

Operation instructions for axial piston variable displacement pumps type V30D

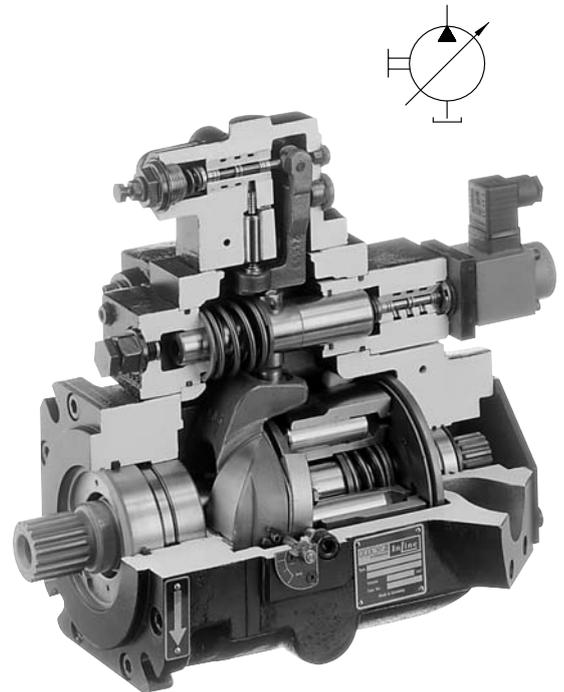
acc. to pamphlet D 7960 and D 7960 Z

In/line

1. Pump installation

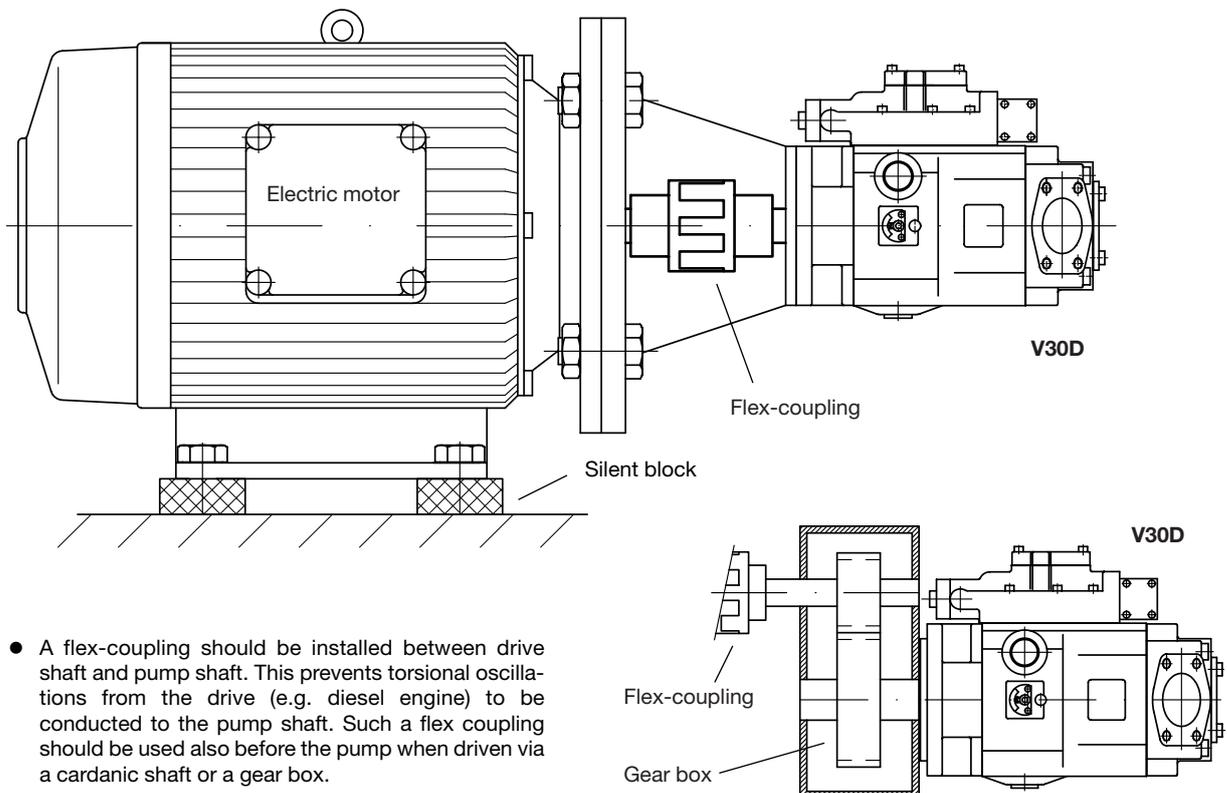
The following interfaces have to be connected for installation of a hydraulic pump in a hydraulic system:

- Mechanical connection of the pump housing to the basic flange
- Flexible coupling of the pump-shaft to a driving motor
- Flexible hose connection of the pump-suction flange to the oil tank
- Flexible hose connection of the uppermost positioned drain port to the oil tank
- Flexible hose connection of the pressure port to directional valves or direct consumers
- Flexible hose connection from remote control to pilot valve
- Flexible hose connection to a auxiliary pump when a flow controller is specified
- Electrical connection to the solenoid in case of electro-proportional control
- Hydraulic connection to the tank for bleeding the pump housing when installed with erect pump drive shaft



2. Execution of interfaces between pump and system

- The mechanical connection of the pump housing to the drive motor flange, a gear box or a bell housing should be direct and solid, usually without any flexible parts in-between. This way the housings of drive motor and pump form one unit which itself should rest on silent blocks.



- A flex-coupling should be installed between drive shaft and pump shaft. This prevents torsional oscillations from the drive (e.g. diesel engine) to be conducted to the pump shaft. Such a flex coupling should be used also before the pump when driven via a cardanic shaft or a gear box.

HAWE
HYDRAULIK

HAWE HYDRAULIK SE
STREITFELDSTR. 25 • 81673 MÜNCHEN

B 7960
Service instruction V30D

2.1 Suction line, self-priming pump

The suction line i.D. must be greater than the suction flange of the pump.

The internal diameter should be increased by 1 cm/m of the suction line. The largest cross-section of the whole suction line should be the tube end in the tank. The end of the suction tube in the tank should be cut off at an angle of 45° or shaped like an open funnel. With several suction tubes in one tank the minimum distance has to be 5 x d. The tube end should be a minimum of 8xd below the fluid level and 2 x d above the tank bottom.

The passages from one diameter to a different one should be made with a slim cone. Tube bendings should be done with a maximum possible radius. Built-in shut-off valves must not reduce the inner diameter of the suction tube.

If several suction lines are connected to one main tube the cross-section of the main one must be at least the sum of the side-line's cross-sections. The passages from the main tube to the side-lines should be made with conical parts which do not interfere with the neighboring cross-sections.

The suction line close to the pump should be made with a hose or a rubber compensator.

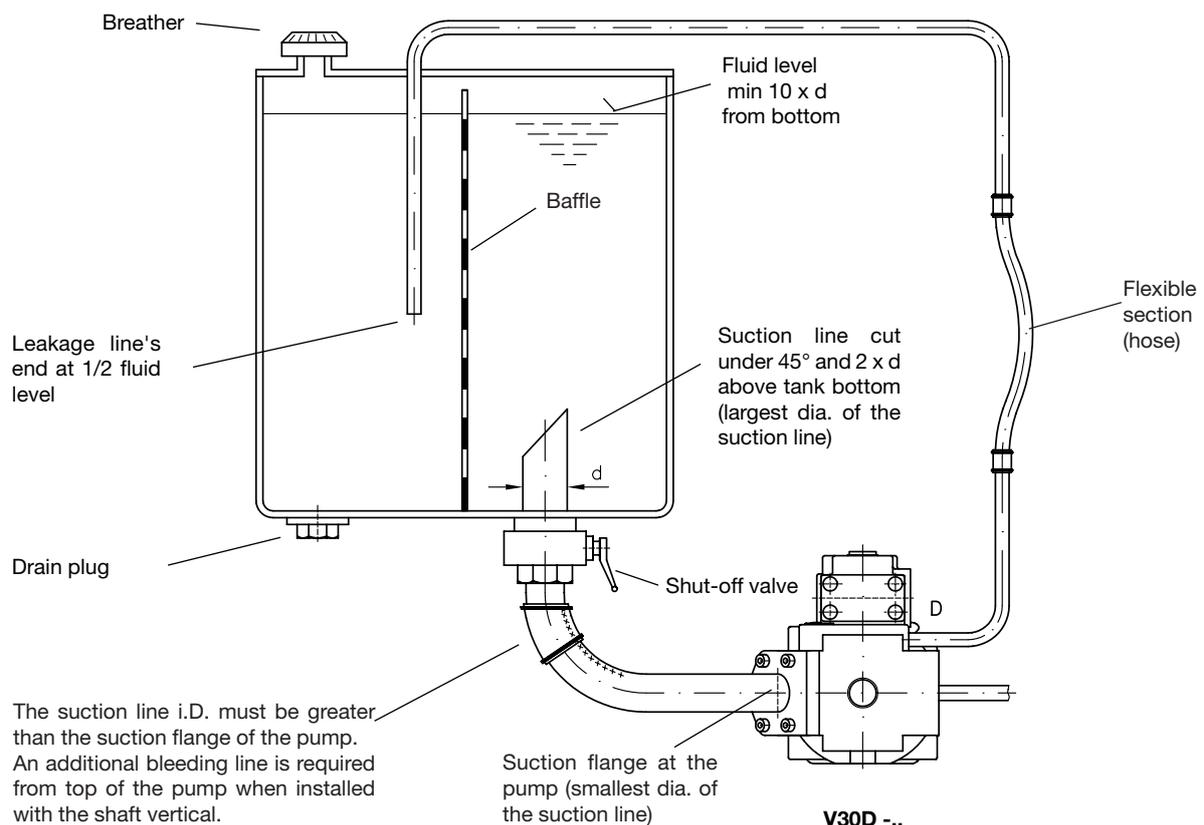
It is important for the position of the compensator that the axis of the pump and compensator lies in the same plane. This ensures that the stress on the compensator which is caused by torsional oscillations of the pump is lateral and not longitudinal. This is because longitudinal stress on a compensator can cause cavitation and noise.

● Tank

The tank should have several, but minimum 2 chambers which are divided by baffles. This is to ensure that the return and leakage oil can be separated from the suction inlet. This is advantageous as contamination can settle down and the air bubbles can rise to the surface.

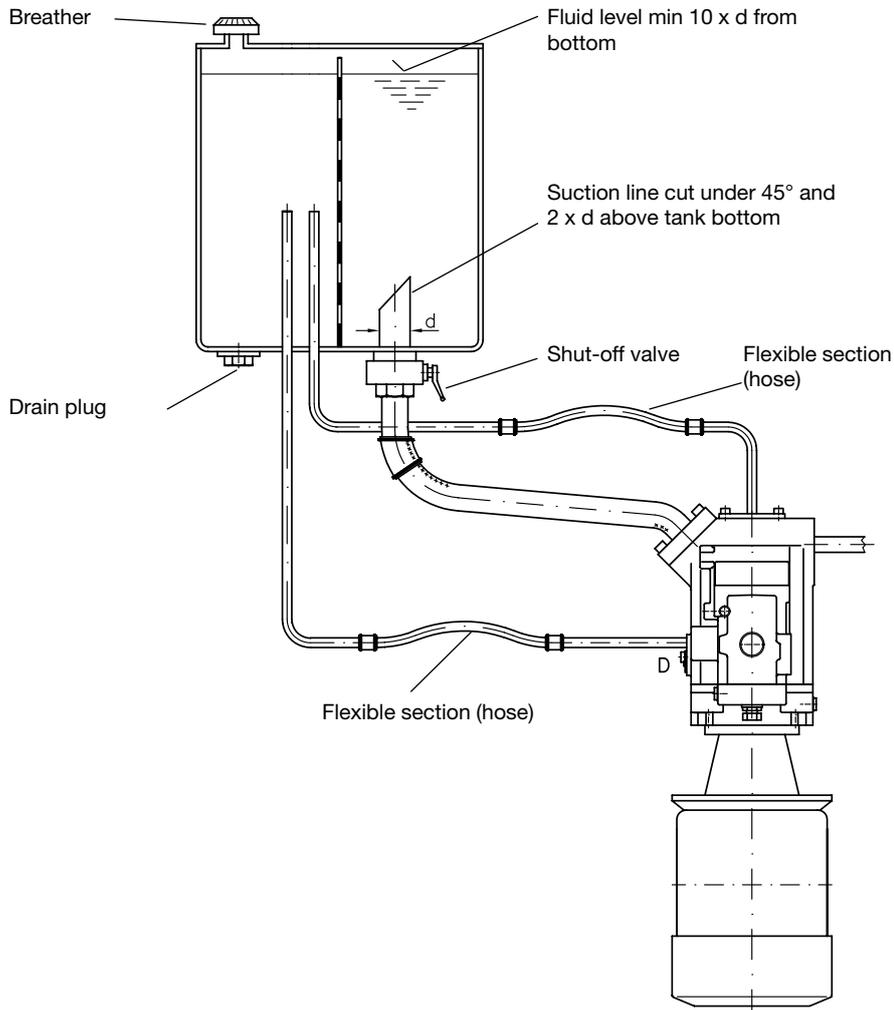
Filter and cooler should be positioned in the return line or in a auxiliary circuit. A sufficiently dimensioned breather should be used, i.e. the air flow at 0.1 bar diff. pressure should be the same as the maximum oil flow.

