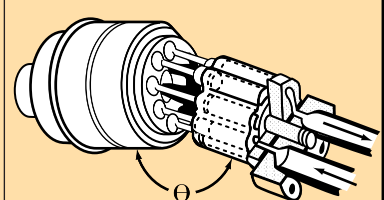
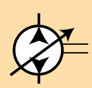
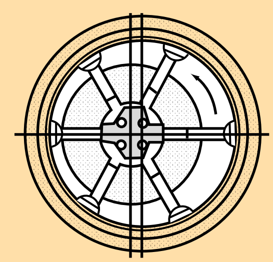
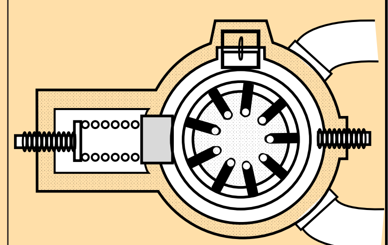
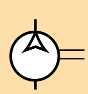
To construct a hydraulic circuit the following is necessary:

1. Convert Mechanical Power to Hydraulic Power
2. Control Force, Direction Of Motion and Speed Of Motion
3. Convert Hydraulic Power to Mechanical Power

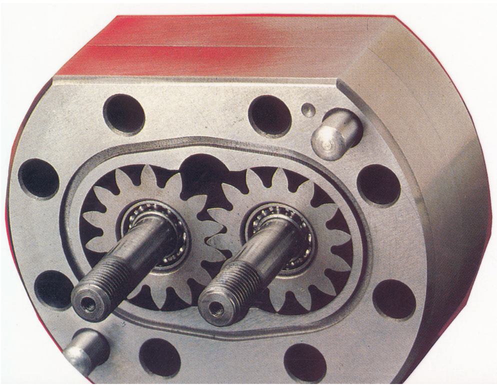
Sounds simple? ... It is.

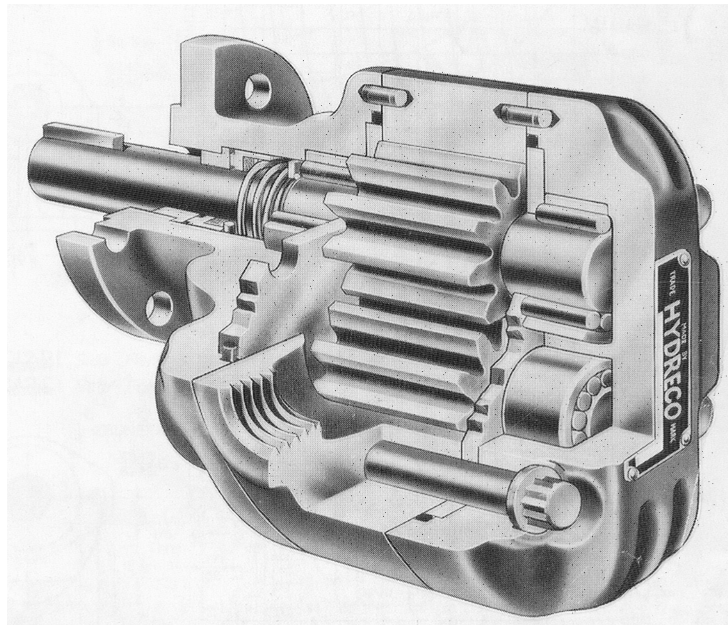
- Pumps convert mechanical power to ***Hydraulic Power***
- Pressure Control Limits ***Actuator Force***
- Directional Valves Control ***Direction of Motion***
- Flow Control Regulates ***Speed***
- Motors / Cylinders Convert Hydraulic Power to ***Mechanical Power***

Pump Symbols

6.1	**PUMPS AND COMPRESSORS**		To convert mechanical energy into hydraulic or pneumatic energy.	
6.1.1 6.1.1.1	**Fixed capacity hydraulic pump:** — with one direction of flow			
6.1.1.2	— with two directions of flow			
6.1.2 6.1.2.1	**Variable displacement hydraulic pump:** — with one direction of flow		The symbol is a combination of 6.1.1.1 and 5.2.3 (sloping arrow)	
6.1.2.2	— with two directions of flow		The symbol is a combination of 6.1.1.2 and 5.2.3 (sloping arrow)	 
6.1.3	**Fixed capacity compressor (always one direction of flow)**			

Gear Pumps





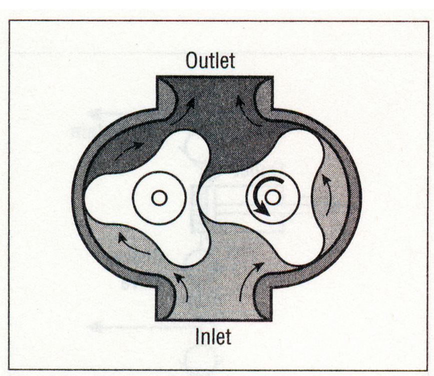
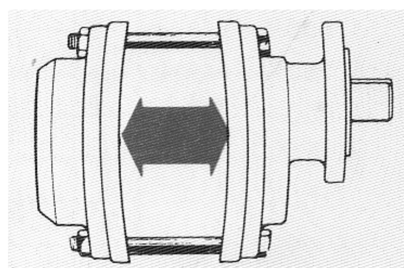


Fig. 3. Lobe pump.



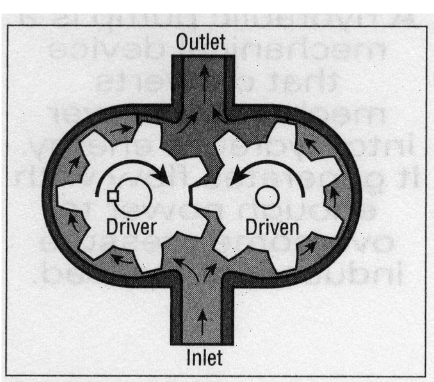


Fig. 2. Spur gear pump.

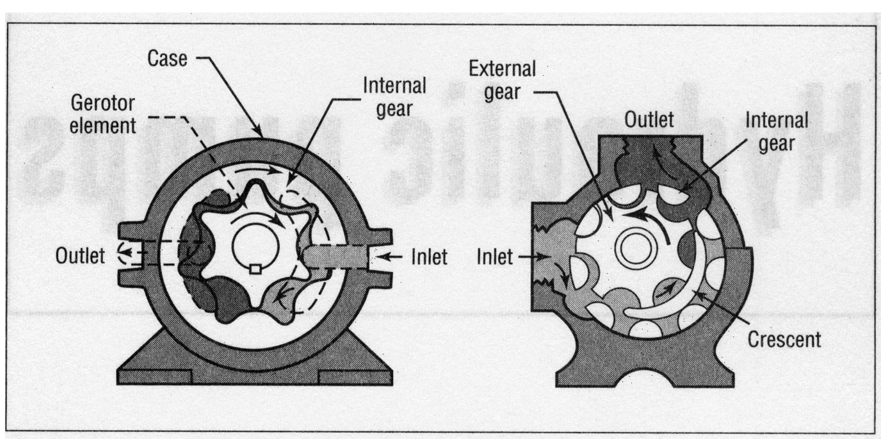
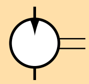
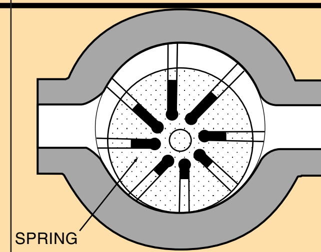
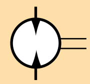
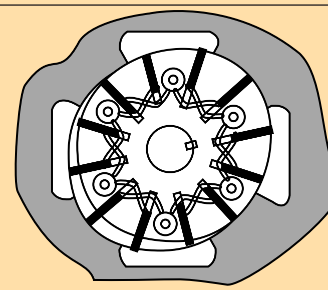
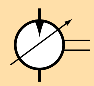
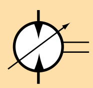
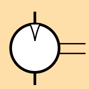
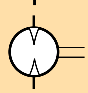
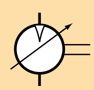
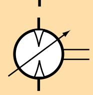
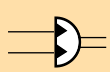
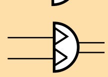


Fig. 4. Internal gear pumps — gerotor and crescent.

Symbols For Motors

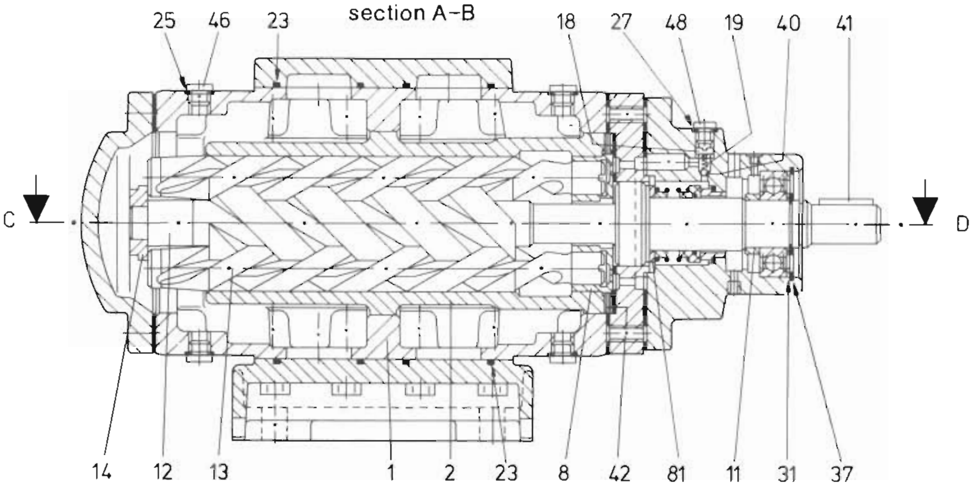
6.2	**MOTORS**		To convert hydraulic or pneumatic energy into rotary mechanical energy	
6.2.1 6.2.1.1	**Fixed capacity hydraulic motor:** — with one direction of flow			
6.2.1.2	— with two directions of flow			
6.2.2 6.2.2.1 6.2.2.2	**Variable displacement hydraulic motor:** — with one direction of flow — with two directions of flow	 	The symbol is a combination of 6.2.1.1 and 5.2.3 (sloping arrow) The symbol is a combination of 6.2.1.2 and 5.2.3 (sloping arrow)	
6.2.3 6.2.3.1 6.2.3.2	**Fixed displacement pneumatic motor:** — with one direction of flow — with two directions of flow	 		
6.2.4 6.2.4.1 6.2.4.2	**Variable displacement hydraulic motor:** — with one direction of flow — with two directions of flow	 	The symbol is a combination of 6.2.3.1 and 5.2.3 (sloping arrow) The symbol is a combination of 6.2.3.2 and 5.2.3 (sloping arrow)	
6.2.5 6.2.5.1 6.2.5.2	**Oscillating motor:** — hydraulic — pneumatic	 		

Sectional drawing

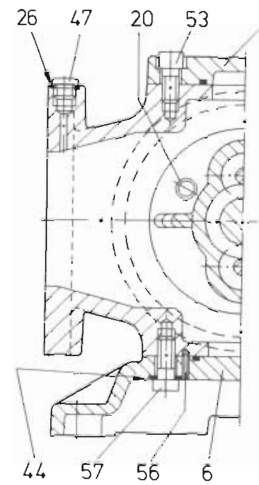
USNH (sizes 40 up to 660) with external ball bearing and mechanical seal, design D6 and E6

Design D6 ①

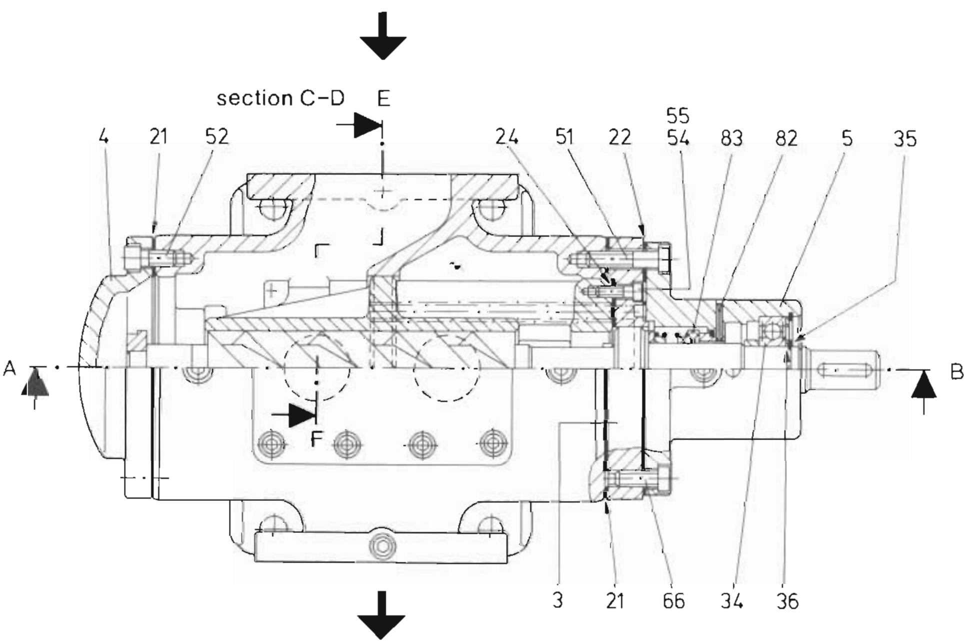
section A-B



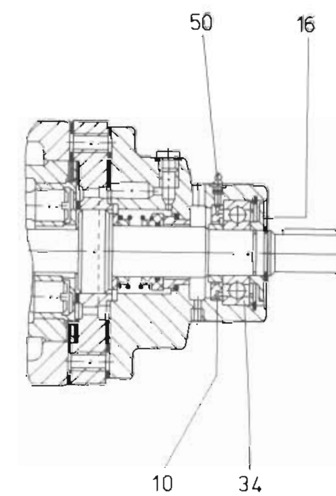
section E-F



section C-D



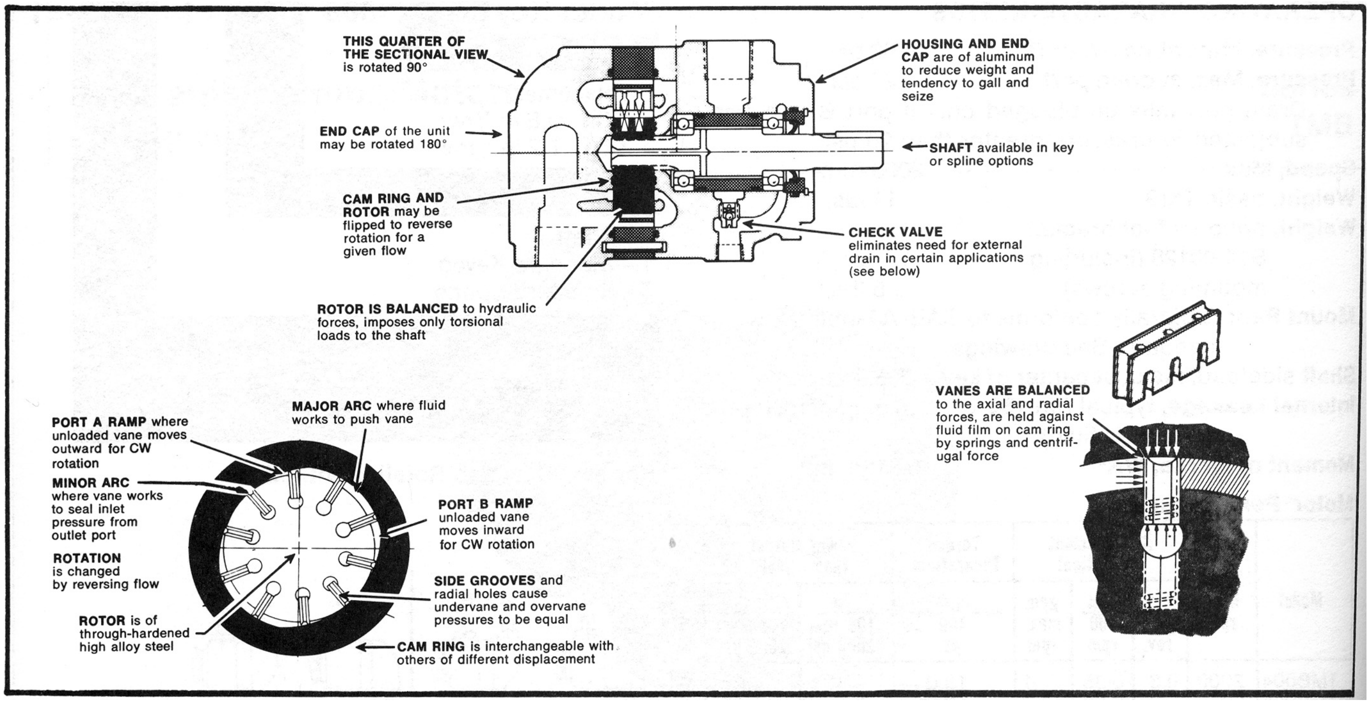
Design E6 ②



Denomination	Part. No.	Denomination	Part. No.	Denomination	Part. No.
pump case	1	balance pipe	20	washer	44
insert	2 ③	gasket	21 ③	plug	46
front cover	3	gasket	22 ③	plug	47
end cover	4	O-ring	23 ③	plug	48
bearing housing	5	gasket	24 ③	lube nipple	50
pump foot	6	washer	25 ③	socket head cap screw	51
coverplate	7	washer	26 ③	socket head cap screw	52
balance bushing	8 ③	washer	27 ③	socket head cap screw	53
greasing ring	10	spacer	31	socket head cap screw	54
spacer	11	ball bearing	34 ③	socket head cap screw	55
main screw	12 ③	snap ring	35	dowel	56
idler screw	13 ③	spacer	36	hexagon screw	57
collar	14 ③	snap ring	37	socket head cap screw	66
overflow disc	16	ball	40	spacer ring	81
adjusting screw	18	key	41	dowel	82
valve spring	19	dowel	42	mechanical seal	83 ③

① Design D6 with pressure control for mech. seal; ball bearing prepacked for life.
② Design E6 without pressure control for mech. seal; ball bearing requiring re-lubrication.
③ Spares

Vane Pump



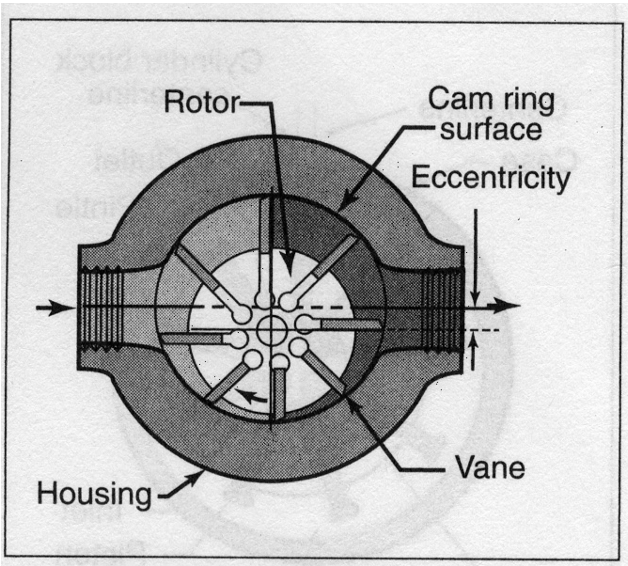


Fig. 5. Basic (unbalanced) vane pump.

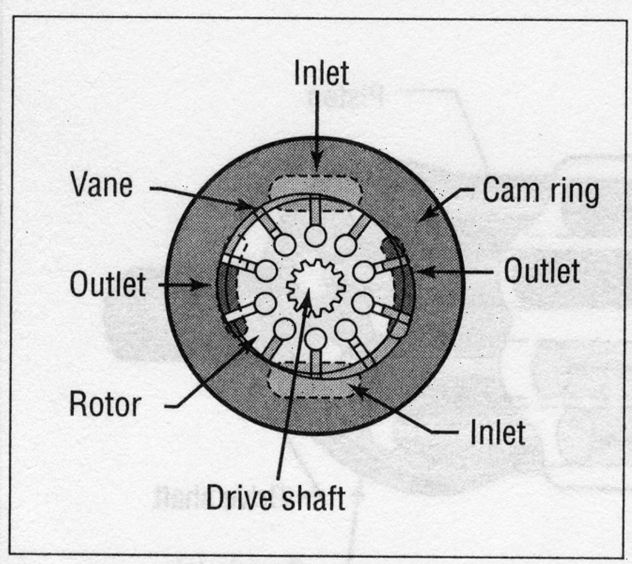


Fig. 6. Balanced vane pump.

