Parker Hannifin Plc
Product Training

Mobile Directional Control Valves

Level 1

List of Figures

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1.0 Introduction

Level 1 training has been devised as a 'self teach' module for persons who have no, or very little prior knowledge of the subject matter. The aim is for persons to work through the information provided at there own pace and in their own time. When they have completed the module and feel confident that they have increased their knowledge they can complete a test that accompanies the module. Successful completion of the module test permits progress onto Level Two.

1.1 What is a mobile directional control valve?

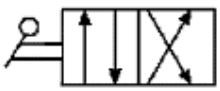
A directional control valve (DCV) is a device for controlling the flow of oil passing through it. In this module we will be considering only basic mobile type control valves. Flow through the valve can be directed out of various ports to perform a function. For example, extend and retract a cylinder or turn a motor.
(N.B. The term mobile valve refers to the type of valve typically used with mobile applications such as, diggers, dump trucks, back-hoe excavators, telescopic handlers, tractors etc). In level two, more complex examples will be considered.

1.2 How does a DCV work?

A mobile direction control valve consists of a single body or multiple cast iron sections joined together with internal chambers. The chambers are connected by designed cast passageways and cross drillings. Sectional valves tend to be more common than single mono block designs.
Each section to be connected to a system function is machined to accommodate a spool. The machined spool is the device that either blocks or opens the various passageways and allows oil to flow into and out of the valve section in a manner that dictates the movement of an actuator, see figure 2.1 for a diagrammatic explanation.
A mobile control valve is operated either directly or indirectly by the operator. In other words, the machine operator has control of the valve at all times via an electric or hydraulically operated joystick, mechanical lever or even a cable. Valves of this type are sometimes referred to as spool valves due to the spools within the valve controlling the direction of flow. They are also very often abbreviated to DCV, - direction control valve.

2.0 Mobile Direction Control Valve Operation

As mentioned in section1.2, a spool fitted within a cast iron body, when moved from one position to another, allows the flow of oil to the valve to be blocked, or pass through it in a controlled manner to an actuator.
The movement of the spool can be achieved by several different methods. The simplest of these being a hand operated lever or foot pedal attached to one end of the spool, which when pulled or pushed will move the spool in either direction.
Other methods of spool actuation include; hydraulic pilot pressure, pneumatic pilot pressure, and electrical signal. These methods of actuation will be covered in more detail in Level 2 of this module. For the purpose of understanding the principle of a direction control valve only hand operation will be considered in this module.



Shown below, in figure 2.1, is the way in which an actuator is forced to move when the flow through a direction control valve is changed by moving the spool position.

Control valve in the neutral position. Oil enters the valve at port P but is not permitted to pass through the valve due to the spool position blocking off the A and B ports.

When the operator pulls the handle the spool moves to the left and port A is opened and connected with port P. At the same time ports B and T are connected. This condition allows oil to flow through the valve from P to A and extend the cylinder. As the cylinder extends any oil on the opposite side of the piston is forced out of the cylinder and back through port B of the control valve and out of port T back to the hydraulic tank.

If the handle is now pushed away from the operator the spool will move across to the right. In this position port P is now connected to port B. At the same time port A is connected to port T via an internal gallery. Oil can now flow through the valve and cause the cylinder to retract. Oil on the opposite side of the cylinder is forced out and back through the control valve out of port T and back to the hydraulic tank.