The fluid level in the tank should be always above the suction port of the pump with self-priming pumps. Basically the suction line should be routed straight from the tank to the pump, however, it is better to have it hanging like an arch so that the air can quickly rise to the tank and pump. It would be wrong to have one or more vaulted arches because then the air would collect in the vertices, This could cause noise and cavitation and it would take some time before the air is totally flushed out.



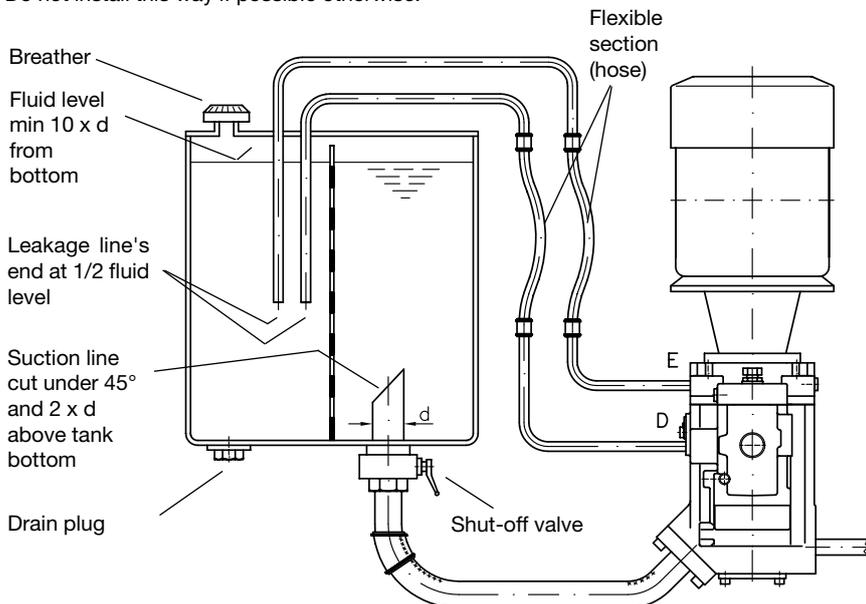
2.2 Drain line

- There is no bleeding port with standard pumps, when the drive side is facing downwards. A special end cover can be ordered for such cases. Drain and bleeder lines must never be reduced. In case any lines are added the main diameter has to be increased accordingly. The drain and bleeder lines should end roughly at 1/2 fluid level in the tank.



- The housing of the pump has 2 to 3 drain ports. The highest located drain port should be used in standard pump positions with a horizontal shaft.
- An additional bleeding connection at the top end of the pump is required with pump positions with a vertical shaft. Port 'E' (1/4") at the camplate bearing is used, when the drive side of the pump is situated on top.

Do not install this way if possible otherwise!



3. Control employing the pump as regulation

The controllers directly mounted at the pump measure the values in the hydraulic system and correct deviations by adjusting the displacement of the pump accordingly.

The following system values are controlled:

- System pressure
- Pressure drop via an orifice in the system (flow control)
- Product of displacement and pressure in the system (torque and power control)

The characteristic of these control values depends not only on the pump but also on the design of the whole circuit, including the kind of load. It is therefore necessary for the controller to be tuned for the corresponding circuit and the respective load characteristic.

Three different kinds of circuits are to be distinguished:

- Short lines, mainly pipes with small pressurized oil capacity
- Long lines, mainly hoses with large pressurized oil capacity
- Long lines with big gas accumulator and large pressurized oil capacity

3.1 Initial operation

All suction lines, pumps, and hydraulic motors should be properly primed and bled prior to initial operation of the hydraulic circuit.

The pressure controller of the pump and the main pressure limiting valve should be set almost to zero for safety reasons.

This will cause the system pressure to be rather low easing bleeding of the complete circuit and lubricating all moving parts.

After 5-10 minutes most of the trapped air will be flushed out and the pressure can be gradually increased using the pressure control and the main limiting valve.

The final setting of the main limiting valve the pressure has to be 30 - 40 bar higher than the nominal pressure. The main pressure limiting valve should be fixed and the nominal pressure is set at the pressure control.

3.2 Pressure control (constant pressure systems)

a) Simple pressure control via pressure controller type N

A simple controller type N is ideally suited for small circuits, mainly piped. It shows only minor amplification as its strong measuring spring bears the whole pressure force of the control spool. Amplification here means the control valve opening per pressure deviation.

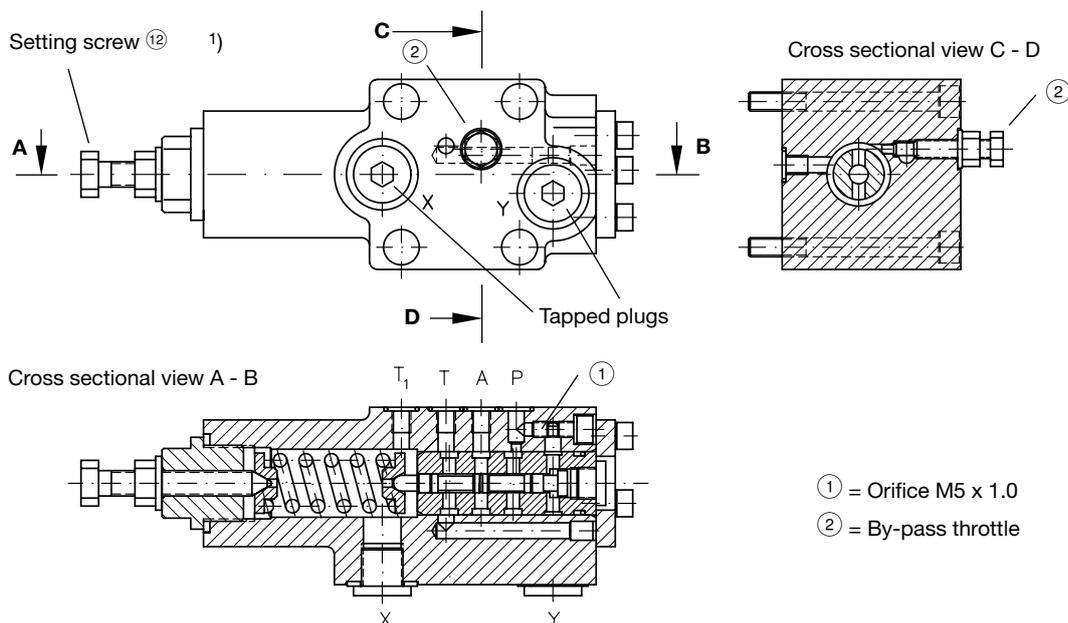
A weaker spring should be used for pressure below 250 bar as the pre-load of a strong 400 bar spring prevents full stroke to the control spool below 150 bar (type N400 / N250).

The controller type N features a by-pass throttle ② enabling fine tuning to the circuit and stabilization. The throttle is factory set at 1/4 - 1/2 turn open. This is suitable for the frequent middle sized pressurized fluid capacities of approx. 2.5 l. The by-pass throttle should be opened further with smaller pressurized fluid capacities while it should be closed a bit further with larger pressurized fluid capacities to enhance the control accuracy.

A drain orifice can be mounted when oscillations do still occur despite bypass adjustment.

This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable controller combinations to be dampened (see illustration in sect. 3.5). When the controller piston housing is prepared for fitting of a power controller, the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V30D-250). This drain orifice slows down the response of the pump thereby dampening oscillations.

Pressure controller type N and ND



1) **Attention:** The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!

● Adjustment of controller type N (non piloted)

The starting positions of the adjustment screws are as follows:

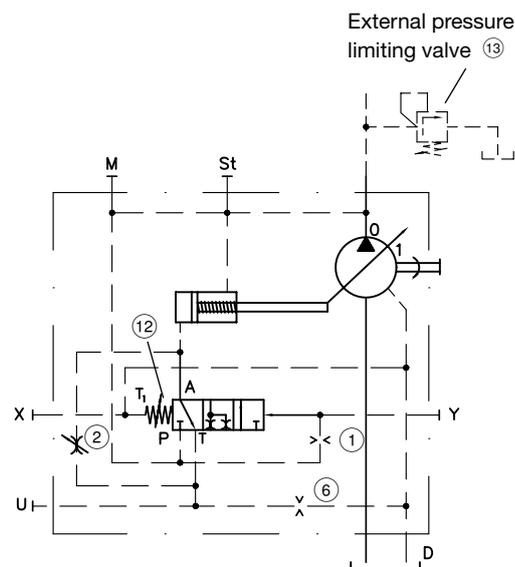
- Adjustable bypass throttle ② 1/4 ... 1/2 turn open
Tools: spanner 10 mm
- Drain orifice ⑥ (see sect. 3.5)
Remove tapped plug "U" (M6) and check the orifice for contamination when installed.
Tools: Allan key 5 mm and 3 mm
- Pressure adjustment screw ⑫
Undo the locknut and rotate the adjustment screw anti-clockwise until the controller spring is totally unloaded.
Tools: 2 spanners 13 mm

Attention: The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!

- Check the external pressure limiting valve ⑬ in the pump line, whether a low pressure is set. Turn the screw anti-clockwise when necessary.

Guideline for adjustment

	Δp (bar/turn)
N 250	54
N 400	82



① = Orifice M5 x 1.0

② = By-pass throttle

⑥ = Open, optional orifice M6x1.2 (0.8 ... 1.6)

b) Dampened pressure control with pressure controller type ND

The amplification or signal resolution must be higher than in the system a) when the pressure system is larger utilizing long pipe and hose lines.

The non-piloted pressure controller type ND shares the same spring with type N, but the differing piston features an increased signal resolution.

The pressure from the pump is conducted through the control piston to an annular gap at the spring sided piston guide.

The piston floats due to the pressure in this annular gap, thereby minimizing friction (induced by lateral components of the spring force) between sleeve and piston. This enables the piston to respond even on small pressure deviations causing an increased resolution.

It is also suited for higher pressure systems and systems utilizing gas type accumulators.

A weaker spring should be used for pressure below 250 bar as the pre-load of a strong 400 bar spring prevents full stroke to the control spool below 150 bar (type ND400 / ND250).

The controller type ND features a by-pass throttle ② enabling fine tuning to the circuit and stabilization. The throttle is factory set at 1/4 -1/2 turn open. This is suitable for the frequent middle sized pressurized fluid capacities of approx. 5 l. The by-pass throttle should be opened further with smaller pressurized fluid capacities while it should be closed a bit further with larger pressurized fluid capacities to enhance the control accuracy.

A drain orifice can be mounted when oscillations do still occur despite bypass adjustment.

This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5). When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V 30D-250). This drain orifice slows down the response of the pump thereby dampening oscillations.

Symbol, illustration are like with pressure controller type N (see sect. 3.2.a)

c) Remote pressure control with pressure controller type P

The amplification or signal resolution must be higher than in the system a) when the pressure system utilizes long pipe and hose lines. A remote controlled pressure controller P has a substantially weaker measuring spring and therefore a substantially higher resolution which makes the P controller suitable for larger systems. The pressure range is not limited by the measuring spring because the pressure is determined by the piloting pressure limiting valve.