Axial Piston Pump

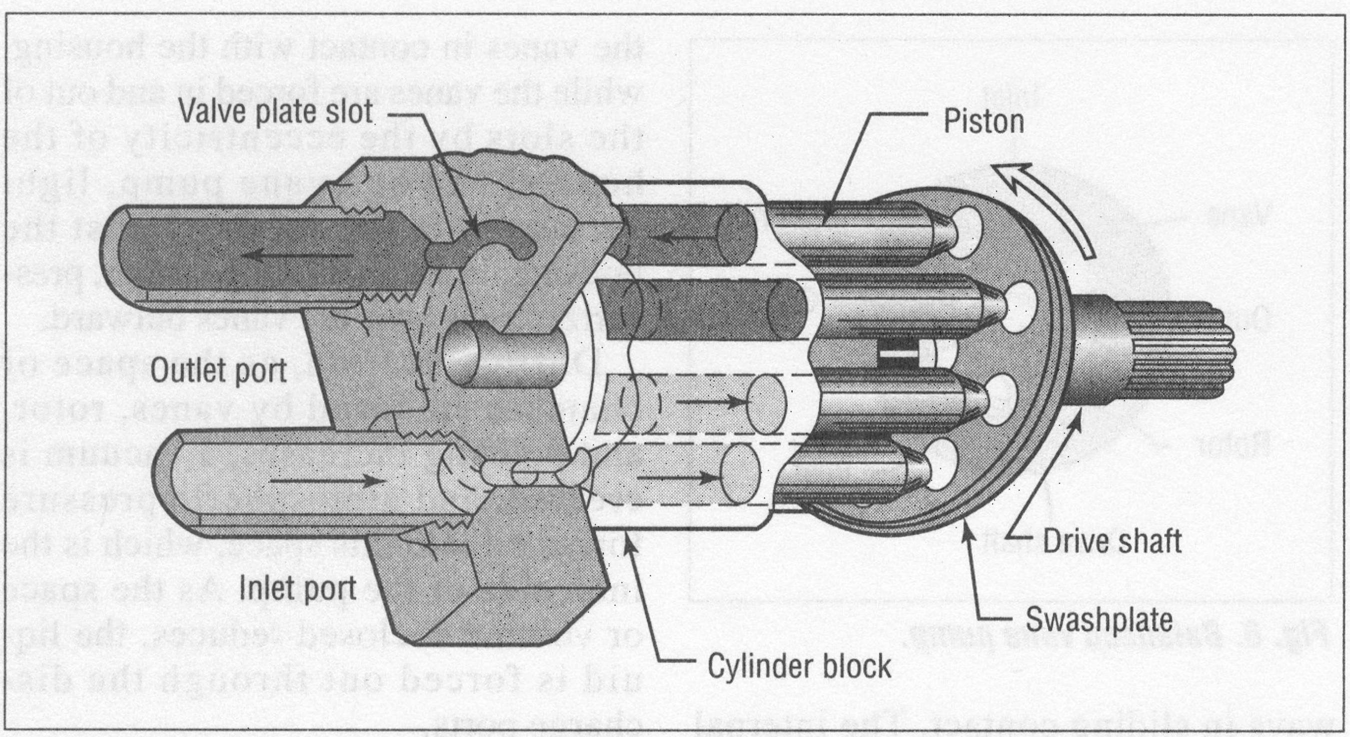


Fig. 8. Axial-piston pump varies displacement by changing angle of swashplate.

HARTMANN

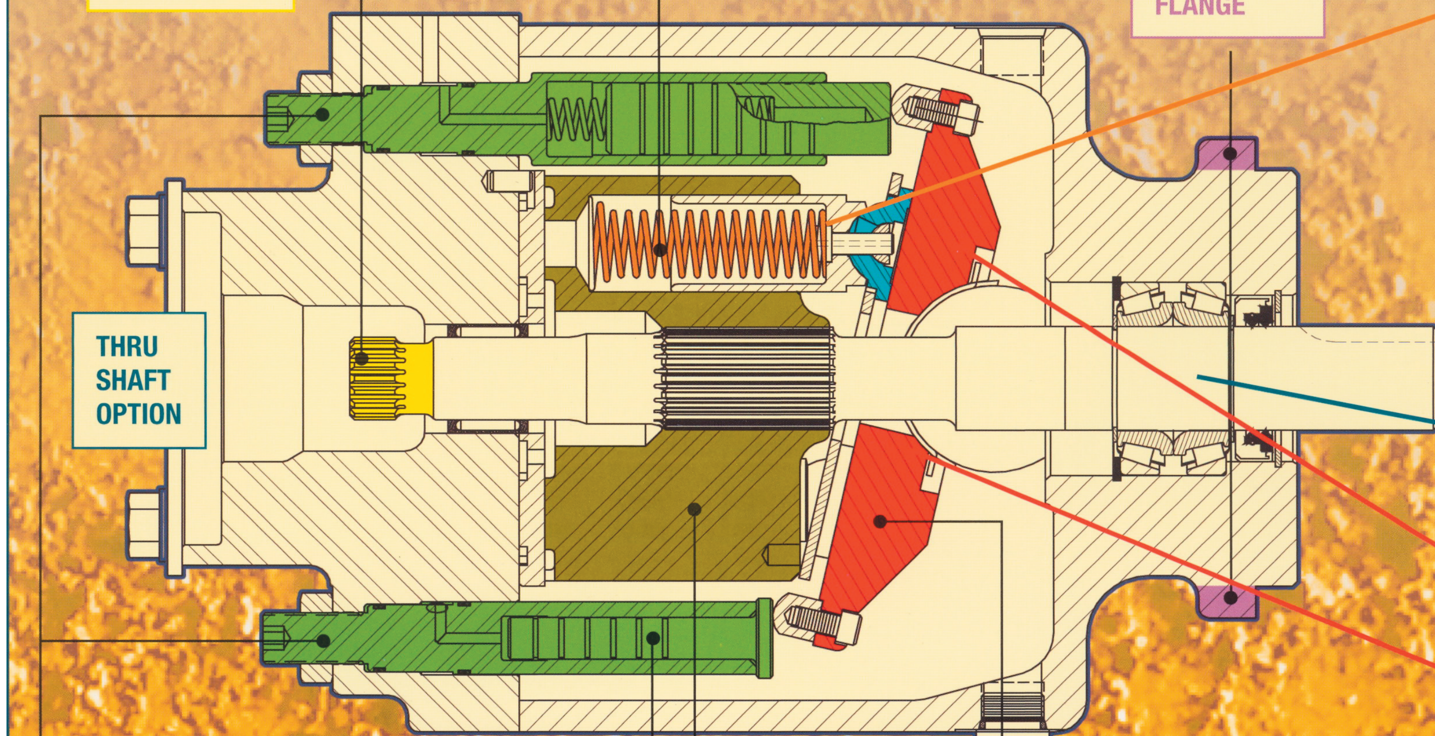
"HART OF GOLD"

INDIVIDUAL PISTON SPRINGS
Offset piston assembly weight holds slippers on swashplate and reduces hydroplaning

MULTIPLE DRIVESHAFT SIZES

SAE 2 BOLT AND 4 BOLT MOUNTING FLANGE

THRU SHAFT OPTION



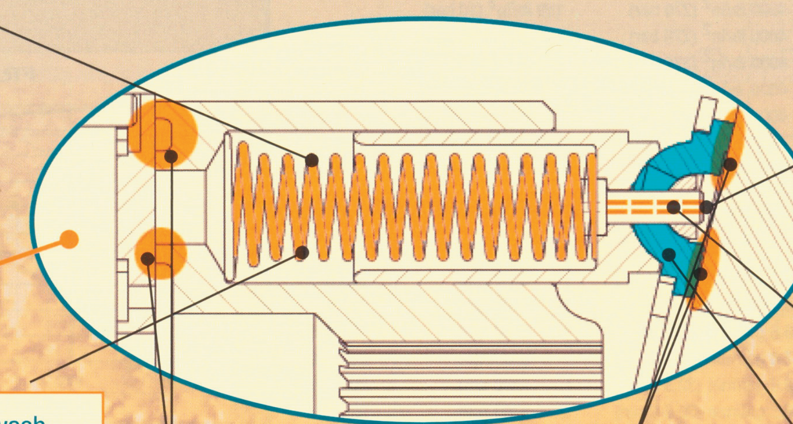
DUAL CONTROL PISTONS WITH ADJUSTABLE NULL AND VOLUME STOPS – STANDARD
Two piston design allows faster response time and offers greater control flexibility

BRONZE ROTOR
Excellent for low lubricity and contamination resistance

PATENTED SWASHPLATE
"In-Board" Trunnion Design Large Swashplate Bearings are located directly under high forces. Self aligning bearing design puts all components in compression for long life

Engineered spring similar to modern automotive value designs

A small amount of oil lubricates the shoe

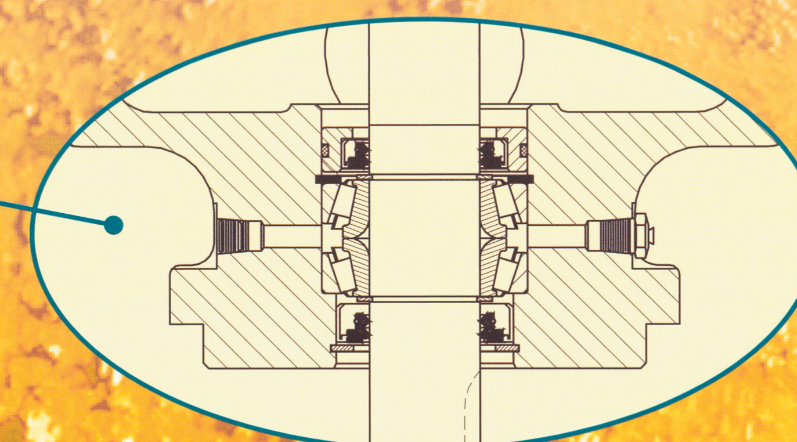


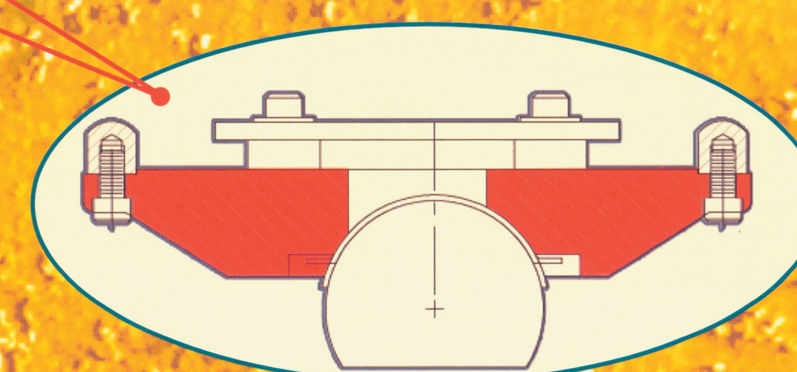
Riveted design eliminates swaging of shoes and thinner neck than traditional designs

Spring holds shoe to swash plate eliminating hydroplaning, blowby, and side wear

Soft on hard combined with 90˚ machined grooves not tapered means the timing will never change

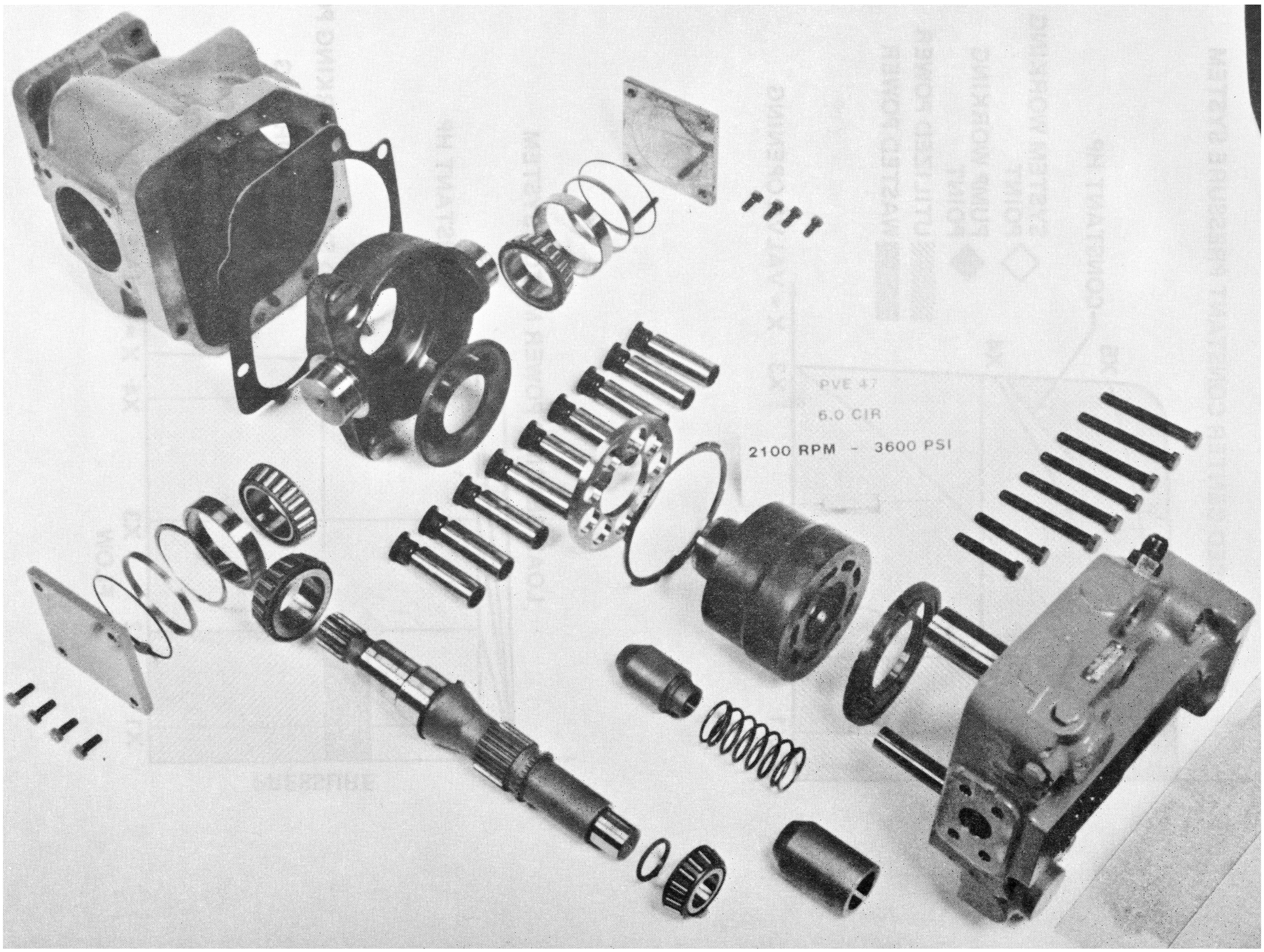
BRONZE SLIPPER SHOE
Unique spherical convex slipper design reduces unit loading and provides longer life





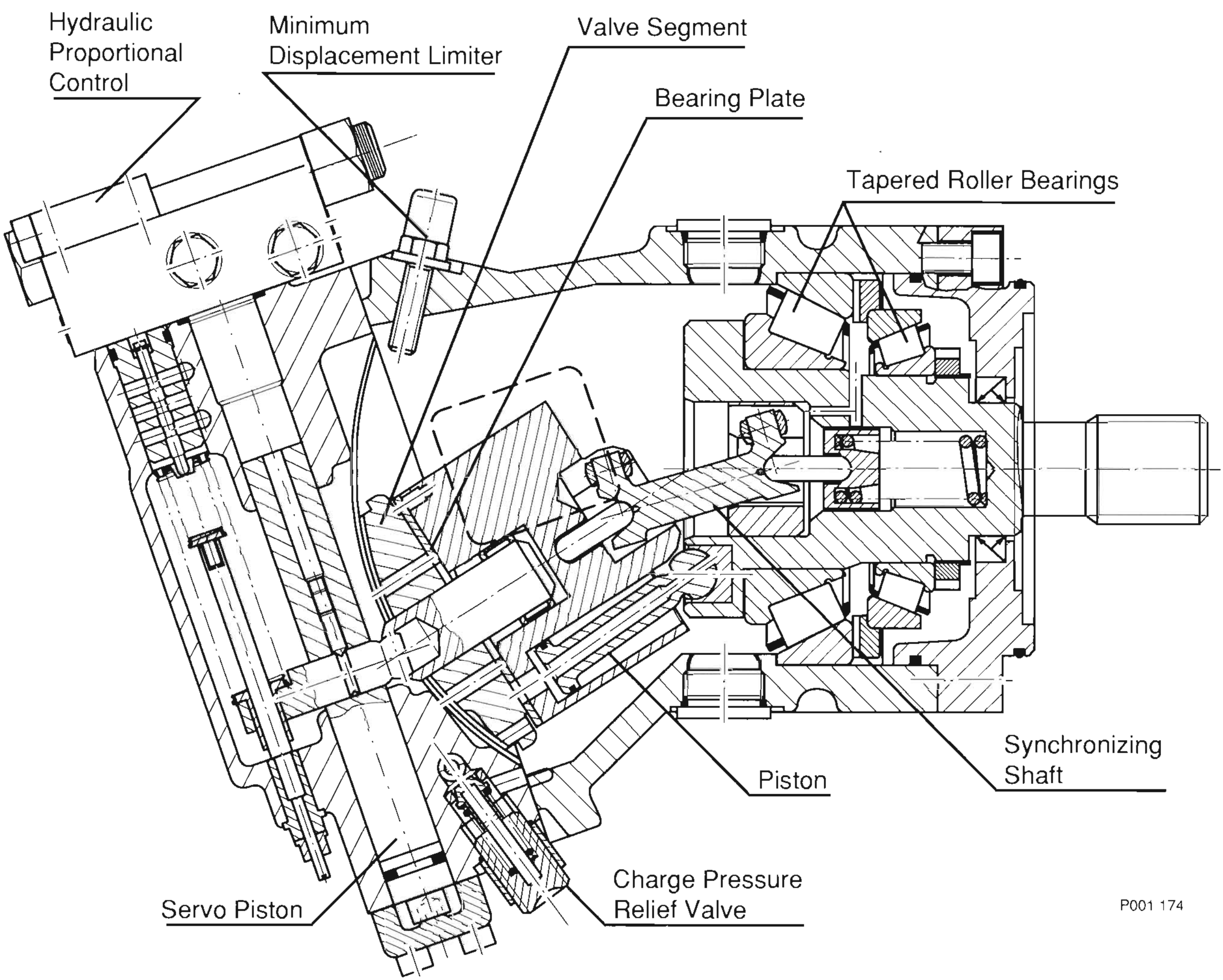
Piston Pump Parts

Axial Piston Pump Breakdown



Sectional View

Figure 2: Series 51 variable displacement motor with Hydraulic Proportional Control



MANNESMANN REXROTH

Variable Displacement Pump A2V

Series 5, for open, closed and semi-closed circuits
Axial Piston, Bent Axis Design

Extract from RE 92450/05.95

Brueninghaus Hydromatik

Size 250…1000 | Nominal pressure 350 bar | High pressure 400 bar

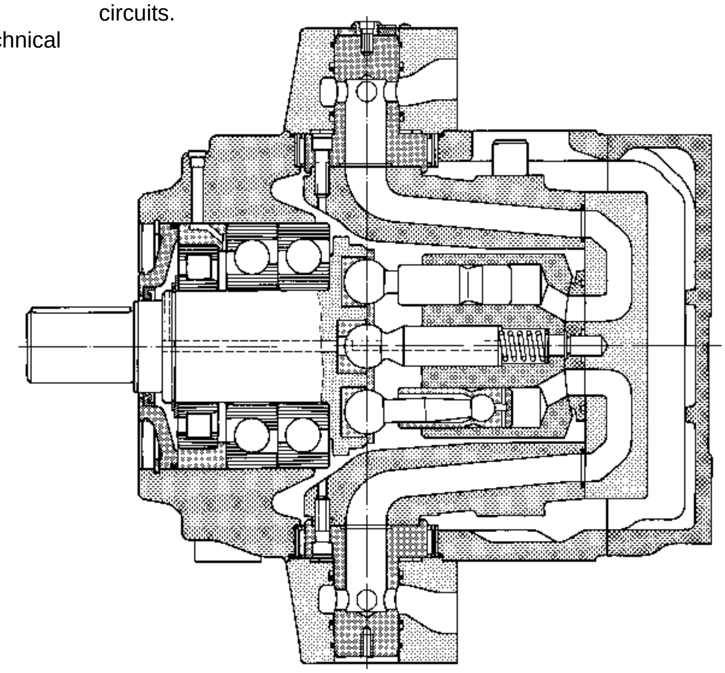
metric

Axial piston unit of bent axis design with variable displacement, for hydrostatic drives in closed, semi-closed, and open circuits.
Maximum flow is proportional to the drive speed and displacement and is infinitely variable at constant drive speed.
Comprehensive control program for every control and regulating function.

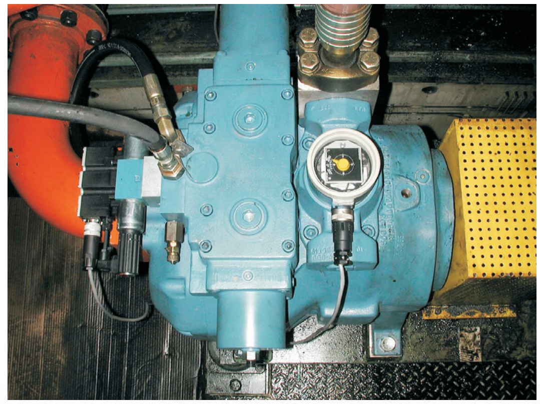
Special Features of Series 5:
Simplified high performance rotary group with enhanced technical data and well-proven spherical control area.

