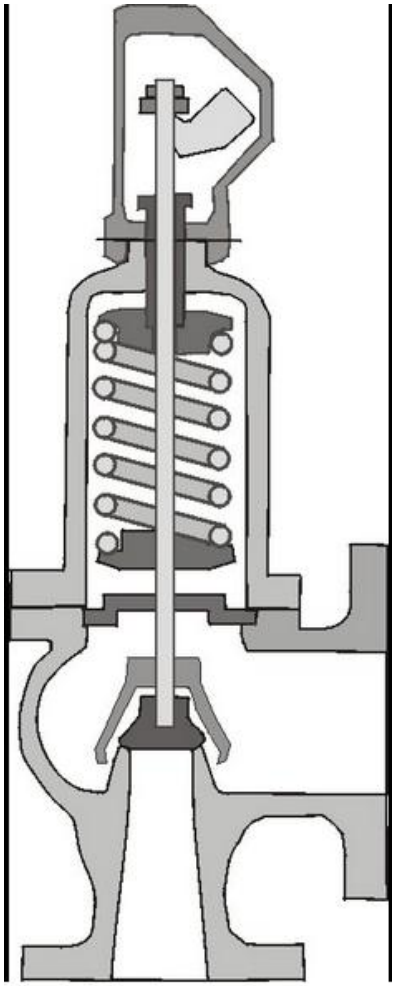
Unit III Class IV

Proportional valves

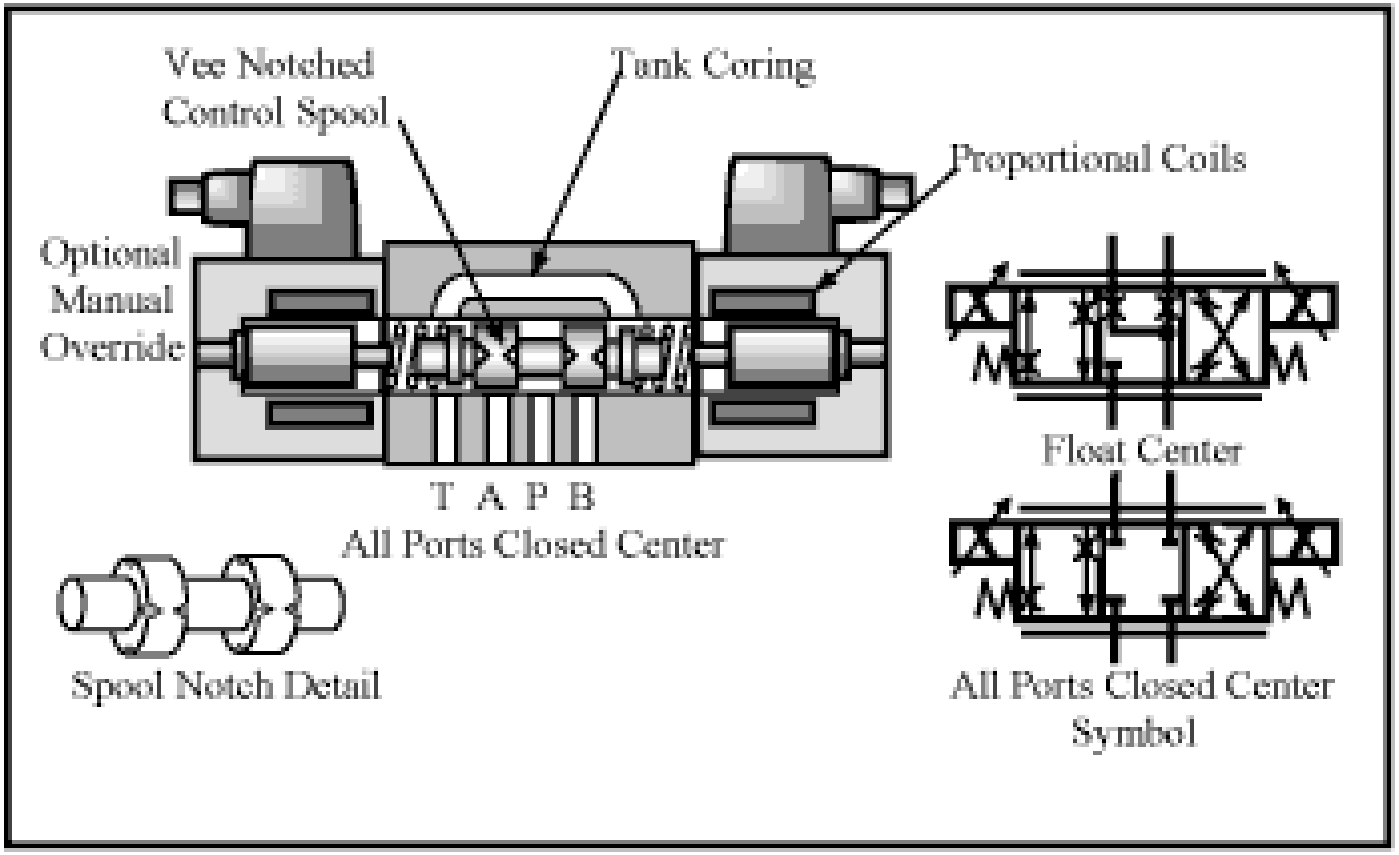
Proportional valves

- A **proportioning valve** is a valve that relies on the statics to supply a reduced pressure to an output line.
- A simple example is where spring load applies a reducing force so that the output pressure is reduced.
- Proportioning valves are frequently used in cars to reduce the brake fluid pressure to the rear brakes.

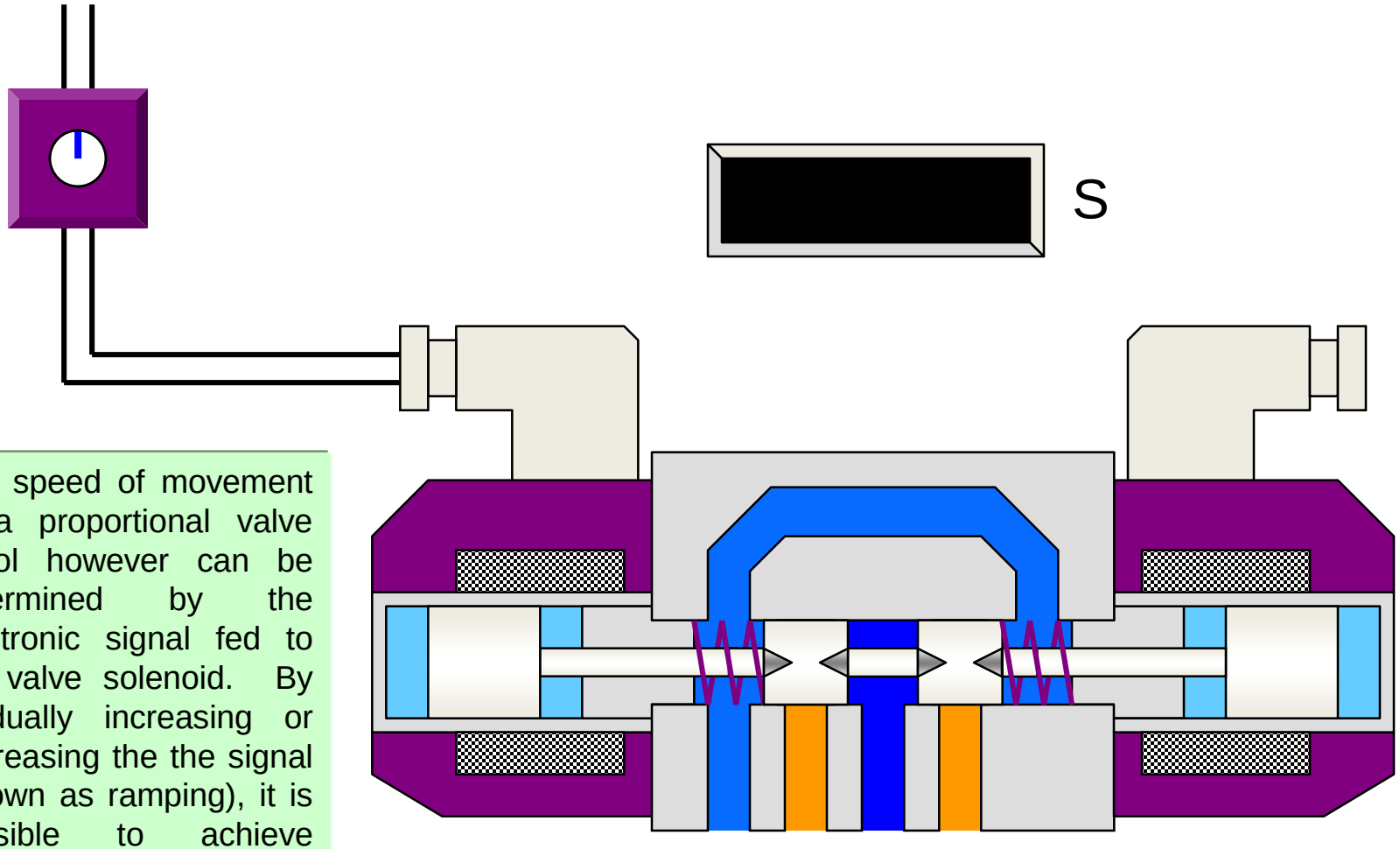
Proportional valves



Proportional valves

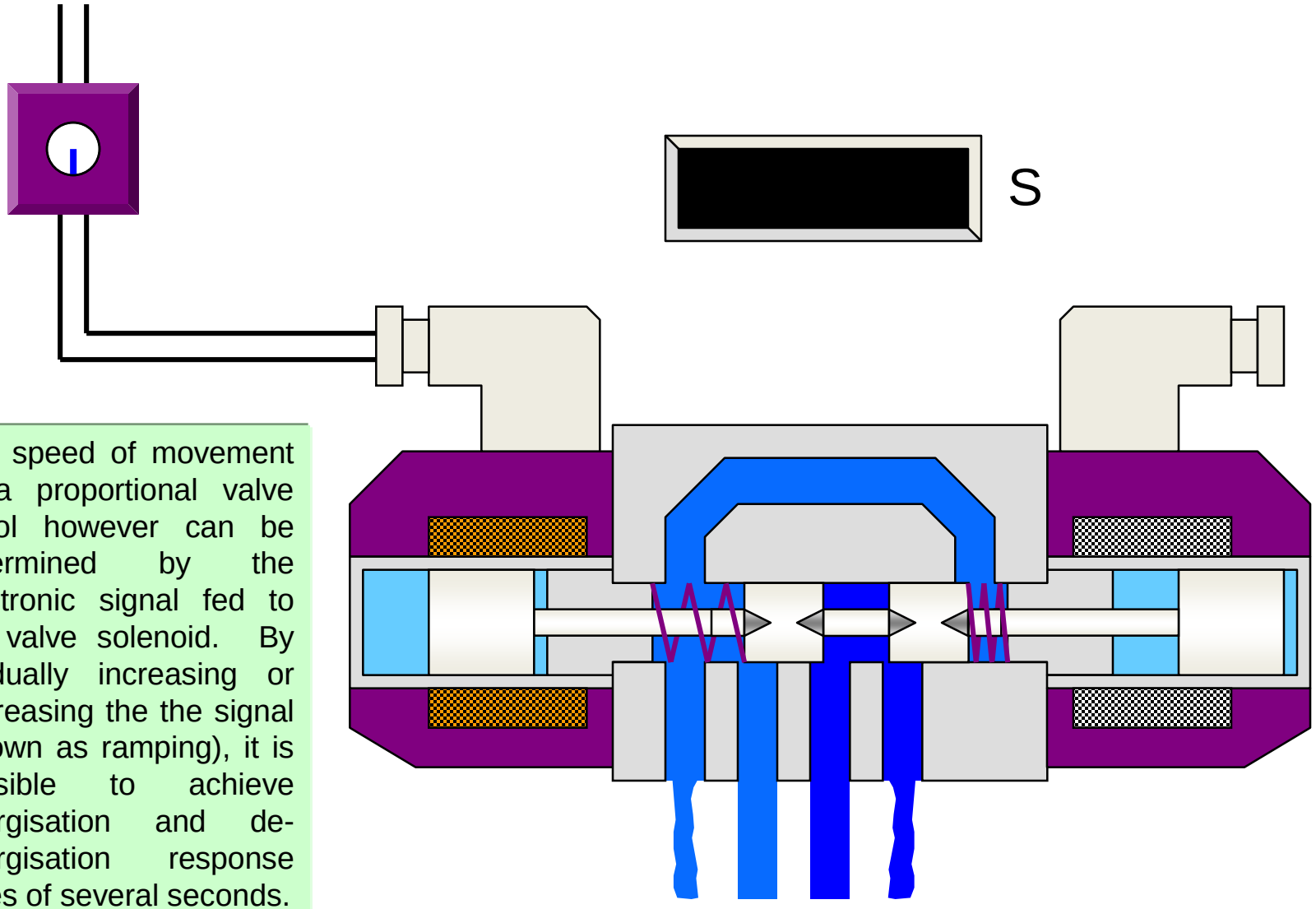


PROPORTIONAL VALVE RESPONSE TIME



The speed of movement of a proportional valve spool however can be determined by the electronic signal fed to the valve solenoid. By gradually increasing or decreasing the the signal (known as ramping), it is possible to achieve energisation and de-energisation response times of several seconds.