To attune the controller type P to the circuit and for stabilization purpose it has the bypass throttle ② and a pre-located dampening throttle ③ on the pilot valve. The signal line between controller type P and pilot valve must contain 50 ... 100 ml. The pre-setting of the by-pass throttle is 1/4 - 1/2 turn open. If the circuit is smaller than 5 l the bypass throttle can be opened further whereas it should be closed a bit further with larger pressurized oil capacities.

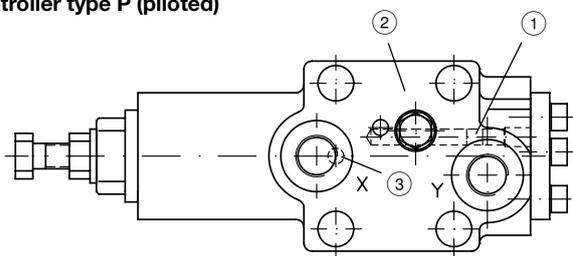
The control flow of the controller type P should be shut off till the pump pressure reaches 50 bar with the pre-located dampening throttle ③ on the pilot valve. At that point the throttle should be fixed.

When the controlled pressure range is intended to be lower than 50 bar, the oil capacity of the signal line must be at the upper limit of the appropriate capacity (100 ml). This way the pressure can be adjusted down to 25 - 30 bar without oscillations.

Should oscillations appear in spite of bypass adjustment, pre pilot throttle adjustment and appropriate capacity in the signal line a drain orifice ④ can be installed. The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V 30D-250).

This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5). When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". This drain orifice slows down the response of the pump thereby dampening oscillations.

Adjustment of pressure controller type P (piloted)

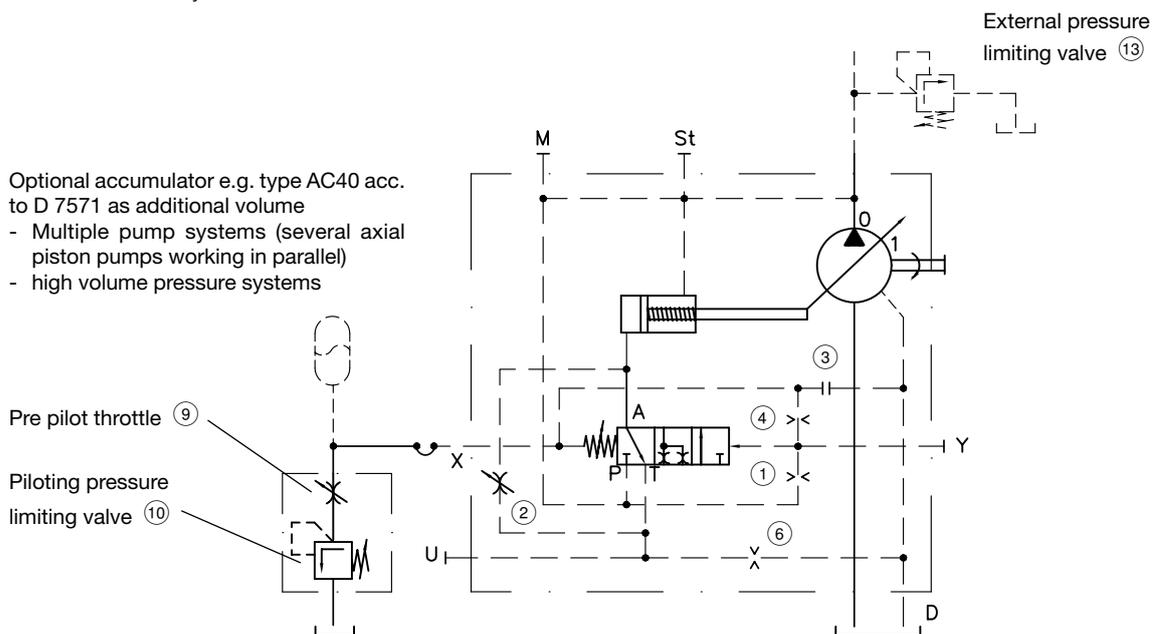


- ① = Orifice M5x1.0
- ② = By-pass throttle
- ③ = Grub screw M6
at T₁ (see illustration in sect. 3.2.a)

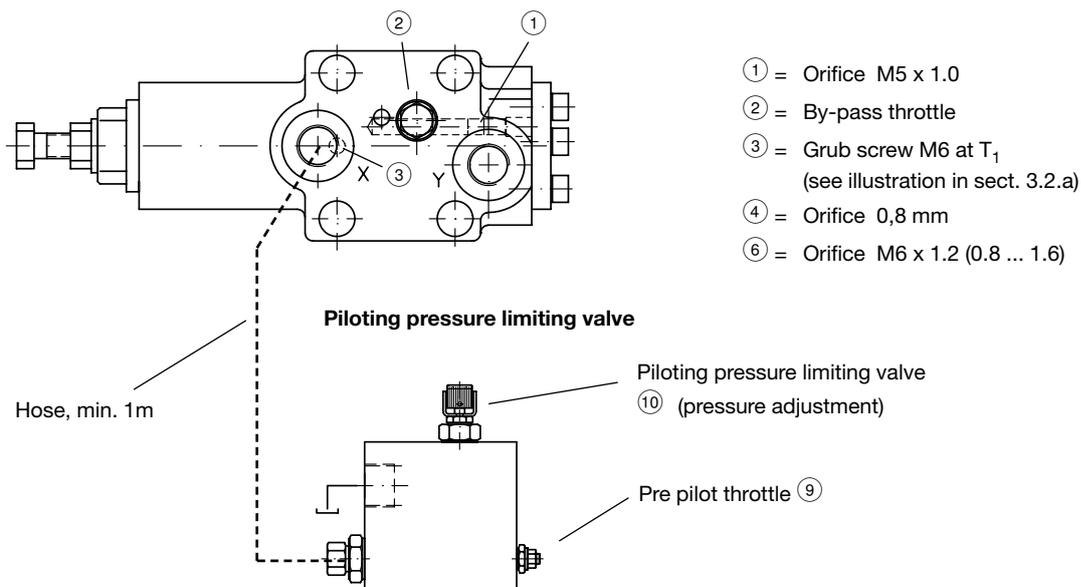
● **Adjustment of pressure controller type P (piloted)**

The starting positions of the adjustment screws are as follows:

1. Adjustable bypass throttle ②:
1/4 .. 1/2 turn open
Tools: Spanner 10 mm
2. Drain orifice ⑥ (see sect. 3.5):
Remove tapped plug "U" (M6) and check the orifice for contamination when installed.
Tools: Allan key 5 mm and 3 mm
3. Pre pilot throttle ⑨
Undo the locknut and turn the throttle needle anti-clockwise until it's 1 to 2 turns open
Tools: Allan key 4 mm and spanner 13 mm
4. Pressure adjustment screw ⑩
Undo the locknut and rotate the adjustment screw anti-clockwise until the controller spring is totally unloaded.
Tools: 1 spanner 13 mm
5. Check the external pressure limiting valve ⑬ in the pump line, whether a low pressure is set. Turn the screw anti-clockwise when necessary.



Pressure controller P



d) Remote pressure control for large circuits with pressure controller type Pb

(Pressure controller type ND with direct pressure reduction may be used as well, see sect. 3.2.b)

The measuring resolution must be even better for large circuits with big gas type accumulators than in system c), because the system pressure depends on the momentary filling grade of the accumulators and corresponds with that direct to the gas pressure. The compressibility is according to the relation of gas /oil amount with the factor 10 to 100 weaker than the compressibility of pure oil.

The measuring task of the pressure control becomes even more difficult when a check valve is installed (as in most of these cases) between pump and accumulator system. This check valve may close in bad cases and momentarily disconnect the pump from the system, which can lead to permanent oscillations.

Out of these reasons an additional signal port was added to the controller type P, enabling a more accurate measuring of the system pressure. This special controller is called Pb.

The special signal port Y is connected via a T-connector directly to the pressure side of the control spool where two signal lines can be connected (between pos. ① and ④). The first line comes from the pressure port of the pump and can quickly inform the controller type Pb about the setting response of the pump.

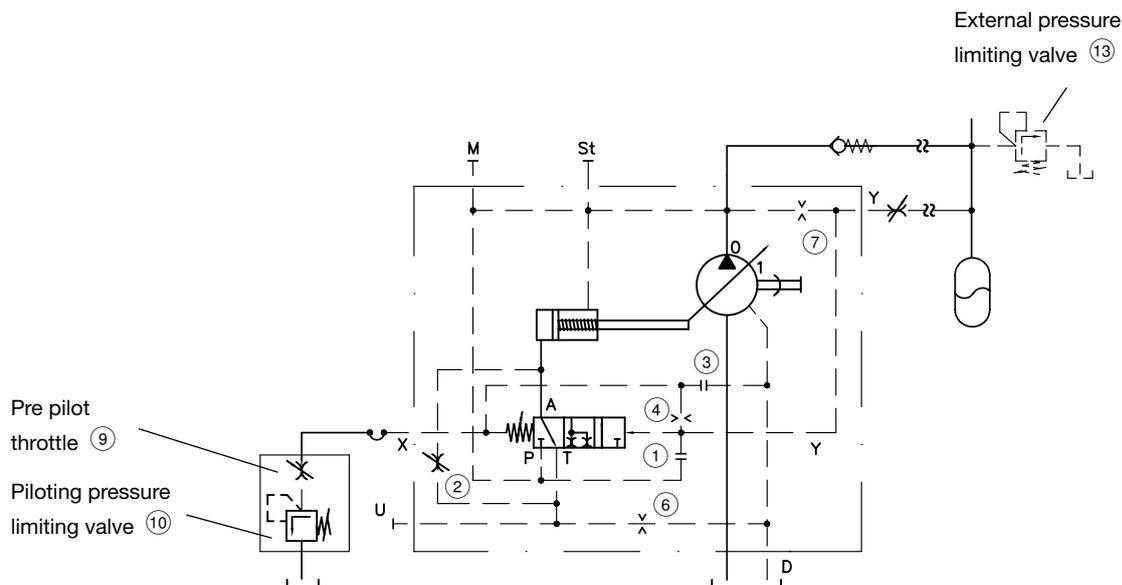
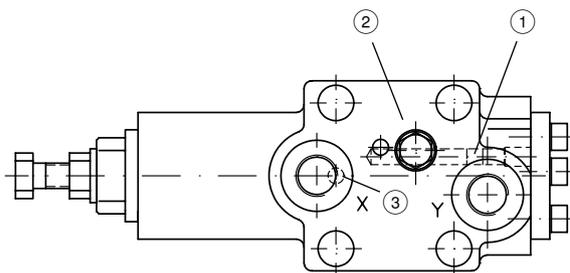
The second signal line connects the controller type Pb to the circuit behind the check valve of the main line. This way the controller type Pb is permanently informed about the pressure in the whole system and can respond on even the slightest deviations. Both signal lines are joint ahead of the controller type Pb and the pressure measuring side of the spool therefore gets a mixed pressure. That means an additional possibility to influence both lines with orifices differently. Thus it is possible to attune the controller type Pb optimally to the circuit. A stronger throttling of the signal line from the pressure port (orifice ⑦) has the effect that the pump is quicker on the up-stroke and slower on the down-stroke. Similarly the pump is slower stroking up and quicker stroking down if the signal line of the system is throttled stronger.

Also the controller type Pb features the standard bypass throttle and the pre-located dampening throttle on the pilot valve for stabilization and attuning to the system. While the bypass throttle is pre-adjusted to 1/4 -1/2 turn open, the pre-located throttle in the pilot signal line must be closed so far that the pump pressure reaches 50 bar with open pilot limiting valve.

The capacity of the signal line should be roughly 1% of the main line to ensure that the resonance characteristic of both match. The same applies to the accumulator. This way even pressure down to 25 ..30 bar can be set without oscillations.

Should there still be oscillations in spite of all these measures a drain orifice ⑥ should be installed. The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V30D-250).