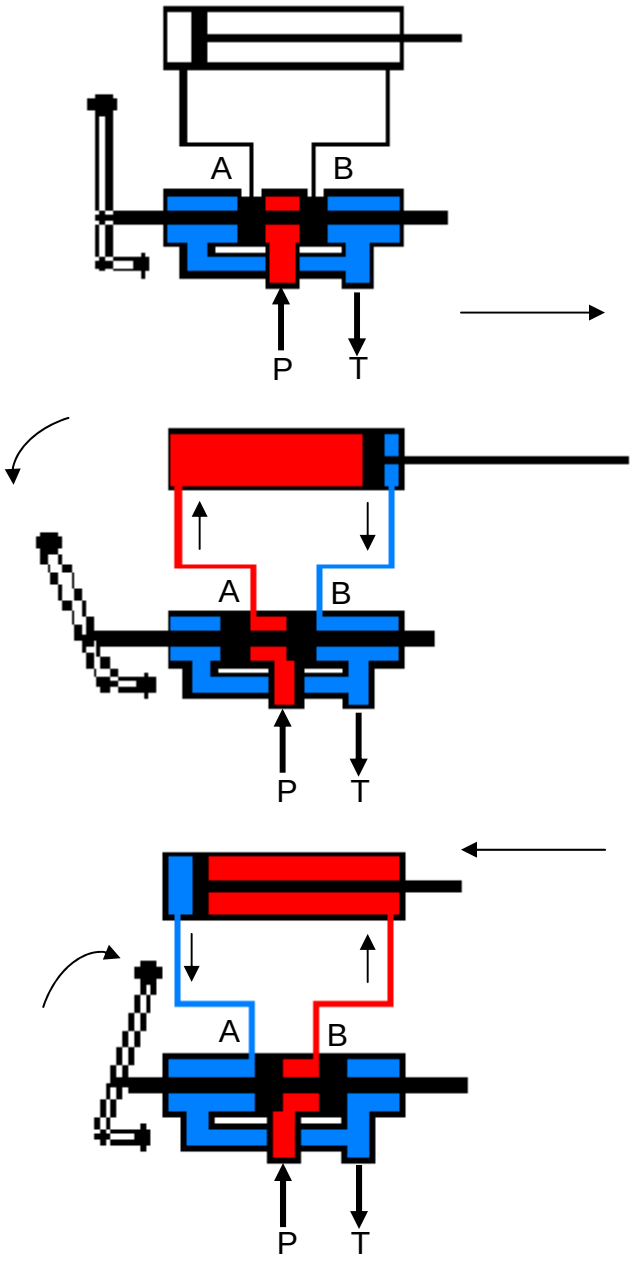
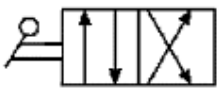


Figure 2.1 Simple explanation of flow control through a directional control valve. The cylinder speed will be governed by how much the spool is moved towards the fully open position in either direction. Cylinder travel will stop at any point if the handle is returned to the neutral position.



2.1 Mobile Direction Control Valve Construction

Mobile direction control valves come in two main assembly arrangements. The first arrangement is a single cast block, known as a mono block design, which is generally designed suit a particular purpose or application. The block is machined to accommodate all the relevant valves and spools and is normally a bespoke unit.

The second arrangement is known as a sectional type valve, where single work sections, each containing a spool and relevant valves, are joined together by tie rods passing through the each section joining them all together. The two arrangements are shown in figure 2.2. The multi section type valve is the more popular of the two as it offers greater flexibility with the option of being able to change a single section or add more sections to it should the system design change.

Except in special applications, both valve layouts follow a general format, beginning with an inlet section, followed by the work sections and then an end section. Figure 2.3 shows this general layout. We will concentrate on the section or stackable arrangement.

Mono block design
(Parker V11)

Sectional design
(Parker V16PC)

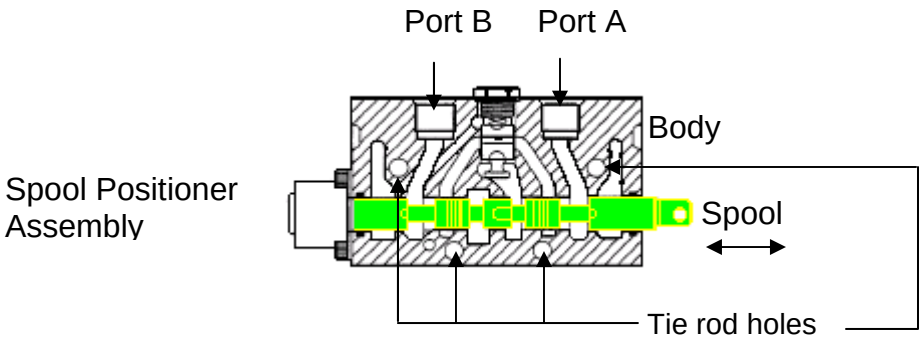


Figure 2.2 – Section through a stackable valve body showing the spool in the neutral position, work ports A & B and the tie rod holes. (Parker V16PC)

2.1.1 Inlet Section

The inlet section is where the oil flow from the pump enters the valve. Frequently it is situated at one end of the valve. There are valve arrangements however when it is situated at a mid point in the valve assembly or there may even be more than one inlet depending on system design and demand. The inlet section generally contains a maximum pressure relief valve and other porting with control or signal components depending on the system requirements. These different arrangements will be covered in greater detail in Level 2 of this module.

2.1.2 Work Sections

The work sections contain the spools for controlling the direction of flow to and from the actuator. Each section is also fitted with various controlling valves that will be described in Level 2 of this module.