PROPORTIONAL VALVE RESPONSE TIME



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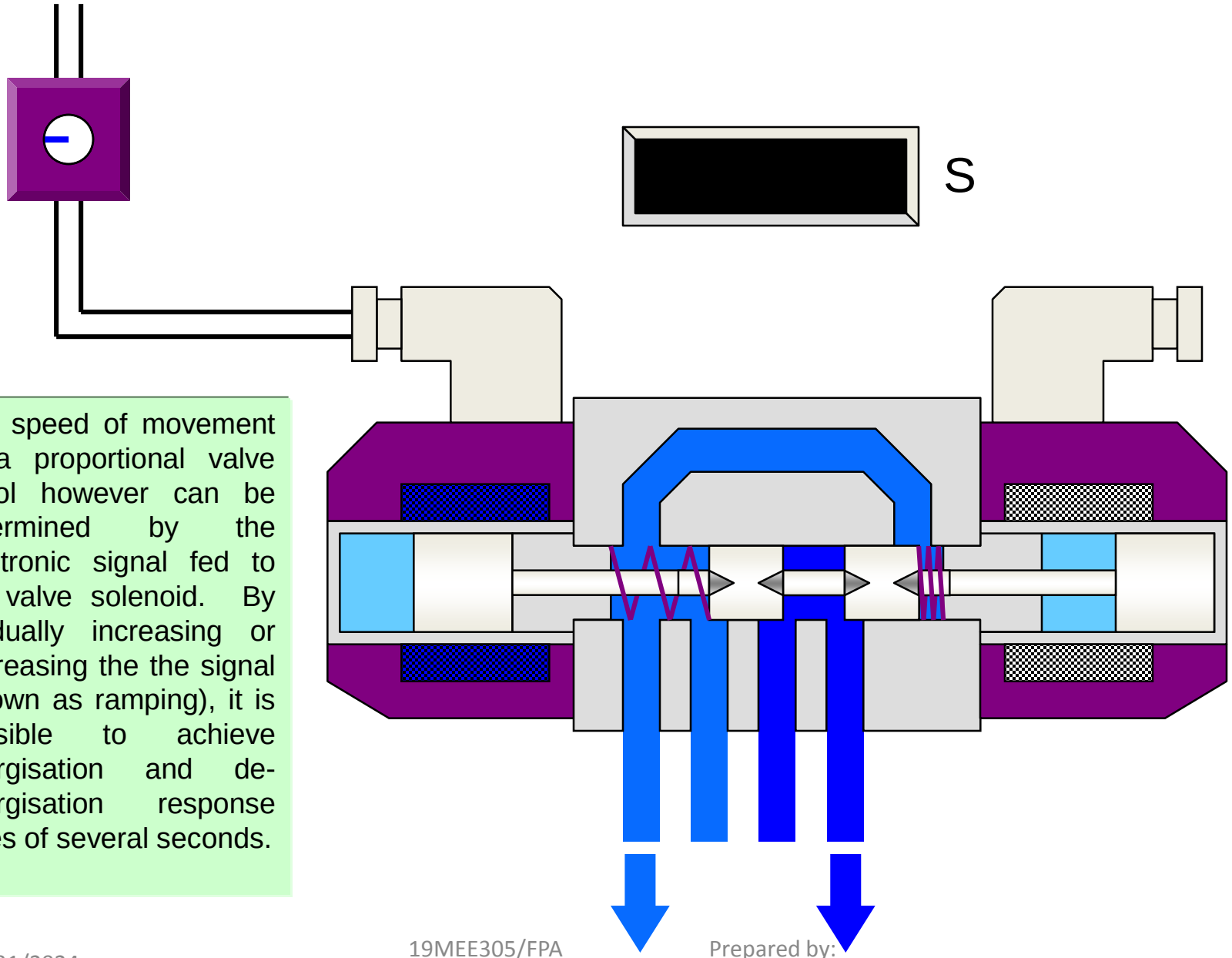

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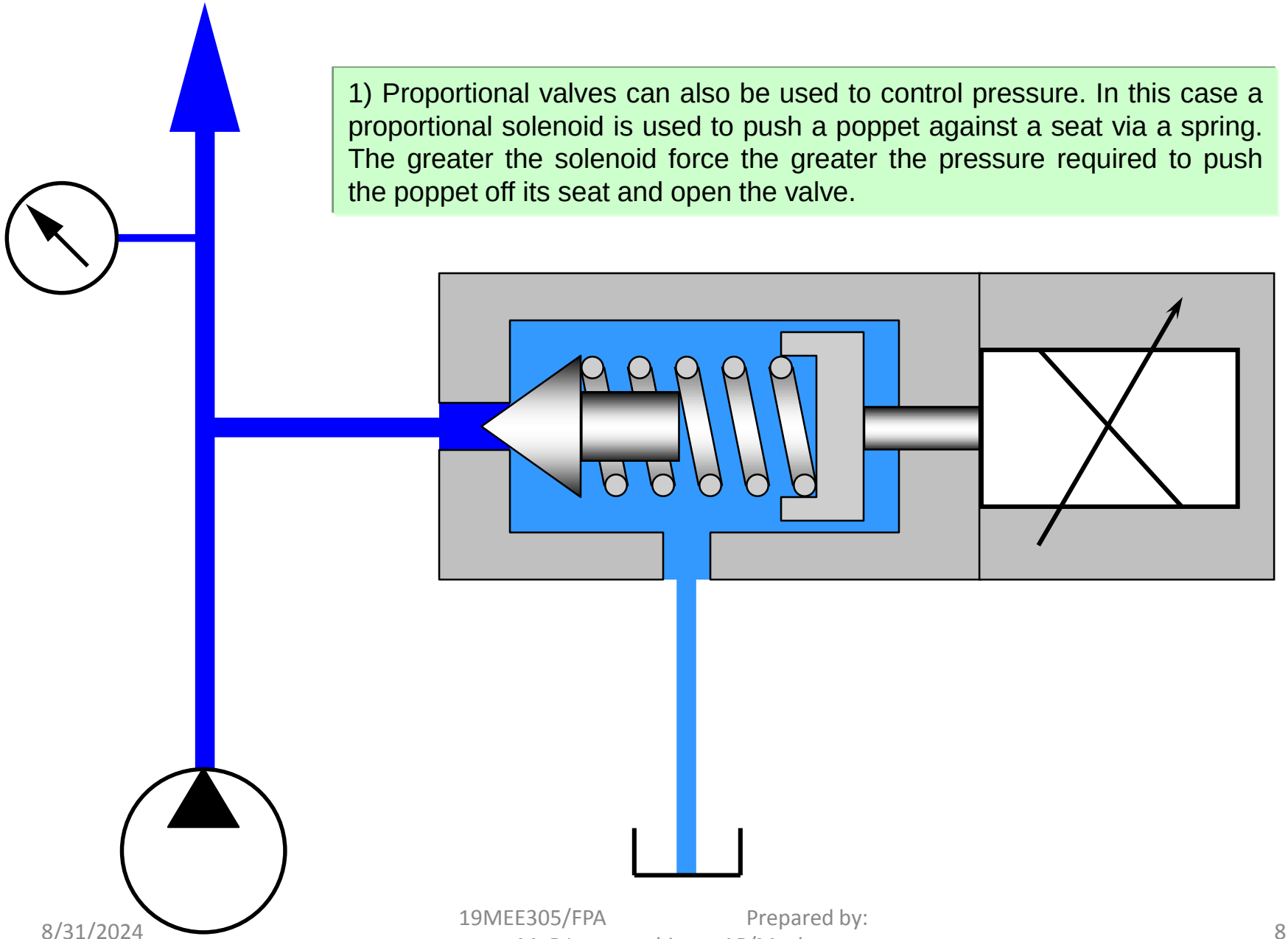
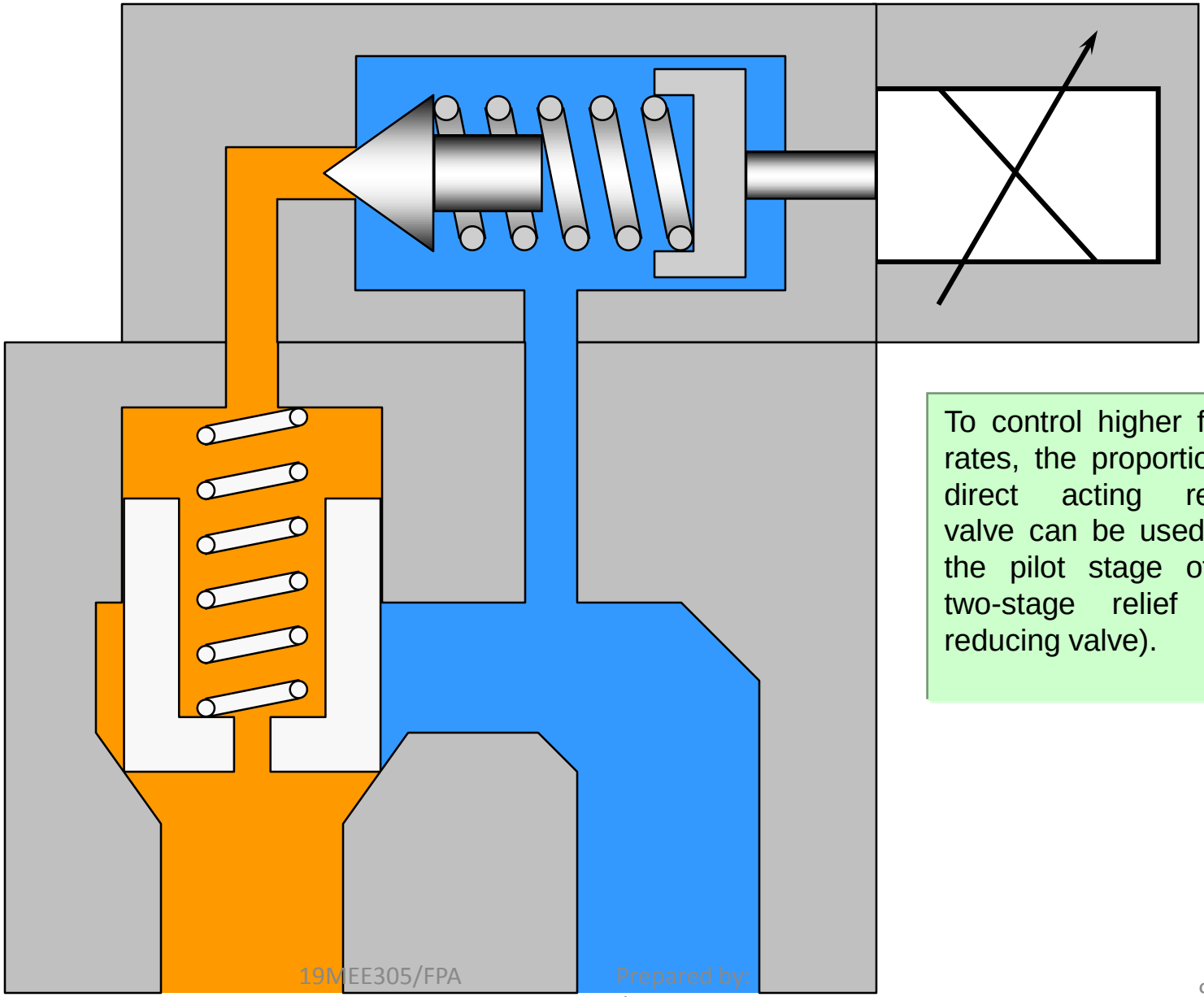
DIRECT ACTING PROPORTIONAL RELIEF VALVE

1) Proportional valves can also be used to control pressure. In this case a proportional solenoid is used to push a poppet against a seat via a spring. The greater the solenoid force the greater the pressure required to push the poppet off its seat and open the valve.