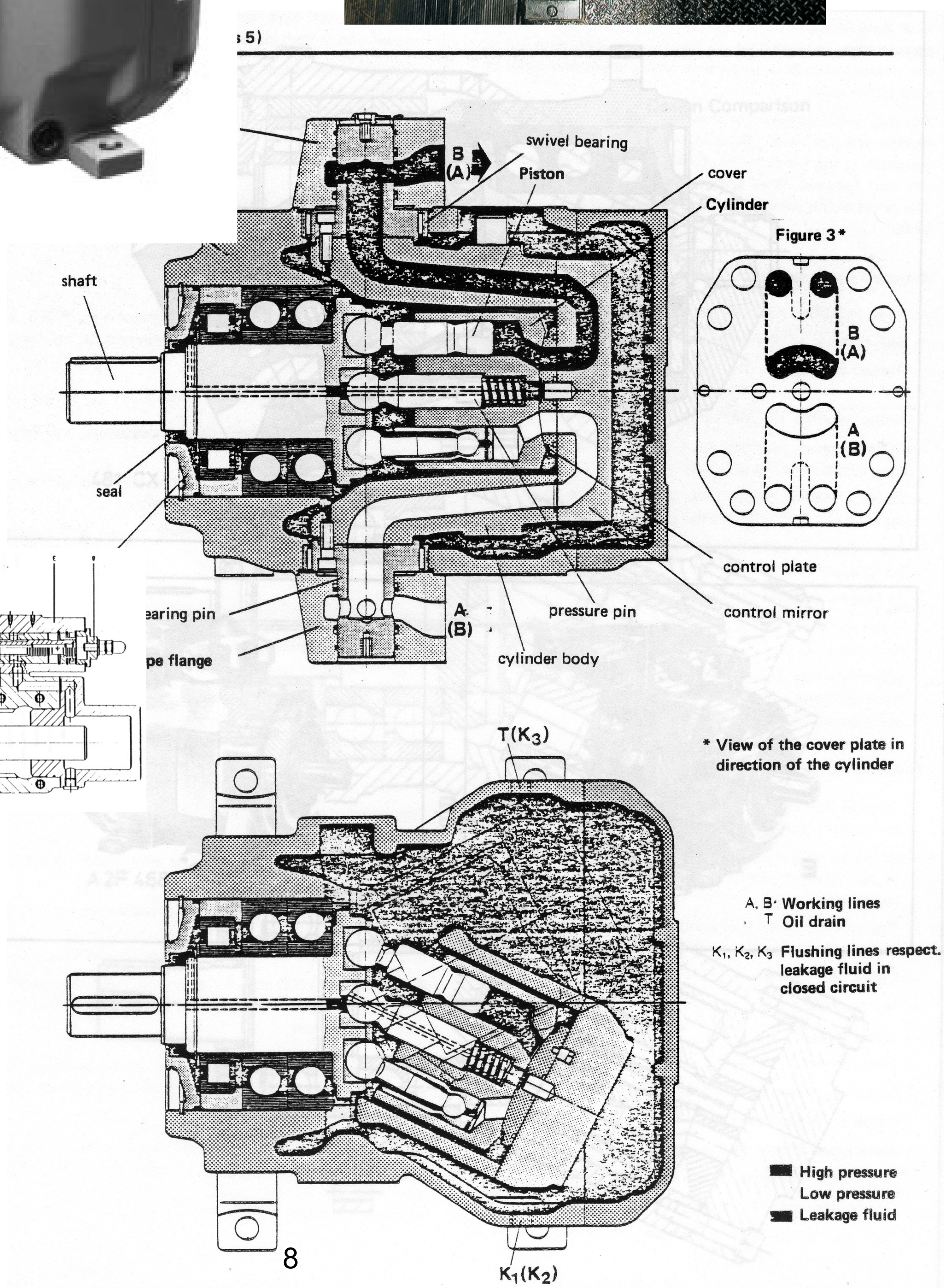
Housed pump for closed circuit

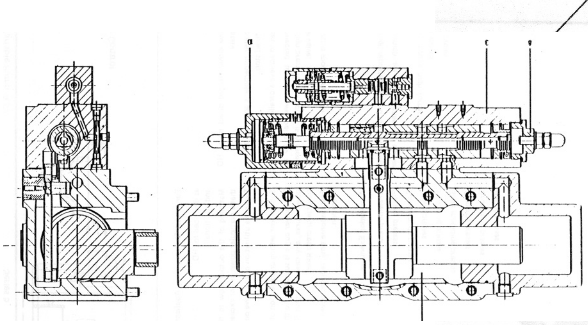
Heavy duty rolling bearings for intermittent high pressure operation.
For continuous duty at high pressures, hydrostatic bearings are available.
Operation on fire-resistant fluids is possible (please consult us).
Complete primary units with all auxiliary devices for closed circuits.



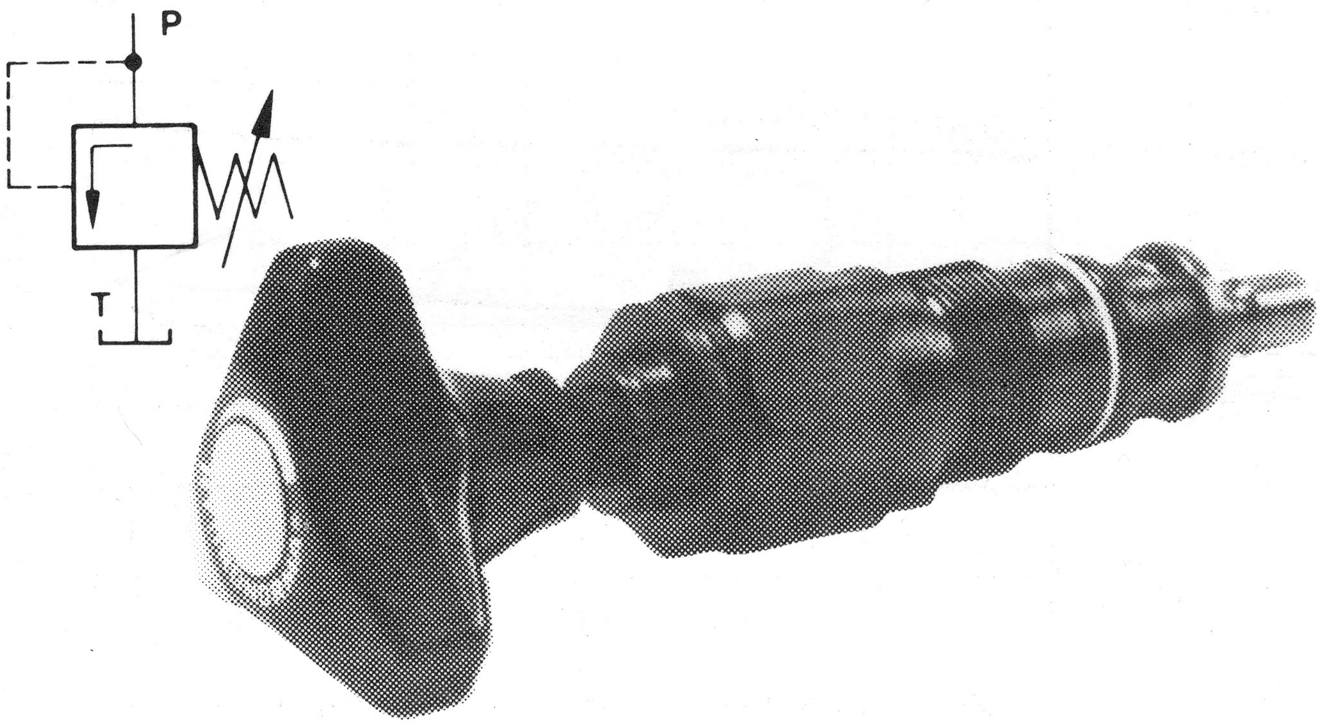
Bent Axis Piston Pumps

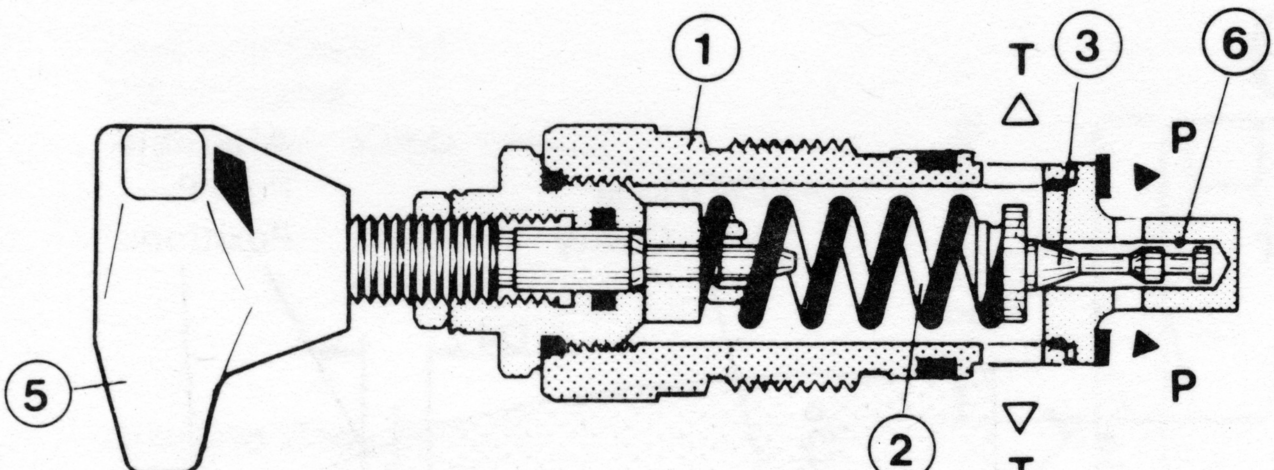






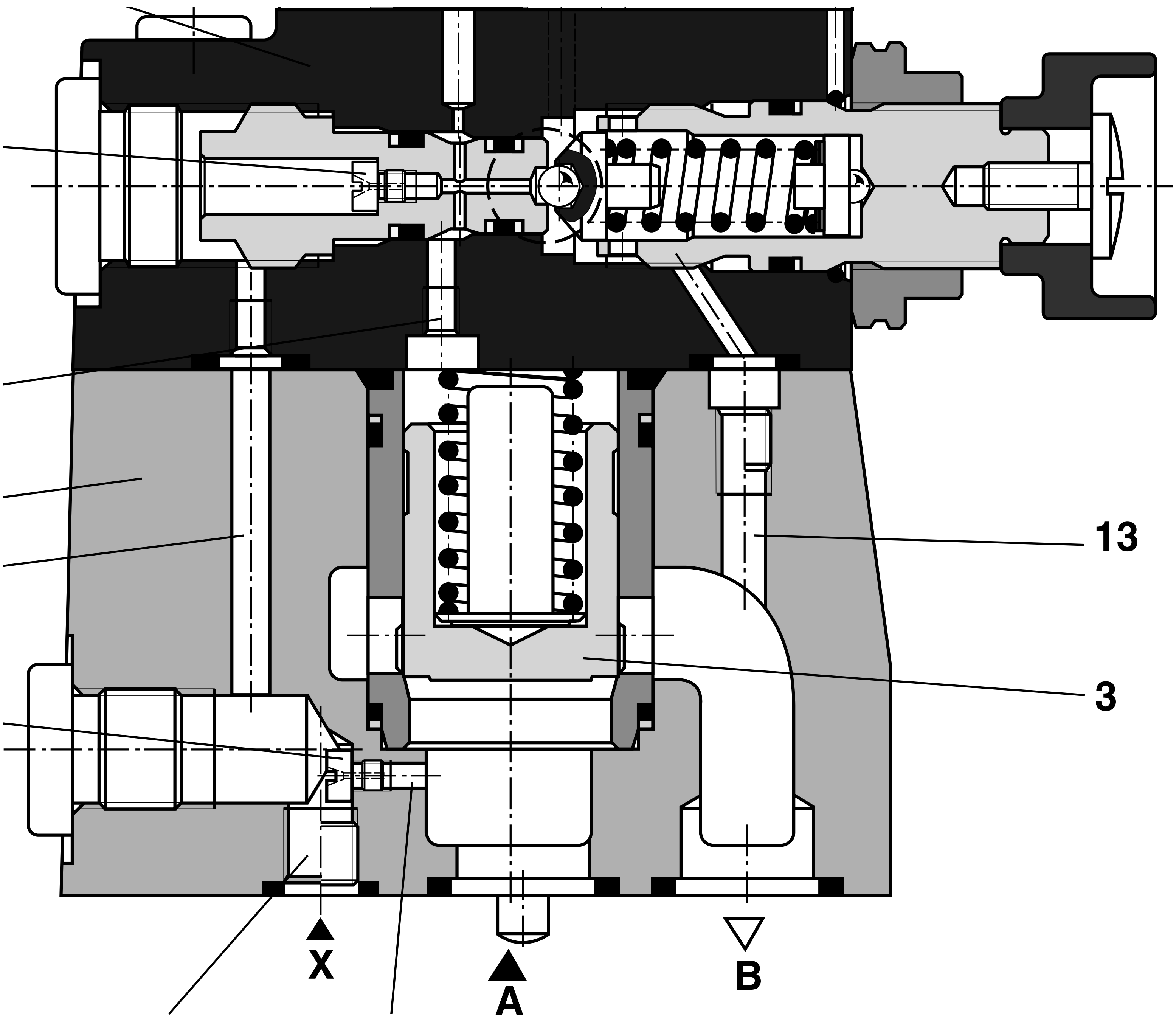
Direct Acting Relief



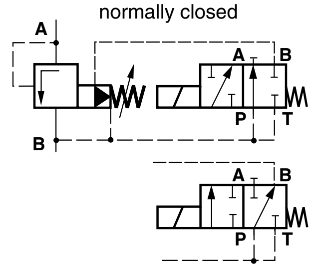


DBDH...K10... Model up to 5800 PSI (400 bar) poppet valve

Pilot Operated Relief

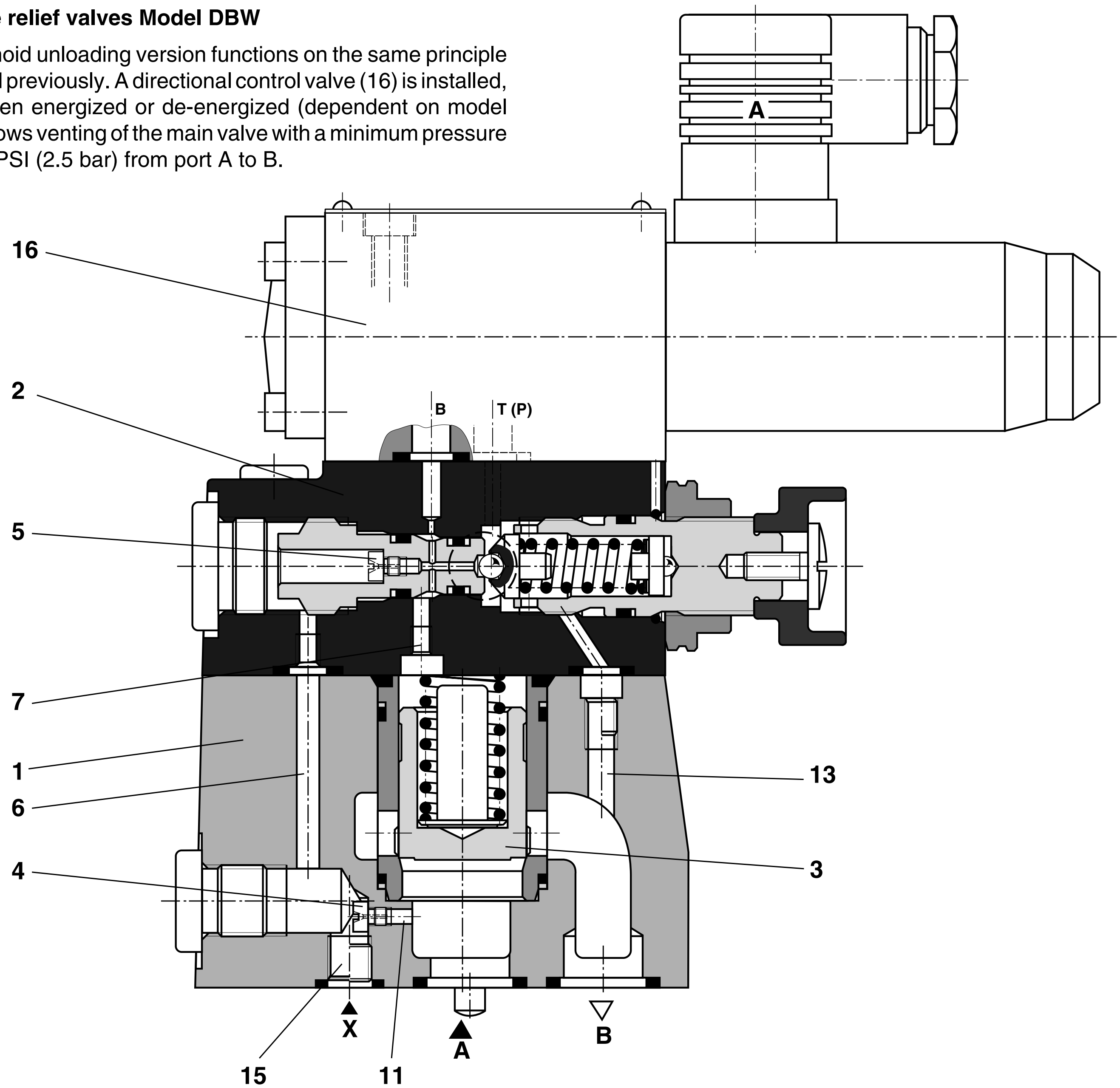


Pilot Operated Relief / Unloader

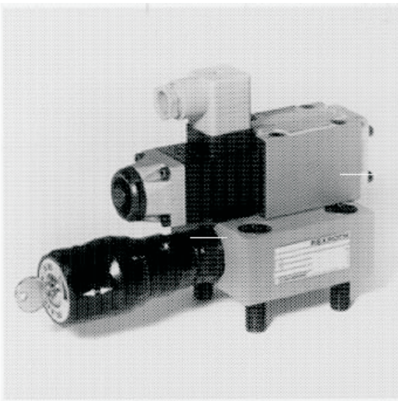


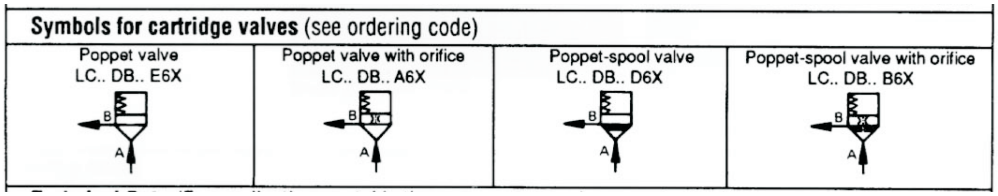
Pressure relief valves Model DBW

The solenoid unloading version functions on the same principle described previously. A directional control valve (16) is installed, which when energized or de-energized (dependent on model code), allows venting of the main valve with a minimum pressure drop, 36 PSI (2.5 bar) from port A to B.

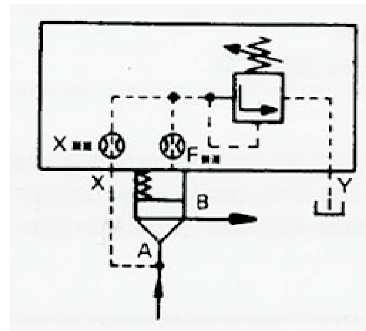


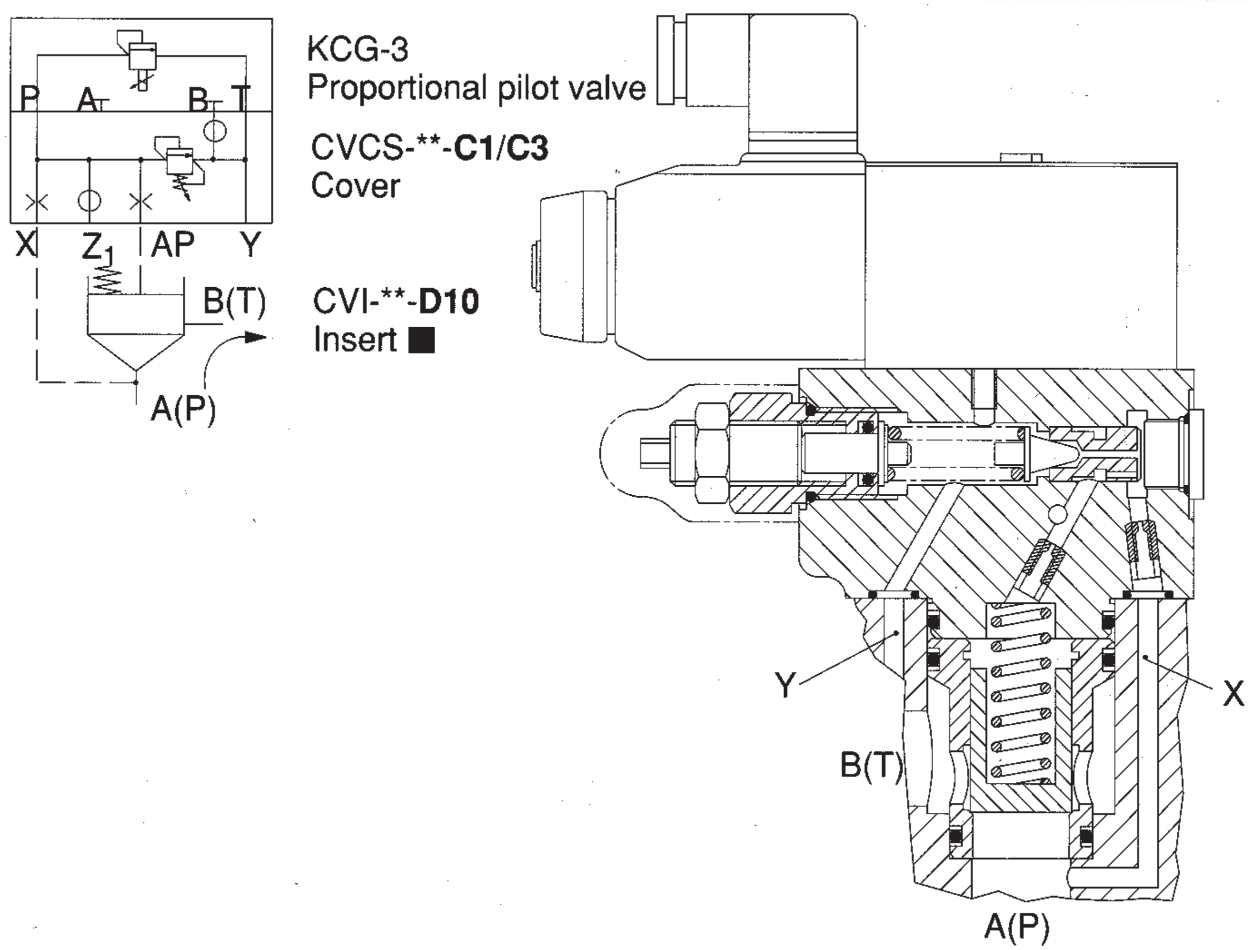
Cartridge Type Relief





Symbols for cartridge valves (see ordering code)			
Poppet valve LC.. DB.. E6X	Poppet valve with orifice LC.. DB.. A6X	Poppet-spool valve LC.. DB.. D6X	Poppet-spool valve with orifice LC.. DB.. B6X

