Parker Hannifin Plc
Product Training
Remote Controls
Pneumatic/Hydraulic/Electro-Hydraulics

Level 1

0 Introduction

evel One 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 their 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.

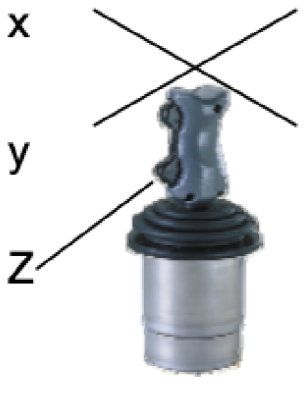
1.1 What is remote control?

Remote control means to separate the operators levers from the directional control valves to get better environment for the operator. The improvements can be seen as more productive machines. The levers are more user friendly, compared to manual levers (figure 1.1). There are 3 common types of remote controls on the market, pneumatic-, hydraulic- and electro-hydraulics controlled levers (figure 1.2). When the levers are separated from the directional control valve you will get two options. If the manual operated directional control valve was placed on/in a cab, you remove the directional valve out of the cab and close the cab, noise, heat and smell is reduced. The levers that are mounted inside the cab can be placed wherever you want and instead of single levers you can get 2 or 3 proportional (figure 1.3). This makes it much easier for the operator to handle several cylinders at the same time. The productivity of the machine is improved. The cab can be built in another way and the cost of the cab can be reduced. The other option is if the directional control valve is mounted e.g. on the frame of a truck. The directional control valve is at the same place and the levers are moved somewhere else. With electro-hydraulics levers you are mobile as operator and are free to moved around. Depending on the different types of remote controls more functionality is also added.

Figure 1.1

Figure 1.2

Figure 1.3



1.2 How does remote control work?
Manual levers are mechanically attached to the spool on the directional valve. The spool is moved to central position by a centring spring packaged. The simplest type of remote controlled system is through cable systems (figure 1.4), not mentioned above. Cable length about 5 metres maximum.
Pneumatic controlled systems are built up by using a pneumatic proportional lever. From the lever there is a proportional output signal, typical air pressure at 0-8 bar. On the directional control valve there is a cup attached to each side of the spool and hoses connected between both sides of the directional control valve and the pneumatic lever. Maximum distance between lever and directional control valve is 5 metres.
On a hydraulic proportional lever the media is hydraulic oil instead of air, typical pressure 5-20 bar. In an electro-hydraulic system the proportional electric lever converts the position into electric parameters. At the directional control valve there is a solenoid converting current from an amplifier into hydraulic pressure, which acts on the spool in the same way as for the hydraulic type.

Figure 1.4

2.0 Pneumatic/Hydraulic Proportional Lever Operation
(Figure 2.1)The operator moves the lever handle and the plunge compresses the spring package. The spring package acts with a force on the hydraulic spool. The hydraulic spool moves downwards and connects the supply air/oil pressure, through the drilled hole on the spool, through the spool and to the bottom of it. The bottom of the spool is connected to the air/oil cup on the directional control valve. The main spool in the directional control valve is forced to move towards the centring spring package and a pressure is built up in the hose between the lever and the directional control valve. The pressure acts on the bottom area of the hydraulic spool in the hydraulic lever. The pressure on the bottom area of the spool forces the spool into a balanced position. Depending on the spring package force, different pressures are built up v.s. the lever stroke. When the lever position is changed towards neutral

position, the pressure is reduced as the drilled hole in the spool is connected to tank. And the spool will return into the balanced position again.
The pneumatic spring package has no pre set setting but the hydraulic spring packaged is pre set to typical 5 bar. This will effect the output signal level from the hydraulic lever. There is a jump in the beginning of the output signal, which will improve the operation for the operator. Flow from the directional control valve will start at a shorter lever stroke (figure 2.2).
The force to move the lever is direct affected by the output pressure. The stronger spring package the higher the force needed to move the lever.