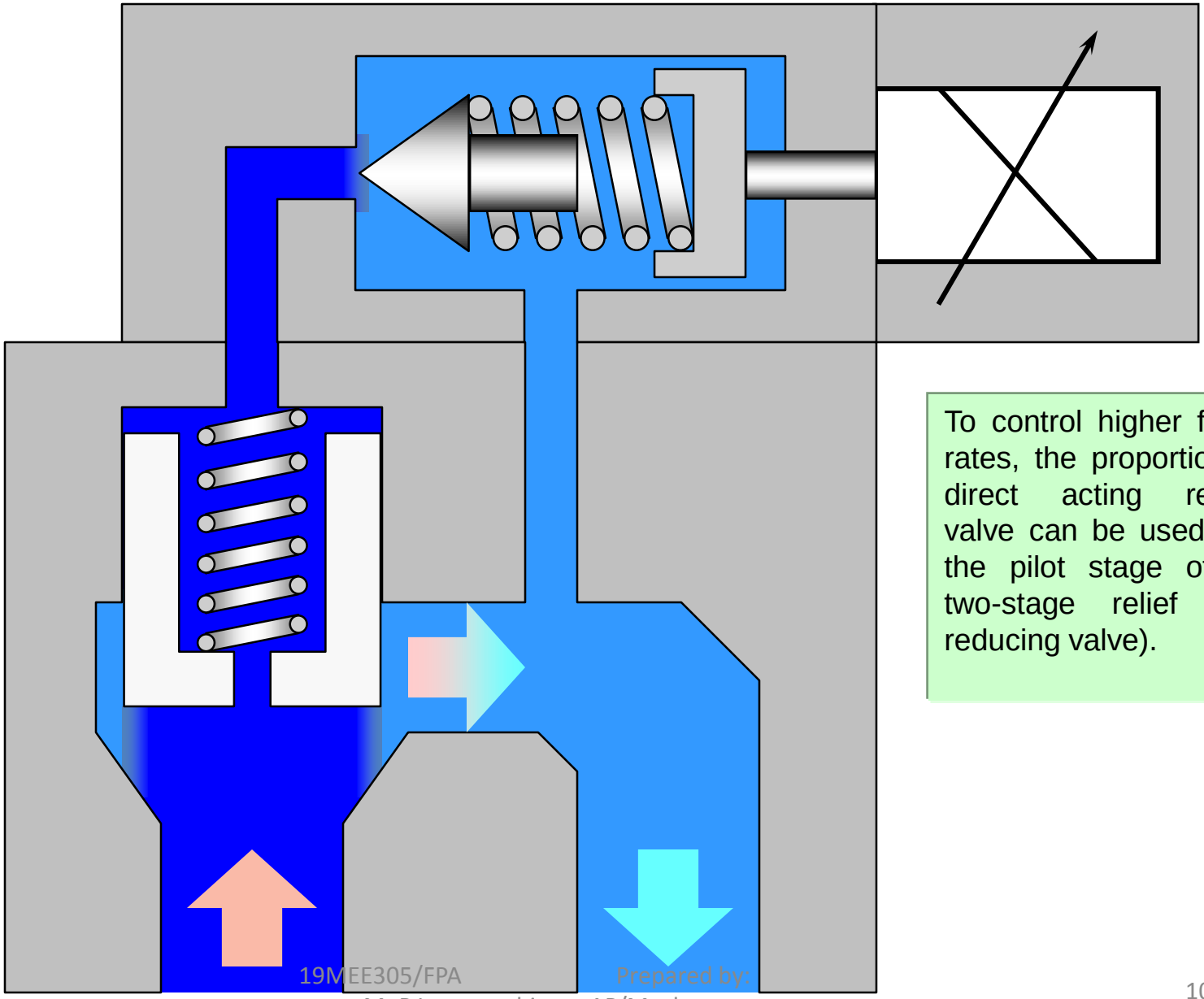


TWO-STAGE PROPORTIONAL RELIEF VALVE



To control higher flow rates, the proportional direct acting relief valve can be used as the pilot stage of a two-stage relief (or reducing valve).

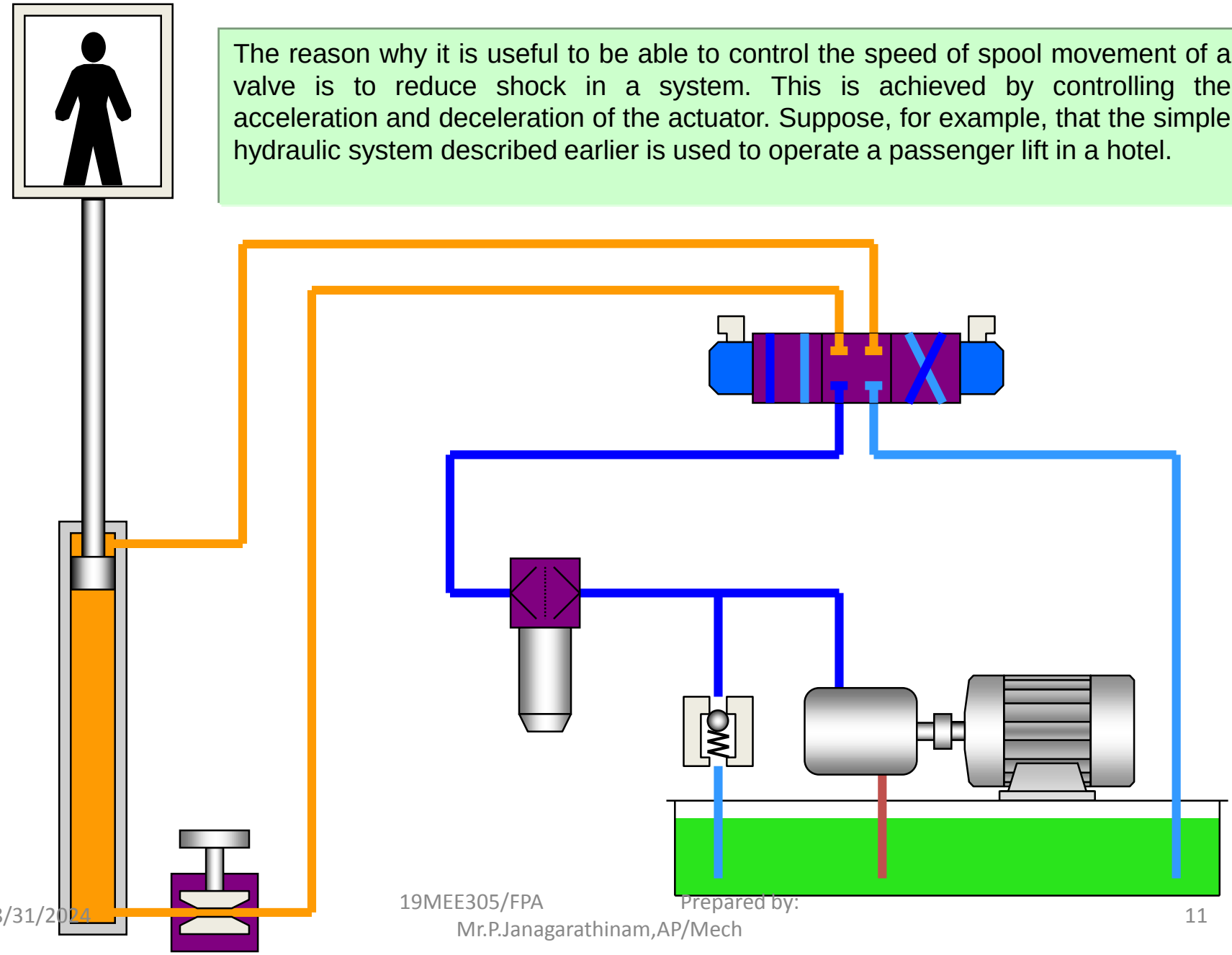
TWO-STAGE PROPORTIONAL RELIEF VALVE



To control higher flow rates, the proportional direct acting relief valve can be used as the pilot stage of a two-stage relief (or reducing valve).

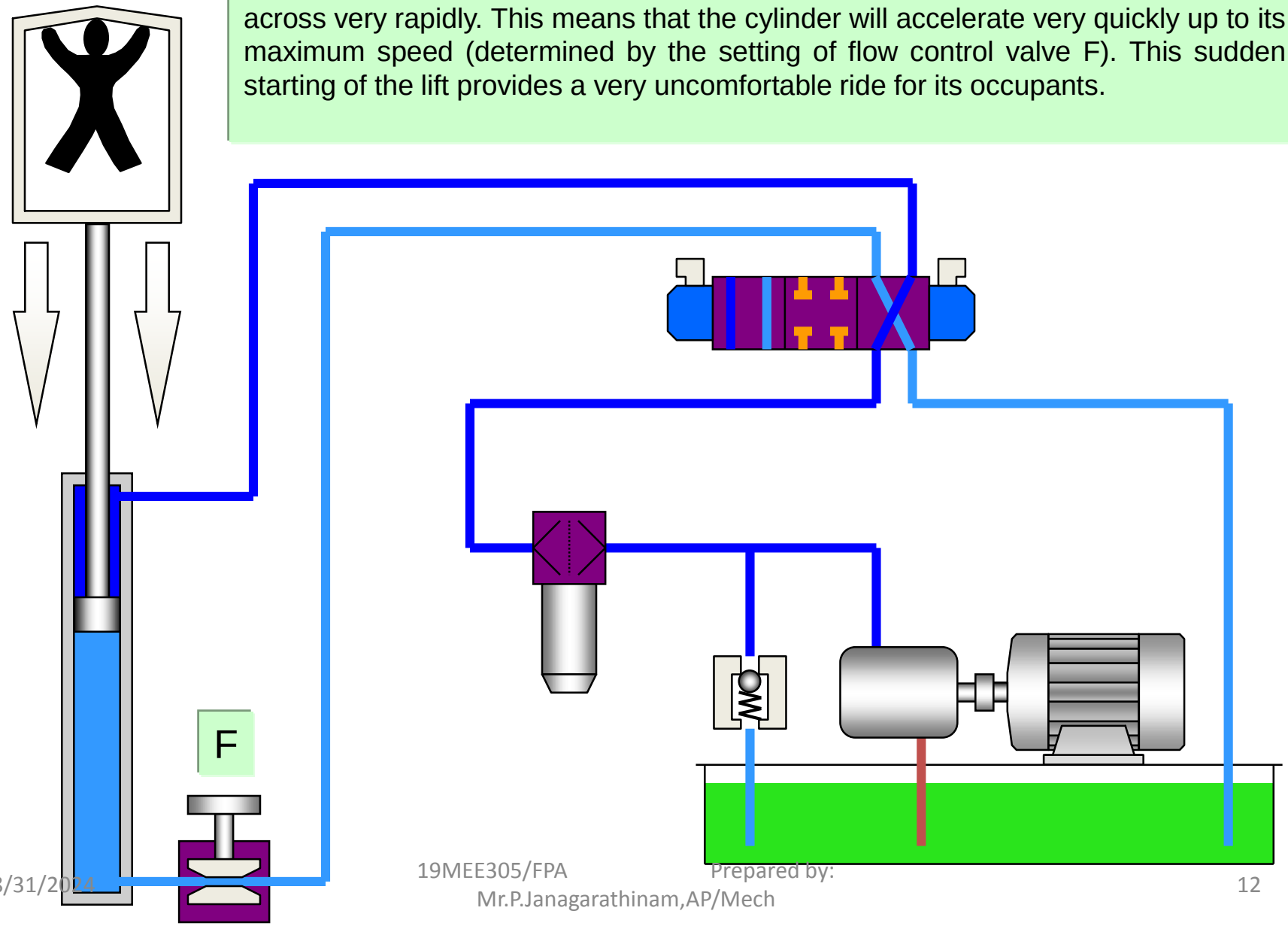
LIFT EXAMPLE - CONVENTIONAL SYSTEM

The reason why it is useful to be able to control the speed of spool movement of a valve is to reduce shock in a system. This is achieved by controlling the acceleration and deceleration of the actuator. Suppose, for example, that the simple hydraulic system described earlier is used to operate a passenger lift in a hotel.



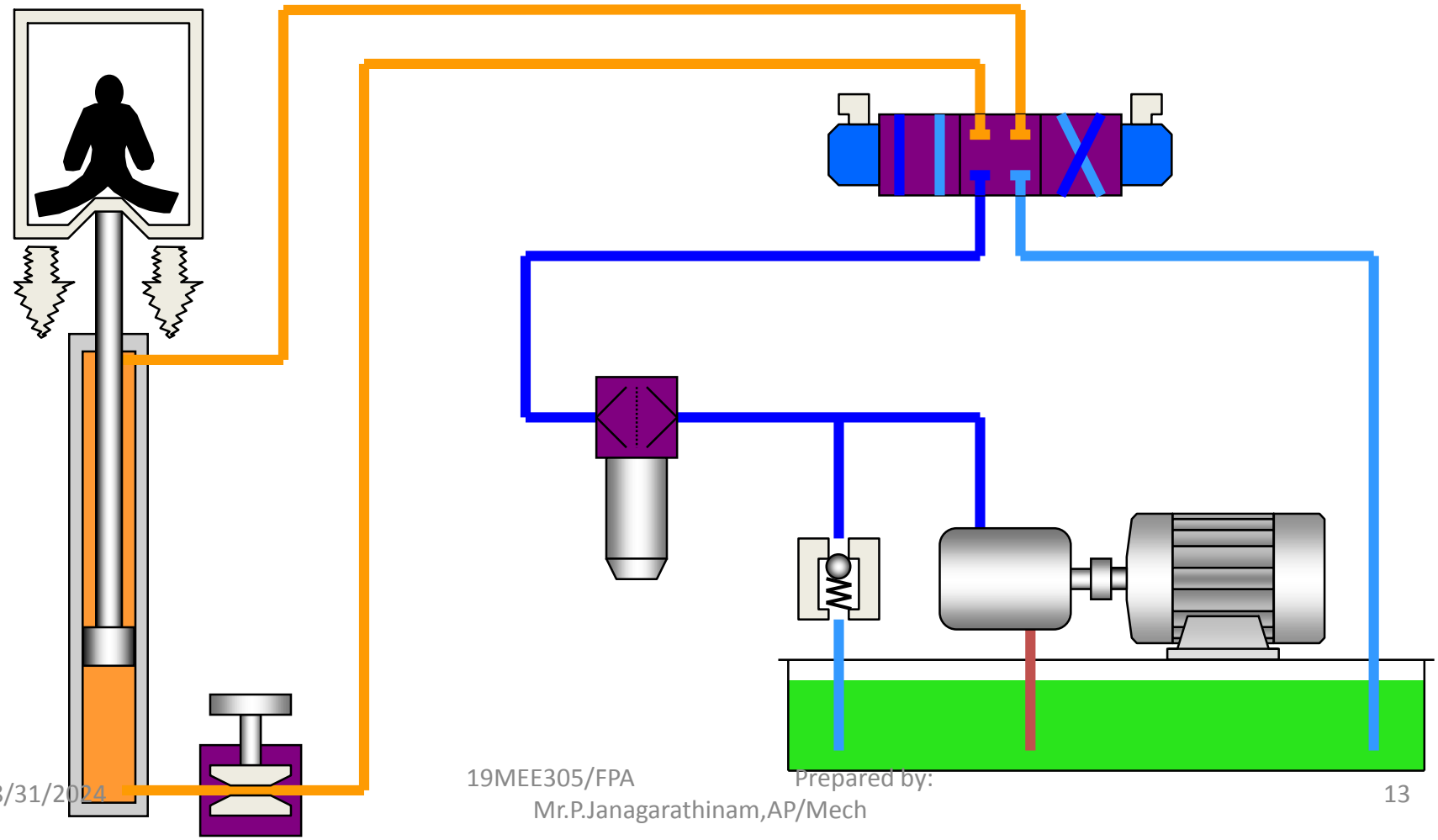
LIFT EXAMPLE - CONVENTIONAL SYSTEM

When the solenoid valve is energised to lower the lift, the valve spool will move across very rapidly. This means that the cylinder will accelerate very quickly up to its maximum speed (determined by the setting of flow control valve F). This sudden starting of the lift provides a very uncomfortable ride for its occupants.