This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5). When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". This drain orifice slows down the response of the pump thereby dampening oscillations.

**Pressure controller type Pb**

- ① = Grub screw M5
- ② = By-pass throttle
- ③ = Grub screw M6 at T1
(see illustration in sect. 3.2.a)
- ④ = Orifice 0.8 mm
- ⑥ = Orifice M6 x 1.2 (0.8 ... 1.6)
- ⑦ = Orifice M6 x 1.8

3.3 Flow control

a) Simple flow control with flow controller type Q

The flow of the pump can be maintained constant independent of the pump shaft speed and the pressure level in the system by means of a pressure-drop control via an orifice. Any consumer with fixed displacement e.g. a hydro-motor will be driven with constant speed independent of its load.

This controller type Q with only one signal line is suited for small systems where the pressurized fluid capacity is approx. 2 l and a static accuracy of $\pm 2\%$ is sufficient.

There is a metering orifice (15) in the main pressure line between pump and hydromotor, which has a pressure drop between 10-15 bar at the desired flow. The diameter for this orifice is calculated as follows: $d \text{ (mm)} = 0,7\sqrt{Q}$ $Q = \text{Flow (lpm)}$.

The diameter determines the flow range which can be fine-tuned via the setting screw of the flow controller.

Downstream this orifice is the port "X2" for the signal line to port "X" at the controller type Q.

The signal line should be a hose with an internal diameter of 1/4" (6 .. 9 mm) and should have an adjustable needle throttle near to the measuring orifice.

For stabilization of the controller type Q there is a throttle (14) e.g. type ED11 acc. to D 7540 or type Q acc. to D 7730, beside by-pass throttle (2) and drain orifice, in the signal line. The needle throttle should be set first with standard setting 1/2 to 1 turn open (a smaller adjustment gives a better dampening).

The standard opening of the bypass throttle (2) is between 1/4 and 1/2 turn. A wider opening has beside the improved dampening effect also influence on the pressure drop of the control and increases it. Since, moreover, the amount of bypass oil increases with rising pressure (load) the opening of the by-pass throttle has more influence with higher pressure which causes an additional growing of the pressure drop. Therefore the output flow of the pump will increase over-proportionally with increasing load of the consumer (hydraulic motor). This influence is used to keep the output speed of consumers (hydro-motor) constant as this will compensate their higher leakage during load via a slightly increased pump delivery.

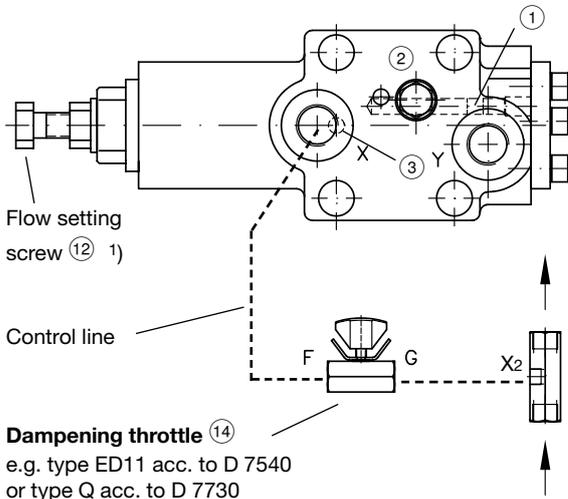
A drain orifice (6) can be mounted when oscillations should still occur in spite of proper adjustment of dampening and by-pass throttle (2). This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5). When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V 30D-250). This drain orifice slows down the response of the pump thereby dampening oscillations.

● Adjustment of flow controller type Q

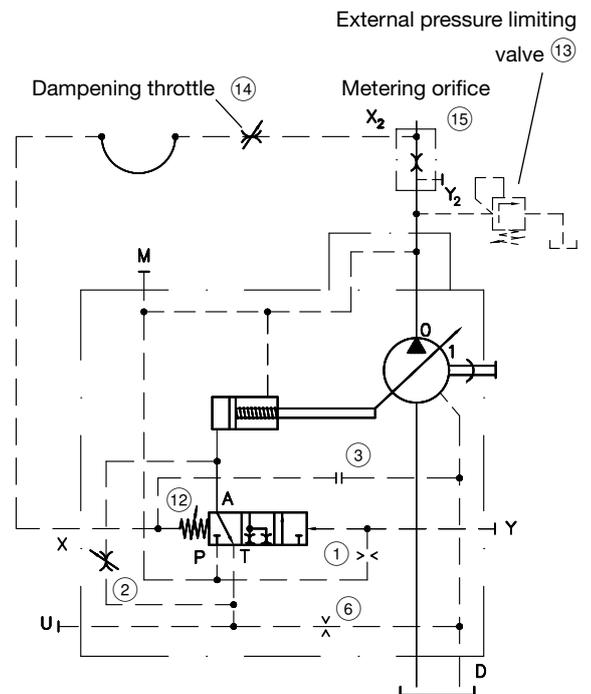
The starting positions of the adjustment screws are as follows:

1. Adjustable bypass throttle (2):
1/4 .. 1/2 turn open
Tools: Spanner 10 mm
2. Drain orifice (6) (see sect. 3.5):
Remove tapped plug "U" (M6) and check the orifice for contamination when installed.
Tools: Allan key 5 mm and 3 mm
3. Flow setting screw (12) 1)
Clockwise rotation increases, anti-clockwise rotation decreases the flow
Tools: 2 spanners 13 mm
4. Dampening throttle (14)
Start with 1 ... 2 turns open
5. Signal line
Hose, internal diameter 1/4" (6 ... 9 mm)
6. Check the external pressure limiting valve (13) in the pump line, whether a low pressure is set. Turn the screw anti-clockwise when necessary.

Flow controller Q



Dampening throttle (14)
e.g. type ED11 acc. to D 7540
or type Q acc. to D 7730



- ① = Orifice M5 x 1.0
- ② = By-pass throttle
- ③ = Grub screw M6 at T₁
(see illustration in sect. 3.2.a)
- ⑥ = Orifice M6 x 1.2 (0.8 ... 1.6)

Guideline for adjustment:
 $\Delta Q \text{ (lpm)} \approx 1.23 \frac{d^2}{\text{turn}}$
($\Delta p = 4.5 \text{ bar/turn}$)
d-Orifice diameter (mm)

1) **Attention:** The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!

b) Flow control with increased accuracy with flow controller type Qb

It is advisable to choose the more accurate controller type Qb for large systems where the pressurized fluid capacity is approx. 3 l and a static accuracy of ± 1 % is required.

The pressure-drop control over a constant orifice maintains a constant pump delivery flow, independent of the pump speed and the pressure level in the system. Any consumer with fixed displacement e.g. hydraulic motor will be driven with constant speed independent of its load.

There is a metering orifice in the main pressure line between pump and hydraulic motor, which has a pressure drop between 10-15 bar at the desired flow. The diameter for this orifice is calculated as follows: $d \text{ (mm)} = 0,7\sqrt{Q}$ Q = Flow (lpm).

The diameter determines the flow range which can be fine-tuned via the setting screw of the flow controller type Qb. Upstream this orifice is port Y₂ for signal connection to port Y of the flow controller type Qb. Downstream of it is the port "X₂" for the signal line to port "X" at the controller type Qb.

Both signal lines should be hoses with an internal diameter of 1/4" (6 ... 9 mm). Line X₂-X should have an adjustable throttle (14) e.g. type ED11 acc. to D 7540 or type Q acc. to D 7730 near to the measuring orifice for stabilization of the controller. The additional Y signal line ensures more accuracy compared to the controller type Q because disturbances of the execution of the main pressure line and of the pump setting do not influence the measuring of the pressure drop directly at the measuring orifice.

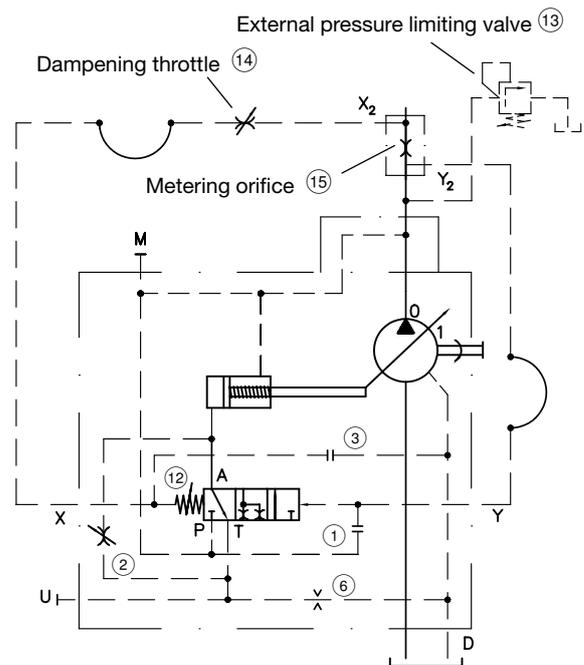
For stabilization of the controller type Qb there is beside the by-pass (2) and the drain throttle yet the needle throttle (pos. 4) in the signal line. The needle throttle should be set first with standard setting 1/2 to 1 turn open (a smaller adjustment gives a better dampening). The standard opening of the bypass throttle (2) is between 1/4 and 1/2 turn. A wider opening has beside the improved dampening effect also influence on the pressure drop of the control and increases it. Since, moreover, the amount of by-pass oil increases with rising pressure (load) the opening of the by-pass throttle has more influence with higher pressure which causes an additional growing of the pressure drop. Therefore the output flow of the pump will increase over-proportionally with increasing load of the consumer (hydraulic motor). This influence is used to keep the output speed of consumers (hydraulic motor) constant as this will compensate their higher leakage during load via a slightly increased pump delivery.

A drain orifice (6) can be mounted when oscillations should still occur in spite of proper adjustment of dampening and by-pass throttle (2). This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5). When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V 30D-250). This drain orifice slows down the response of the pump thereby dampening oscillations.

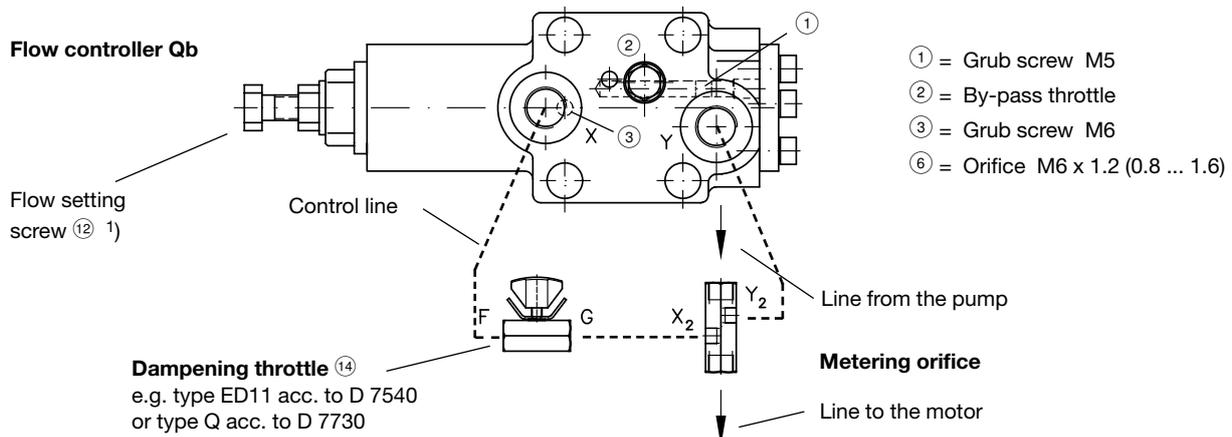
● **Adjustment of flow controller type Qb**

The starting positions of the adjustment screws are as follows:

1. Adjustable bypass throttle (2) 1/4 ... 1/2 turn open
Tools: Spanner 10 mm
Ancestor version:
Fixed by-pass orifice M6x1.0
Tools: Allan key 5 mm and 3 mm
2. Drain orifice (6) (see sect. 3.5):
Remove tapped plug "U" (M6) and check the orifice for contamination when installed.
Tools: Allan key 5 mm and 3 mm
3. Flow setting screw (12) 1)
Clockwise rotation increases, anti-clockwise rotation decreases the flow
Tools: 2 spanners 13 mm
4. Dampening throttle (14)
Start with 1 ... 2 turns open
5. Signal line
Hose, internal diameter 1/4" (6 ... 9 mm)
6. Check the external pressure limiting valve (13) in the pump line, whether a low pressure is set. Turn the screw anti-clockwise when necessary.