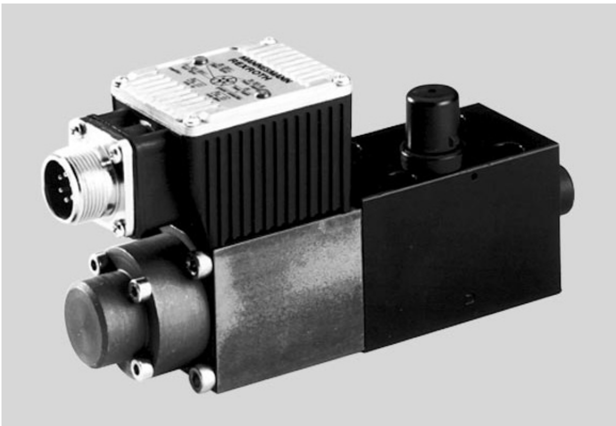




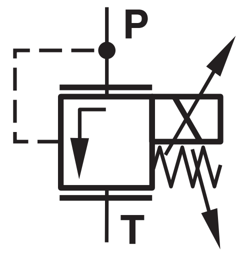
Area ratio
$A_A:A_{AP} = 1:1$

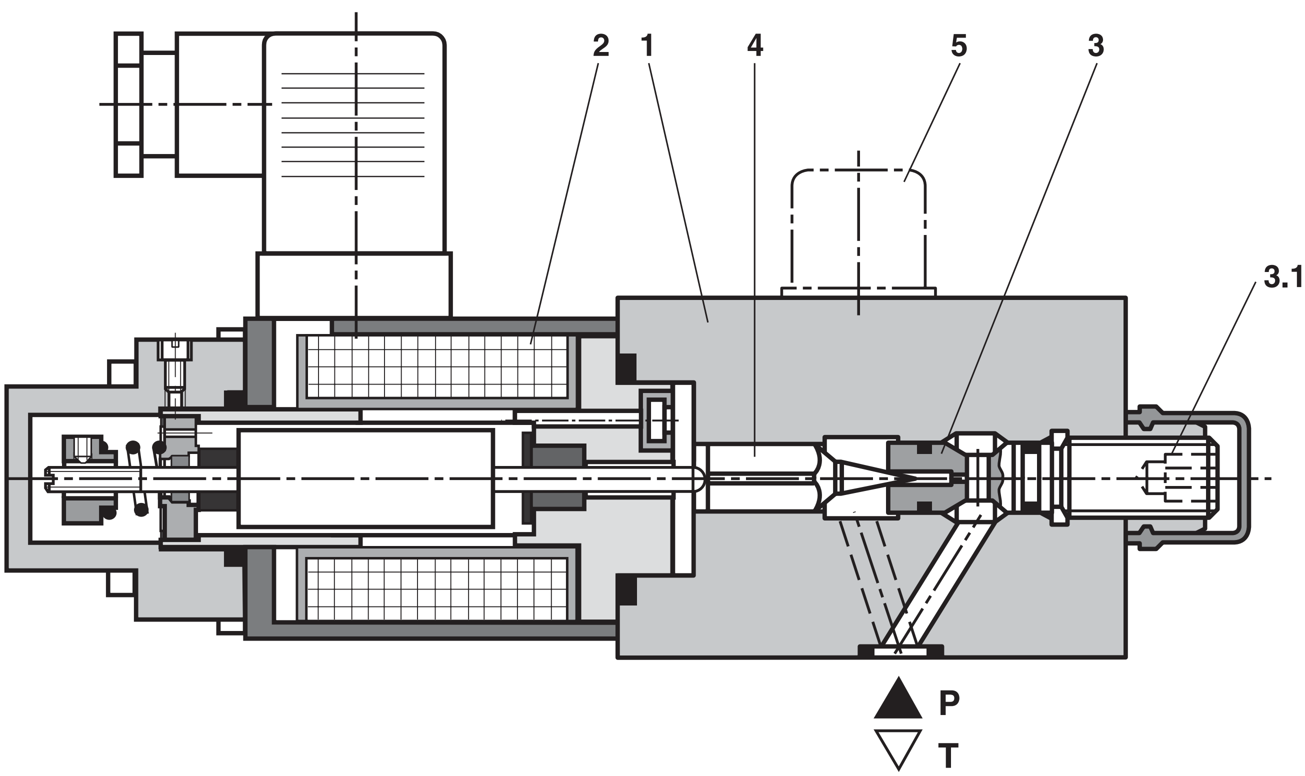
Figure 27

Direct Acting Proportional Relief



with maximum
pressure protection





MANNESMANN REXROTH	Electrical amplifier for the control of proportional pressure control valves without electrical position feedback Model VT 2000, Series 5X	RA 29 904/2.96

VT 2000 amplifiers are suitable for the control of direct and pilot operated proportional pressure control valves without electrical position feedback.

Features:

– Differential input
– Additional command value input
– Ramp generators, acceleration and deceleration times can be set separately
– Clock-pulsed current output stage
– Polarity reversal protection for the voltage supply

Note:

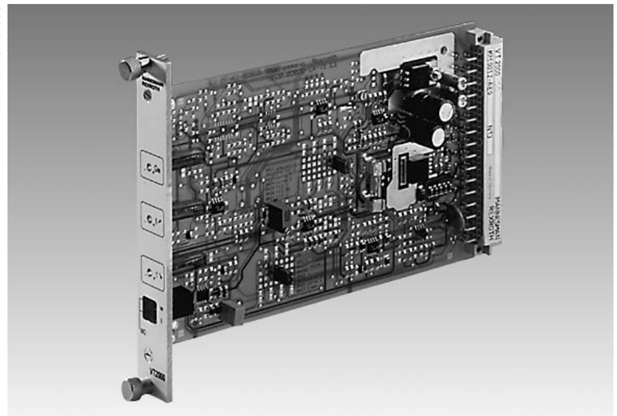
As supplied, an amplifier of series 5X is interchangeable with units of series 4X with a ramp time of 5 s and a clock frequency of 200 Hz. (For the setting of parameters, see page 5).

If a unit of series 5X is to be used as a replacement of series 4X in a rack system, a 4HP (4 division) blanking plate can be ordered separately (see page 6).

Card holder:

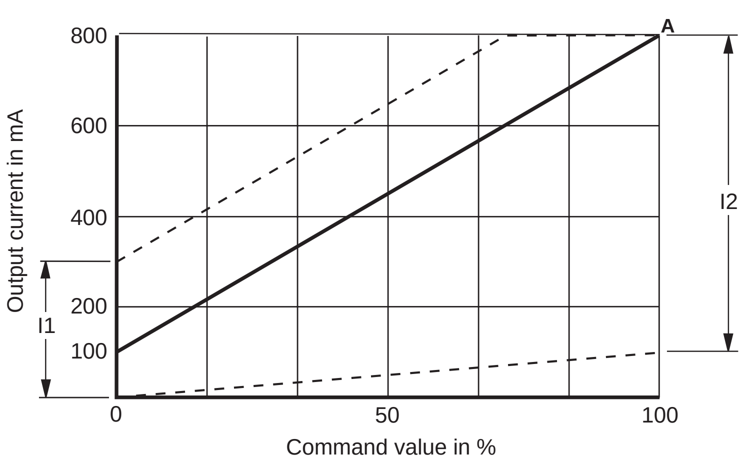
– CH 32C-1X, see RA 29 921
– VT 3002-2X/32, see RA 29 928
Single card holder without power pack

H/A 5104/95



VT 2000-5X

Output characteristic curve

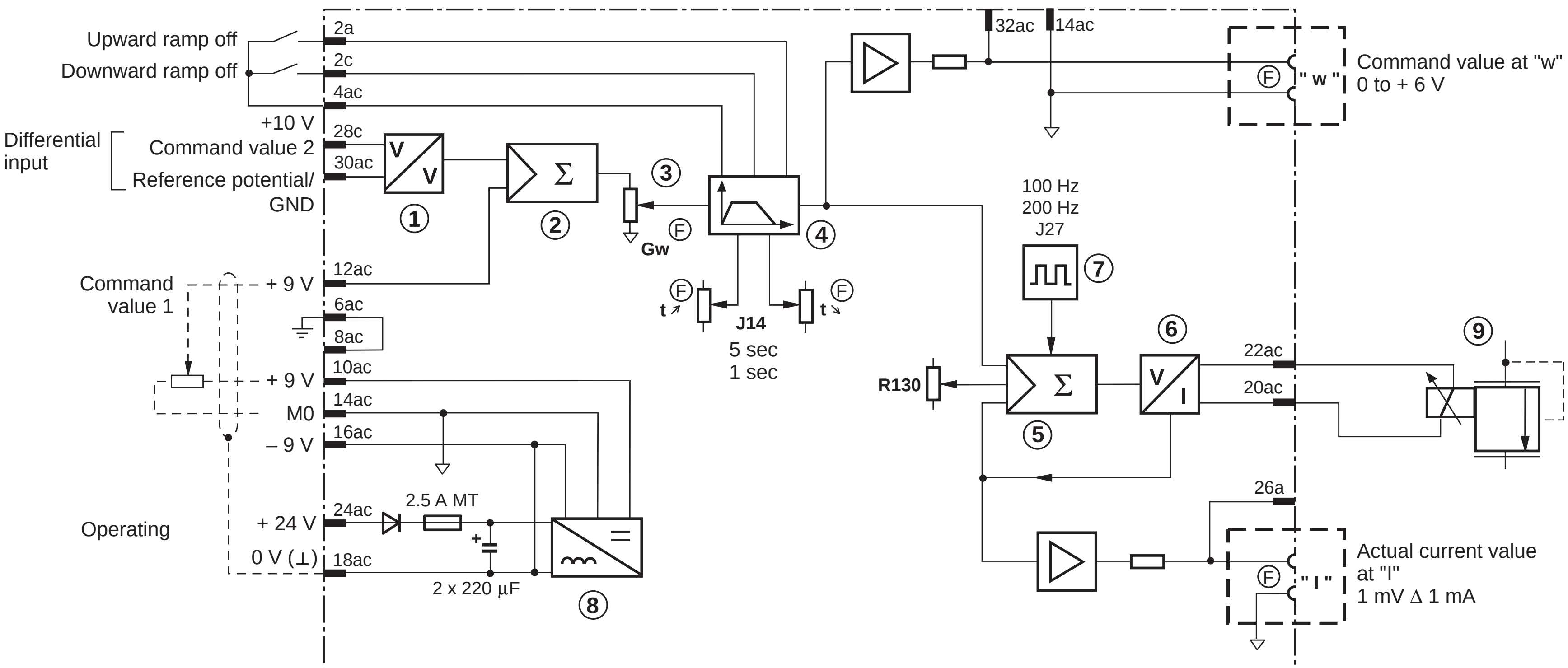


I1 Setting range of the biasing current (0 to approx. 300 mA) via potentiometer R130 on the printed circuit board

I2 Setting range of the maximum command value via potentiometer "Gw" on the front panel

A Characteristic curve as supplied

Measuring zero (M0) is raised by 9 V compared to 0 V operating voltage !



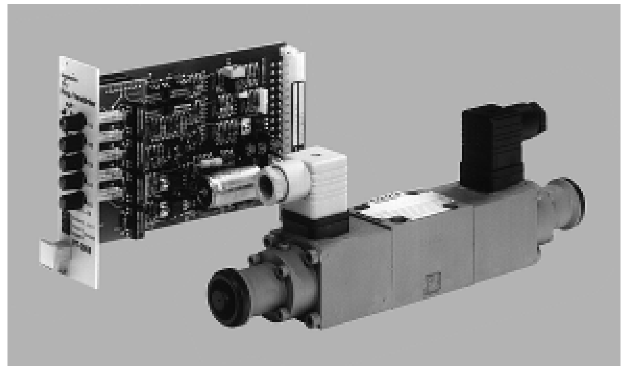
1	Differential input	**5**	Current regulator with summator	**Gw**	= Command value attenuation
2	Summation	**6**	Current amplifier	**t ↗**	= Time setting upward ramp
3	Max. command value potentiometer	**7**	Pulse generator	**t ↘**	= Time setting downward ramp
4	Ramp generator	**8**	Power supply	**R130**	= Biasing current (0 to 300 mA)
		9	Valve with proportional solenoid		

Ⓕ = on the front panel

MANNESMANN REXROTH	Proportional Pressure Control Valves 3-Way Design Model 3 DREP 6 (Series 1X)			RA 29 183/05.94
	Size 6	up to 1450 PSI (100 bar)	up to 4 GPM (15 L/min)	Replaces: 02.92

Features:

- 3-way proportional pressure reducing valves, control both pressure and direction of the fluid flow
- Mounts on standard ISO 5781-03 (ISO 4401-3), NFPA T3.5.1M R1 and ANSI B 93.7 P 03 (D 03) interface
- For subplates, see RA 45 052
- Also used as the pilot valve for Model 4 WRZ proportional direction control valves
- Matching electronic amplifiers Model VT 3000 or VT 3006, see RA 29 913 or RA 29 925



K 4239/12
Model 3DREP 6 C1X/...A...NZ4..
with associated electronics (ordered separately)

Functional description

Direct operated proportional pressure reducing valves Model 3 DREP 6 are used to control the pressure and direction of a fluid flow. The required pressure is set with a 0 ± 9 V (or a 0 ± 10 V differential) input signal to the associated electronic amplifier card (VT 3000 or VT 3006).

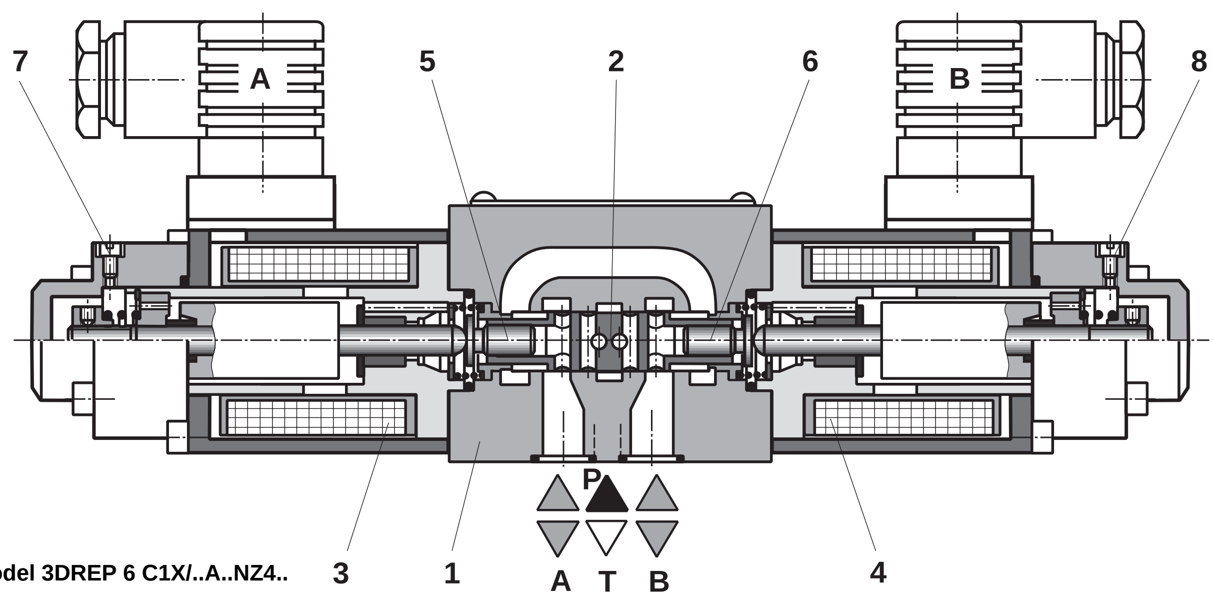
The valve basically consists of the housing (1), control spool (2), two sensing pistons (5 & 6) and proportional solenoids (3 & 4). When the proportional solenoid (3) is supplied with an input signal, a corresponding force which pushes directly against sensing piston (5) shifts the control spool (2) to the right. This allows fluid flow from ports “P” to “B”. At the same time pressure building in port “B” is fed back through two radial drilled holes in the control spool to the sensing piston (6). Since the piston is free to move in the end of the control spool (2), the pressure pushes the piston (6) out which, after bottoming out the push-pin of solenoid (4) if extended, applies an opposing force to the solenoid force (3). When pressure in port “B” builds high enough to equal the force of the solenoid (3), the control spool centers and moves to a no-flow condition, closing off the connection from “P“ to “B”, while modulating to hold pressure in port “B” constant.

If the force of solenoid (3) is reduced, the pressure in port “B” pushes the spool even further to the left. Fluid can then drain from “B” to “T” until pressure is reduced to where it once again corresponds to the force of the solenoid.

Likewise, if an input signal is given to proportional solenoid (4) the process reverses with port “P” opening to port “A”.

At rest – when there is no current flow of the proportional solenoids port “P” is blocked and ports “A” and “B” are open to tank.

Important: To achieve optimum operation of the valve, the air must be bled from the proportional solenoids on the initial start-up. This may be done two ways: 1) pressurize the valve, remove the two bleed screws (7 & 8) until no more air bubbles appear, then reinstall bleed screws; or 2) remove both bleed screws (7 & 8), insert standard oil can nozzle and pump fluid in one side until it flows, without air bubbles, out the other side, then reinstall screws. In both cases the tank line must be prevented from emptying if there is no inherent back pressure in the tank port of the circuit. This may be achieved by installing a check valve in the tank line of the main valve. The valve’s cracking pressure should be in the range of 22 … 45 PSI (1.5 … 3 bar).



Model 3DREP 6 C1X/..A..NZ4..

Technical data, Electrical amplifier Model VT 3000, Series 3X (separate order)

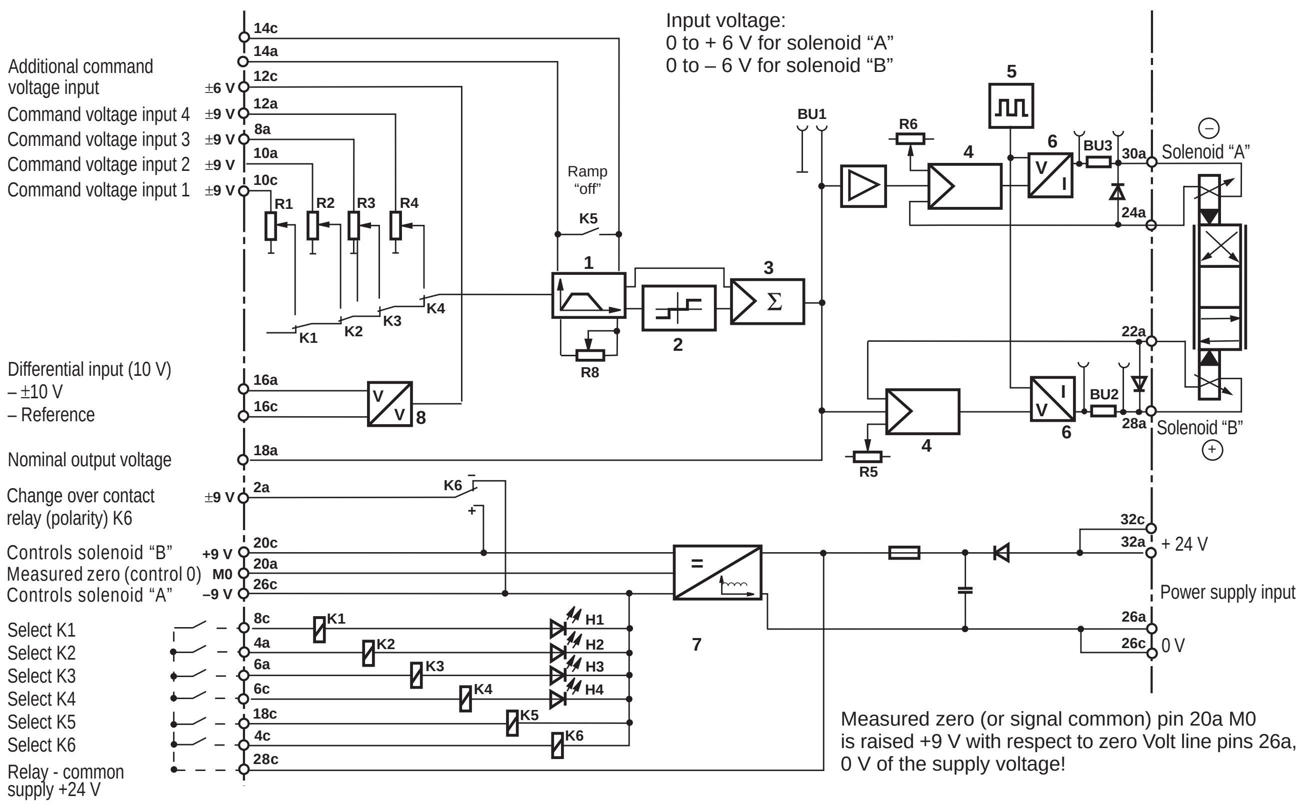
Operating voltage	V_{eff}:	
– Full wave rectification		24 V_{ef} ± 10%
– 3-phase bridge rectification		28 V to 35 V
Maximum output load (coil resistance)	***R*** **:**	19.5 Ω
Min. output (Bias) current	***I*** **:**	20 mA
Maximum output current	I_{max}:	800 mA

Card dimensions:	Euro-card 3.94 x 6.3 inches (100 x 160 mm)
Space requirements:	
– Width, conductor side of card:	1 div. 0.2 inches (5.08 mm)
– Width, component side of card:	7 divisions

For applications outside these parameters, please consult us!

