Chapter 16

# Connections

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## 1 Introduction

The hydraulic system components are connected together to form hydraulic circuits by means of suitable connections.

High demands are placed upon these connections:

- They must be good for flow, i.e. cause as few losses in pressure as possible
- They should be easy to produce, mount and service
- They must be able to withstand high pressures (and dynamic pressure peaks)
- They must be permanently leak tight
- They must be able to withstand dynamic loads (vibrations of components).

Pipe lines, hoses, fixings and flanges, etc. as connections are dealt with in their own chapter in the Hydraulic Trainer, volume 3.

In this chapter subplates, control plates, stacking assemblies, etc. will be dealt with.

## 2 Valves for mounting in pipe lines

Nowadays there are very few devices left in hydraulics which are mounted directly into the pipe line system.

Belonging to this group are for example the very simply designed check valves as well as simple throttle valves.

Fig. 1: *Check valve as pipe armature*

Fig. 2: *Throttle valve as pipe armature*

Such valves need only be rarely serviced, usually have two ports and hence do not require much effort when servicing or repairing them.

## 3 Cartridge valves with threaded cavity

Fig. 3: *Pressure reducing valve as cartridge*

Valves such as pressure relief or pressure reducing valves for example may be directly mounted into the line system. For this purpose the cartridge design has become predominant. All functional elements are collected together in a cartridge, which is completely mounted into the housing with threaded cavity. If services or repairs are carried out the complete cartridge is removed, so that the pipe line system does not need to be opened.

Valve cartridges may be used in many applications. They are also used for mounting in control and sandwich plates (see following sections).

# 4 Valves for subplate mounting

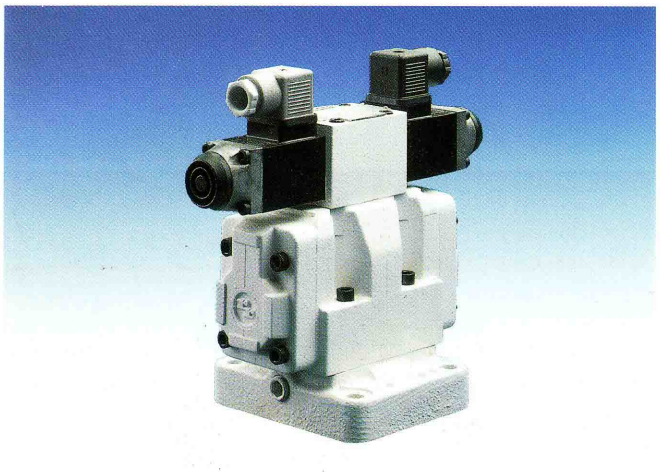

Fig. 4: *Directional valve mounted on subplate*

In many areas of application, but particularly in industrial systems valves for subplate mounting are preferred.

The advantages of this design are:

- The valves are easily disassembled for the purpose of servicing
- The ports lie on one plane, the fixings and sealing surface is flat
- The sealing of ports by means of elastic sealing rings is very reliable

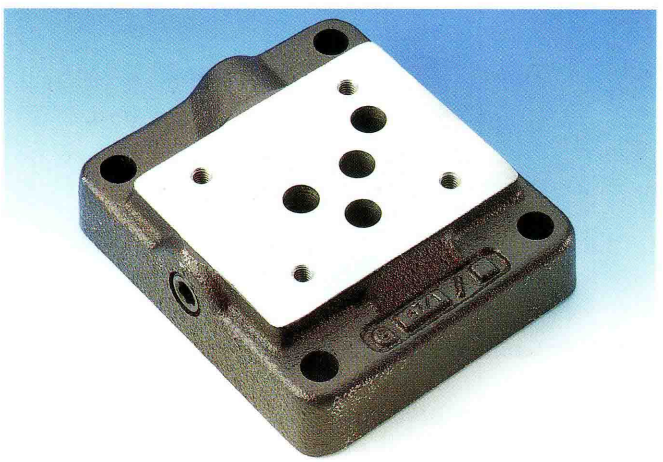

Fig. 5: *Subplate, viewed onto valve mounting surface*

## 4.1 Standard mounting patterns

The mounting patterns for the subplate mounted valves are standardised to DIN 24 340. The following diagrams show typical mounting patterns.