Flow controller Qb



1) **Attention:** The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!

3.4 Load-Sensing controls

a) Simple Load-Sensing control with Load-Sensing controller type LS

The function of the controller type LS is quite similar to that of the flow controller type Q. Main difference is that type Q features a fixed main orifice whereas the one with type LS is variable, as usually several different consumers are to be supplied. Since the orifice can be even totally closed, it is not necessary that the pump pressure drops below the load pressure. In order to save energy the LS-signal line is automatically discharged to the tank when the main orifice is closed. This has the effect that the pump idles (zero stroke) with a standby pressure of only 20 - 30 bar which is created by the pre-load of the control spring.

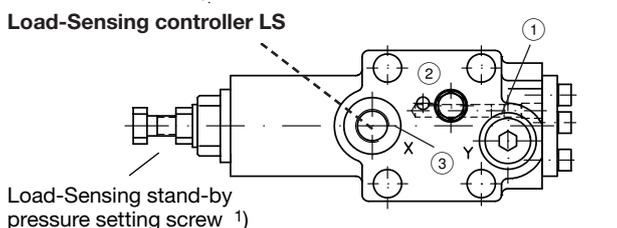
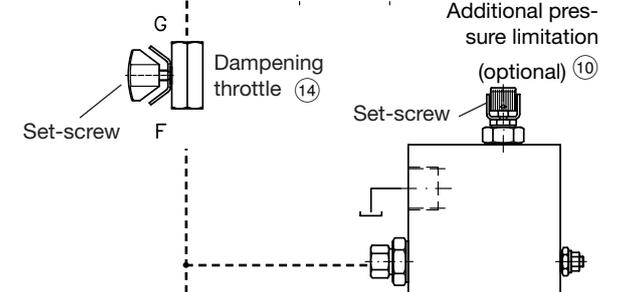
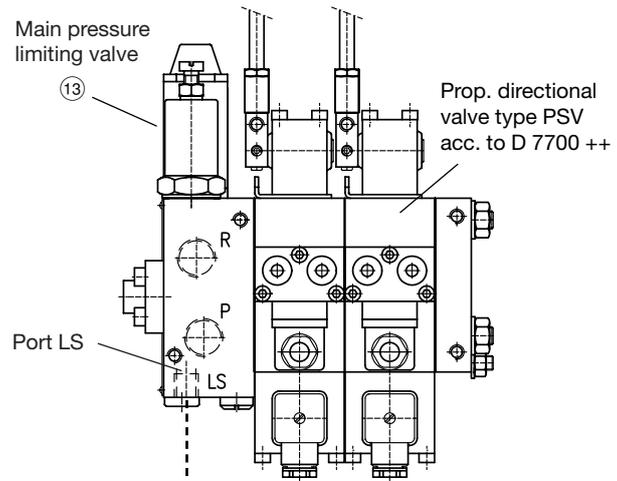
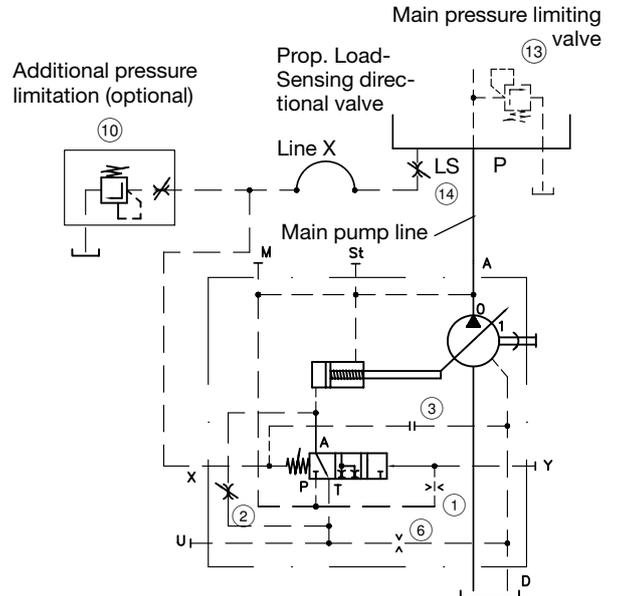
The circuits with LS application spread from small up to large systems (see sect. 3.3.a.+b.). These different sized systems require that the size of the signal line must be adapted to the respective system size.

The signal velocity respective the signal dampening is optimal when the capacity of the LS signal line has 10 % of the main line capacity between pump and directional valve. In case both lines have the same length the inner diameter of the LS signal line should be 1/3 of the inner diameter of the main pressure line. The signal line should preferably be a hose.

For fine tuning a needle throttle (14) should be installed in the signal line close to the directional valve. If some oscillations still occur this throttle can be closed down to 1/2 turn open.

In difficult cases a further stabilization can be achieved with the by-pass throttle (2). It's pre-adjustment is between 1/4 and 1/2 turn open. The last step of stabilization is a drain orifice (6) that can be mounted when oscillations still occur in spite of proper adjustment of dampening and by-pass throttle (2). This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5). When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V 30D-250). This drain orifice slows down the response of the pump thereby dampening oscillations.

A pressure control function can be obtained by connecting a pilot pressure limiting valve via a T-connector in the signal line between controller type LS and needle throttle (14). Thus the controller type LS receives a pressure control function in addition as the pilot valve limits the pressure in the signal line resp. the pump pressure.



Adjustment guideline: $\Delta p = 14 \text{ bar/turn}$

● Adjustment of controller type LS

The starting positions of the adjustment screws are as follows:

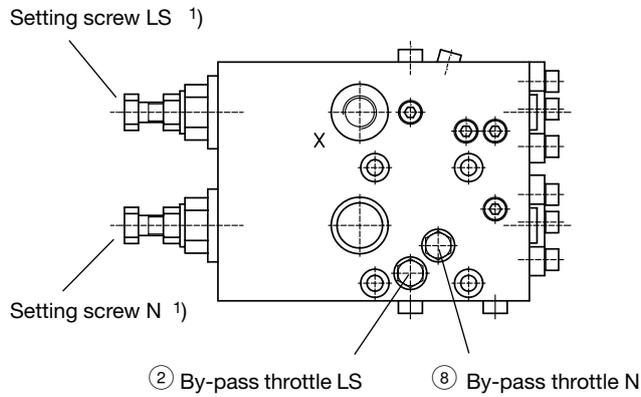
1. Adjustable bypass throttle (2):
1/4 .. 1/2 turn open
Tools: Spanner 10 mm
2. Drain orifice (6) (see sect. 3.5):
Remove tapped plug "U" (M6) and check the orifice for contamination when installed.
Tools: Allan key 5 mm and 3 mm
3. Signal line
The capacity of the LS signal line should be 10 % of the main line capacity between pump and directional valve. In case both lines have the same length the inner diameter of the LS signal line should be 1/3 of the inner diameter of the main pressure line.
4. Dampening throttle (14)
Start with 2 ... 3 turns open
5. Pressure limitation for LS-duct (10)
Turn set screw anti clockwise until stop
6. Check the external pressure limiting valve (13) in the pump line, whether a low pressure is set. Turn the screw anti-clockwise when necessary.
7. Adjustment of stand-by pressure of the controller type LS

1) **Attention:** The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!

- ① = Orifice M5 x 1.0
- ② = By-pass throttle
- ③ = Grub screw M6
- ⑥ = Orifice M6 x 1.2 (0.8...1.6)

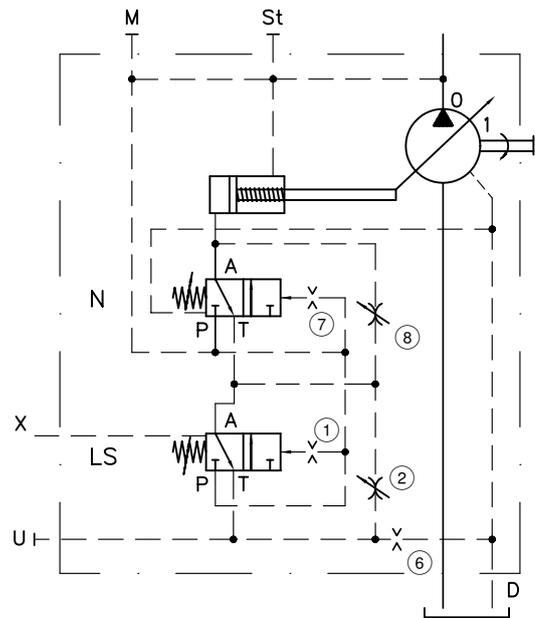
b) Load-Sensing control with additional pressure limitation with Load-Sensing controller type LSN

The function and stabilization of the controller type N is as detailed in sect. 3.2.a).
 Adjustment of the controller type LS is as detailed in sect. 3.4.a)
 When coordinating both controllers it is important that the by-pass throttle of the controller type N is always 1/2 turn more closed than the one of controller type LS. The drain orifice ⑥ (right below "U") covers both controllers and is installed and used as detailed in the previous sections.



Guideline for adjustment

	Δp (bar/turn)
LS	14
N250	54
N400	82



- ① Orifice $\varnothing 1.0$ mm (LS)
- ② By-pass throttle (LS)
- ⑥ Orifice M6 x 1.2 (0.8 ... 1.6)
- ⑦ Orifice $\varnothing 1.0$ mm (N)
- ⑧ By-pass throttle (N)

1) **Attention:** The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!

3.5 Power control

a) Power control with power controller type L

The power control can be used in all kinds of circuits in spite of the fact that it lacks a stabilizing by-pass throttle. The reason for this self-stabilization is that not one but two status values are fed back to the power control. Apart from the actual system pressure also the actual displacement of the pump is fed to the force-comparing control spool by a stroke-depending length of a measuring lever. This double feed back acts so prompt and well-timed that no further stabilization measures are necessary apart from an optional drain orifice.

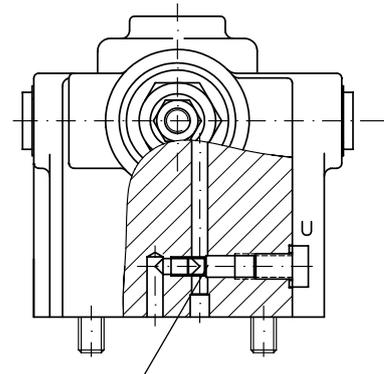
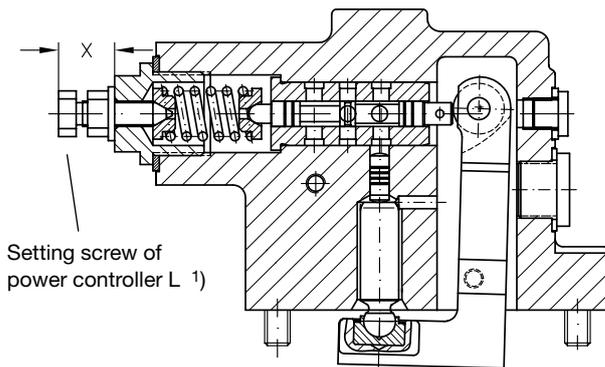
This orifice is located below the letter "U" as detailed in the previous sections. This place was chosen in order to have only one drain orifice for all controller combinations. The drain orifice slows down the up-stroking of the pump and has a dampening effect on oscillation stimulations.

The thread is M6 and the hole is between \varnothing 1.8 mm in the big V30D-250 and down to \varnothing 0.8 mm in the smaller pumps.