2.1.3 End Section

The end section contains the porting for the return flow of oil leaving the valve. This flow can be returned straight back to the hydraulic reservoir or it may pass on to another valve. For the purposes of this module we will assume it returns to the reservoir.

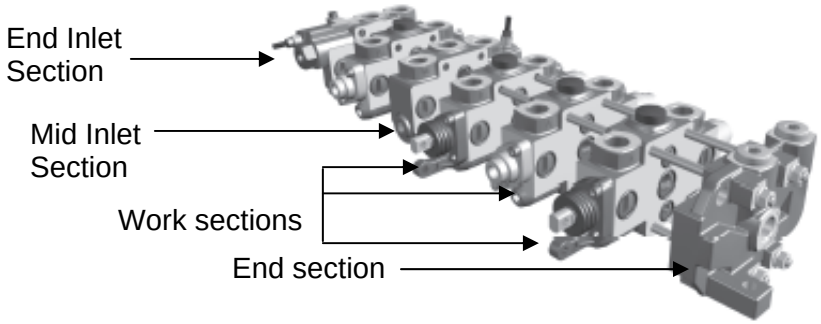


Figure 2.3 Exploded view of a sectional direction control valve indicating the main parts that go to making up a final assembly. Sectional valves have the advantage that they can be added to or changed to suit requirements. Up to ten sections may be coupled together. One of the factors limiting the number of sections is the length of the tie rods and the forces acting on them in order to keep the valve assembly together without leaking.

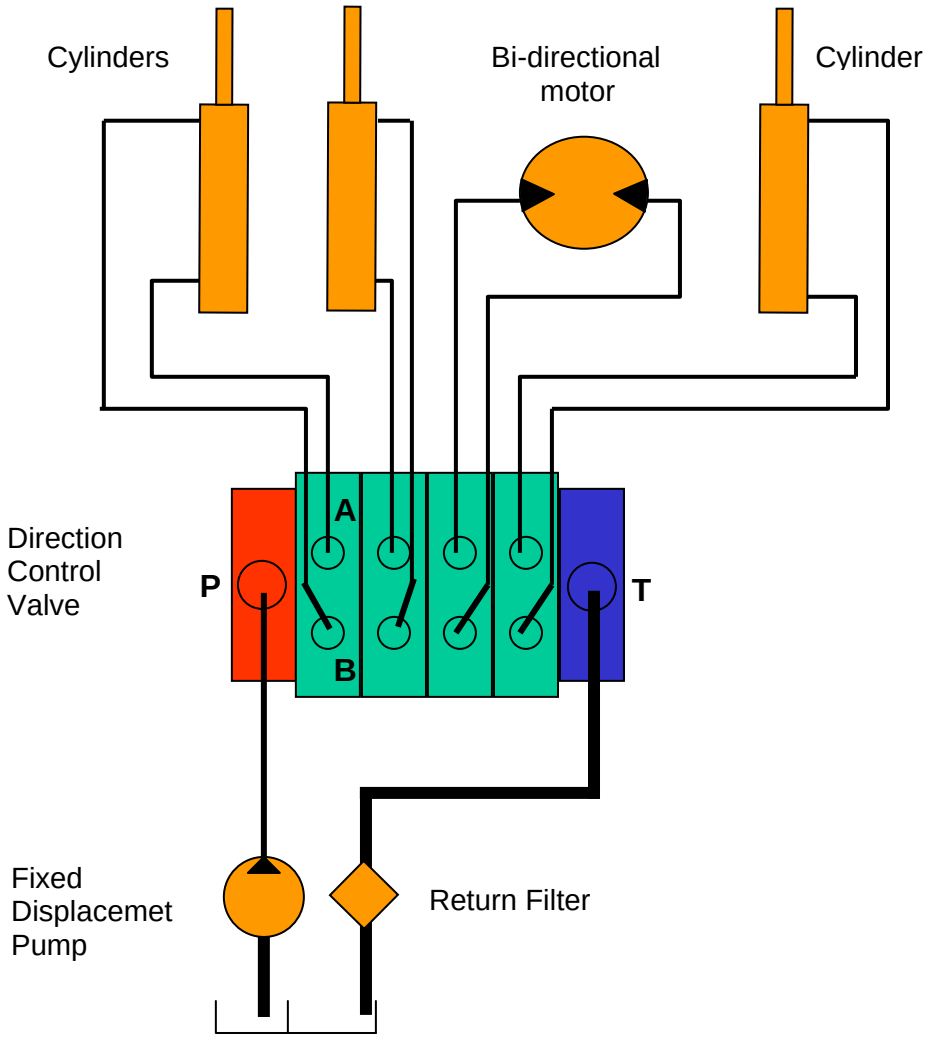


Figure 2.4 – Example of a simple hydraulic circuit showing a fixed displacement pump supplying port P on the inlet of a four-section control valve. (Only the working sections are counted). Ports A and B are repeated on the center four sections, and allow flow to and from the actuators when the respective spool is moved. As described in figure 2.1, internal galleries allow flow from the actuator to pass through the valve and exit through the outlet port in the end section.