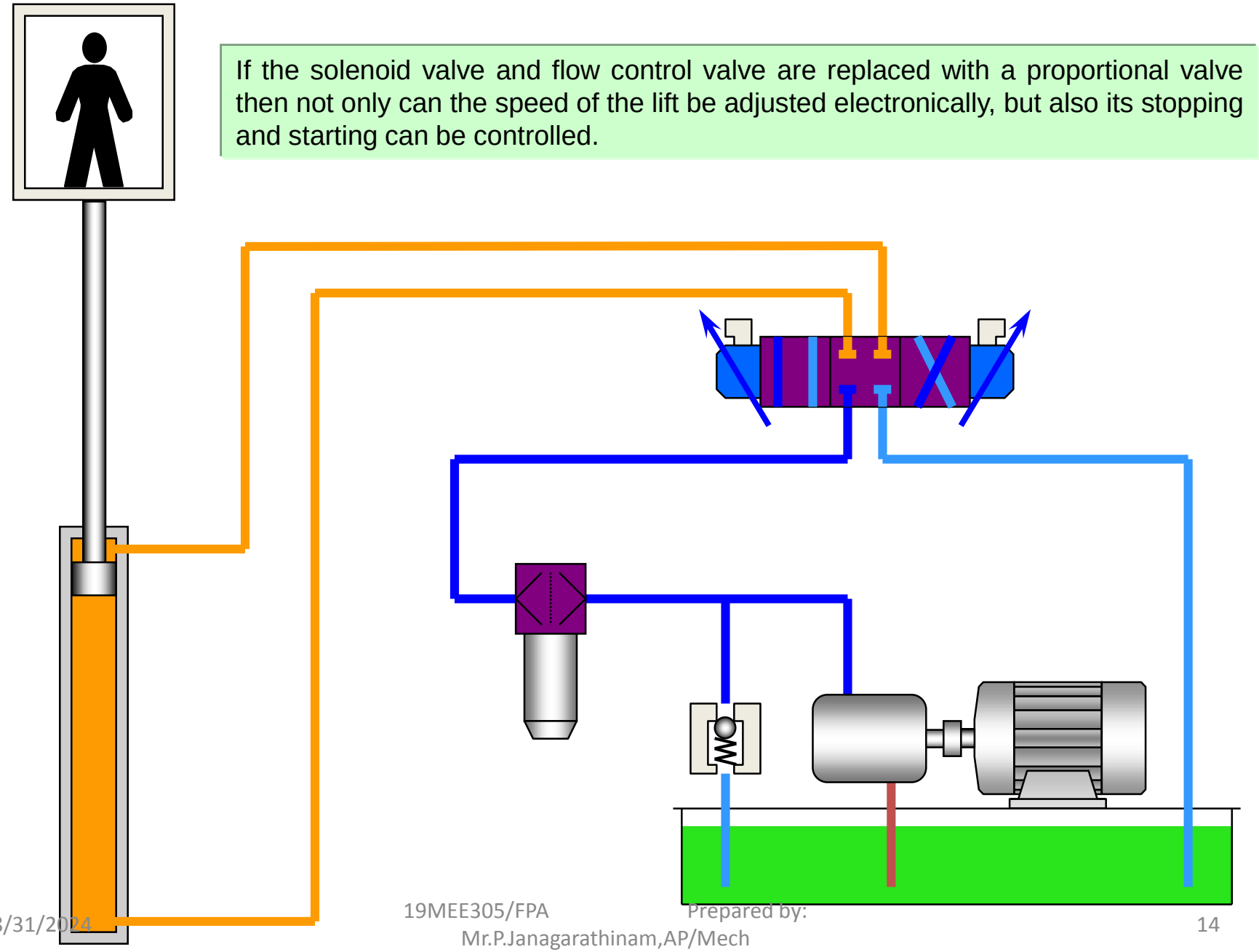
LIFT EXAMPLE - CONVENTIONAL SYSTEM

Similarly, when the lift reaches its destination, the solenoid valve will shut off very rapidly causing a sudden stopping of the lift and again a very uncomfortable situation for the occupants. In real hydraulic systems, the shocks generated by sudden starting and stopping of actuators create high peak pressures which are one of the principle causes of fluid leakage.



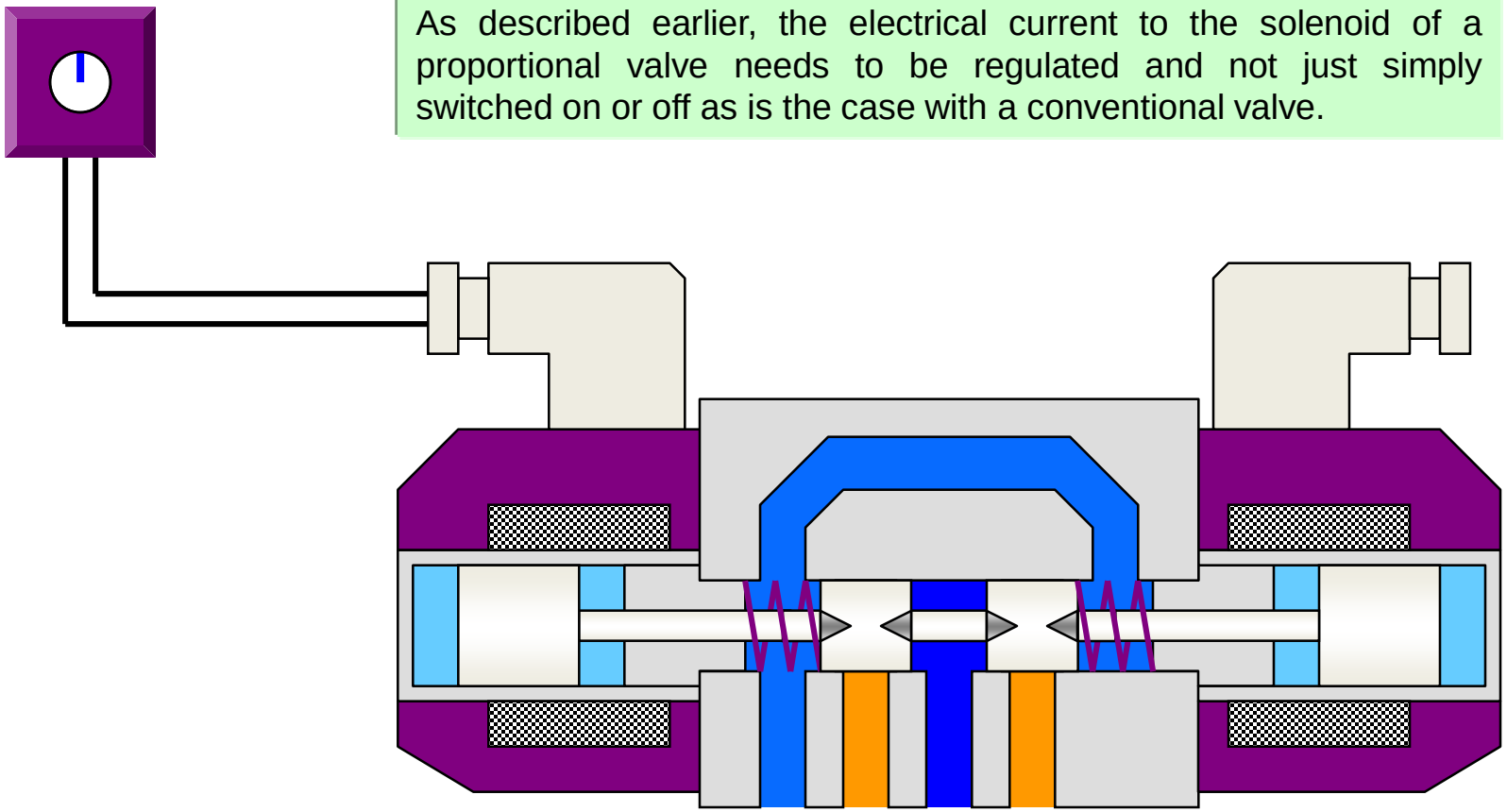
LIFT EXAMPLE - PROPORTIONAL SYSTEM

If the solenoid valve and flow control valve are replaced with a proportional valve then not only can the speed of the lift be adjusted electronically, but also its stopping and starting can be controlled.

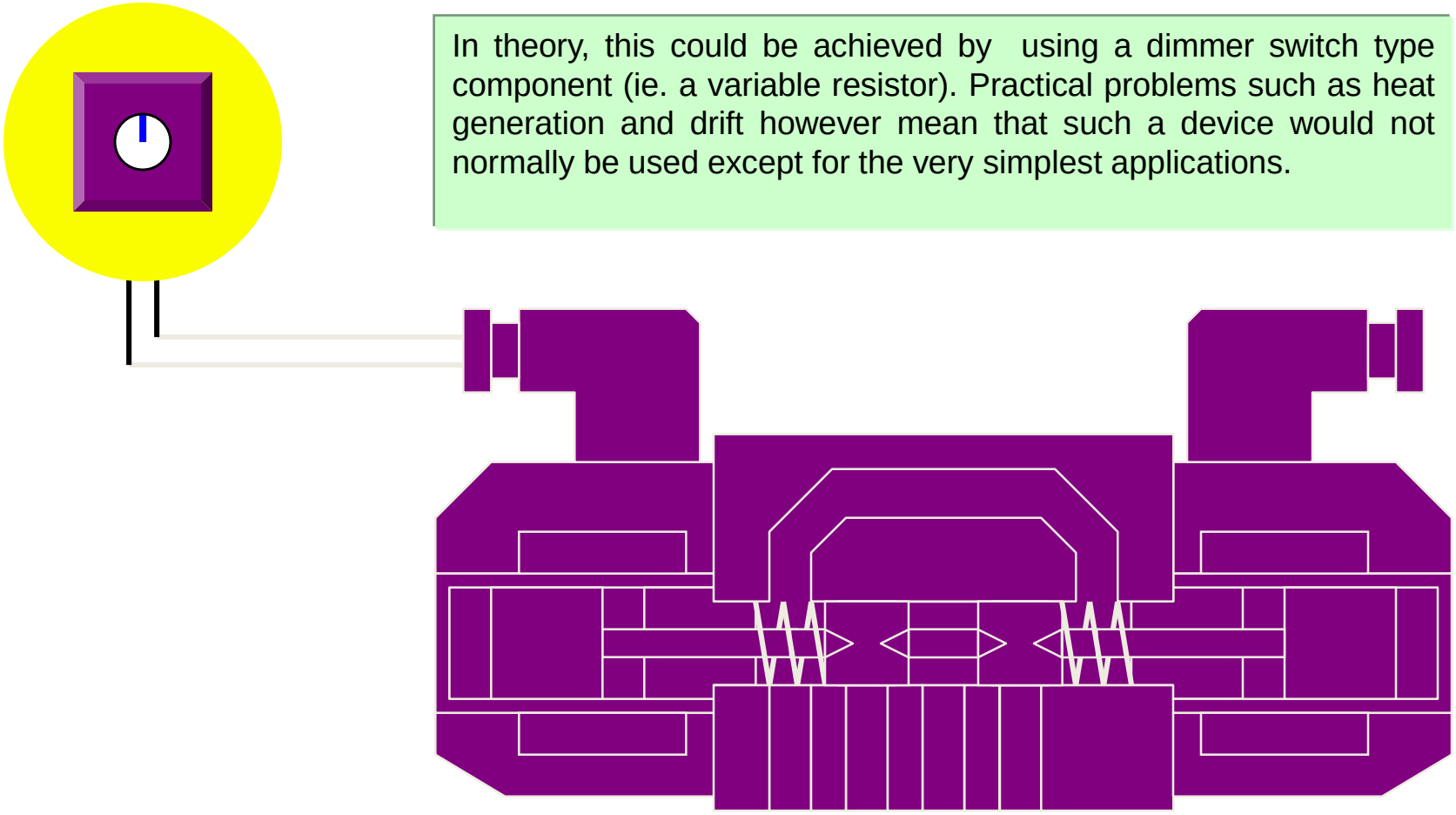


VALVE INPUT SIGNAL

As described earlier, the electrical current to the solenoid of a proportional valve needs to be regulated and not just simply switched on or off as is the case with a conventional valve.