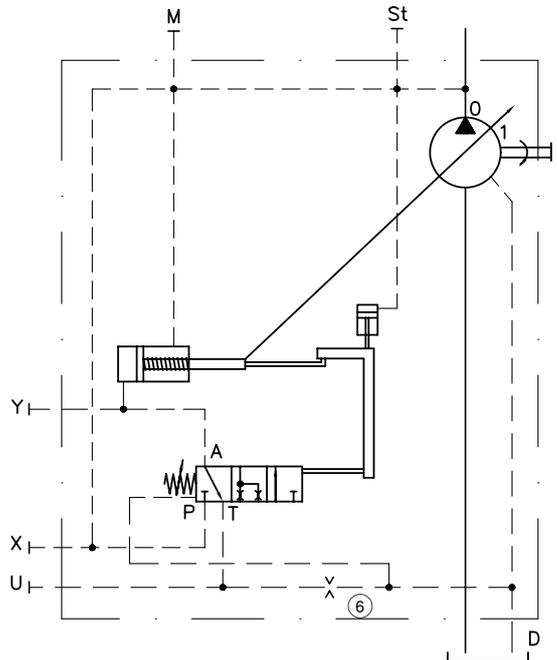
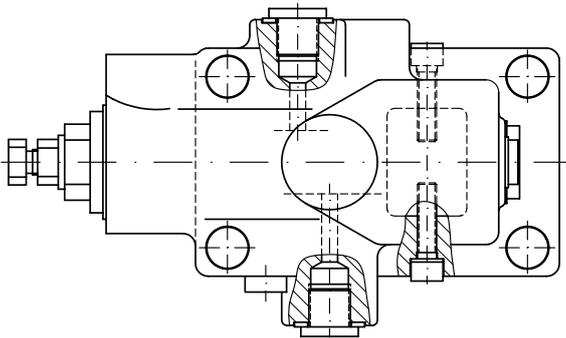
Since the power controller type L is the last member in the chain of controller combinations, the drain orifice ⑥ must be installed also in the power controller for pre-connected controllers of the combination. This drain orifice slows down the response of the pump thereby dampening oscillations.

Guidelines for adjustment of the power controller L are illustrated in the curve on page 14.s

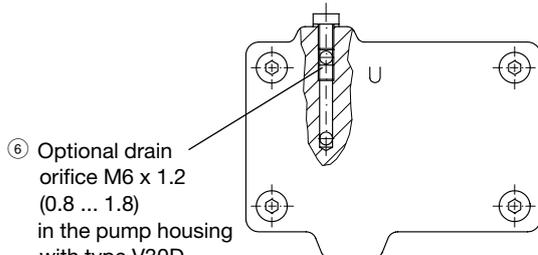
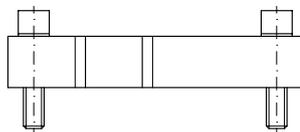
Power controller L



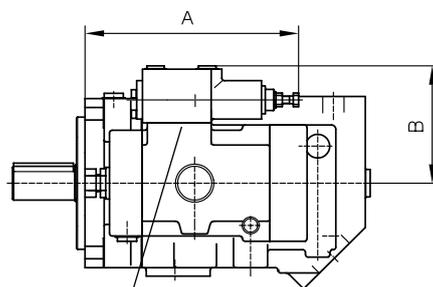
⑥ Drain orifice M6 x 1.2 (0.8 ... 1.6) for versions with power controller (not apparent with type N/ND)



Cover at the controller head (without power controller L)



Location of the drain orifice ⑥ M6x1.2 (0.8...1.6) with type V30D-045 (075, 140, 160) without power controller



1) **Attention:** The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!

b) Variable power control with power controller type Lf1

The hydraulically adjustable power controller type Lf1 works without control pressure at port P_{st} just like a standard power controller type L.

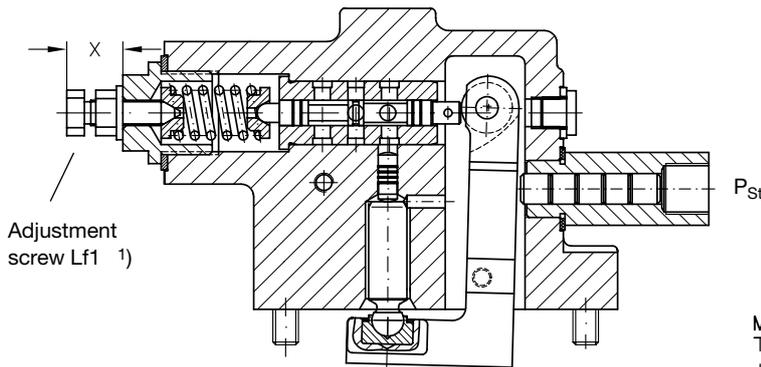
The pressure at control port P_{st} proportionally compensates the force of the controller spring and therewith reduces both the spring force set via the adjustment screw and the set power.

The working direction of the control pressure from nominal power to minimal power has the advantage that the own pump pressure can be used as source for the control pressure.

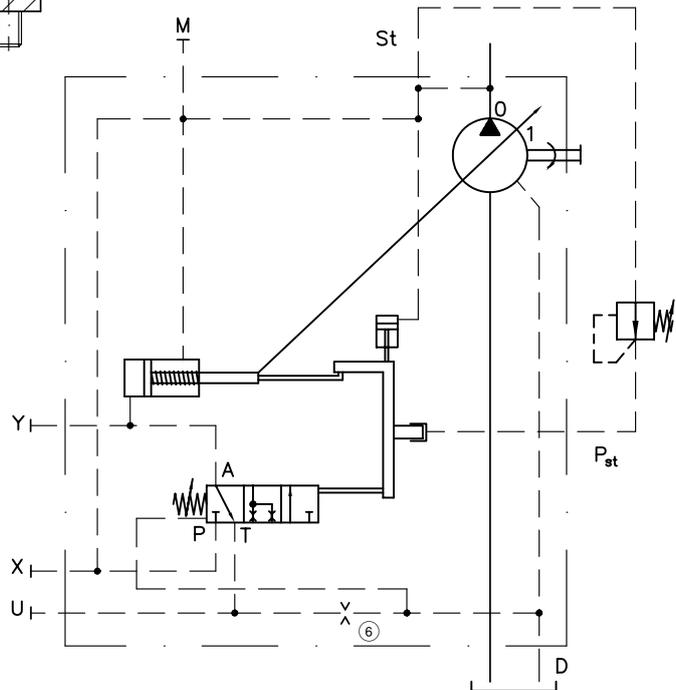
A pressure reducing valve installed between pump pressure and control pressure suffices to regulate the pump between nominal power (no control pressure) and zero power (open valve). At power less than 50% of the corner performance this controllable power controller can be regarded also as rough pump delivery flow control valve. An additional advantage is that the set nominal power cannot be overridden by the control.

Stabilization is like with standard power controller L via a drain orifice. It has to be installed by the customer with pumps equipped power controller. Installation position is marked "U" below the (see illustration below).

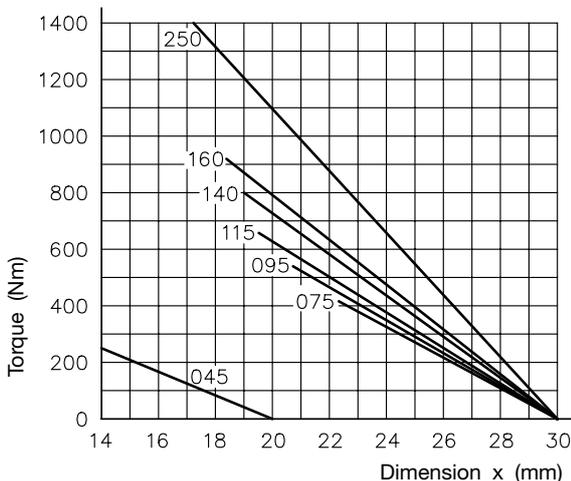
Since the power controller type L is the last member in the chain of controller combinations, the drain orifice ⑥ must be installed also in the power controller for pre-connected controllers of the combination. Recommended diameter is Ø1.8 mm in the big V30D-250 and down to Ø0.8 mm in the smaller pumps This drain orifice slows down the response of the pump thereby dampening oscillations.



1) **Attention:** The lock-nut has to be loosened before adjustment to prevent damage of the vulcanized thread seal!



Rough guideline for the setting of the power controller



Power calculation:

$$P \text{ (kW)} = M \text{ (Nm)} \times n \text{ (rpm)} / 9550$$

Example: V30D.250.../L,

x = 21mm, i.e. torque M ≈ 1000 Nm

Drive motor speed n ≈ 1450 rpm

$$P = 1000 \cdot 1450 / 9550 \approx 152 \text{ kW}$$

3.6 Proportional flow control

a) Hydraulic proportional controller type VH

The displacement of a variable pump with hydraulic proportional control can be set according to the pilot pressure in the range 7 ... 32 bar.

● Design

A variable piston pump features a swash plate that can be tilted and which is linked to the setting piston. The stroke of the setting piston determines the displacement of the pump. For a hydraulic proportional control there is a measuring spring acting on the larger side of the setting piston and on the spool of the proportional valve.

Because the setting pressure is also acting on the proportional spool, the opposite end is counterbalanced by receiving the same pressure. In the control part it is the same case. Both far ends of the spools (small areas) get the same setting pressure. The annular areas of the differential spool have at the side to the proportional valve a pressureless tank connection and at the plug side the control pressure P_{St} . That offers the possibility to act with a control pressure against the measuring spring.

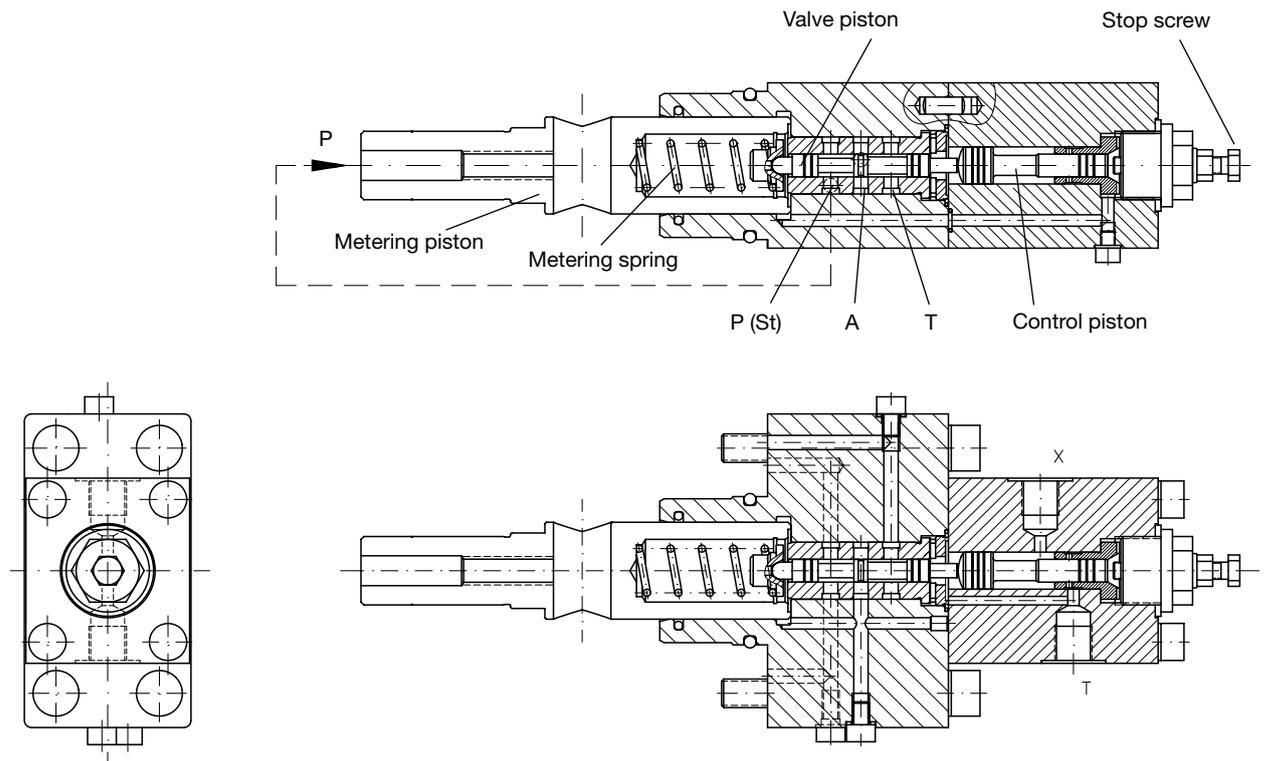
● Supply and control circuit diagram

The minimum displacement of the main pump is no stroke i.e. zero flow therefore no sufficient pressure to supply the controller piston is available in such conditions. Therefore a servo pump is needed, which has to be connected to port St via a check valve. The other check valve in the main pump makes sure that always the higher pressure is fed to the controller piston. The servo pump should deliver 14 lpm (for V30D 250) and 7 ... 10 lpm for the smaller pumps at a pressure of 50 - 60 bar.