3.0 Direction Control Valves Configurations

3.1 Typical Layouts

As mentioned briefly in section 2.1.1 the different valve configurations will be covered in greater depth in Level 2. However, figure 3.1 shows just a few typical layouts as an introduction.

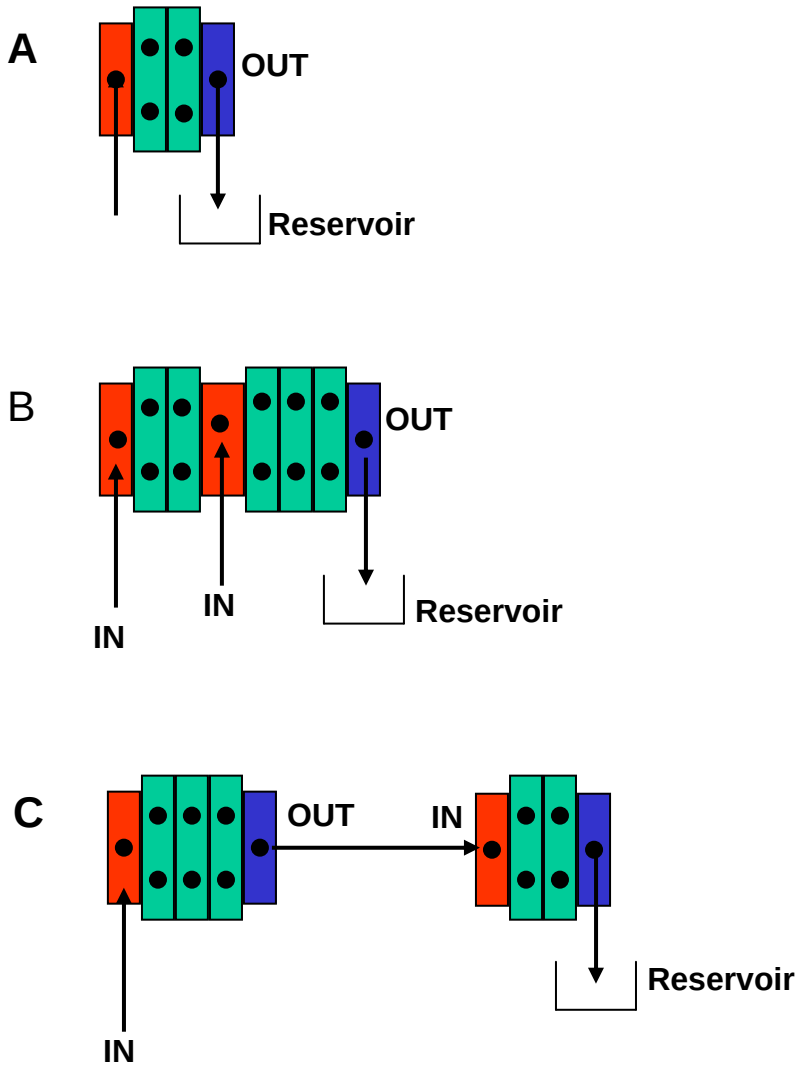


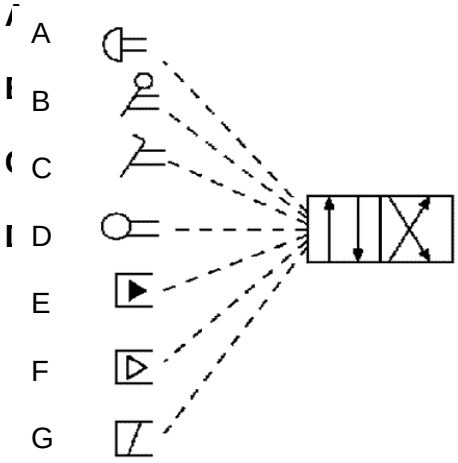
Figure 3.1 – Three typical layouts that may be encountered in mobile hydraulic systems. (**A**) – Normal feed in and return to tank flow.
(**B**) – Two inlet feeds, (usually different rates of flow). Both flow rates combine within the valve when the first two work sections are not in use giving a higher rate of flow to the last three sections.
(**C**) Feed into the first valve and functions before passing onto a second valve. This is known as 'Power Beyond'. The first valve has priority for flow demand over the second valve.