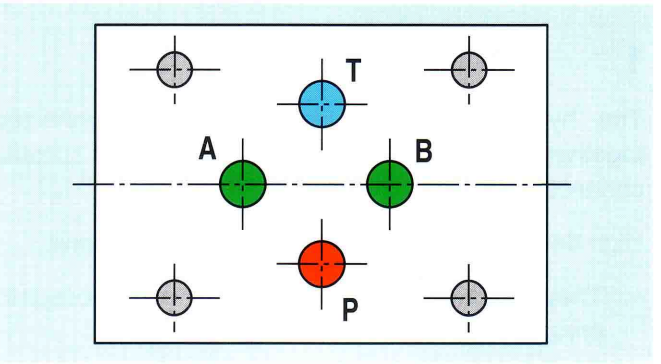


Fig. 6: *Mounting pattern, form A6 DIN 24 340*
*Mounting pattern size 6 preferrably used for directional valves, but also used for pressure and flow contol valves*

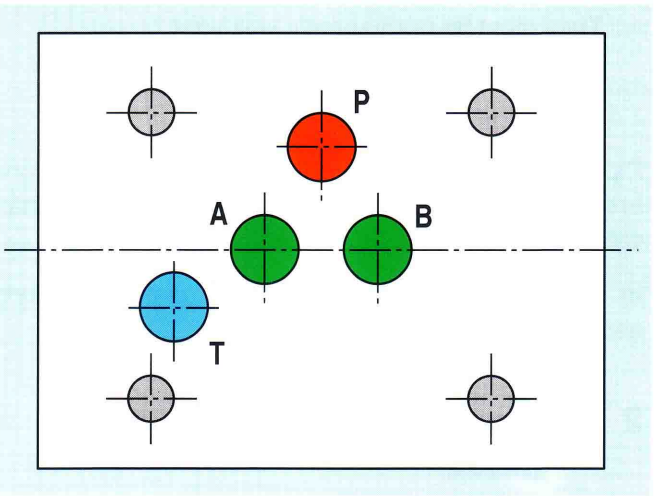


Fig. 7: *Mounting pattern, form A10 DIN 24 340*
*Mounting pattern size 6 preferrably used for directional valves*

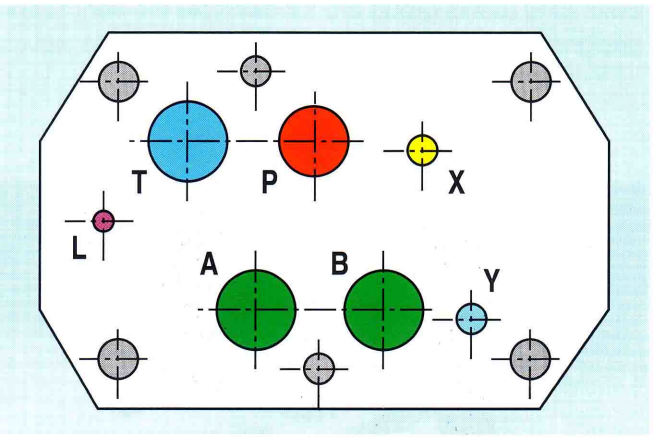


Fig. 8: *Mounting pattern, form A16 DIN 24 340*
*Mounting pattern size 16 preferrably used for pilot operated directional valves of this size*