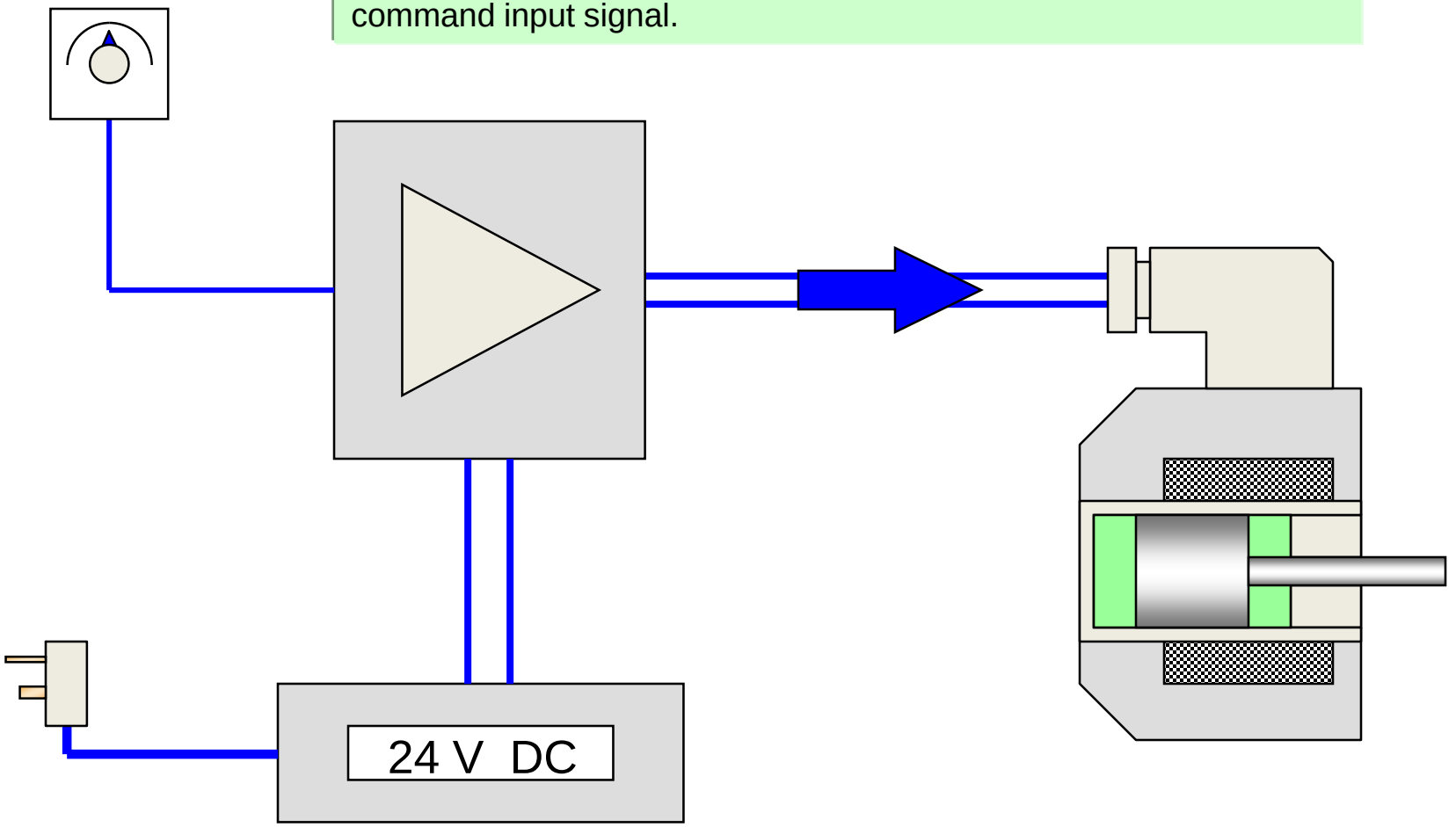
VALVE INPUT SIGNAL



In theory, this could be achieved by using a dimmer switch type component (ie. a variable resistor). Practical problems such as heat generation and drift however mean that such a device would not normally be used except for the very simplest applications.

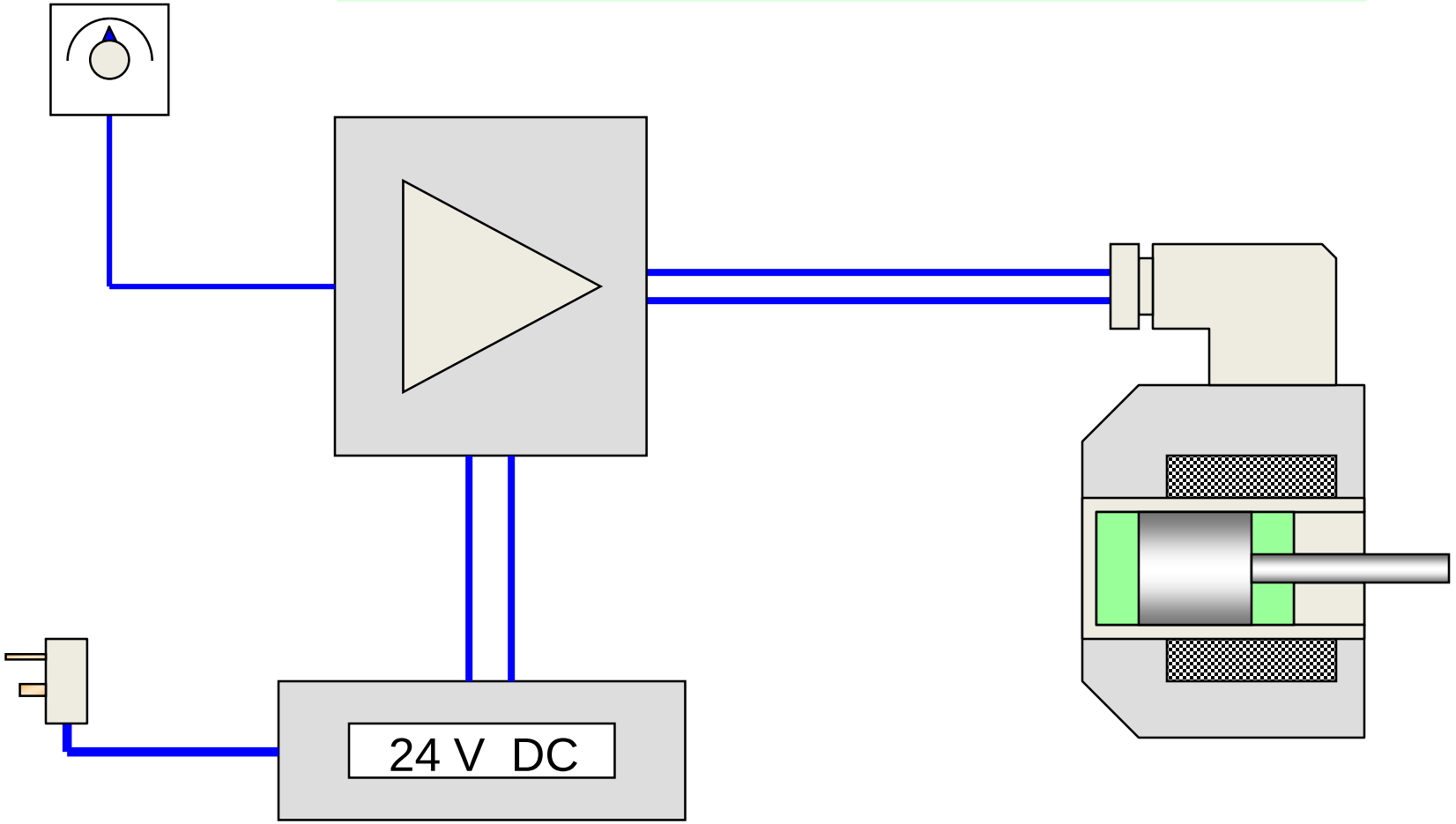
PROPORTIONAL VALVE AMPLIFIER

Normally, the current flowing through the proportional solenoid will be controlled by some form of electronic amplifier. The amplifier itself will require a power supply (usually 12 or 24 VDC) and a command input signal.



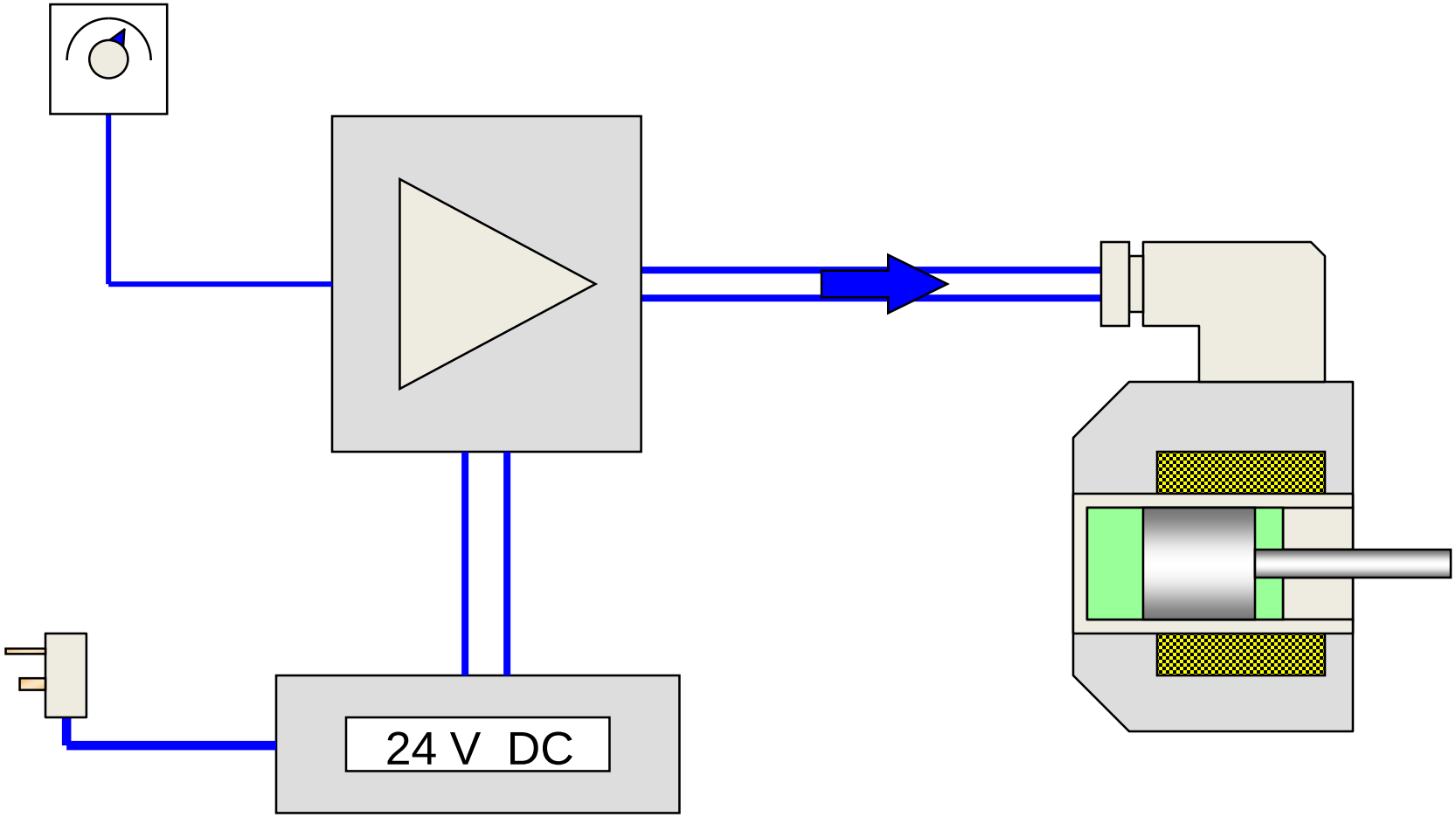
PROPORTIONAL VALVE AMPLIFIER

The output of the amplifier (electrical current) is controlled by the input signal so with zero input the output current is also zero.



PROPORTIONAL VALVE AMPLIFIER

Increasing the input signal to the amplifier results in a corresponding increase in output current to the valve solenoid.