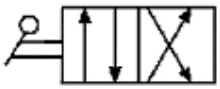
3.2 Spool Actuation

There are several methods of moving (actuating) the spool in order to control the direction of oil flow through the valve. In the earlier sections of this module we have only considered operation of the spool by using a hand lever. The schematic symbol for this is shown at the foot of every page in this module. Figure 3.2 shows the range of other possibilities for moving the spool and the symbol used to indicate the method of actuation.

Key

A	Push button
B	Hand lever
C	Foot-pedal or treadle
D	Mechanically actuated
E	Hydraulic pilot
F	Pneumatic pilot
G	Electrical solenoid





4.0 Direction Control Valve Identification on Schematic Drawings

Hydraulic components are identified on schematic drawings by internationally recognised symbols. The symbol used for one type of direction control valve is shown at the foot of every page in this module. These symbols can change to represent the actual type of valve configuration. Figure 4.1 shows how a solenoid operated, four port, three position valve would appear on a typical section of a hydraulic schematic diagram.

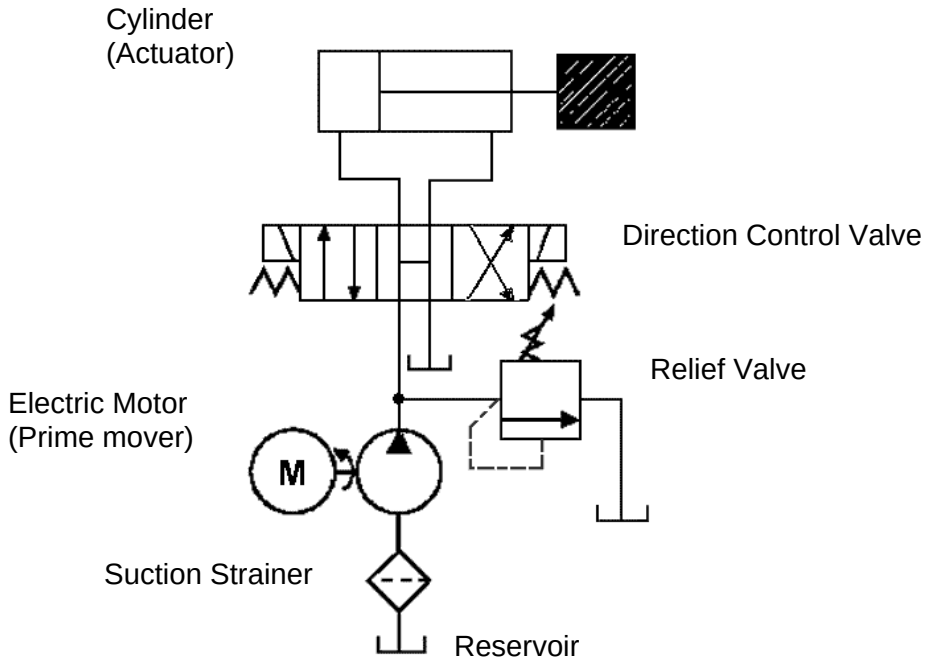


Figure 4.1 Schematic Diagram - typical arrangement showing how a particular direction control valve is represented.

5.0 Applications

As the module title suggests, these types of valves will be found on most mobile hydraulic equipment ranging from ;

Large Excavators

Mini Excavators

Cranes

Tractors

Drilling Rigs

Lorry Tippers, Grabs, and Cranes

Aerial Platforms

Backhoe Loaders

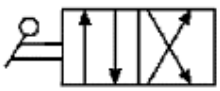
Forklift Trucks

Combines

Hedge Mowers

Refuse Trucks

Skip Loaders



Summary Points

- Direction Control Valves direct and control oil flow by the use of spools fitted within a cast iron body
- Mobile valves are manually operated, either directly or remotely
- They are usually manufactured from cast iron
- They can be manufactured as a mono block or sectional assembly
- Sectional assemblies generally comprise an inlet, work and end sections
- The inlet section port is normally identified by the letter P
- The work section ports are normally identified by the letters A and B
- The end section port is normally identified by the letter T
- The inlet section is normally fitted with a pressure relief valve
- Each work section can be fitted with a relief valve if the system demands
- Direction Control Valves can come in different configurations to suit system demands