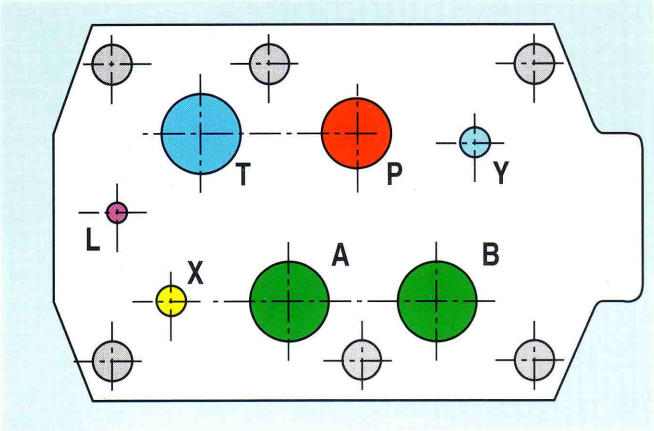


Fig. 9: *Mounting pattern, form A25 DIN 24 340*
*Mounting pattern size 25 preferrably used for pilot operated directional valves of this size*

The ports are designated by P, T, A, B, X and Y. These designations are used for orientation. In which direction the valves operate and which ports are to be used may be found out from the functional descriptions of the devices as well as from the circuits.

Valve fixings are normally not symmetrical. By means of locating pins or offset fixing threads, the possibility of the valve
being incorrectly mounted by mistake is avoided.

## 4.2 Individual subplates

the simplest form of connecting valves is by mounting valves on individual subplates and then connecting these plates together.

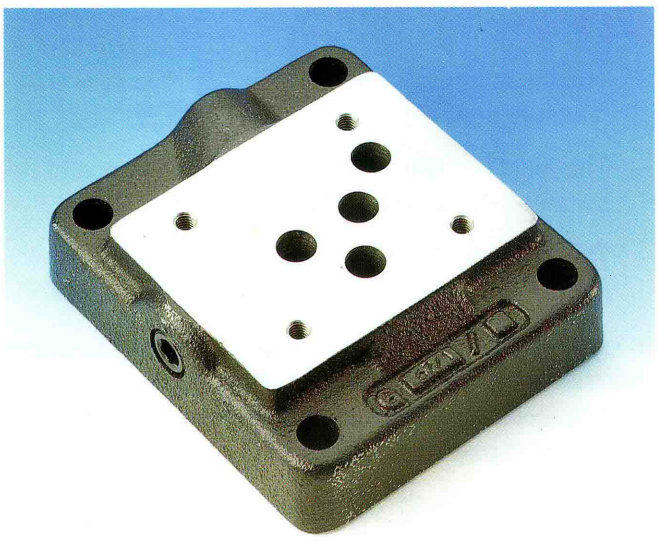

Fig. 10: *Subplate*

Usually the valve mounting surface is at the top and the output ports next to each other at the bottom. As a lot of space is required for the pipe fittings, the subplate is often larger than the surface mounting surface of the valves. The channels are then fed by means of diagonal and horizontal drillings to the output ports.

## 4.3 Standard manifold

Often several actuators are supplied with fluid from a common pump and tank line.

If the control valves are the same size or if they only vary by one stage, then it is possible to mount the valves on standard manifolds.

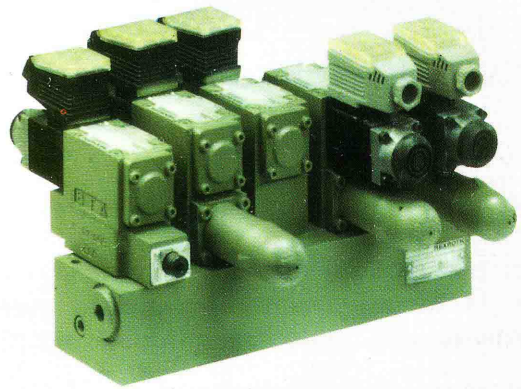

Fig. 11: *Standard manifold, size 6 with vertical stacking*

Standard manifolds with mounted stacking assemblies result in compact control units for several actuators. They require a minimum amount of space, do not need to be piped together and have only a few sealing points.

## 4.4 Control plates and control manifolds

Controls which are connected in a complex way require the use of individually designed and manufactured control plates and control manifolds.