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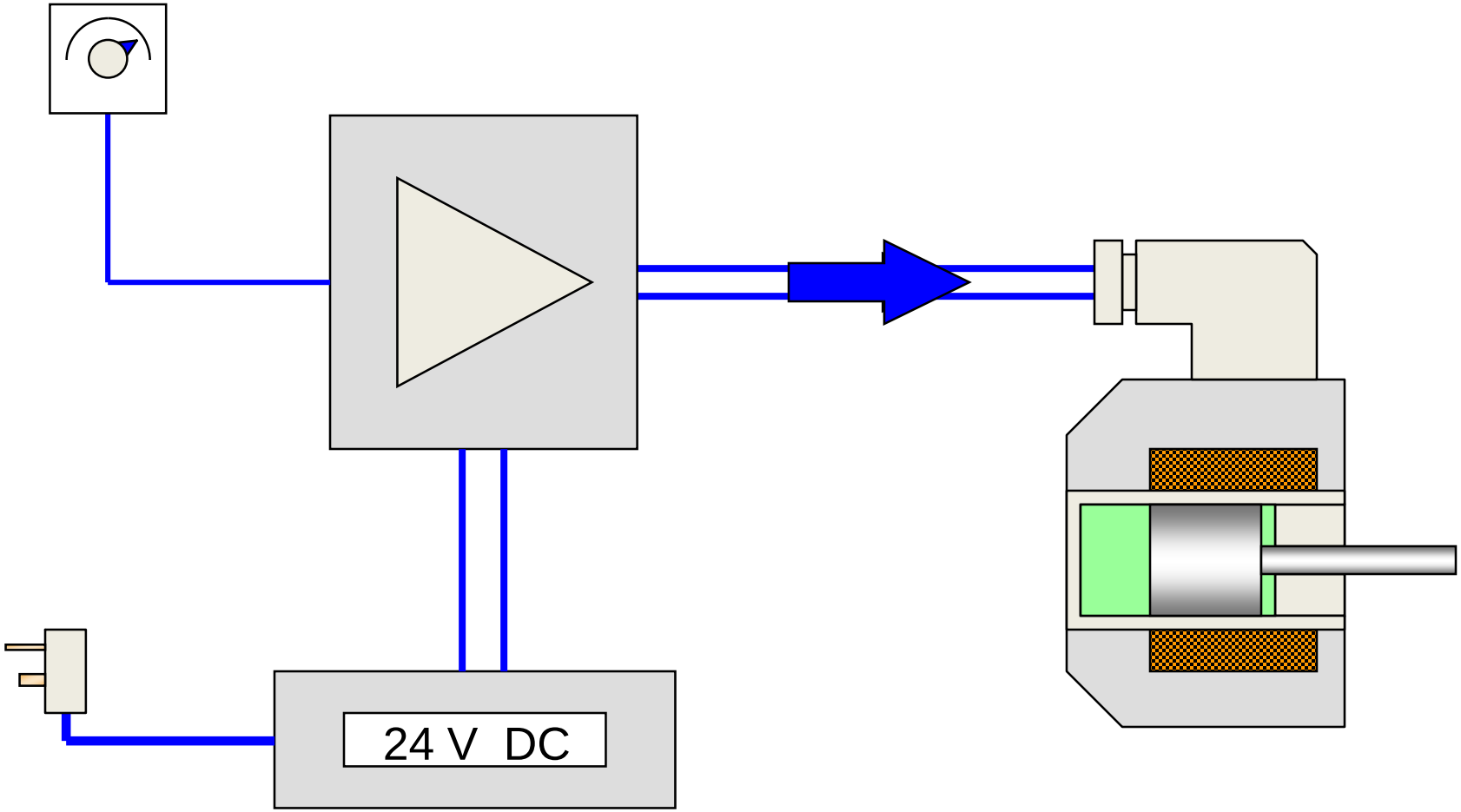

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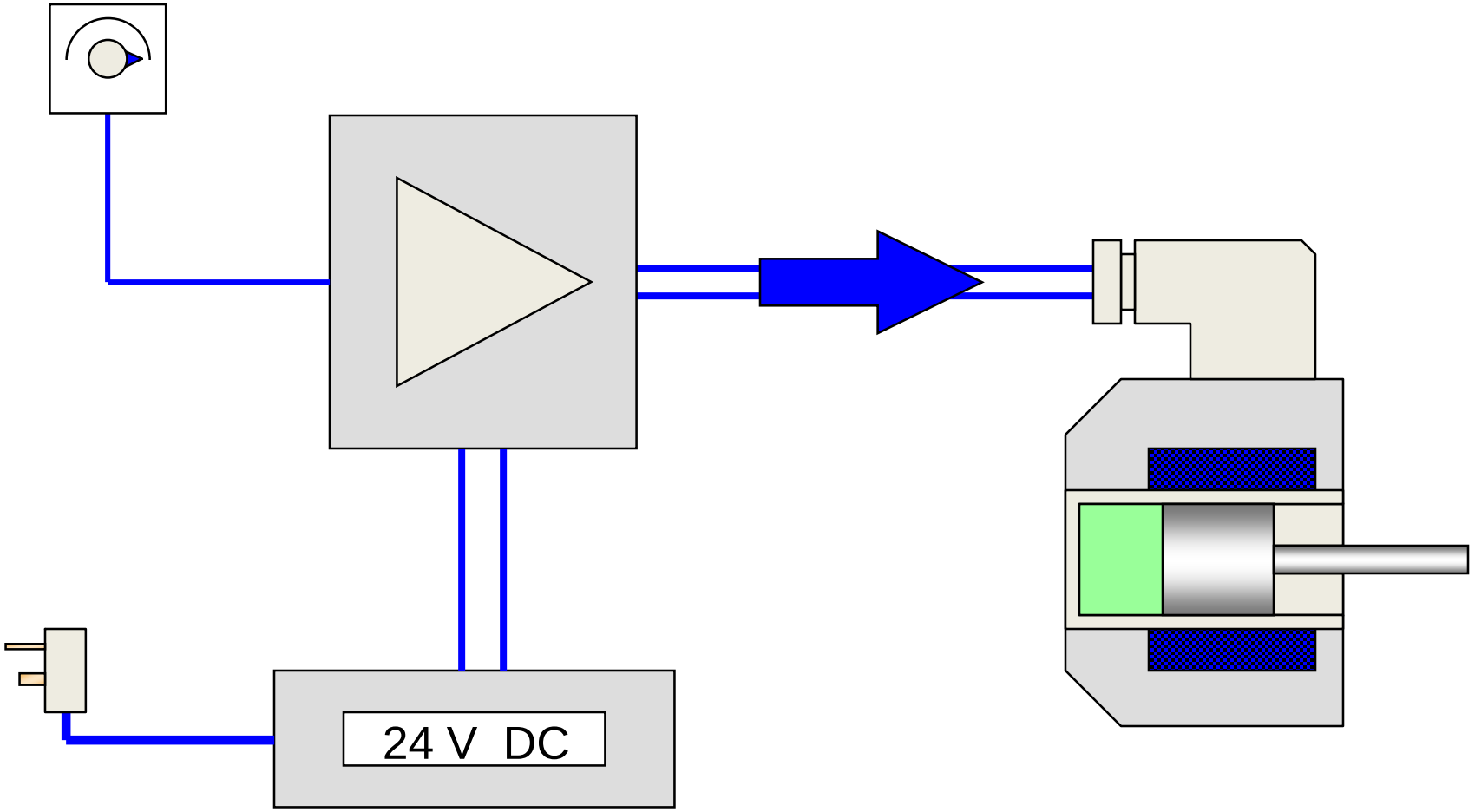
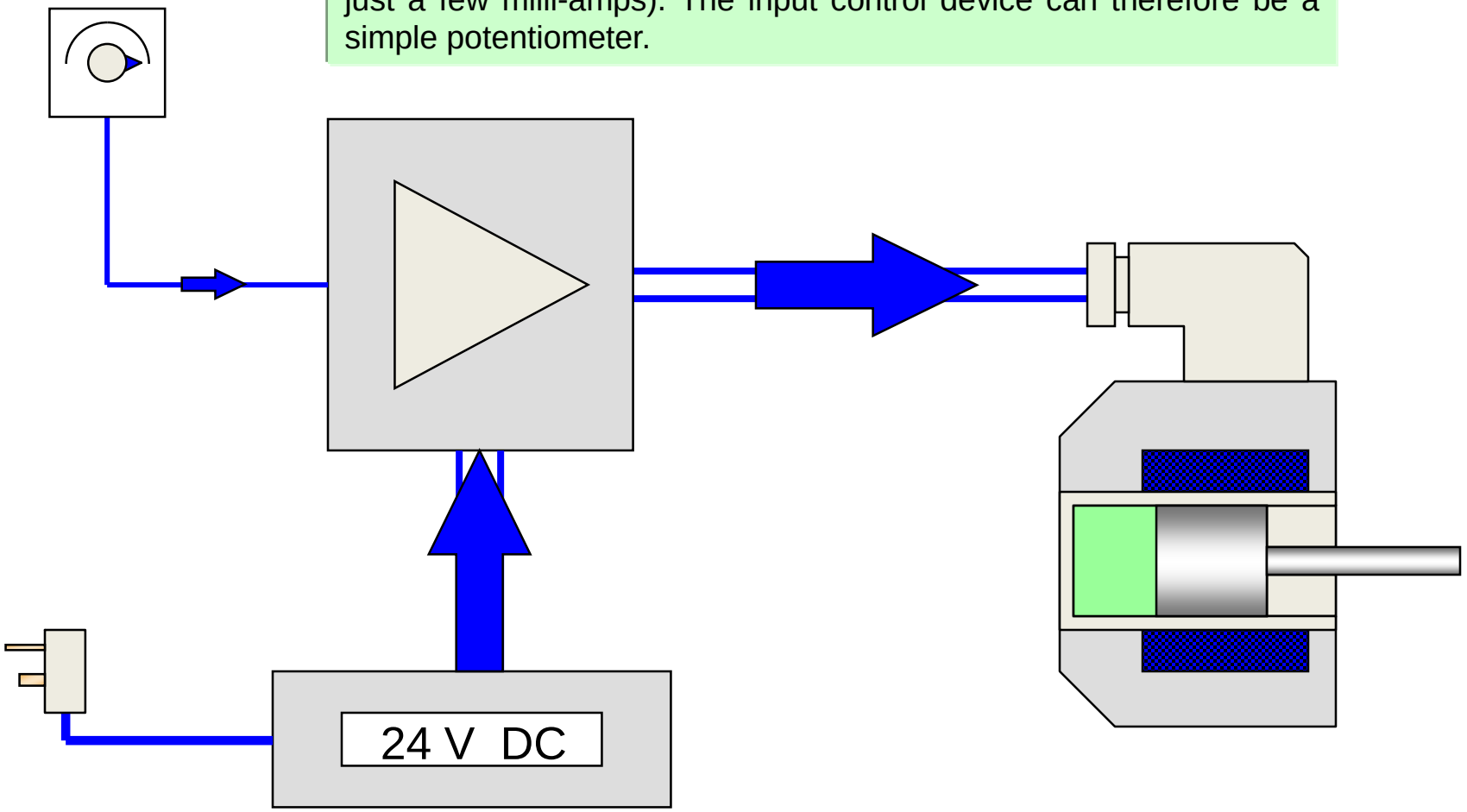


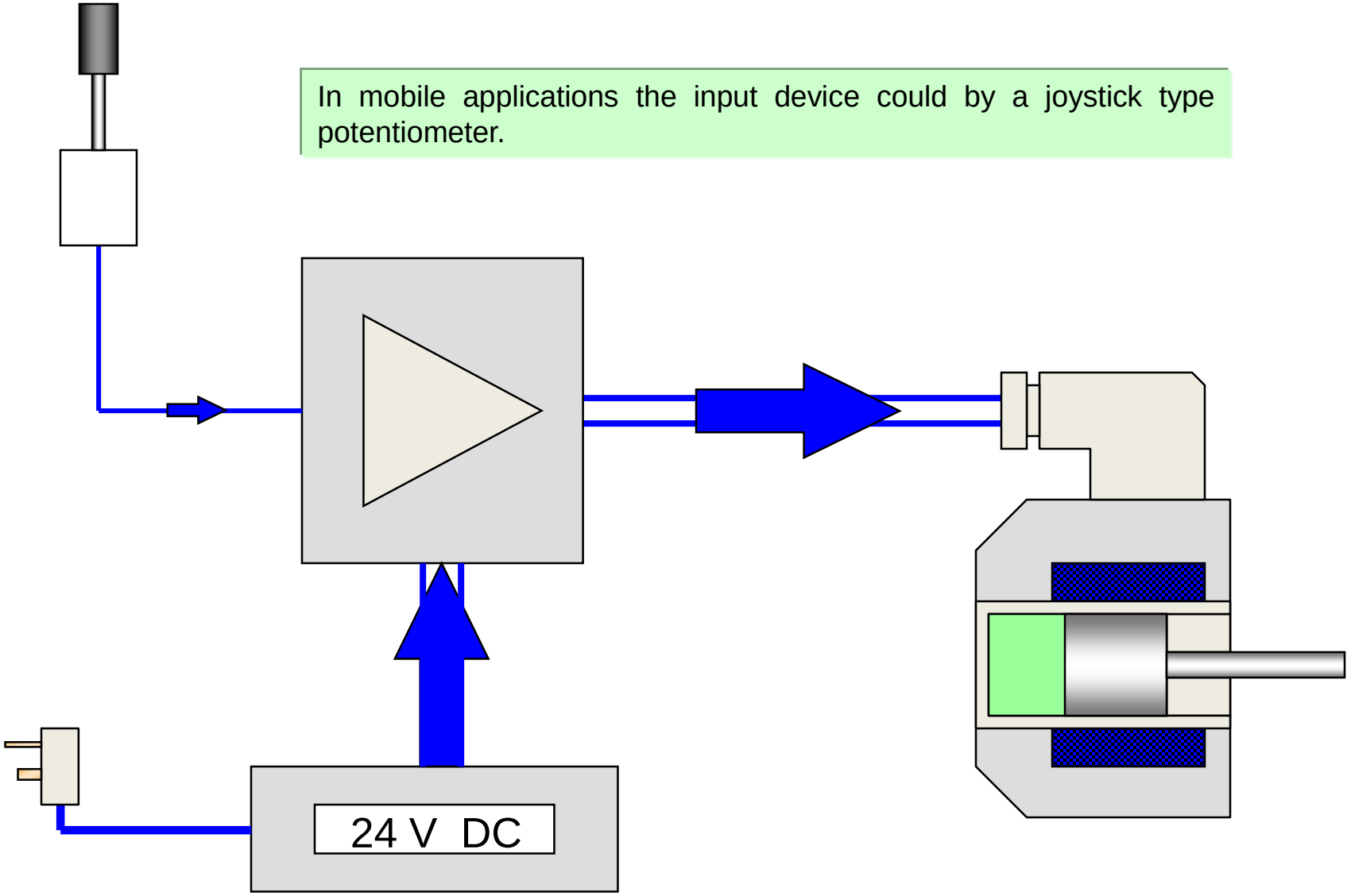
PROPORTIONAL VALVE AMPLIFIER

The relatively large current required to drive the valve solenoid (typically 2 to 3 amps) is provided by the power supply so the current required from the input signal device is very small (normally just a few milli-amps). The input control device can therefore be a simple potentiometer.