Detailed information: Data sheet RA 29 935

Terminal connections, Model VT 3000



H1 to **H4** = LED indicators “contact relay on”
K1 to **K4** = Input contact relays
K5 = Ramp “on” or “off”
K6 = C/O contact relay
R1 to **R4** = Input command voltage potentiometer

R5 = Minimum (Bias) current sol. “B”
R6 = Minimum (Bias) current sol. “A”
R8 = Ramp time “up” and “down”

1 Ramp generator
2 Stepped function generator
3 Summing amplifier
4 Power amplifier
5 PWM oscillator
6 Output stage
7 Voltage regulator
8 Differential input amplifier

Ordering code, Model VT 3000

VT 3000	S	3X /		E	*

32-pin plug-in Eurocard design to DIN 41 162 form D (for installation in Euro magazines or card holders) **= S**

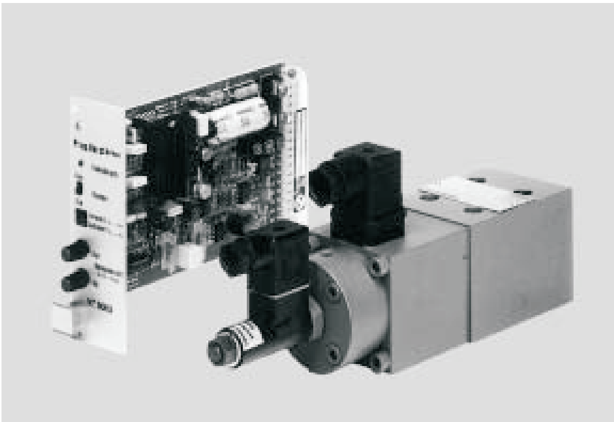
Series 30 to 39 (Series 30 to 39: externally interchangeable) **= 3X**

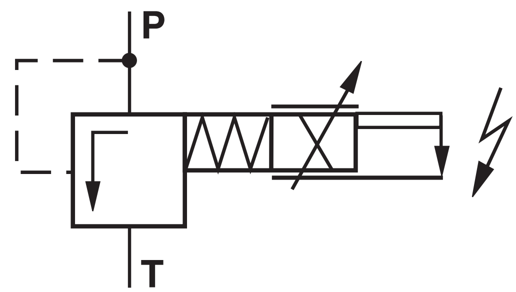
Further details to be written in clear text

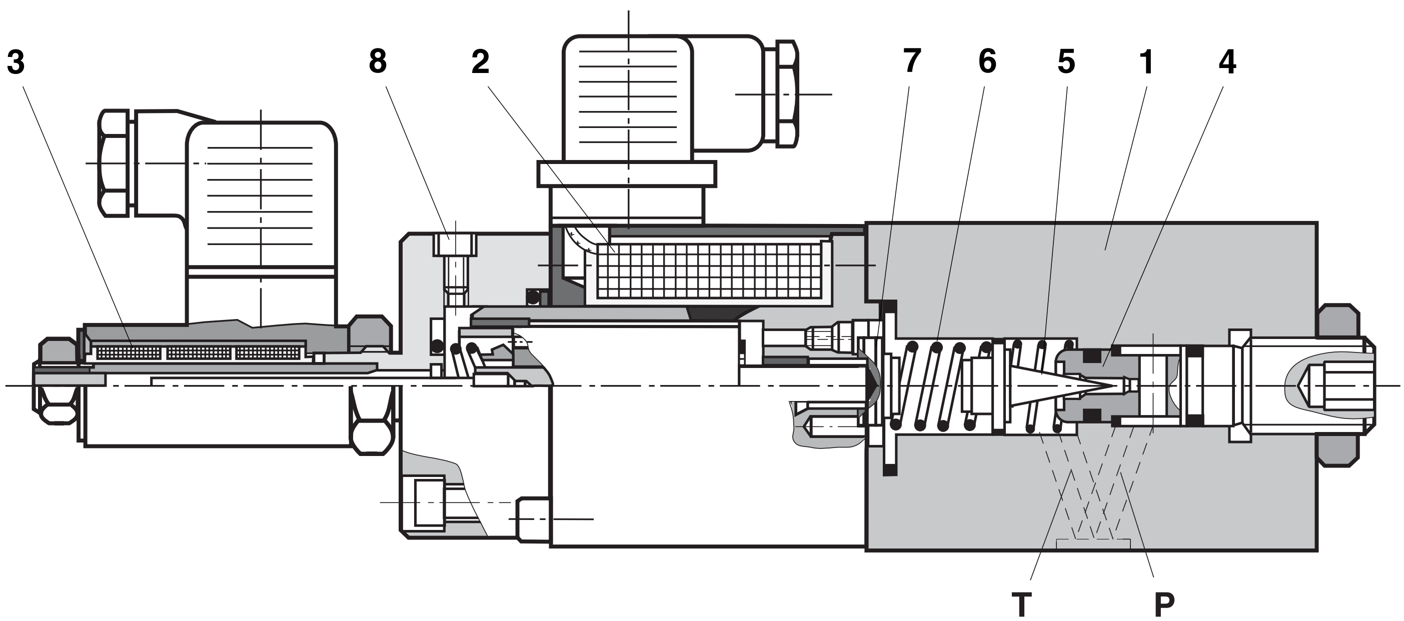
E = English face plate

R1 = Ramp time adjustable from 0.03 to 1 sec.
R5 = Ramp time adjustable from 0.3 to 5 secs.

Direct Acting Proportional Relief

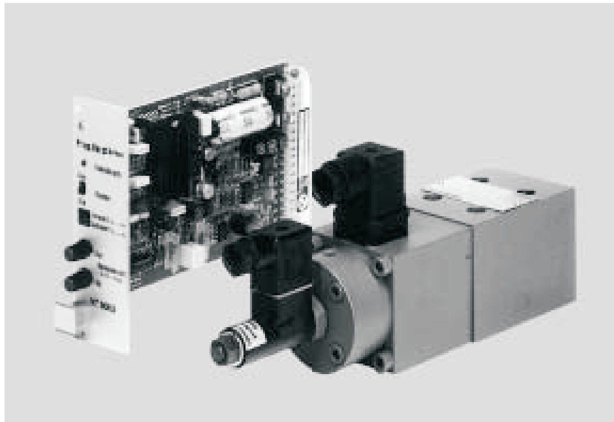


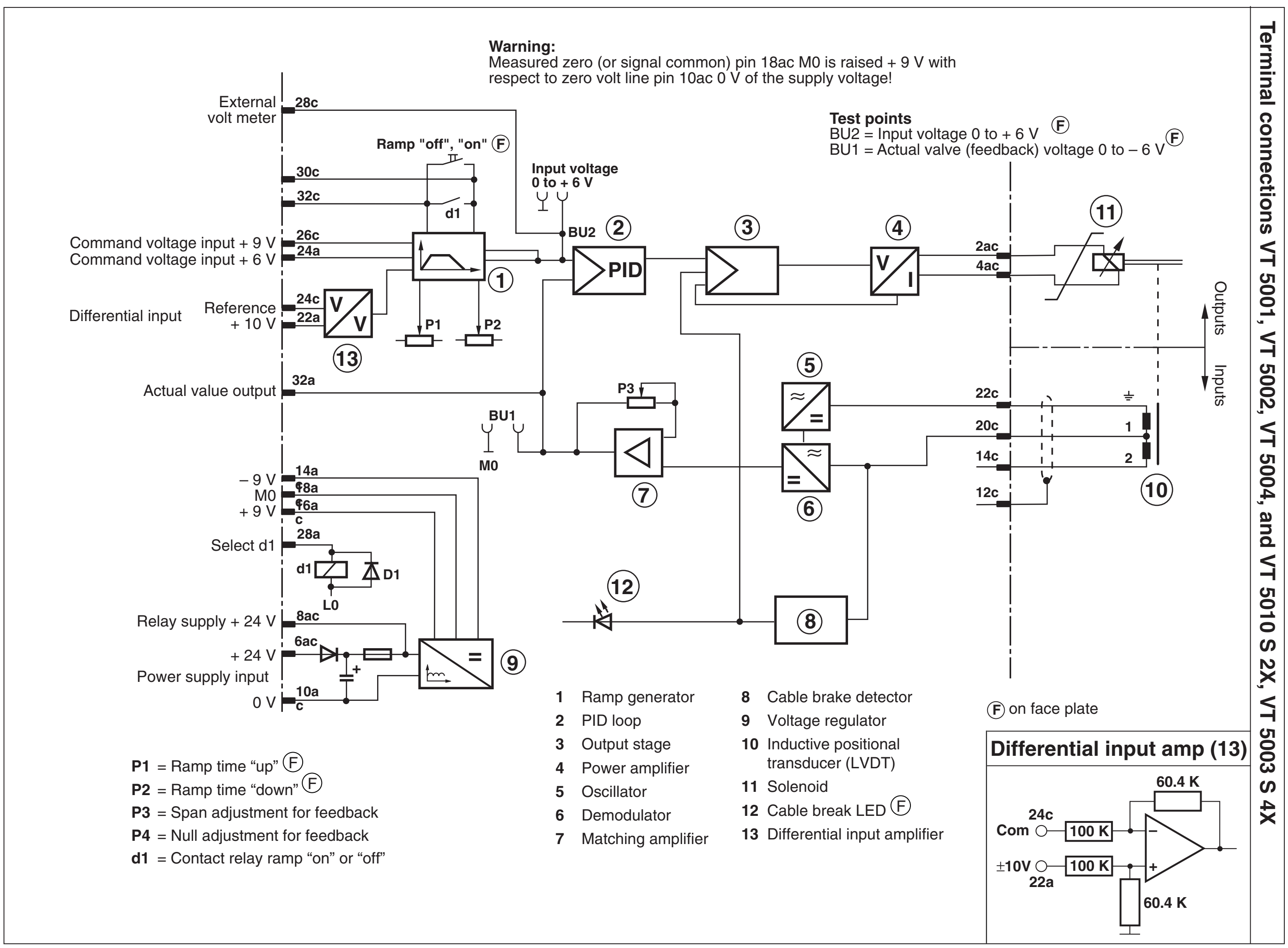




Model DBETR-1X/...

Electronics For DBETR





Electronics For DBETR

MANNESMANN REXROTH	**Electronic Amplifier Model VT 5001, VT 5002, VT 5004, VT 5010 (Series 2X) and VT 5003 (Series 4X) for controlling proportional directional, flow, and pressure valves, Eurocard format**	**RA 29 945/05.94** Replaces: 04.92

Electronic amplifier cards Model VT 5001, VT 5002, VT5004, VT 5010 (Series 2X) and VT 5003 (Series 4X) are used for controlling proportional directional, flow, and pressure, as follows:

- VT 5001, WRE 6
- VT 5002, WRE 10
- VT 5003, DBETR 10
- VT 5004. 2FRE 10 & 16
- VT 5010, 2FRE 6

They incorporate the following features:

– Voltage stabilizer to provide a constant voltage for consistent performance

– Pulse width modulated output which provides a dither effect to reduce hysteresis, and allows high ambient temperature range

– Ramp generator (signal vs. time) to control acceleration and deceleration rates (Models VT 5001, VT 5002, VT 5010, VT 5004) or rate of pressurization (Model VT 5003)

– Ramp time options of either 1 or 5 seconds

– 10 V differential amplifier input which enables interface with programmable controllers, microprocessors, or computers

– Factory calibrated and optimized PID control to match each valve type, thereby simplifying installation or replacement

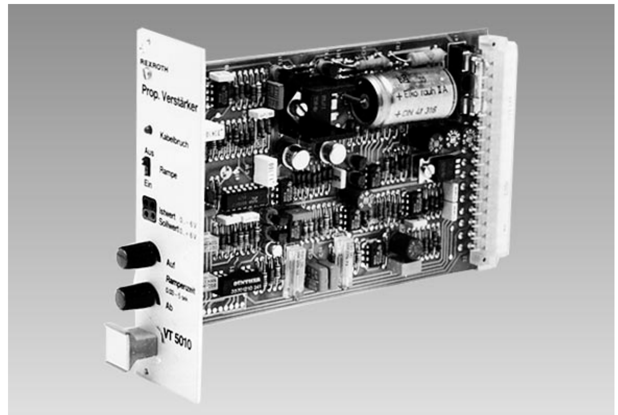
– Inductive feedback circuitry to provide excellent valve repeatability and performance

– Face plate mounted switch or internal contact relay, to disable the ramp function

– Cable break detector which can deactivate outputs if feedback wires become disconnected

Matching Single Card Holder:

– Model CH32C-1X, see RA 29 921



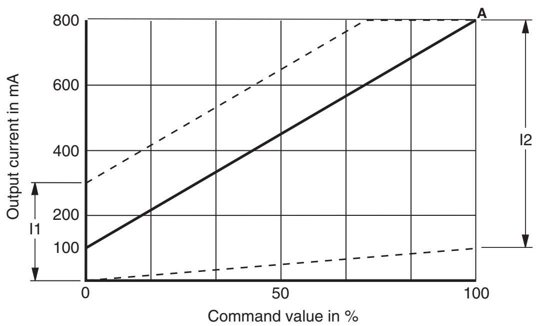
R 85/6

VT 5010 S 2X/.E

Technical data (For applications outside these parameters, please consult us!)

Power supply voltage	V_{DC}	24 V ±10%
Internal control voltage	V_{IN}	±9 V with reference to M0
Power requirement	P	50 W
Minimum input load	R_{IN}	≥500 Ω (±9 V at ±18 mA)
Nominal solenoid resistance at 68°F (20°C)	R	VT 5001 – 5.4 Ω VT 5002 – 10 Ω VT 5003 – 10 Ω VT 5004 – 10 Ω VT 5010 – 5.4 Ω
Oscillator frequency (LVDT)	F_{osc}	~2.5 kHz
Maximum output current	I_{max}	VT 5001 – 1.8 A VT 5002 – 2.2 A VT 5003 – 2.2 A VT 5004 – 2.2 A VT 5010 – 1.8 A
Fuse (5 mm x 20 mm)	I_S	2.5 A
Type of connection		32-pin connector DIN 41 612, type C
Card dimensions		Eurocard 100 x 160 mm DIN 41 494
Space requirements – Height – Width, conductor side – Width, component side – Total width		 3 U – 5.05 in (128 mm) 1 division – 0.2 in (5.08 mm) 7 divisions 8 divisons (8 HP)
Temperature drift	T_D	32 to 122°F (0 to 50°C)
Weight (approx.)	W	0.33 lb (0.15 kg)
Storage temperature range	T	–4 to 158°F (–20 to 70°C)

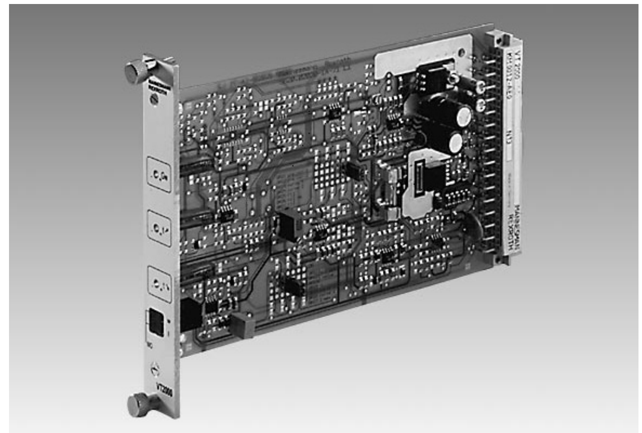
Electronics For DBET



I1 Setting range of the biasing current (0 to approx. 300 mA) via potentiometer R130 on the printed circuit board

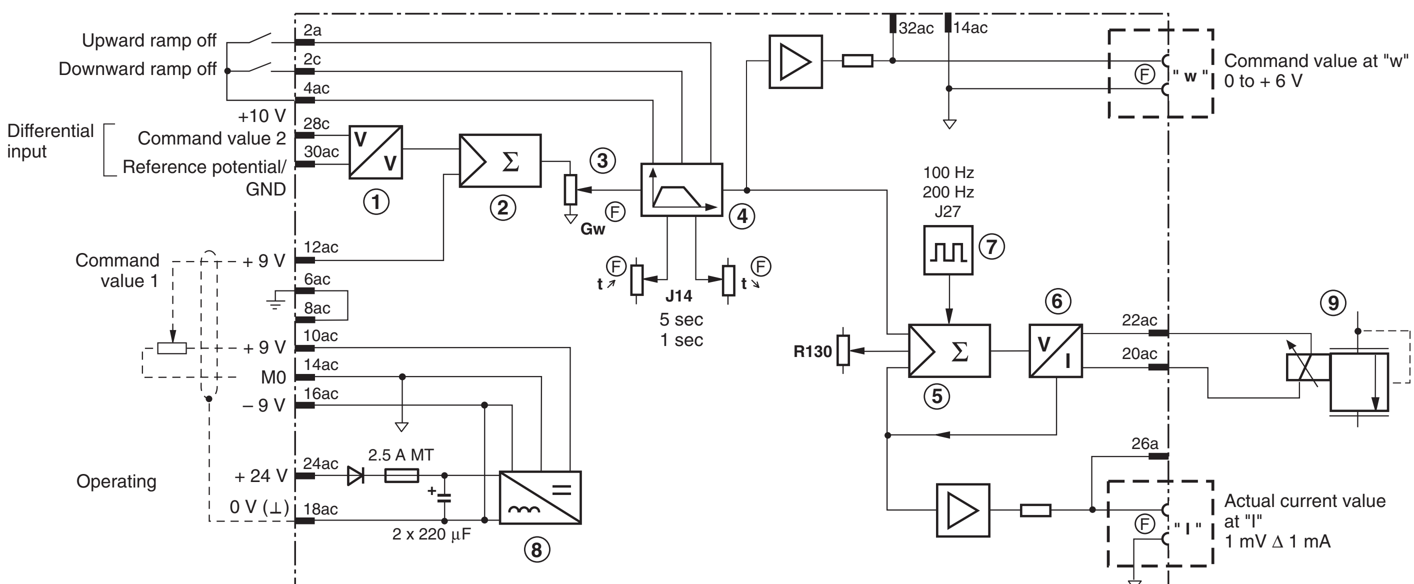
I2 Setting range of the maximum command value via potentiometer "Gw" on the front panel

A Characteristic curve as supplied



Block circuit diagram / pin allocation VT 2000-5X

Measuring zero (M0) is raised by 9 V compared to 0 V operating voltage !



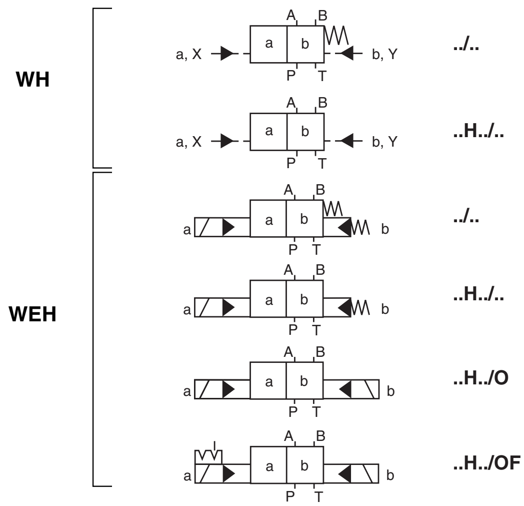
1 Differential input
2 Summation
3 Max. command value potentiometer
4 Ramp generator
5 Current regulator with summator
6 Current amplifier
7 Pulse generator
8 Power supply
9 Valve with proportional solenoid

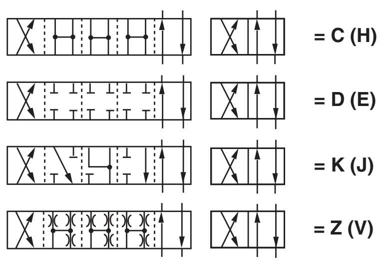
Gw = Command value attenuation
t↗ = Time setting upward ramp
t↘ = Time setting downward ramp
R130 = Biasing current (0 to 300 mA)

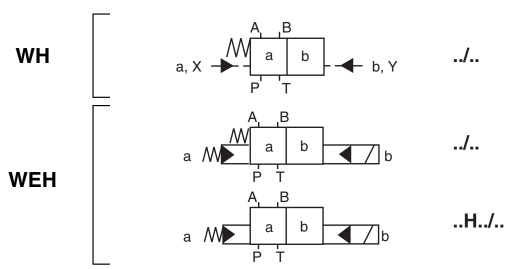
Ⓕ = on the front panel

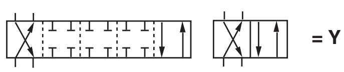
Directional Control Symbols

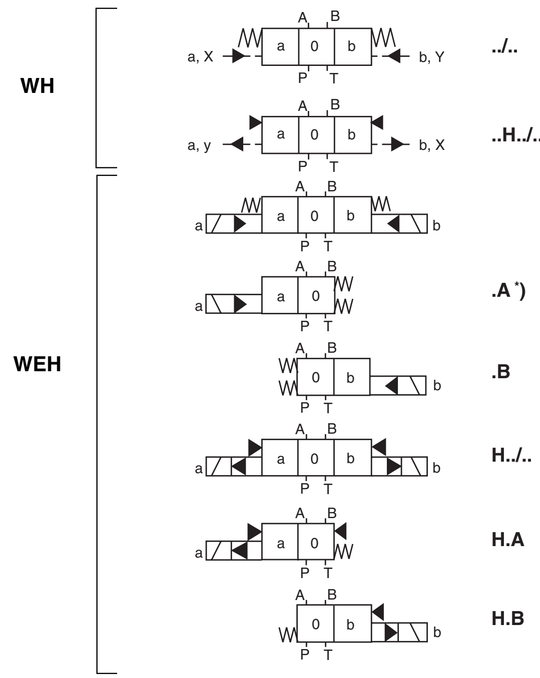
Spool symbols (to ISO 1219)

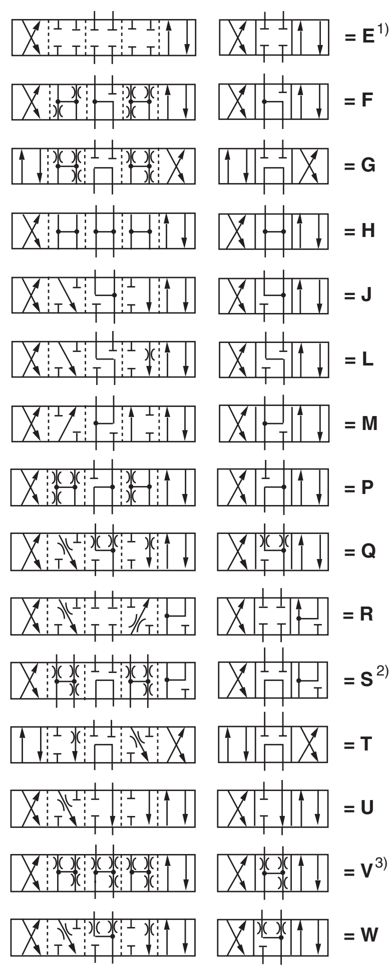












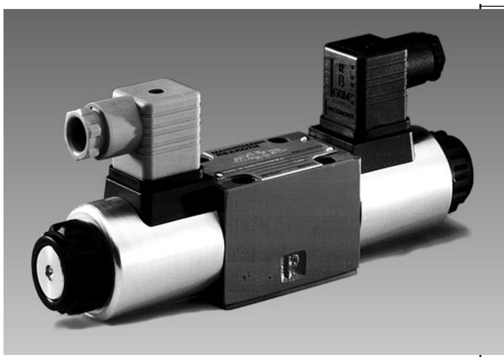
1) Example: spool "E", 2-position valve with position "a" only (solenoid on side A)

Ordering example:
H-4WEH 16 HEA6X/6AG24NETSZ4..B10..V..