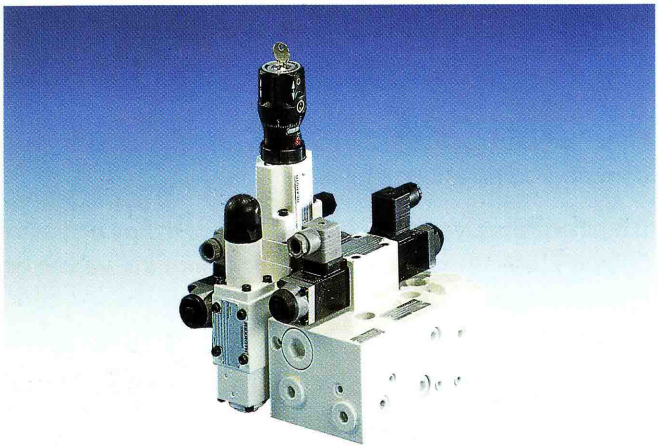

Fig. 12: *Manifold*

For a small number of components these manifolds are made of steel blocks, in which connecting channels are drilled. The manifolds are fitted with cartridge valves, cartridges, surface mounted valves and even with complete stacking assemblies.

For larger sizes (from about size 40) the advantages of this design become especially clear. No other design allows such compact controls for the smallest possible number of sealing points as this manifold design. Prime examples of these control plates may in particular be found in large hydraulic presses.

## 4.5 Adaptor plates

Fig. 13: *Cylinder with mounted servo valve and adaptor plate*

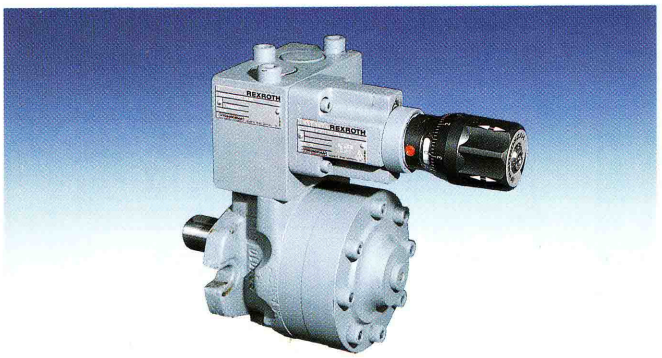


Fig. 14: *Hydraulic motor with adaptor plate*

Because of reasons in control , it is advantageous if the control valves are mounted as closely as possible to the actuator. Ideally the valves should be mounted directly on the cylinders or motors by means of adaptor plates. Adaptor plates have on the one side the mounting pattern of the cylinder or motor and on the other side the mounting pattern of the control valve. The free sides are used for pipe line ports.

# 5 Stacking assemblies

## 5.1 Vertical stacking assembly

Several functions are required within the control stack for a hydraulic actuator, which may be achieved by means of various valves, e.g.:

- The function "start/stop/direction" is controlled by means of a directional valve
- The function "speed" is controlled by means of a flow control valve
- The function "force" is controlled by means of a pressure control valve
- The function "shut-off" is controlled by means of a suitable check valve
- The function "monitor pressure" is controlled by means of a pressure switch

In order to collect these continually recurring functions together in functional devices, flow control, pressure control, isolating and directional valves were developed as sandwich plates.

One or more sandwich plates below a subplate mounted valve mounted on a subplate results in a very compact functional unit.

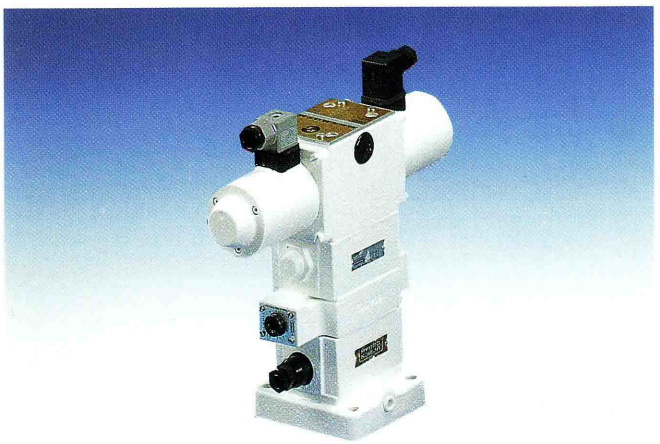

Fig. 15: *Vertical stacking assembly*

This design is generally known as a vertical stacking assembly. The top valve is usually a directional valve.