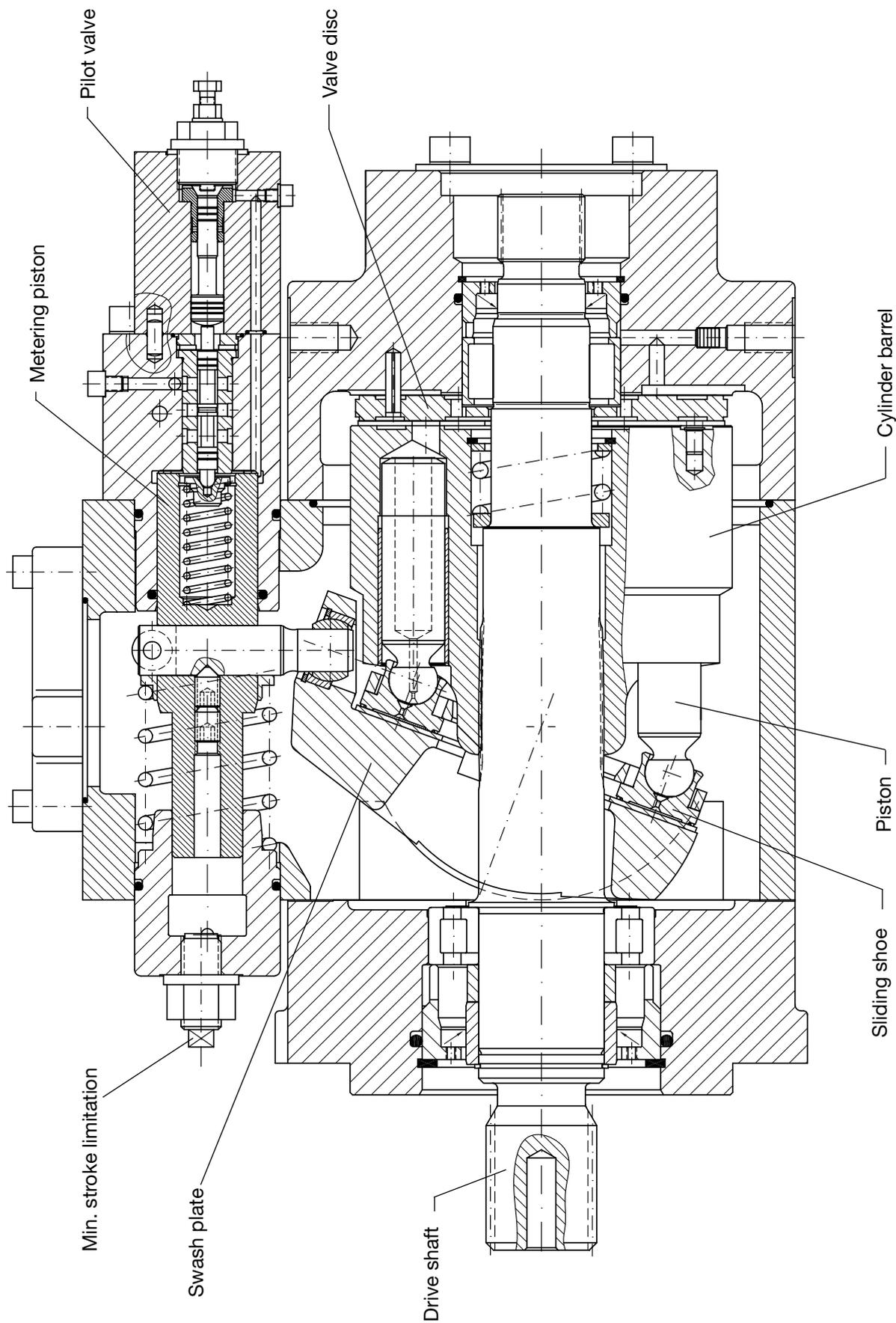
A second pressure line from the servo pump can be used as supply for the control port respectively for the pilot pressure limiting valve. This line must have an orifice to limit the flow down to 1 ... 2 lpm.

The control pressure must show a range of approx. 7 bar (zero flow) up to approx. 32 bar (full pump delivery flow).

Hydraulic proportional controller VH



Hydraulic proportional controller VH



● **Function**

The cross-sectional view of the controller shows the parts in idle position. The main pump is supplied with servo pressure via port St as soon as the servo pump is started. The piloting pressure limiting valve is usually open during start of operation, i.e. only a minimum pressure is apparent at port X. Thus enabling the metering spring to push the piston to its mechanical stop. This opens a passage to the larger area of the piston which returns the swash plate to its idle position. There is always pressure apparent at the smaller side of the control piston.

When the piloting pressure limiting valve is set higher than 7 bar both control and valve piston will move with the metering spring connecting the larger area of the control piston with the tank. The control piston will move the swash plate against the metering spring in direction of increased delivery flow and loading the metering spring. This movement will stop as soon as the forces of the metering spring and the pressure at the piloting pressure limiting valve are balanced thereby closing the prop. valve.

The swash plate is completely elevated (full stroke of the pump pistons) when 32 bar of piloting pressure are achieved. A gear pump is recommended as servo pump.

● **Adjustment**

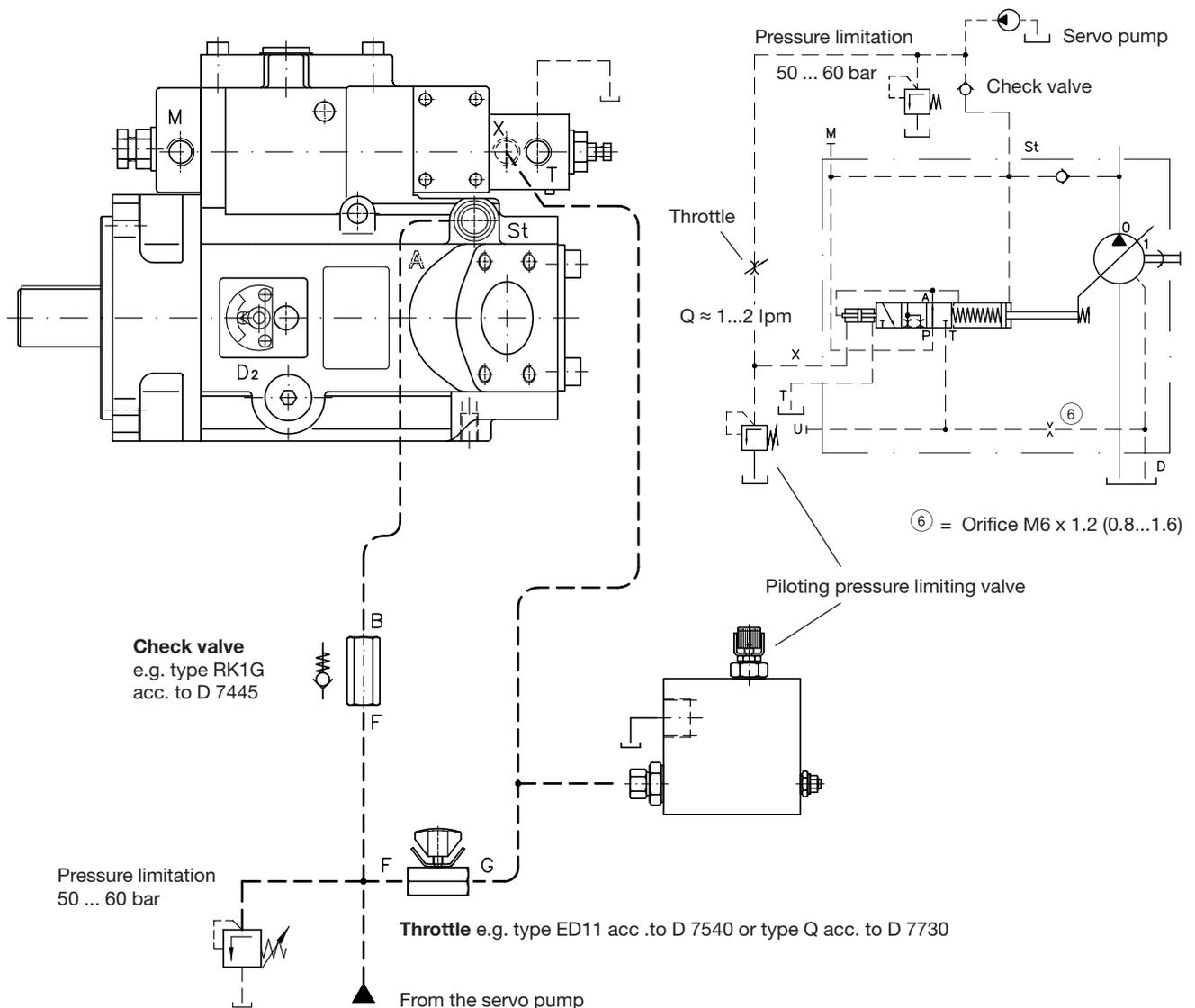
The stroke of the valve is adjustable via a set screw (M6 with seal lock nut) at the facial side of the valve, allowing a fine tuning of the amplification and resolution. The servo pump must be running and the piloting pressure limiting valve be open for any kind of adjustment (main pump may stand still).

The first thing to do is to detect the response point of the swash plate. Turn the set screw clockwise after the lock nut is loosened. The swash plate will respond immediately after a few turns (visible at the swash plate angel indicator). Now the set screw is turned counter-clockwise by 1 to 1.5 turns after the first response is detected. The lesser the set screw is turned back the more sensitive the pump will be.

A drain orifice ⑥ can be installed when oscillations (uneven pump delivery) occur. This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5).

When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V 30D-250). This drain orifice slows down the response of the pump thereby dampening oscillations.

Hydraulic proportional controls type VH



b) Electro-hydraulic proportional controls type V

The displacement of a variable displacement pump can be adjusted via an electro-hydraulic proportional adjustment. Control current range is ca. 300 mA to ca. 800 mA.

● Design

An adjustable axial piston pump features a hinged swash plate linked with a control piston. The lift of the control piston determines the displacement of the pump. The electro-hydraulic proportional control is based on a balance of forces between the solenoid and the metering spring both connected via the valve piston. Both the control piston and the proportional solenoid are pressure compensated to prevent any influence of the control pressure.

This allows influencing the position of the control piston via the current applied to the proportional solenoid.

● Supply with servo pressure

The main pump cannot supply sufficient pressure for the control piston when idling (zero delivery position). It is therefore necessary that a servo pump is connected to port St of the main pump via a check valve.

This check valve and the one installed in the main pump act like a shuttle valve making sure that always the higher pressure is fed to the control piston.

The servo pump must deliver 14 lpm for the V30D-250 and 7 to 10 lpm for the smaller versions at 50 to 60 bar.

● Current supply

A special power supply for the prop. solenoid is required to ensure a low hysteresis. A amplifier card should be used for the solenoid which delivers the required current in rectangular pulses. Recommended are the HAWE prop. amplifiers type EV1M2 acc. to D 7831/1, EV22K2 acc. to D 7817/1 or EV1G1 acc. to D 7837 or the programmable logical valve controls type PLVC acc. to D 7845.

The solenoid force is determined via the pulse width, dither frequency should be 80 Hz. Both min. and max. current values can be adjusted to suit the prop. solenoid. The min. current value should be a set just below the point where the pump starts delivering to prevent any start-up hesitation. The max. current value should be set below the max. rating for the proportional solenoid.

The reference voltage can be set via a potentiometer (0 ... 10 V DC) which is self-supplied by the card.

The response time can be set via ramp functions.