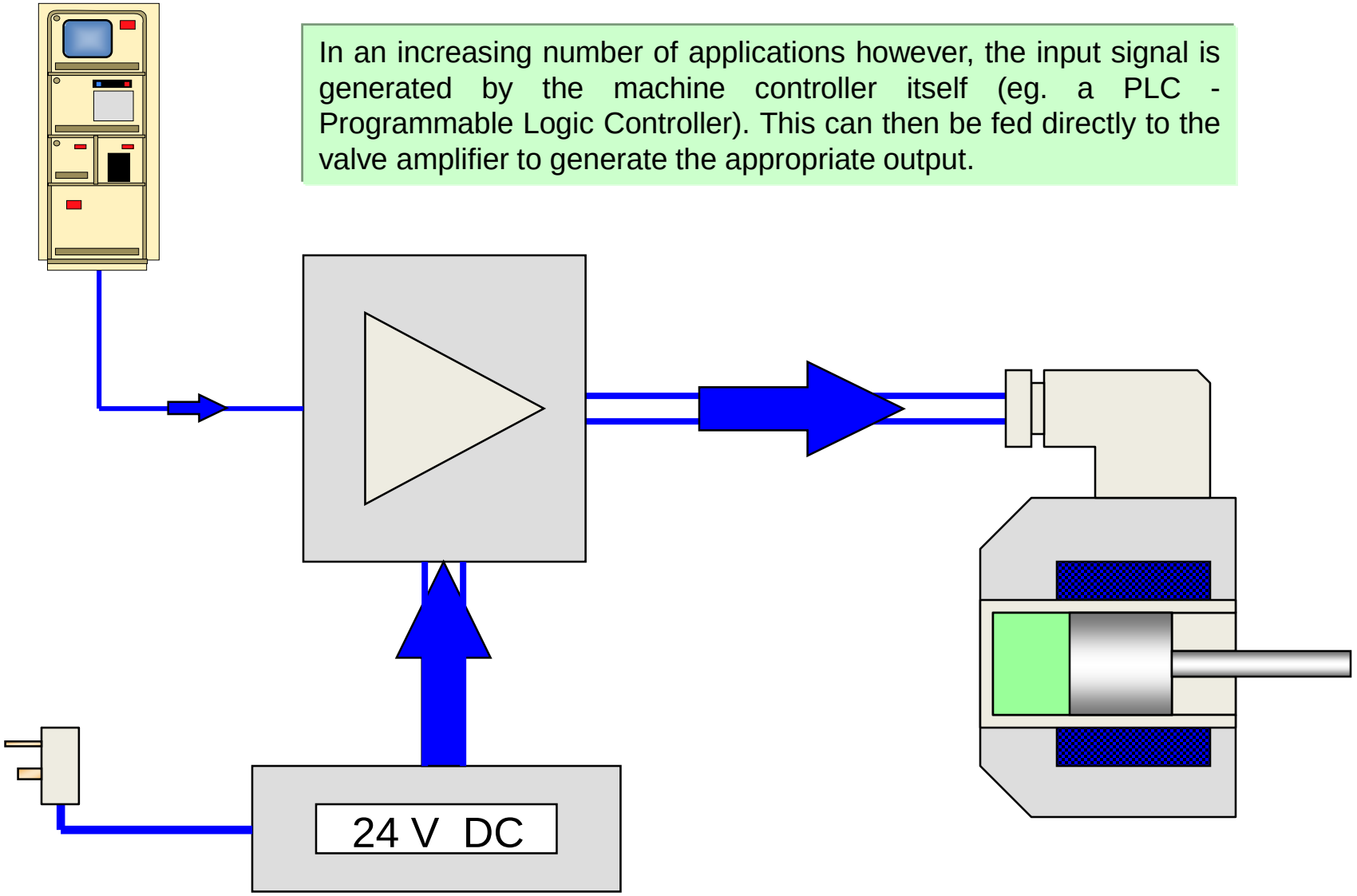
PROPORTIONAL VALVE AMPLIFIER

In mobile applications the input device could by a joystick type potentiometer.



PROPORTIONAL VALVE AMPLIFIER

In an increasing number of applications however, the input signal is generated by the machine controller itself (eg. a PLC - Programmable Logic Controller). This can then be fed directly to the valve amplifier to generate the appropriate output.



Fluidics

- Fluidics, or fluidic logic, is the use of a fluid to perform analog or digital operations similar to those performed with electronics.

- The term *fluidics* is normally used when devices have no moving parts, so ordinary hydraulic components such as hydraulic cylinders and spool valves are not considered or referred to as fluidic devices.

- Logic gates can be built that use water instead of electricity to power the gating function. These are reliant on being positioned in one orientation to perform correctly.

- Moving-part logic devices are miniature valve-type devices, which by the action of internal moving parts perform switching operations in fluid logic systems.

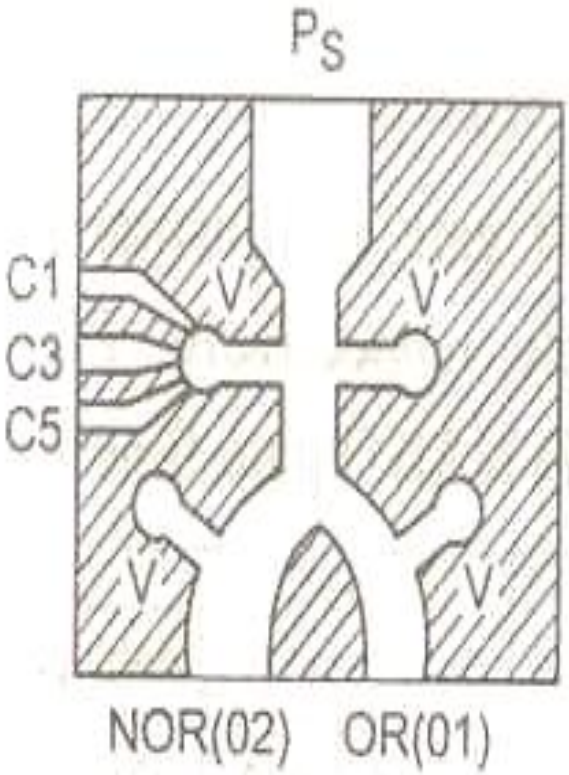
Coanda effect

- The **Coandă effect** is the tendency of a fluid jet to be attracted to a nearby surface.

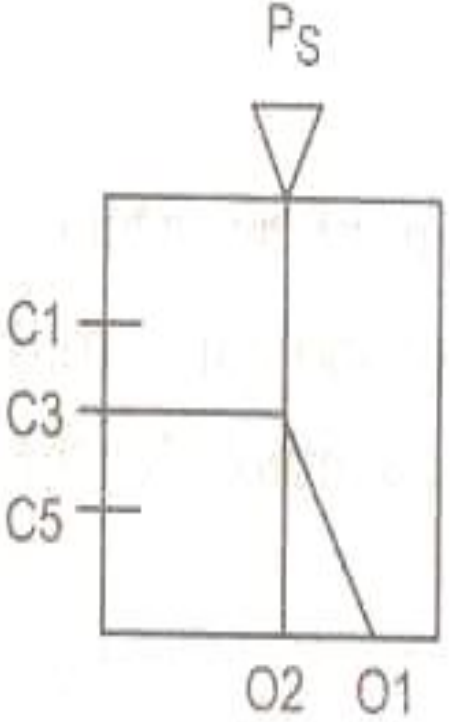
- The principle was named after Romanian aerodynamics pioneer Henri Coandă, who was the first to recognize the practical application of the phenomenon in aircraft development.

- The Coandă effect has important applications in various high-lift devices on aircraft.

OR / NOR GATE



(a) Construction

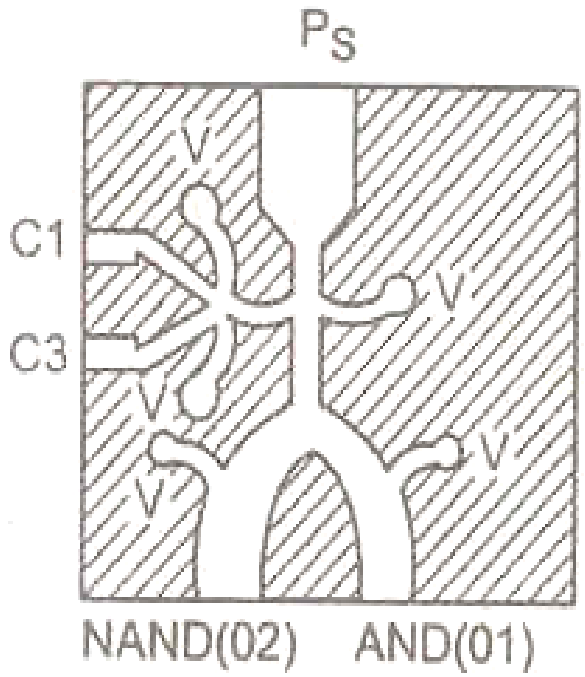


(b) Symbol

		OR	NOR
C1	C3	O1	O2
0	0	0	1
1	0	1	0
0	1	1	0
1	1	1	0

(c) Truth table

AND, NAND



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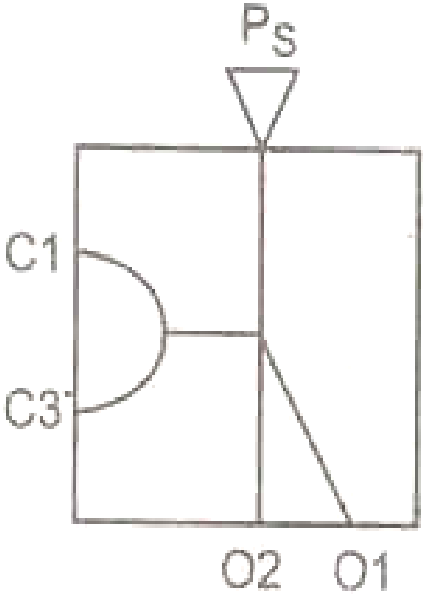
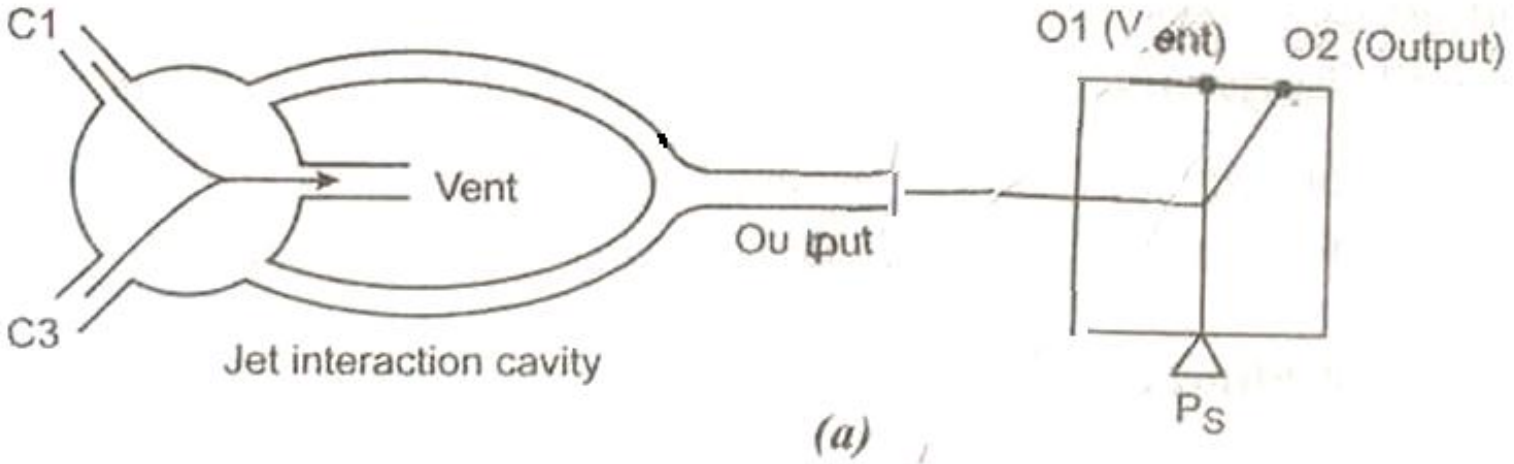