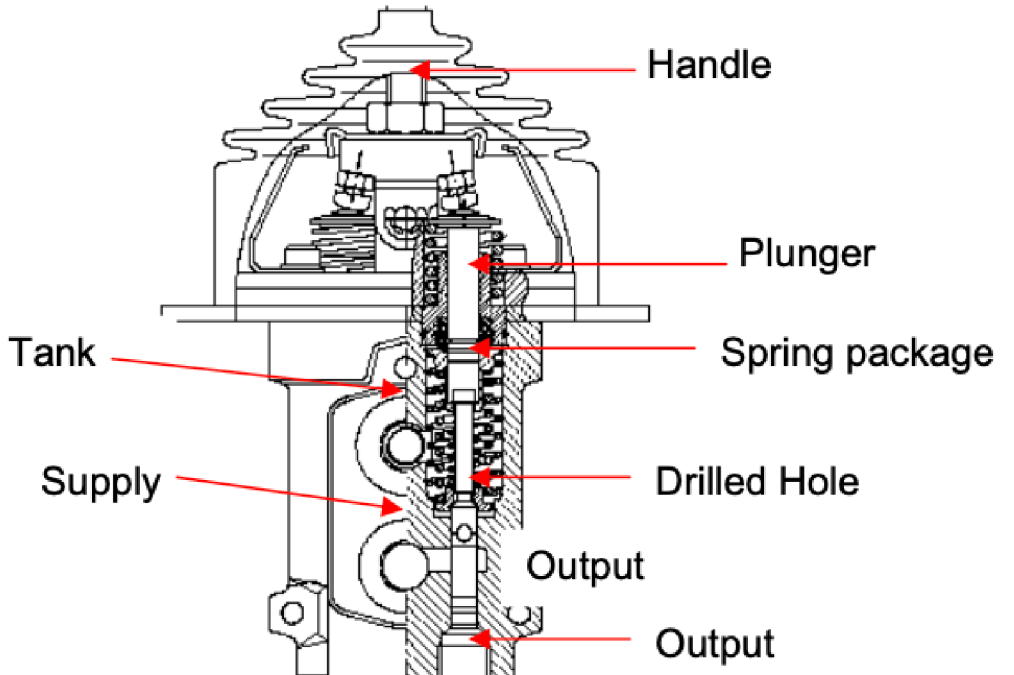


Figure 2.1 – Hydraulic proportional control lever

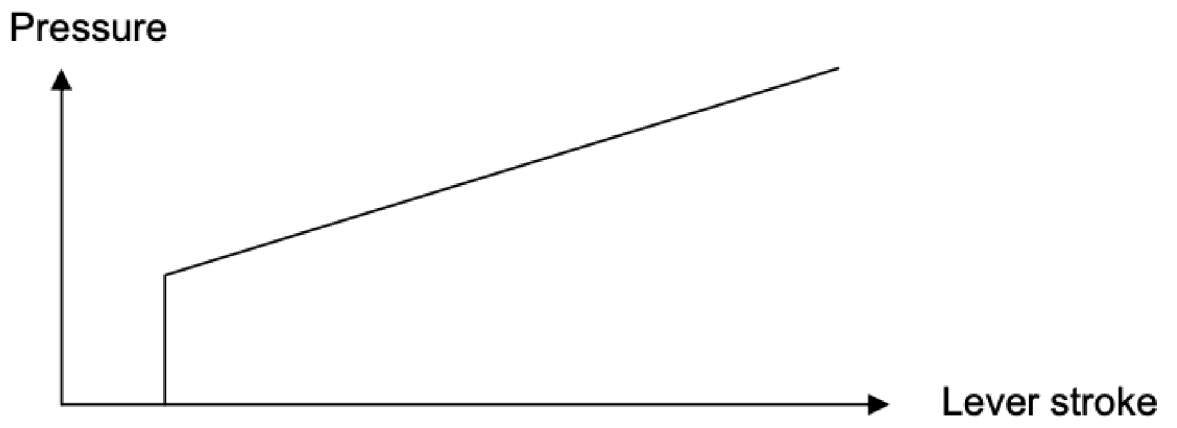


Figure 2.2

2.1 Hysteresis
A pneumatic lever connected to a directional control valve has a high total hysteresis value, 30 %, due to 5 O-rings and a scraper around the main spool on the directional control valve. The hysteresis makes the lever hard to use when fine control is required. The lever is used most on truck applications for e.g. lifting