2) Spools only for size 16, 32

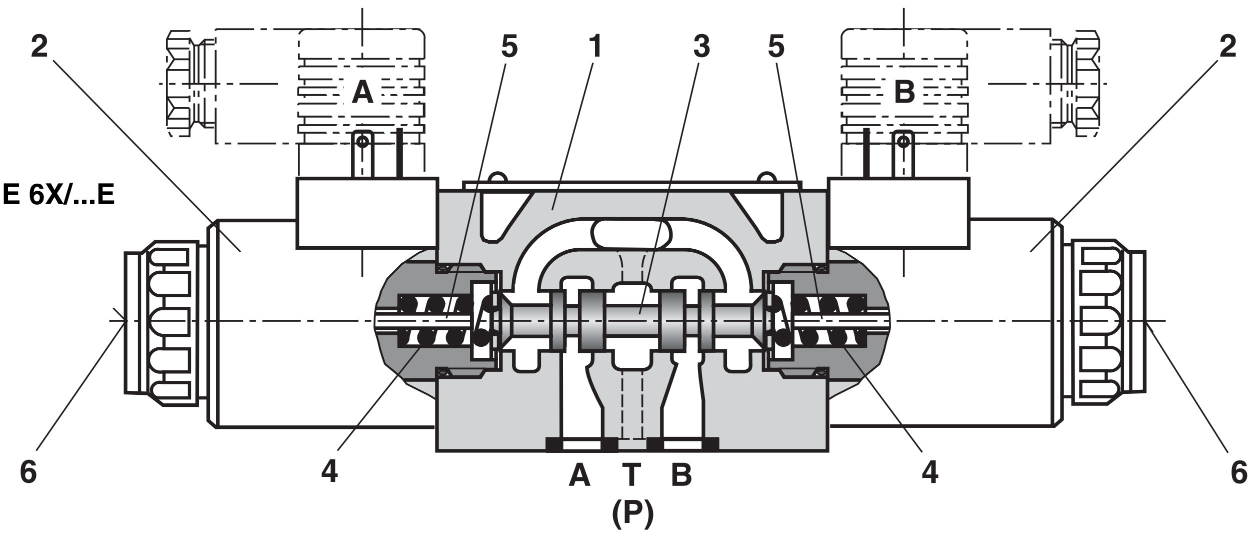
3) Spools only for size 10, 16, 22

Directional Control - Direct Acting



Electrical				
Type of voltage			DC voltage	AC voltage
Available voltages[1]) (for ordering codes for AC voltages see below)	*U*	V	**12, 24,** 42, 60, **96,** 110, 180, **196,** 220	42, **110, 120,** 127, **220, 240** 50/60 Hz
Power consumption	*P*	W	30	–
Holding current	*P*	VA	–	50
In-rush current	*P*	VA	–	220
Duty cycle			continuous	continuous
Switching time to ISO 6403 — ON	*T*	ms	25 to 45	10 to 20
Switching time to ISO 6403 — OFF	*T*	ms	10 to 25	15 to 40
Switching frequency		Sw/h	up to 15000	up to 7200
Insulation			Exceeds NEMA class B	Exceeds NEMA class B
Coil temperature	*t*	°F (°C)	up to 302 (150)	up to 356 (180)

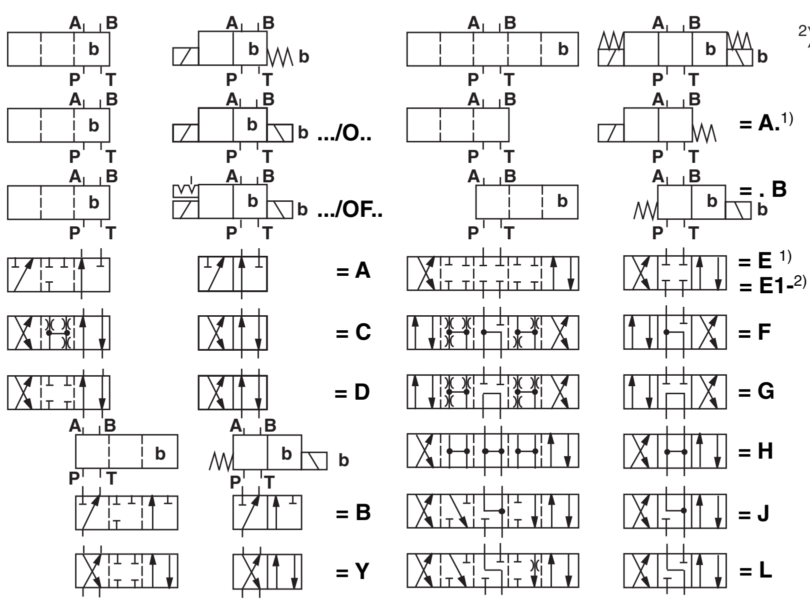
Model 4 WE 6 E 6X/...E

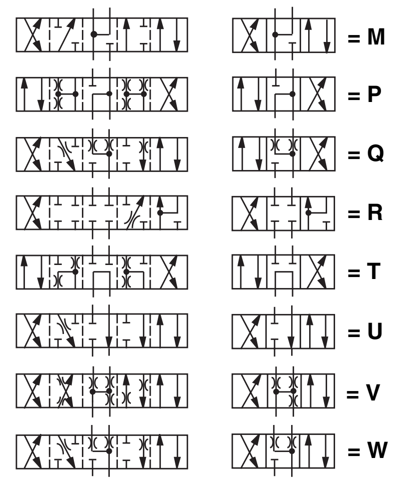


[1]) **Example:** Spool E with switching position "a"
Order code 4 WE6 **EA•**6X/EW 110 NZ45

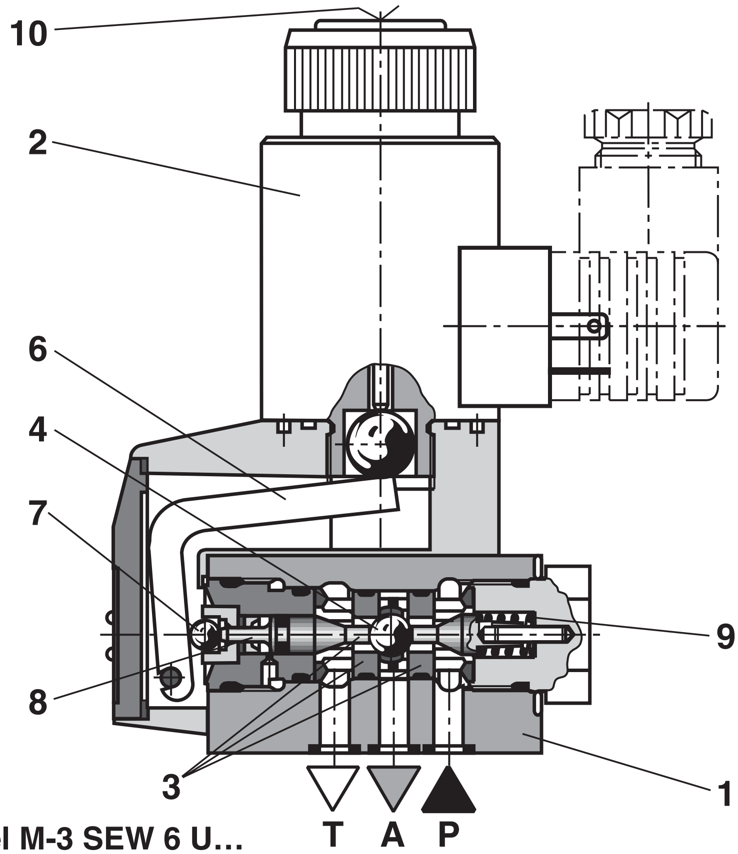
[2]) Symbol E1–: P – A/B pre-opening

Caution: Be aware of pressure intensification in differential cylinders





Directional Control - Direct Acting



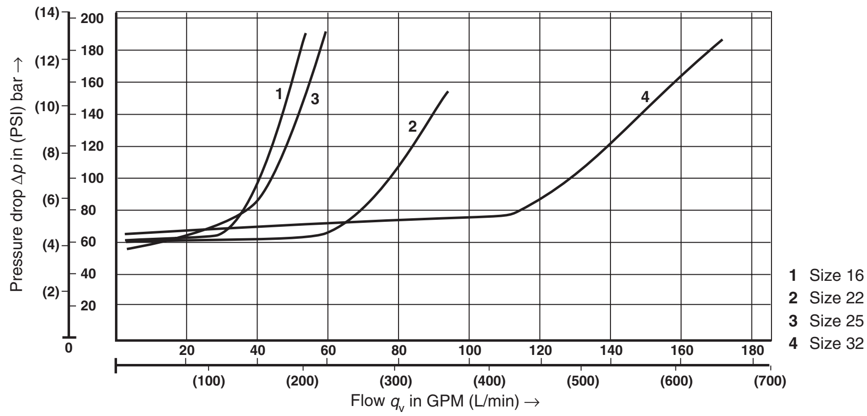
Model M-3 SEW 6 U…

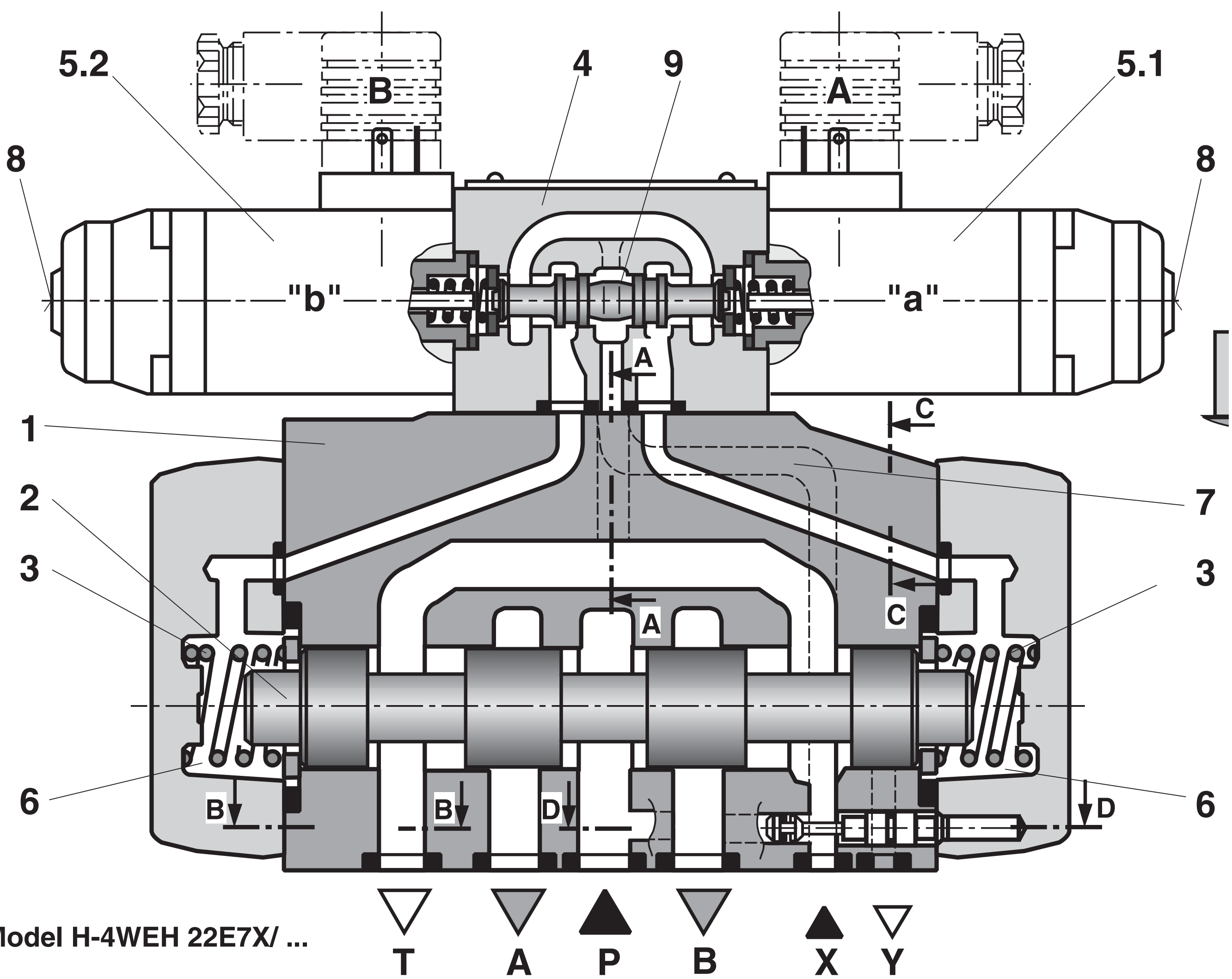
	2/2-way poppet valve	3/2-way poppet valve
Symbol	"P"	"U"
de-energized	P and T connected	P and A connected, T closed leakfree
energized	P closed leakfree	P closed leakfree, A and T connected
	"N"	"C"
de-energized	P closed leakfree	P closed leakfree, A and T connected
energized	P and T connected	P and A connected, T closed leakfree

Power Limits, measured at v = 190 SUS (41 mm²/s) and t = 122 °F (50°C)

	Symbol		Operating pressure in PSI (bar) P	A	B	T	Flow in GPM (L/min)
2-way switching	"P"	Pressure at P ≥ T	6100/9150 (420/630)			2900 (200)	6.60 (25)
	"N"		6100/9150 (420/630)			2900 (200)	6.60 (25)
3-way switching	"U"	Pressure at P ≥ A ≥ T	6100/9150 (420/630)	6100/9150 (420/630)		1450 (100)	6.60 (25)
	"C"		6100/9150 (420/630)	6100/9150 (420/630)		1450 (100)	6.60 (25)
2-way circuit (unloading function only)	"U"	Pressure must be present at port A, before operating valve from de-energized "0" position. Pressure at A ≥ T		6100/9150 (420/630)		1450 (100)	6.60 (25)
	"C"	Pressure at A ≥ T		6100/9150 (420/630)		1450 (100)	6.60 (25)
4-way switching	"D"	Valve with one poppet (Symbol U) with base plate. P > A ≥ B >T	6100/9150 (420/630)	6100/9150 (420/630)	6100/9150 420/630	1450 (100)	6.60 (25)
	"Y"	Valve with two poppets (Symbol C) with base plate. P > A ≥ B >T	6100/9150 (420/630)	6100/9150 (420/630)	6100/9150 (420/630)	1450 (100)	6.60 (25)

Directional Control Pilot Operated

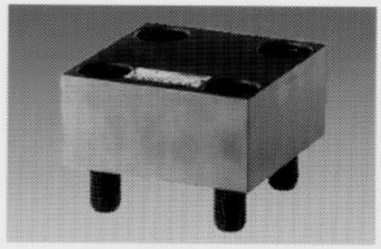


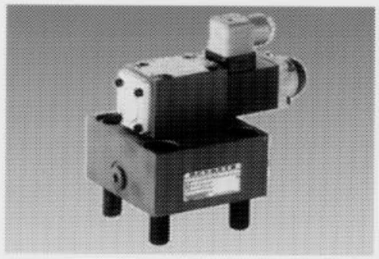


Model H-4WEH 22E7X/ ...

Directional Control - Direct Acting

- Valve with or without damping nose
- Two area ratios
- Four cracking pressures
- Two stroke limiters
- Cover with built-in shuttle valve
- Cover to accept built-on control valve (spool or poppet valve) with or without a built-in shuttle valve
- high functional reliability (low dirt sensitivity)
- large flow range
- high operating pressures
- long service life (minimal wear)
- compact and standardized installation dimensions





2-way cartridge valves are designed as inserts into compact manifold control blocks. The main section with ports A and B (installation dimensions to ISO standards) is built into the block, and sealed with a cover. In most cases, the cover acts as a connecting block between the control and the main section.
By controlling the main valve with a suitable pilot valve, the main valve can receive pressure, directional or throttling functions, or a combination of these.
Economic designs can be achieved by matching the individual valve elements to the varying flows required by the different sides of a driven unit.
When the main logic element can assume more than one function, an economic design is achieved.

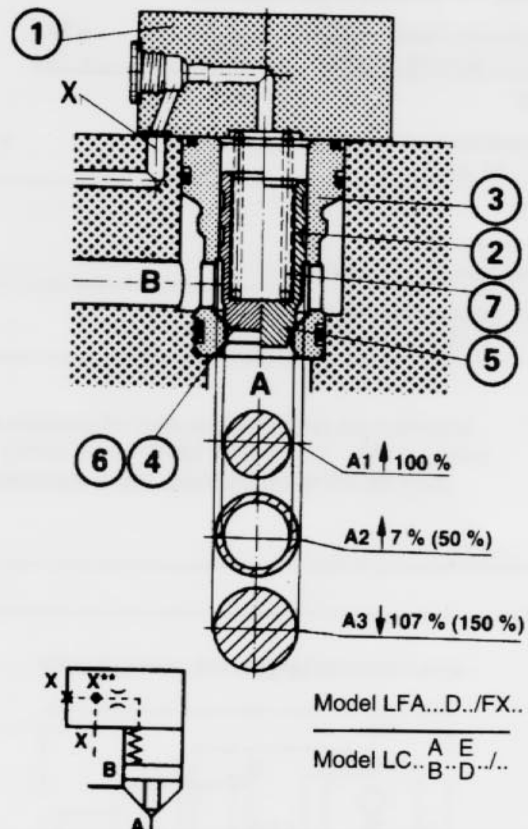
Directional control function

2-way cartridge valves consist basically of a control cover (1) and the cartridge element (2).
The control cover contains the porting relative to the function required, and a stroke limiter or built-in pilot poppet valve if required. In addition, poppet or spool type pilot valves can be mounted on the cover.
The cartridge element consists of a bushing (3), a poppet valve (4) either with an optional dumping nose (5) or without (6) together with a closing spring (7).

Function

2-way cartridge valves are pressure-dependent in operation. There are three operating areas subject to pressure: A1, A2 and A3.
The area of the valve seat (A1) is always taken as 100%. The annular area A2 is either 7% or 50% of area A1, dependent upon the type of valve. The area ratio A1: A2 is therefore either 14.3:1 or 2:1.
The area A3 is equal to the sum of the areas A1 and A2, and can be either 107% or 150% of area A1.

Basically:
Areas A1 and A2 operate to open the valve. Area A3 and the spring close the valve. The effective direction of operation of the resulting force determines whether the logic element will open or close.
2-way cartridge valves can allow flow in either direction.
By pressurising area A3 either from port B, or from an external source, port A is completely sealed.



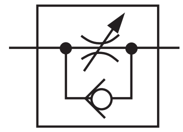
Flow Control

Features:

- Throttle & throttle/check valve
- For in-line mounting
- Leak-free closure in one direction
- Pressure, temperature and viscosity dependent

Symbols

Model MG



Model MK

K 3564/1
Model MK .. G1.2/V

Functional description, section

Flow control valves Model MG/MK are pressure, temperature and viscosity dependent throttle and throttle/check valves, used to restrict flow. They consist of adjustment sleeve (1) and inner housing (2).

Model MG (Throttle valve)

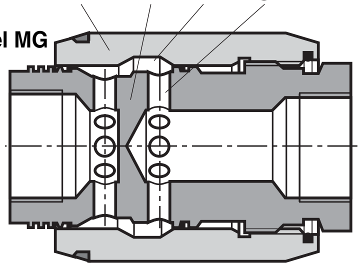
This valve is capable of flow control in either direction. Fluid flows through radial drillings (3) to the throttling area (4), which is defined by the inner housing (2) and adjustment sleeve (1). Turning adjustment sleeve (1), larger or smaller throttle areas are created, thus regulating flow.

Model MK (Throttle/Check Valve)

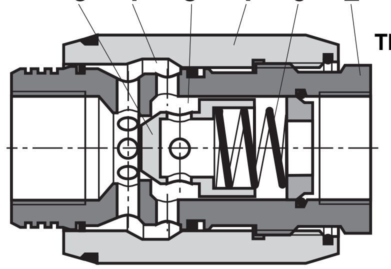
This valve is capable of flow control in one direction while allowing reverse free flow in the opposite. Fluid passes spring (6), through radial drillings and throttling area (4). Throttling is achieved similarly to the MG valve. In the reverse direction, pressure acts on the area of check valve (5). When pressure exceeds spring force (6), the poppet opens, allowing reverse free flow through the valve. Fluid also passes through the throttle area (4), thereby flushing contamination from the valve.

Caution! Do not adjust the valve while under pressure

Throttle Valve Model MG



Throttle Check Valve Model MK



Ordering code

		G	1X	/ V		*

Throttle valve	= MG
Throttle/check valve	**= MK**
Size 6 (1/4")	= 6
Size 8 (3/8")	= 8
Size **10** (1/2")	**= 10**
Size **15** (3/4")	**= 15**
Size **20** (1")	**= 20**
Size **25** (1-1/4")	**= 25**
Size **30** (1-1/2")	**= 30**
In-line mounted	**= G**

Further details to be written in clear text

no desig. =	G (BSP) threads
5 =	NPT threads
12 =	SAE threads (size 10, 15, 20, 25, 30 only)
V =	FPM seals, suitable for Petroleum oils (HM, HL, HLP) Phosphate ester fluids (HFD-R)
1X =	Series 1X (10 to 19; externally interchangeable)

Technical data (for applications outside these parameters, please consult us!)