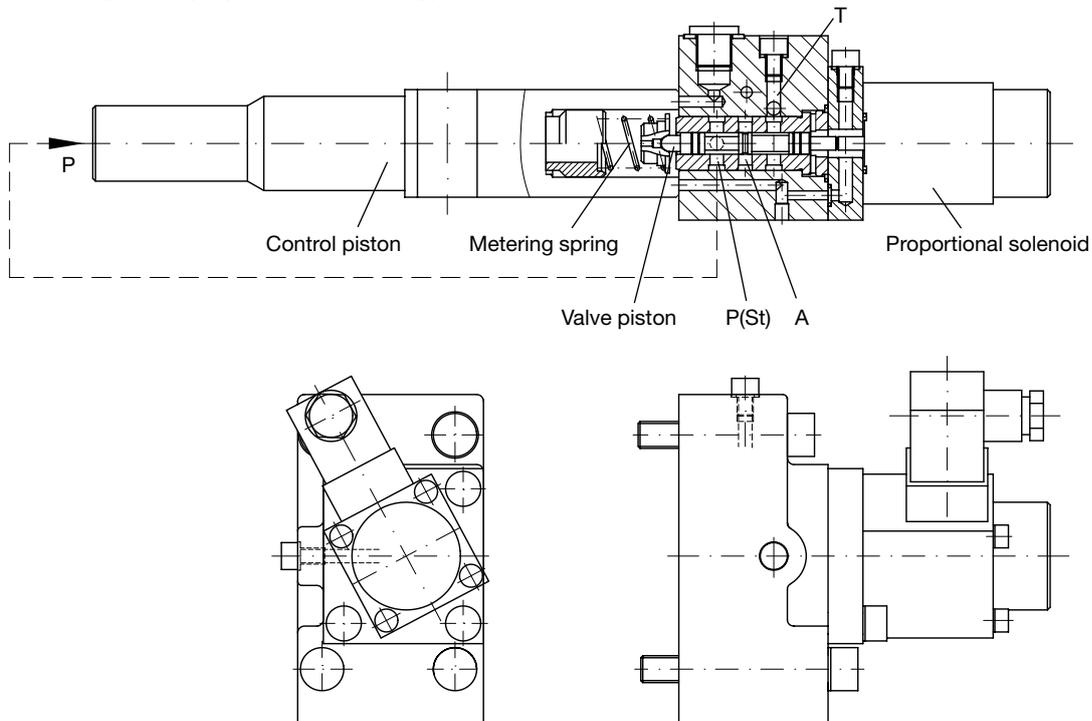
● Function

The cross-sectional view of the controller shows the parts in idle position. The main pump is supplied with servo pressure via port St as soon as the servo pump is started. The solenoid is usually deenergized during start of operation, i.e. the valve piston is pushed against its stop by the metering spring. This opens a passage to the larger area of the piston which returns the swash plate to its idle position. There is always pressure apparent at the smaller side of the control piston.

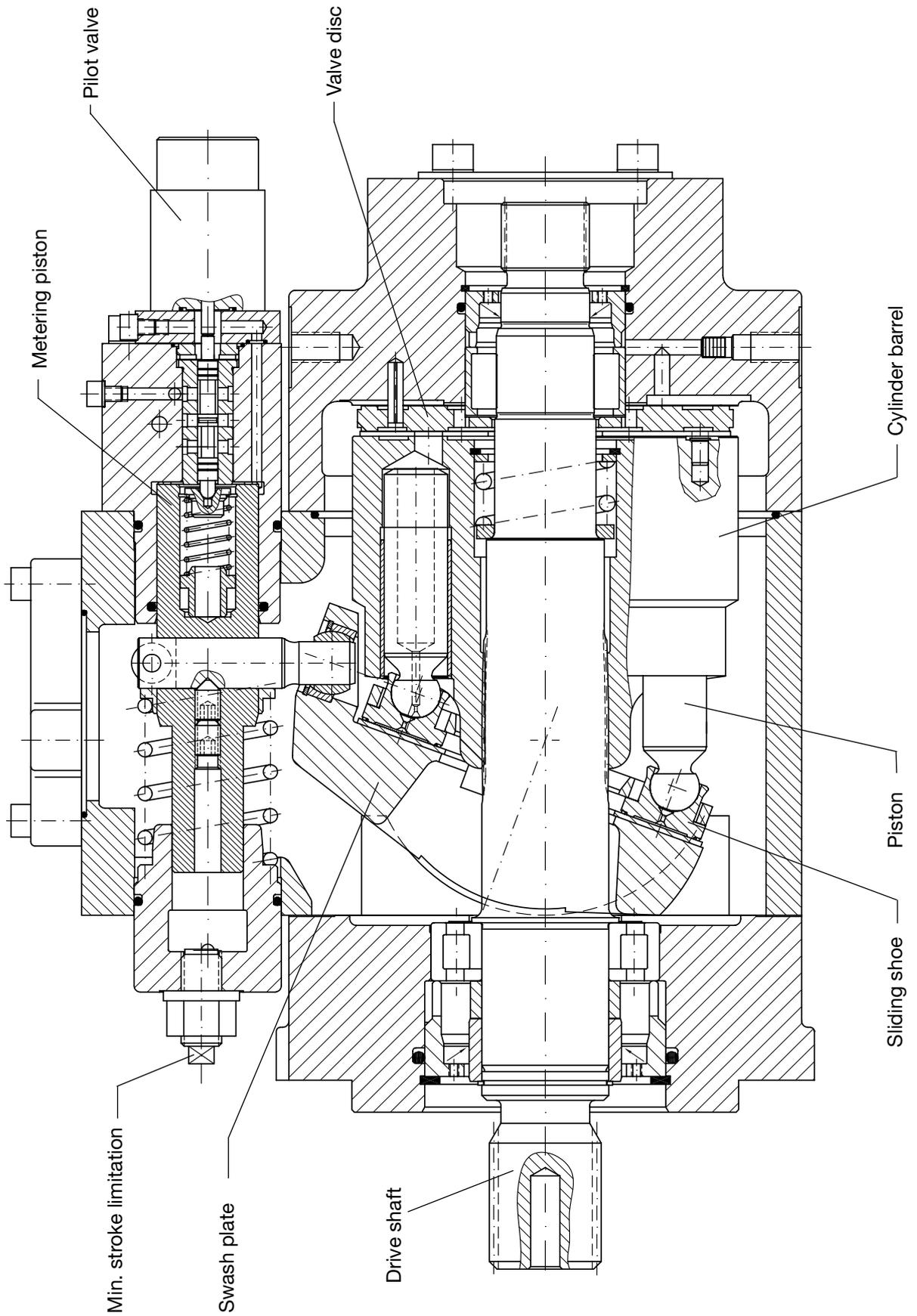
When the solenoid is energized with 300 mA (24 VDC-solenoid) or 600 mA (12 VDC-solenoid) it will push the valve piston against the spring force thereby connecting the larger area of the control piston with the tank. The control piston will move the swash plate against the metering spring in direction of increased delivery flow and loading the metering spring. This movement will stop as soon as the forces of the metering spring and the proportional solenoid are balanced thereby closing the prop. valve.

Both total delivery flow and total stroke of the solenoid are achieved when the solenoid is energized with 800 mA (24 V DC-solenoid) or 1600 mA (12 V DC-solenoid).

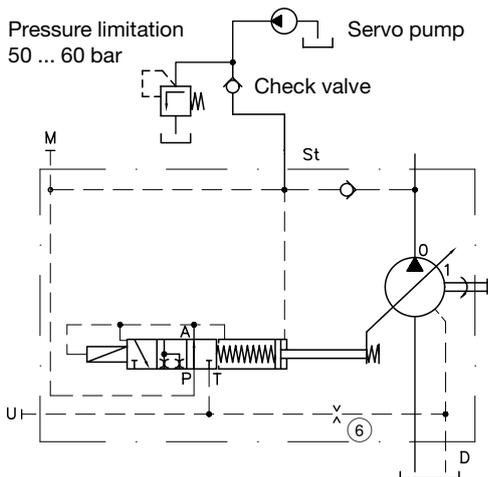
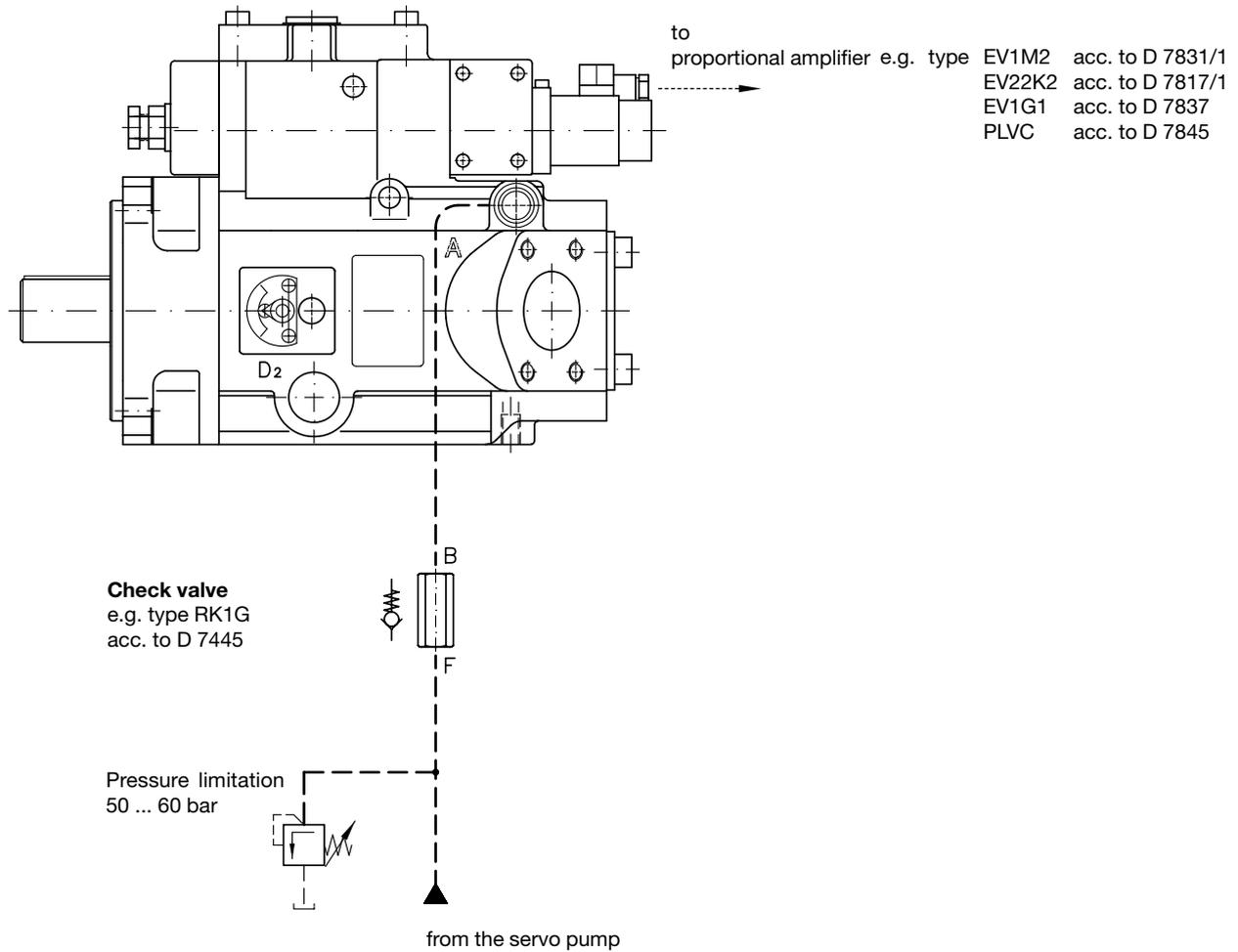
Electro-hydraulic proportional controls type V



Electro-hydraulic proportional controls type V



Electro-hydraulic proportional controls type V



A drain orifice ⑥ can be installed when oscillations (uneven pump delivery) occur. This orifice can be installed at controller piston housing right below stamping "U" with standard versions to enable also controller combinations to be dampened (see illustration in sect. 3.5).

When the controller piston housing is prepared for fitting of a power controller the drain orifice has to be installed at the power controller or at the replacement cover L right below "U". The orifice diameter ranges from M6x0.8 to M6x1.6 (for type V30D-250). This drain orifice slows down the response of the pump thereby dampening oscillations.

⑥ = Orifice M6 x 1.2 (0.8 ... 1.6)