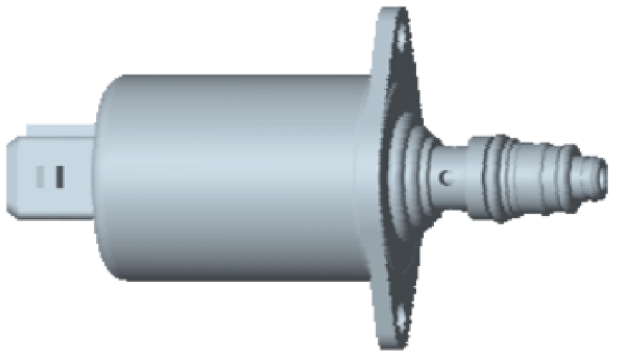
“xxtippers”. Another reason why it is common on truck is that there is already compressed air for the brakes. No added cost for the air supply. Single and co-ordinate levers are available together with handles with electric switches.
The hydraulic lever connected to a directional control valve has a low total hysteresis value, 10 %, there are no O-rings and no scraper around the main spool on the directional control valve. The low value makes the lever very good for fine control applications, e.g. excavators. Single and co-ordinate levers are available together with handles with electric switches.

2.2 Main spool in directional control valve together with hydraulic lever
The main spool in the directional control valve can be machined to improve the flow control for the operator. As the main spool in the directional control valve is pressure controlled toward the spring package there is no mechanical connection between the lever stroke and the main spool position. With the correct machining forces are created moving the spool to another position than what the pressure demands. The benefit for the operator is that it will be easier to operate the machine, e.g. excavators.

2.3 Electro-Hydraulic control
Electro-hydraulics is using electric levers. There are small and big levers. There are single and co-ordinate levers. The co-ordinate levers can be 2, 3 or 4-proportional. The lever forces are controlled by mechanical springs only and can be set at any level. The lever weight is very low so it can be mounted in arm rests that can easily moved into different positions. When many cylinders have to be controlled at the same time electric levers are far superior the other types. The lever converts handle stroke into electric parameters. The sensor inside the lever can be a potentiometer or a contactless type, e.g. hall sensor or inductive sensor. The contactless has a much longer service life compared to the potentiometer. The output signal can be a voltage, a current or a digital value.

2.4 Proportional solenoid
To move the main spool in the dir valve in a electro-hydraulic control system, pressure is needed. The solenoid converts the electric current into hydraulic pressure. To get the function that each lever position correspond to a pre set pressure value. The output signal from the amplifier is current controlled. Due to temperature changes on the solenoid that changes the solenoid resistance. To further improve the fine control there is a dither added to the electric current. The

dither makes the armature in the solenoid, the spool in the solenoid and the main spool to oscillate with typical 100 Hz. The oscillation reduces the hysteresis to 3 %.



2.5 Units

The output signal from the lever is always connected to an amplifier. Today's amplifier are digital. Many times there is a display in the system. This makes it easy to tune the system and to know the value of all settings. Most of the systems can be programmed into to different functions. For that reason a computer programme is added to the system.

More and more common are bus systems. There is a two wire connection between the different units. Standard bus configurations are used. In mobile CAN-busses are most common.

2.6 Functionality

Electro-hydraulic lever and units together with closed centre valves gives full freedom to control machines. It is possible to control flow/cylinder speed at all conditions. This gives the engineering people a tool to control e.g. accelaration, retardation, speed, or pressure. Safety demands on machine can now be taken care of.

2.7 Inputs and outputs

Digital systems can be built up in two different ways. One common unit or several smaller ones. The reason to have smaller units is to give users the possibility to pick components useful for them which gives cost reduction. The units are connected through a two wire connection. There are units equipped with more inputs to be used close to the operator. Other units are equipped with more outputs to be used closed to the directional control valve. There are units for e.g. radio control and modems.

Input signal can be analogue or on/off(digital). An analogue input is used for measuring e.g. temperature or position of cylinder. Common input values are: 0-5 volts or 4-20 mA. Digital input signals are used to measure e.g. position of switches

or high or temperature above a certain level. Another common input signal is frequency input used to measure speed or rotation per minutes.
Output signals are used for controlling solenoids for directional control valves or other type of valves. The output can be proportional or on/off(digital).