Hydraulic fluid: Petroleum oils (HM, HL, HLP); phosphate-ester fluids (HFD-R)

Fluid temperature range: –4 to +176 °F (–20 to +80°C)

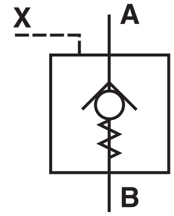
Viscosity range: 60 to 3710 SUS (10 to 800 mm²/s)

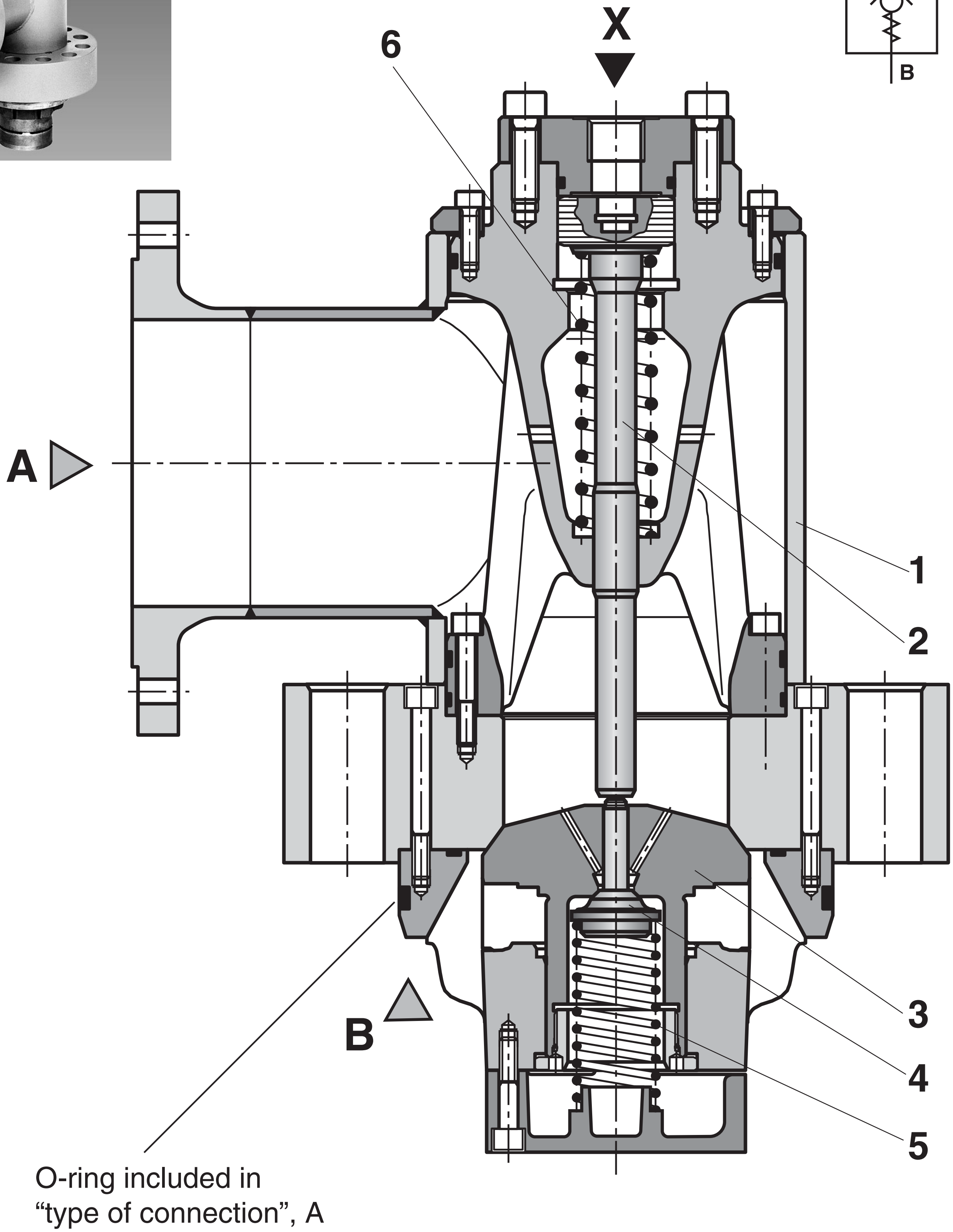
Maximum degree of fluid contamination: Class 19/16 according to ISO 4406.
Therefore, we recommend a filter with a retention rate of $\beta_{10} \geq 75$.

Maximum operating pressure: up to 4600 PSI (315 bar)

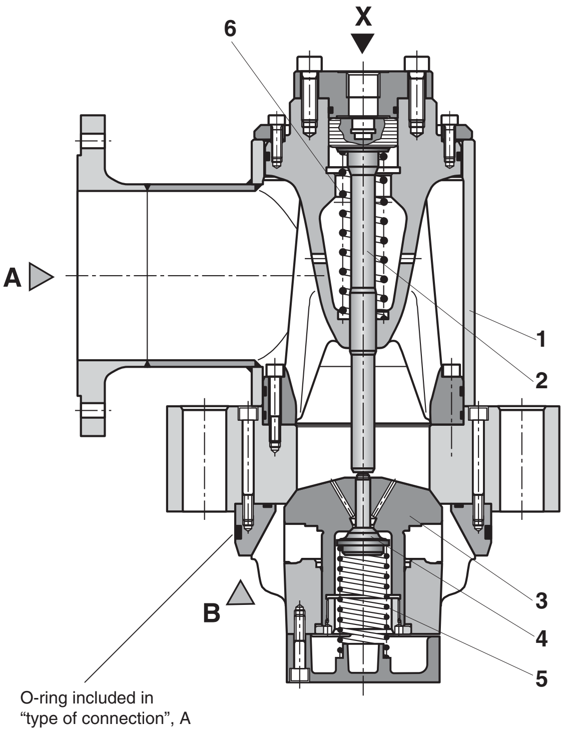
Cracking pressure for check valve: Model MK: 7 PSI (0.5 bar)

Prefill Valve



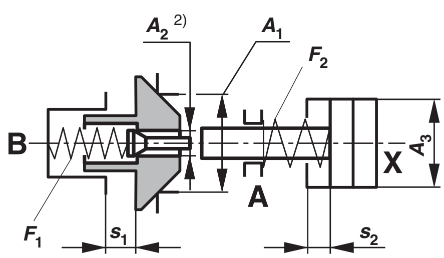


Prefill Valve



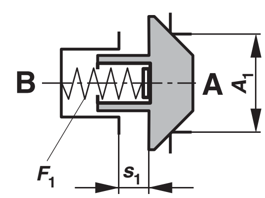
Model SF ... A1-1- 4X/

Connection models "A" and "B"



A_1 = Main poppet area – in^2 (cm^2)
A_2 = Pilot poppet area – in^2 (cm^2)
A_3 = Control spool area – in^2 (cm^2)
s_1 = Main poppet stroke – in (mm)
s_2 = Control spool stroke – in (mm)
F_1 = Force of valve spring – lbs (daN)
F_2 = Force of spool return spring – lbs (daN)
V_{st} = Pilot flow to open valve – in^3 (cm^3)

Connection model "K"



2) Decompression poppet not included in the model "without decompression" (SF...0...)

Size	A_1 in^2 (cm^2)	A_2 in^2 (cm^2)	A_3 in^2 (cm^2)	s_1 in (mm)	s_2 in (mm)	F_1 lbs (daN)	F_2 lbs (daN)	V_{st} in^3 (cm^3)
125 5"	15.7 (101)	0.39 (2.54)	3.82 (24.63)	1.10 (28)	0.75 (19)	49.5 to 80.9 (22 to 36)	261 to 513 (116 to 228)	2.86 (46.8)
150 6"	23.9 (153.93)	0.59 (3.8)	5.96 (38.48)	1.38 (35)	0.91 (23)	78.7 to 128 (35 to 57)	438 to 798 (195 to 355)	5.40 (88.5)
200 8"	33.6 (216.42)	0.76 (4.9)	7.79 (50.26)	1.66 (42)	1.06 (27)	110.2 to 170.8 (49 to 76)	553 to 1021 (246 to 454)	8.28 (135.7)
250 10"	57.9 (373.25)	1.49 (9.62)	14.7 (95.03)	2.09 (53)	1.30 (33)	196 to 321 (87 to 143)	1070 to 1632 (476 to 726)	19.1 (313.6)
300 12"	88.8 (572.6)	2.15 (13.85)	22.2 (143.14)	2.48 (63)	1.49 (38)	335 to 591 (149 to 263)	1610 to 2482 (716 to 1104)	33.2 (543.9)
350 14"	128.1 (826.57)	3.29 (21.24)	33.1 (213.83)	3.07 (78)	1.81 (46)	490 to 872 (218 to 388)	2417 to 3507 (1075 to 1560)	60.0 (983.6)
400 16"	179.5 (1158)	4.98 (32.16)	48.7 (314.16)	3.66 (93)	2.09 (53)	744 to 1401 (331 to 623)	3577 to 5164 (1591 to 2297)	103.6 (1665)

Accumulators

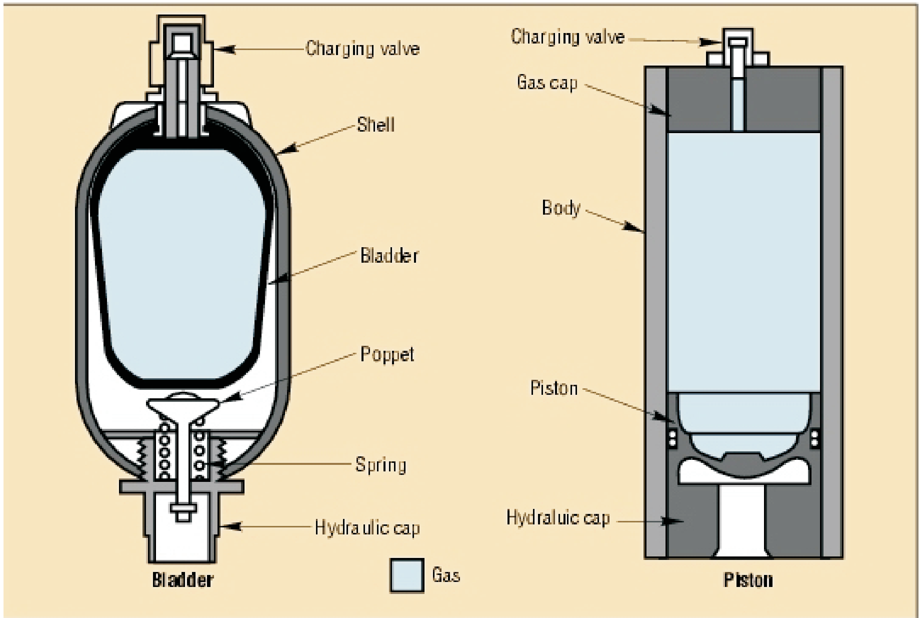


Fig. 1. Cross-sectional views of typical of bladder and piston-type accumulators.

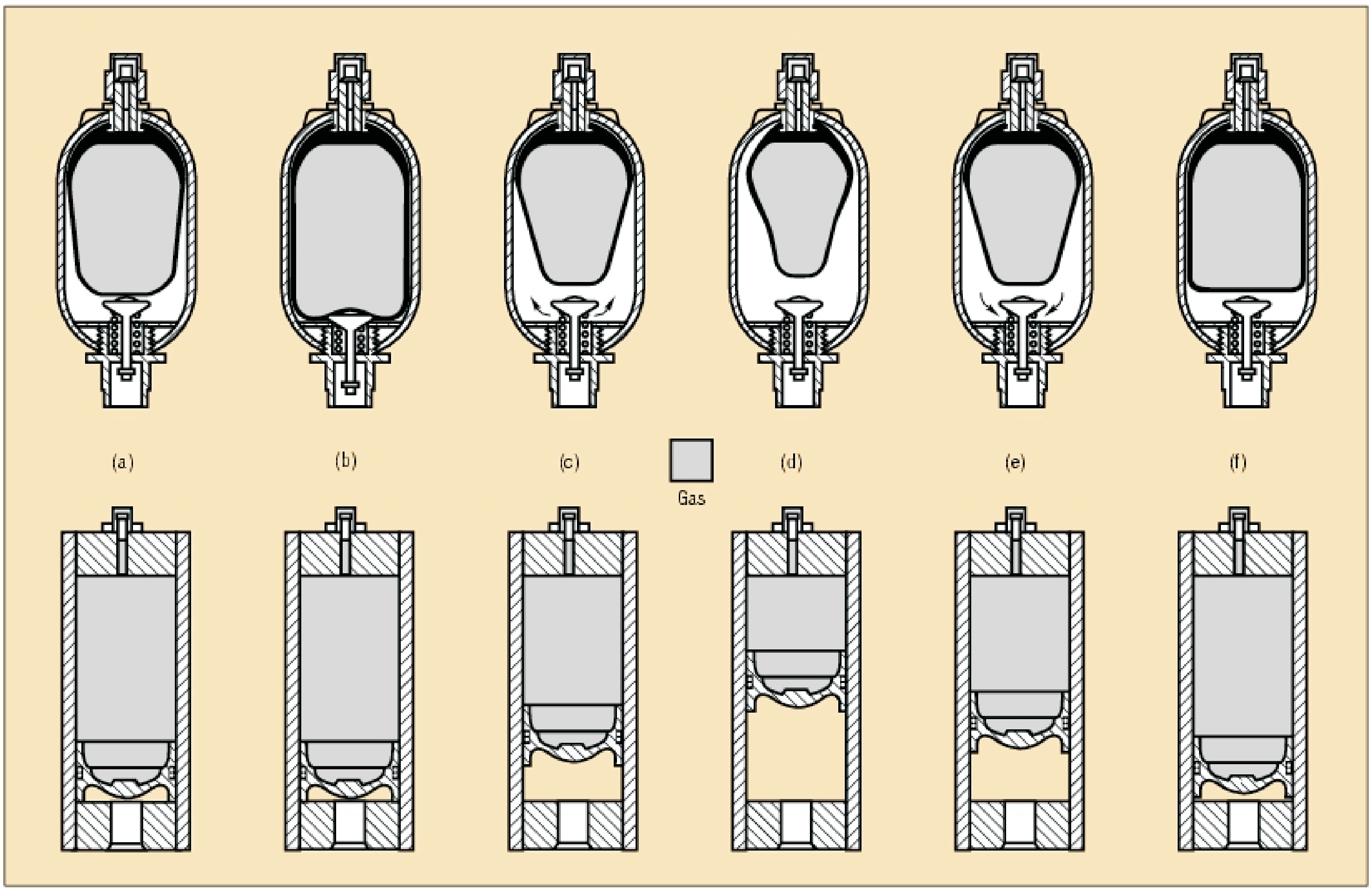


Fig. 2. Six stages of operation accumulators: stage (a), accumulator is empty — no gas charge; stage (b), accumulator has been precharged with dry nitrogen; stage (c), system pressure exceeds precharge pressure, and hydraulic fluid flows into accumulator; stage (d), system pressure peaks, maximum fluid has entered accumulator, and system relief opens; stage (e), system pressure drops, precharge pressure forces fluid from accumulator and into system; and stage (f), system pressure reaches minimum needed to do work.

Accumulators

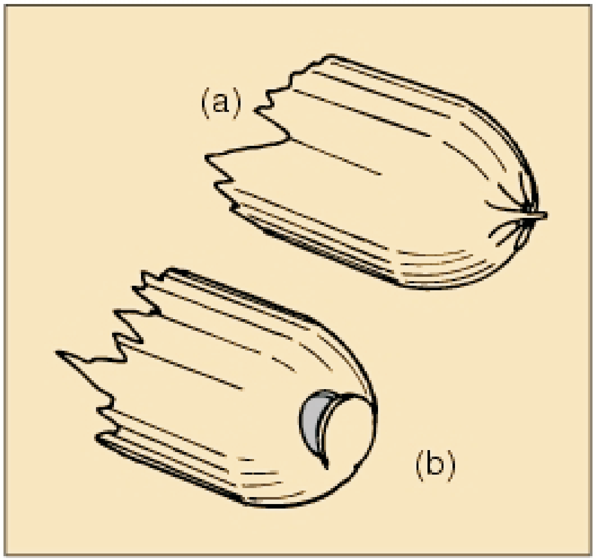


Fig. 10. Starburst rupture in end of bladder, (a), could indicate loss of elasticity of bladder material due to embrittlement from cold nitrogen gas during precharge. If bladder is forced under poppet, (b), bladder could sustain C-shaped cut from poppet.

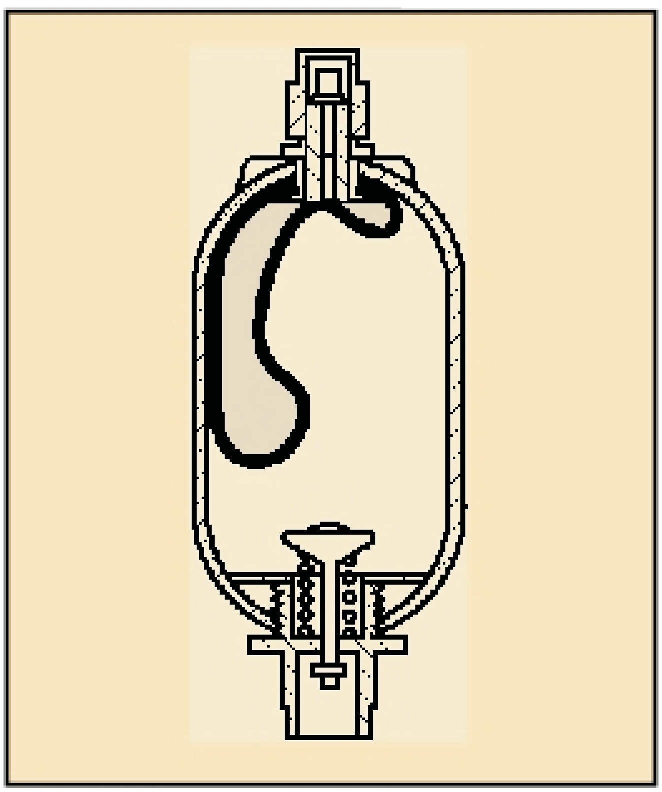


Fig. 11. Pressure fluid in uncharged accumulator, could crush bladder or extrude it into gas valve and puncture it.

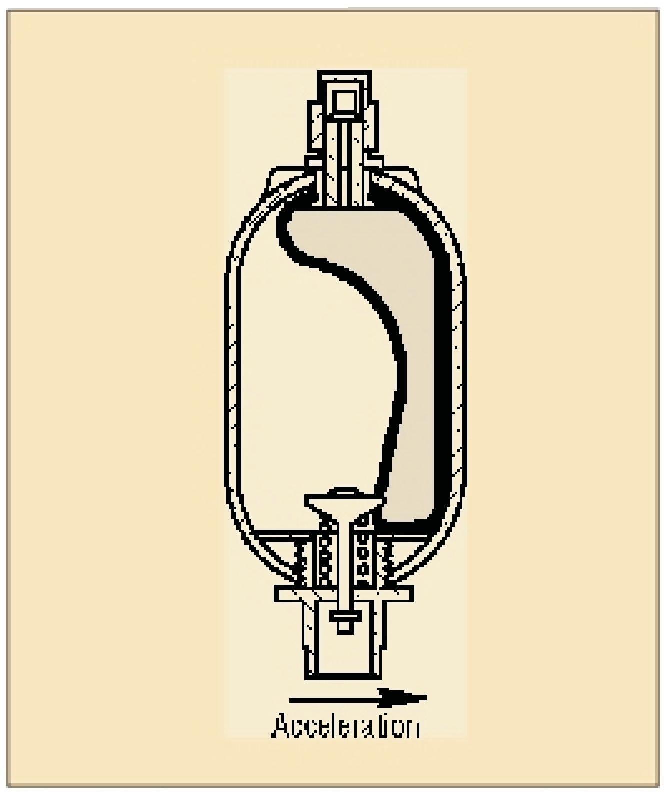
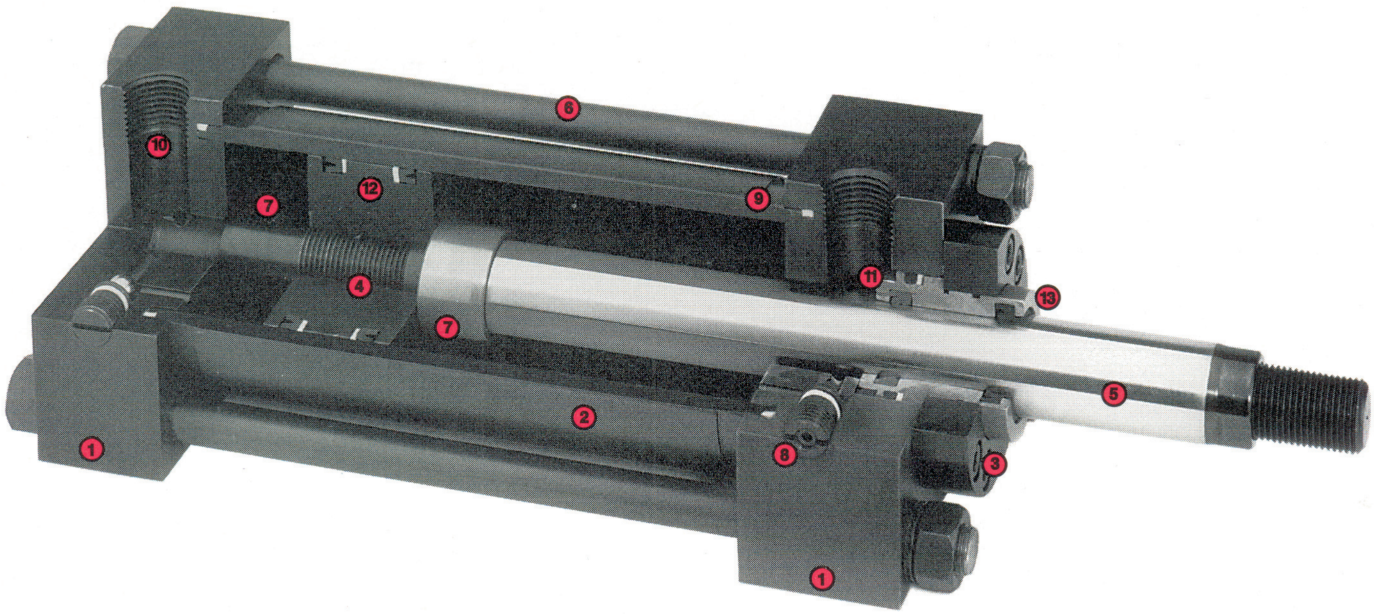
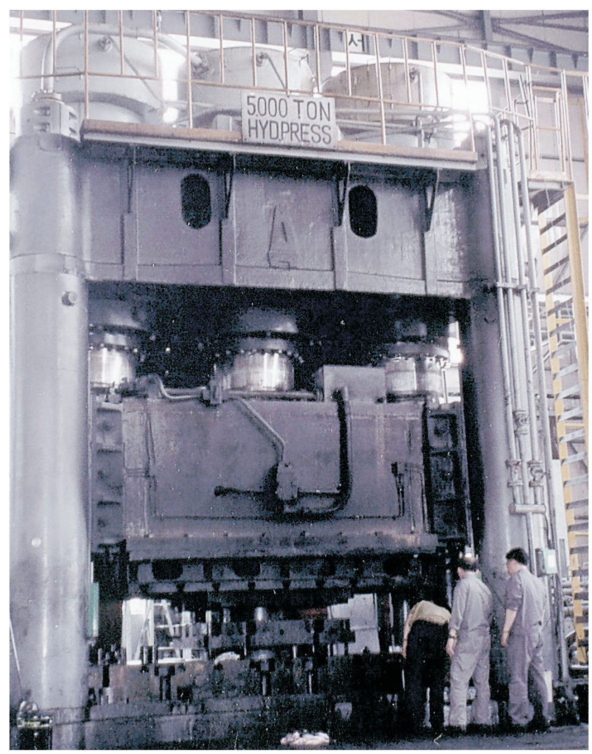


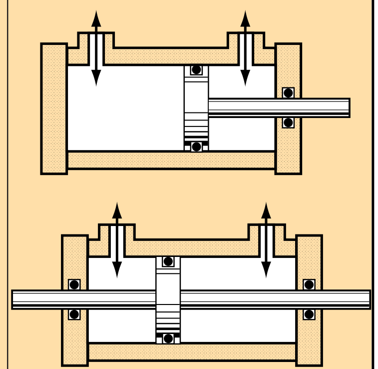
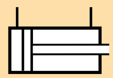
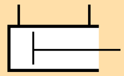
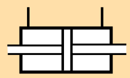
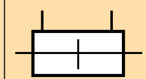
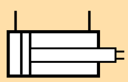
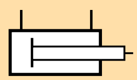
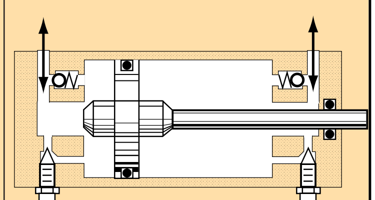
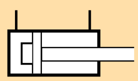
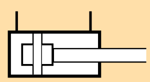
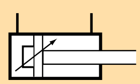
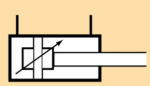
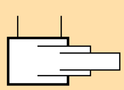
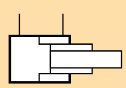
Fig. 12. Forces applied perpendicular to bladder accumulator vertical axis can distort bladder and risk puncturing it.