## 5.2 Horizontal stacking assemblies

Not every control for a hydraulic actuator may be produced without a lot of effort as a vertical stacking assembly of valves. Manifolds do not offer the numerous connection possibilities for mounting the valves for individual controls next to each other. In these cases flexible horizontal stacking systems may be used comprising a number of different port, connection and separator plates and even complex control systems.

Fig. 16: *Horizontal stacking assembly*

The flexibility of horizontal stacking assemblies does however come at a cost. Numerous different plates need to be manufactured and stored. The stacking itself comprises of many parts and has a number of sealing points.

## 5.3 System stacking assemblies

For control tasks which occur again and again control plates were designed, which may be put together to form a system stacking assembly.

The manifolds for a system stacking assembly are fitted with subplate mounted valves (also with sandwich plates as in vertical stacking assemblies).

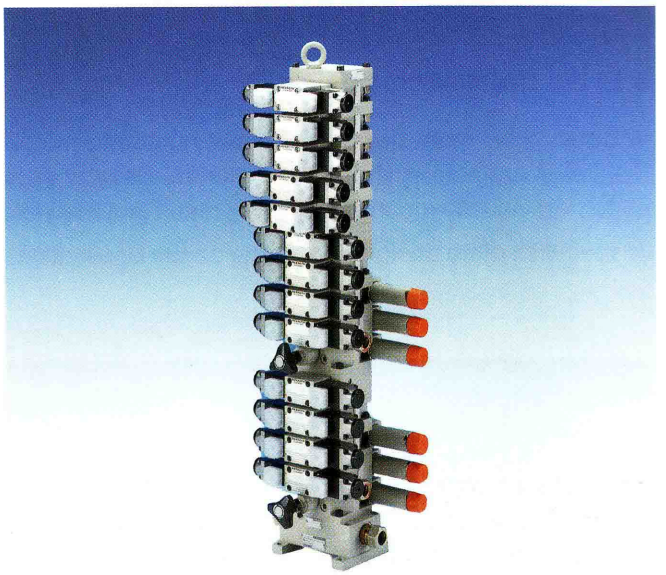

Fig. 17: *System stacking assembly*

# 6 Mobile control valves

## 6.1 Single block design

Mobile machines have their own set of design parameters. Hence the control valves for mobile applications are very different from those used in industrial applications.

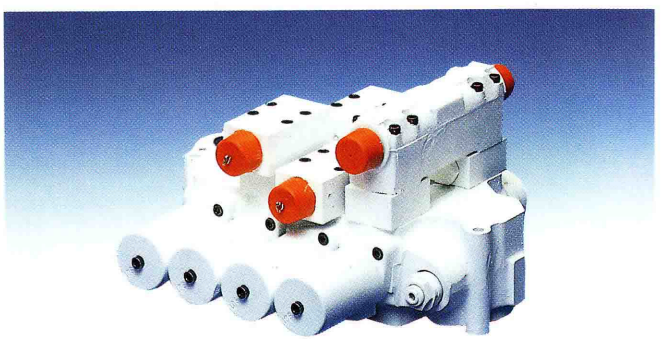

Fig. 18: *Mobile control valve (single)*

The channels are mainly cast; the spools run directly into the block; the operating mechanism for the spools are built on to the block. Cartridges complete the control functions. The cast channels are especially suitable for flow as the cast external form results in a design with complete saving of material and space required. Such a design is possible, as in mobile applications a large number of identical blocks may be used. In industrial applications blocks are often designed as one-offs and gare individually manufactured.

## 6.2 Sandwich design

In order to be more flexible for small numbers, mobile manifolds are also split into valve plates. Several such plates individually mounted together result in a manifold of sandwich plate design depending on the application.

Fig. 19: *Sandwich mobile manifold*