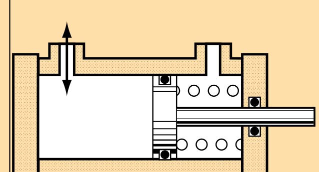
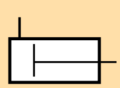
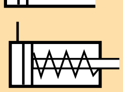
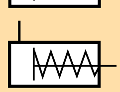
Cylinders



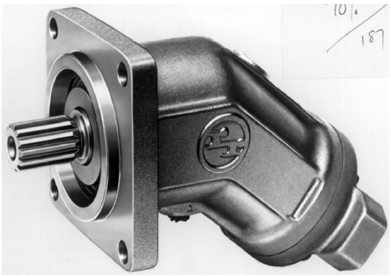


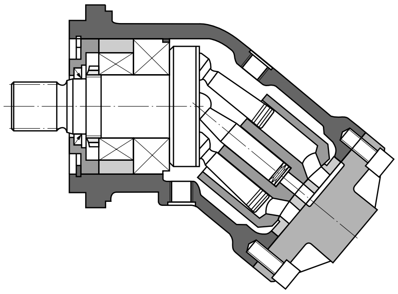
Symbols For Cylinders

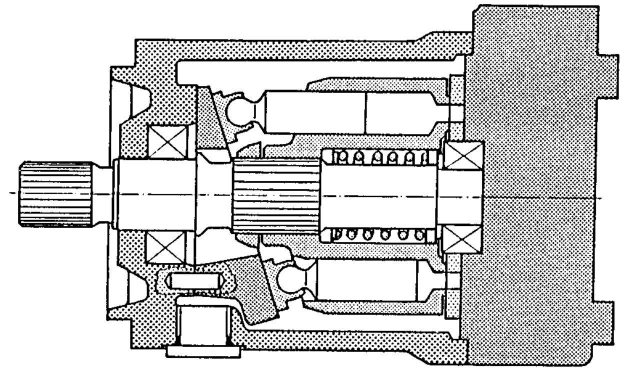
6.5.2	**Double acting cylinder:**			Cylinder in which pressure fluid operates alternately in both directions (extend and retract strokes)	
6.5.2.1	— with single piston rod				
6.5.2.2	— with double-ended piston rod				
6.5.3	**Differential cylinder**			The action is dependent on the difference between the effective areas on each side of the piston	
6.5.4	**Cylinder with cushion:**				
6.5.4.1	— with single fixed cushion			Cylinder incorporating fixed cushion acting in one direction only	
6.5.4.2	— with double fixed cushion			Cylinder with fixed cushion acting in both directions	
6.5.4.3	— with single adjustable cushion			The symbol is a combination of 6.5.4.1 and 5.2.3 (sloping arrow)	
6.5.4.4	— with double adjustable cushion			The symbol is combination of 6.5.4.2 and 5.2.3 (sloping arrow)	
6.5.5	**Telescopic cylinder:**				
6.5.5.1	— single acting			The fluid pressure always acts in one and the same direction (on the extend stroke)	
6.5.5.2	— double acting			The fluid pressure operates alternately in both directions (extend and retract strokes)	

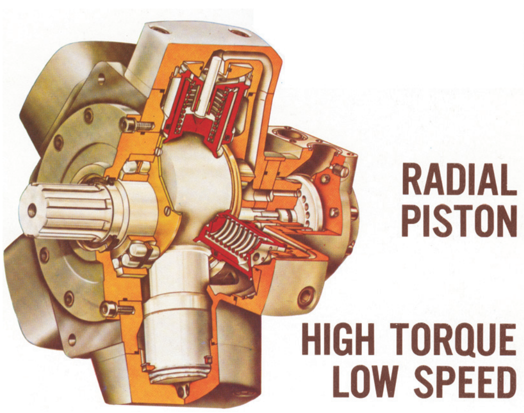
		Detailed	Simplified		
6.5.1	**Single acting cylinder:**			Cylinder in which the fluid pressure always acts in one and the same direction (on the extension stroke)	
6.5.1.1	— returned by an unspecified force			General symbol when the method of return is not specified	
6.5.1.2	— returned by spring			Combination of the general symbols 6.5.1.1 and 5.1.5.2 (spring)	

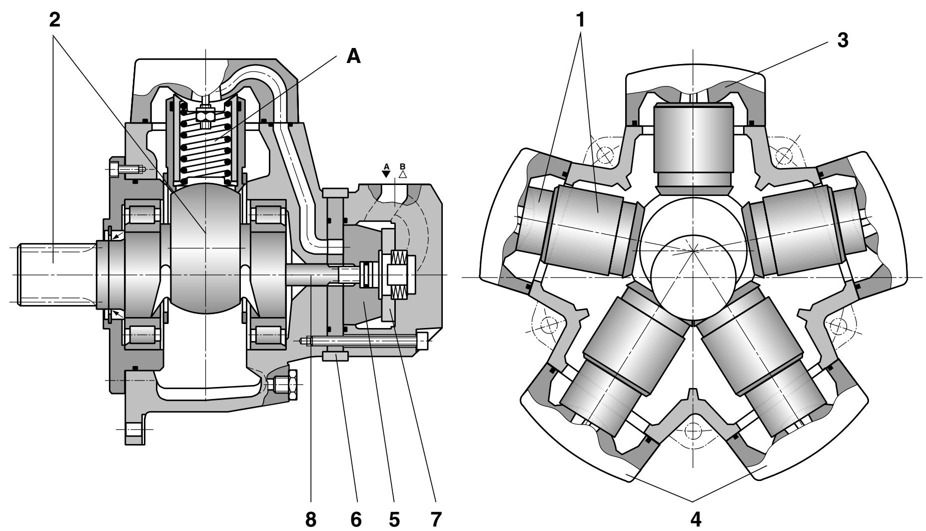
Motors











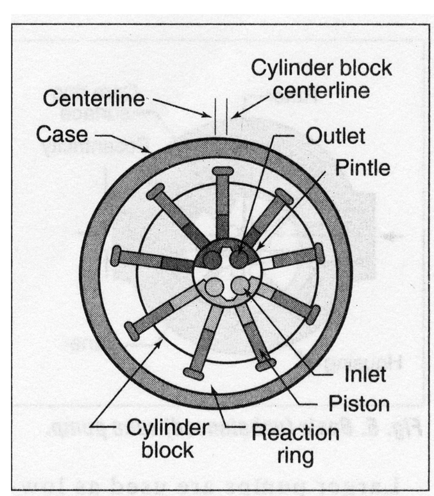
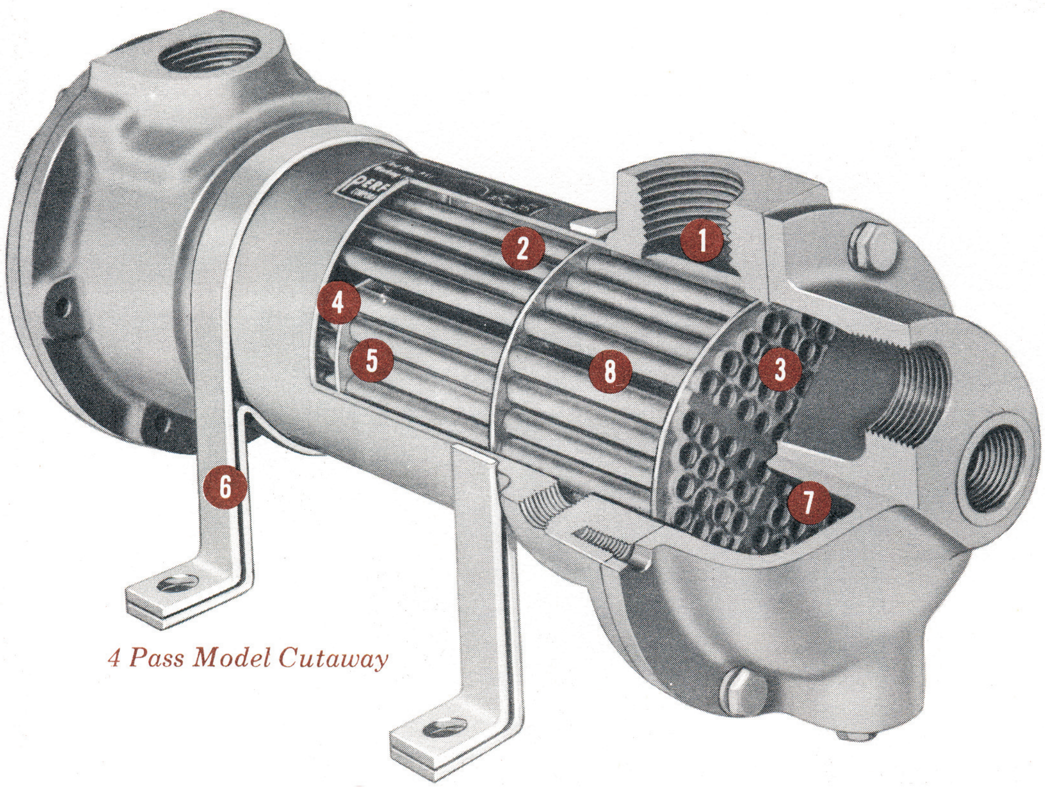


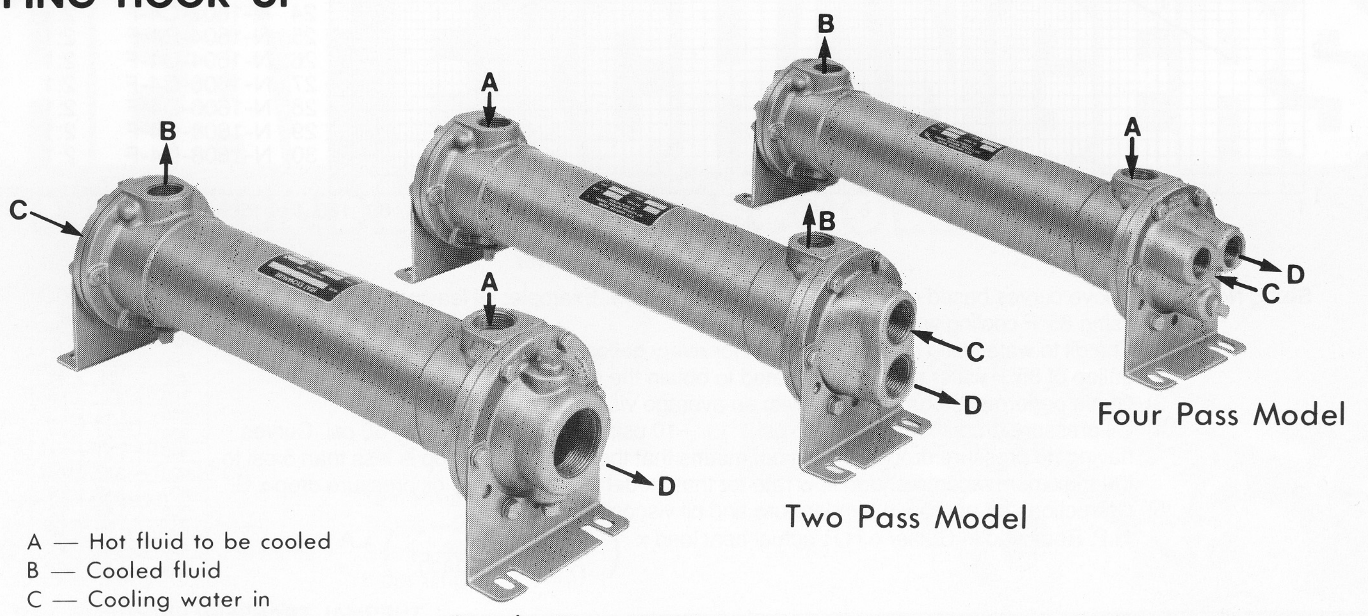
Fig. 9. Radial piston pump.

Heat Exchanger



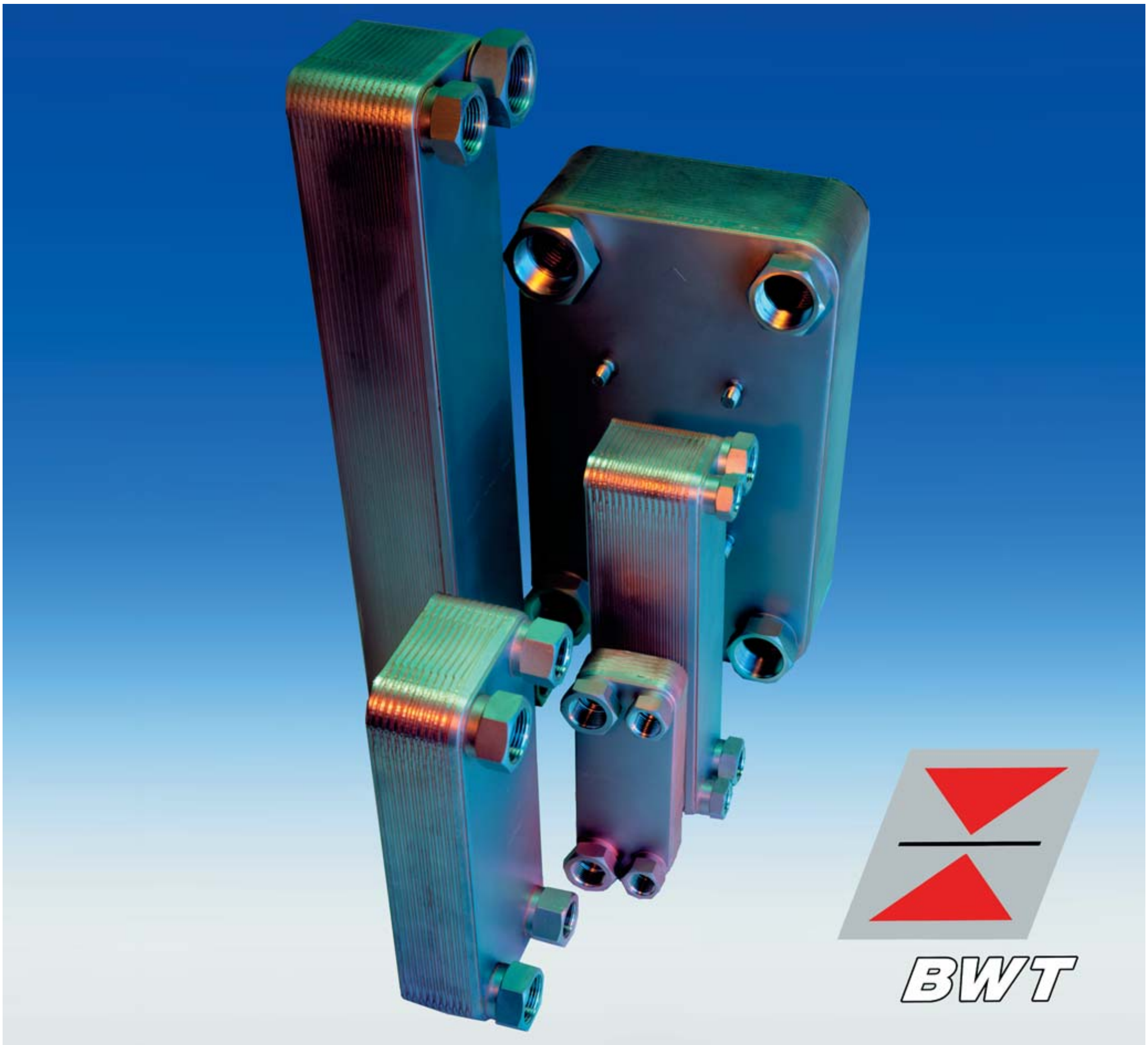
4 Pass Model Cutaway

PIPING HOOK UP



A — Hot fluid to be cooled
B — Cooled fluid
C — Cooling water in
D — Cooling water out

Oil / Water Cooler
Series BWT

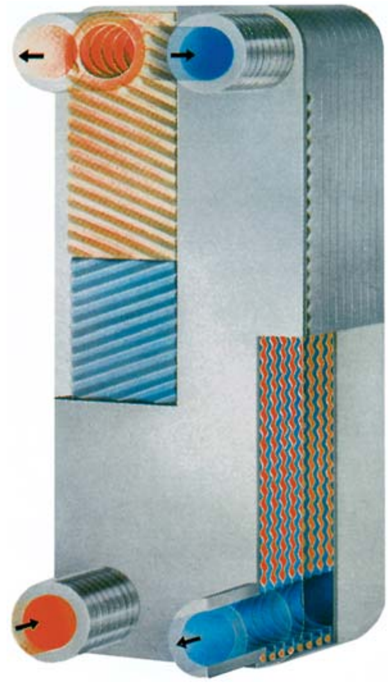


- High exchange efficiency
- Equally distributed turbulent flow
- Little installation space required
- High fatigue life
- Low water consumption
- Maintenance free
- Broad temperature range
- Easy installation

Bühler Technologies GmbH
D - 40880 Ratingen, Harkortstr. 29
Tel.: + 49 (0) 21 02 / 49 89-0   Fax: + 49 (0) 21 02 / 49 89-20
e-mail: fluidcontrol@buehler-ratingen.com

Why Coolers?

There are basically two main concepts in the development of fluid power systems. One is to design systems minus a cooler and if the operational conditions show in practice that the system needs a cooler to install it later.
This however requires compromises that usually result in financial overspend.
The other concept recognises that a system originally designed with an integrated cooler can be built more compact, needs less installation space and runs more reliable due to the stabilized temperature of the fluid.

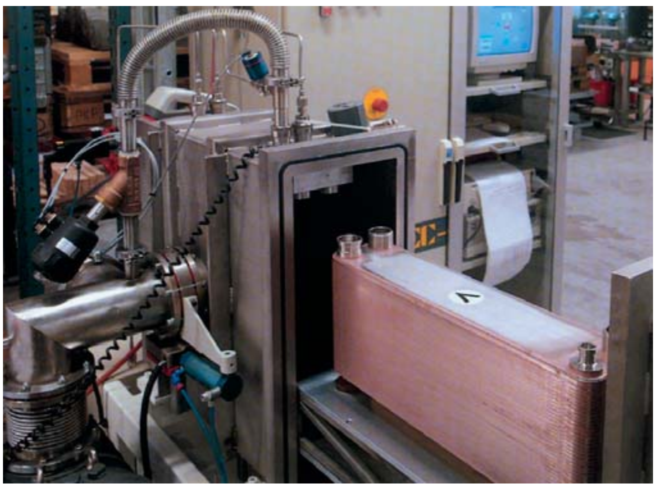


Why Bühler?

Since water is becoming a precious resource, significantly reduced water consumption is favoured by the system designers. After over 25 years experience in design and sales of traditional tube and shell heat exchangers Bühler recognised that a new concept was required to meet the increasing demand for water conservation.
The plate heat exchanger fulfills this requirement particularly for the fluid power market.
In cooperation with a well-known international manufacturer of plate heat exchangers, Bühler has developed a comprehensive range of braced plate coolers specifically for fluid power applications. Bühler has been offering this new concept of oil / water coolers now for over five years with increasing recognition and success.

If our comprehensive standard range of products does not have an answer for your application we will be pleased to find special solutions for your application.

The data contained in this leaflet is sufficient to determine the right cooler for your application. However, we can offer you a software which makes this sizing easier.



Description

The BWT oil / water coolers consist of a number of profiled stainless steel plates. The direction of the profile is reversed on every other plate so that the ridges on adjacent plates intersect with another forming a network of contact points. The subsequent brazing process creates a very compact and pressure resistant package, which virtually utilizes all material for heat transfer.
Compared with traditional systems the complex geometry of the BWT plate cooler provides a highly turbulent flow with very equal distribution resulting in an outstanding heat transfer efficiency. Even at lower velocities a turbulent flow is insured which is constantly changing direction due to the profile and thus disturbing the boundary layer.
BWT plate coolers are much less prone to fouling than coolers of traditional design thanks to the smooth surface quality of the cooler plates and the turbulent flow. Experience shows that fouling is not a problem in plate coolers providing the application parameters have been indicated correctly.