(b) Symbol

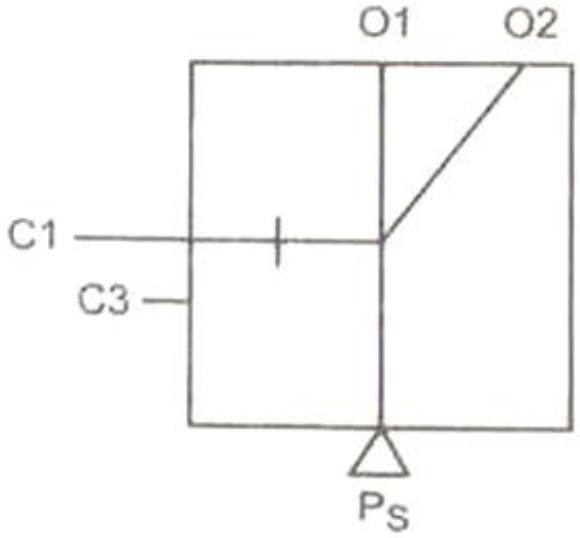
		AND	NAND
C1	C3	O1	O2
0	0	0	1
1	0	0	1
0	1	0	1
1	1	1	0

(c) Truth table

EX OR GATE



(a)



(b) Symbol

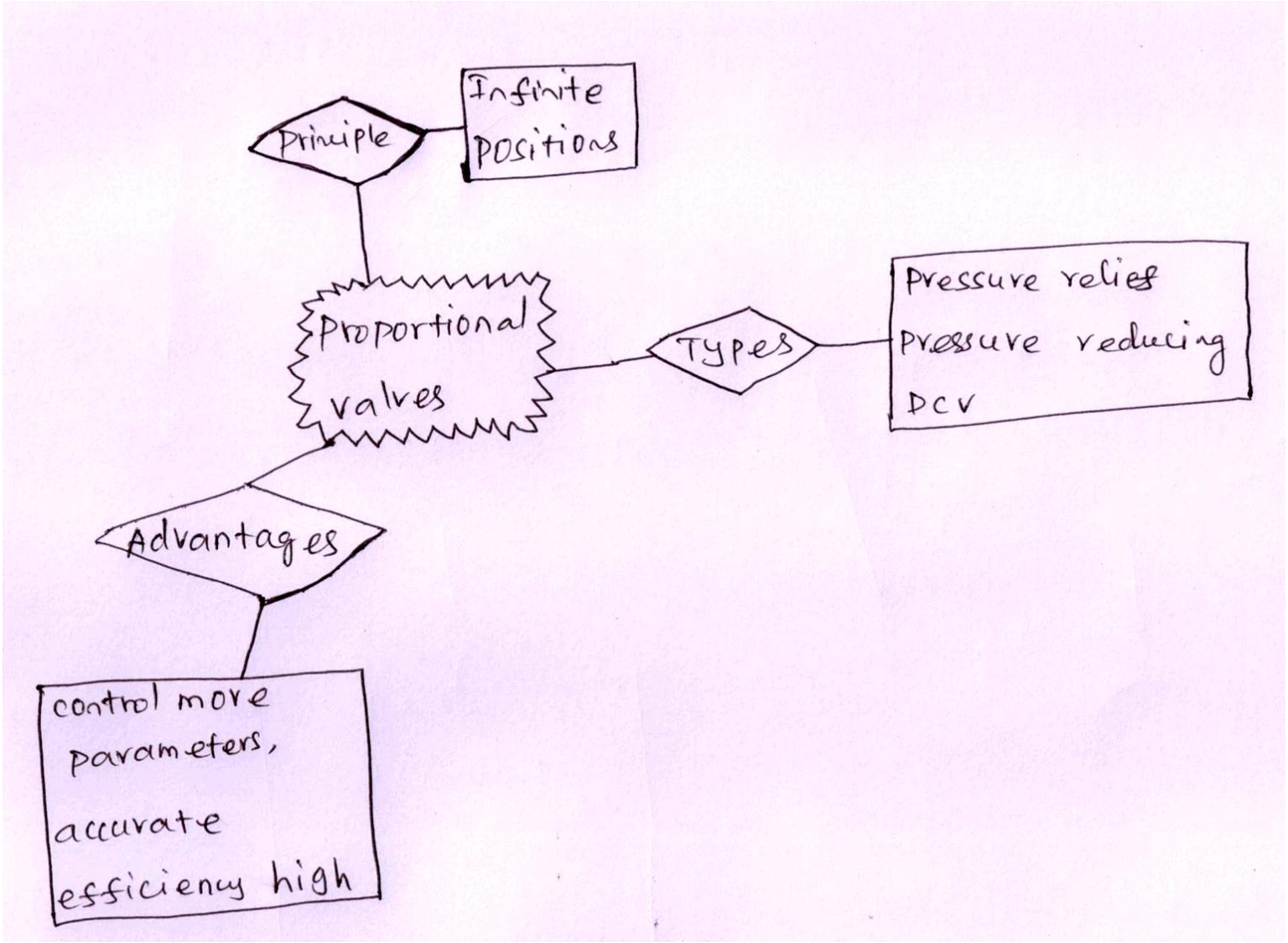
OR Gate

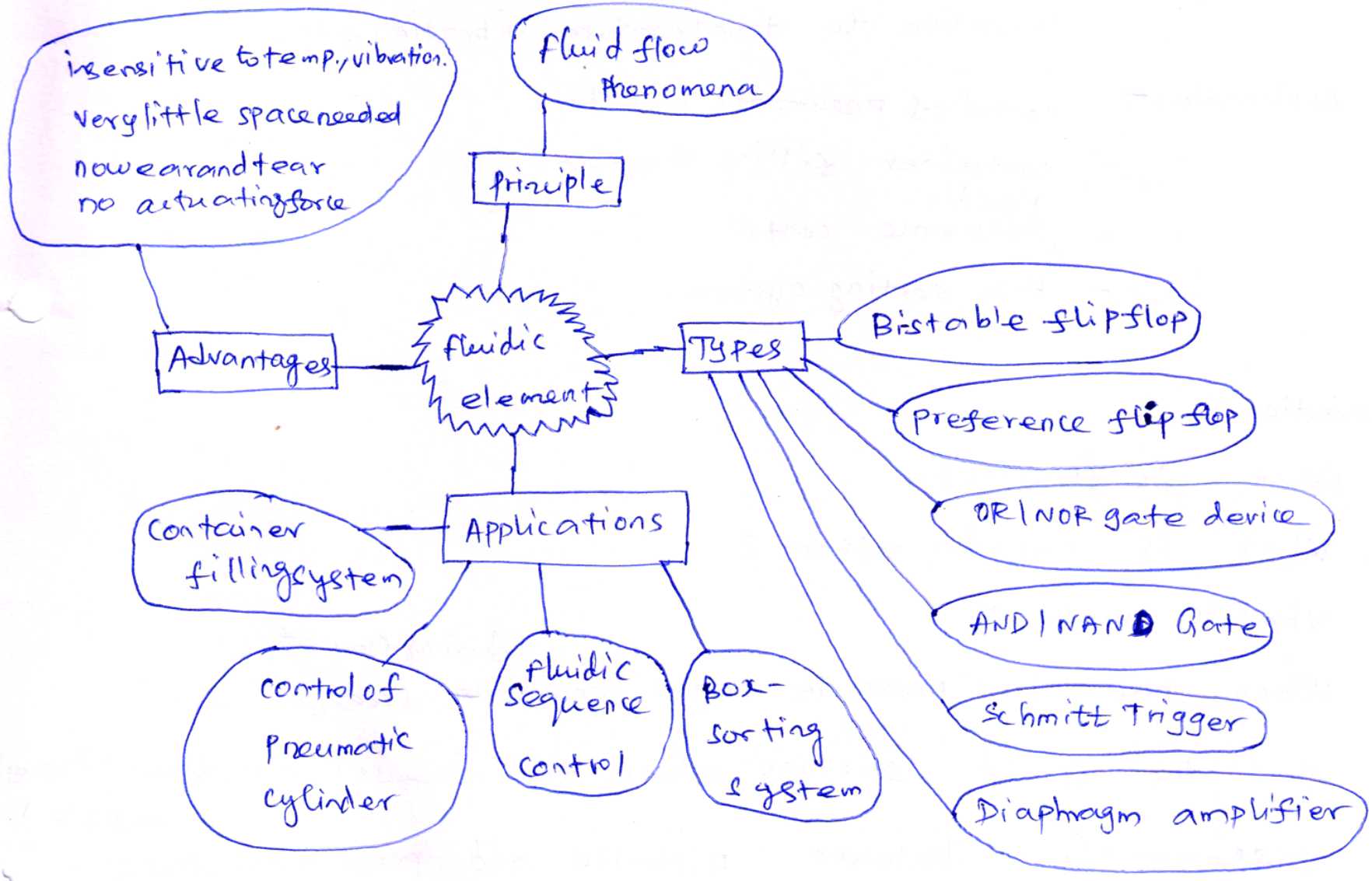
		Vent	Exclusive OR
C1	C3	O1	O2
0	0	1	0
1	0	0	1
0	1	0	1
1	1	1	0

(c) Truth table

Questions

1. What are proportional control valves?
2. What are the advantages of proportional valves?
3. What is fluidics?
4. At what pressure fluidic devices function?
5. State the coanda effect.
6. What is bistable flipflop?
7. Differentaite between bistabe and preference flip flop.
8. When do you use a flip flop with start-up preference?


Principle
Infinite positions
Proportional valves
Types
Pressure relief
Pressure reducing
DCV
Advantages
control more parameters,
accurate
efficiency high


insensitive to temp., vibration.
Very little space needed
no wear and tear
no actuating force
Fluid flow Phenomena
Principle
Advantages
fluidic element
Types
Bistable flipflop
Preference flip flop
OR/NOR gate device
AND/NAND Gate
Schmitt Trigger
Diaphragm amplifier
Applications
Container filling system
control of Pneumatic cylinder
fluidic sequence control
Box-sorting system

Summary

- **Proportional valves** appear the same as their on/off solenoid counterparts.
- The big difference is in the way their solenoid coils perform. Proportional coils operate on DC current and produce varying force with varying voltage.
- The other indication on the symbol that shows the spool is infinitely variable is the parallel lines down both sides of the boxes.
- It operate similarly to manual valves, but they use electronics instead of hand power.

- **Fluid logic control systems** use logic devices that switch a fluid, usually air, from one outlet of the device to another outlet.
- Output of a fluid logic device is either ON or OFF as it is rapidly switched from one stale to the other by the appli, Ncation of a control signal.
- Devices that use a fluid as the power supply medium are broadly classified as either moving-part logic (MPL) devices or fluidic devices.
- AND, OR, NOT, NAND, NOR, EXOR, Memory gates can be executed in this system

MCQ & HOQ

1. A Hydro-stat module under a proportional control valve:

   A. gives a consistent pressure at its outlet. B. gives a consistent flow at its outlet. C. sets maximum pilot pressure.

2. An LVDT on a proportional directional control valve tells the electronic control:

   A. how much flow is going through the it. B. what the pressure is at its outlet. C. what position the spool is in.

3. An “AND” element has an output when it has_____input/s.

   A. One B. two C. three

4. An “OR” element has an output when it has _____input/s.

   A. One B. two E. three

5. “NOT” elements are:

   A. normally passing elements. B. normally non-passing elements. C. normally exhausting elements.

Answer

1. A Hydro-stat module under a proportional control valve:

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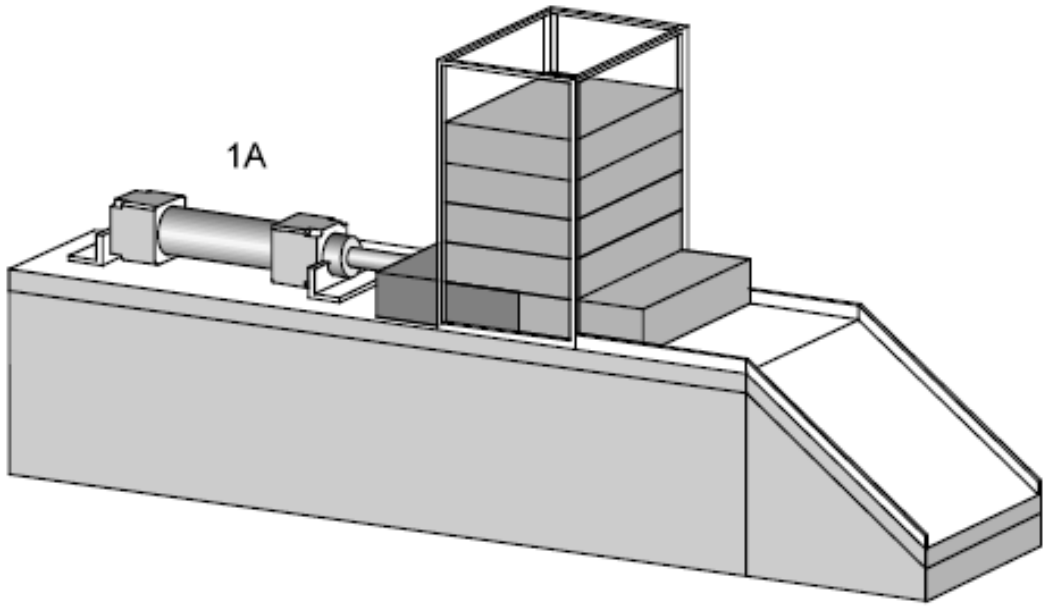
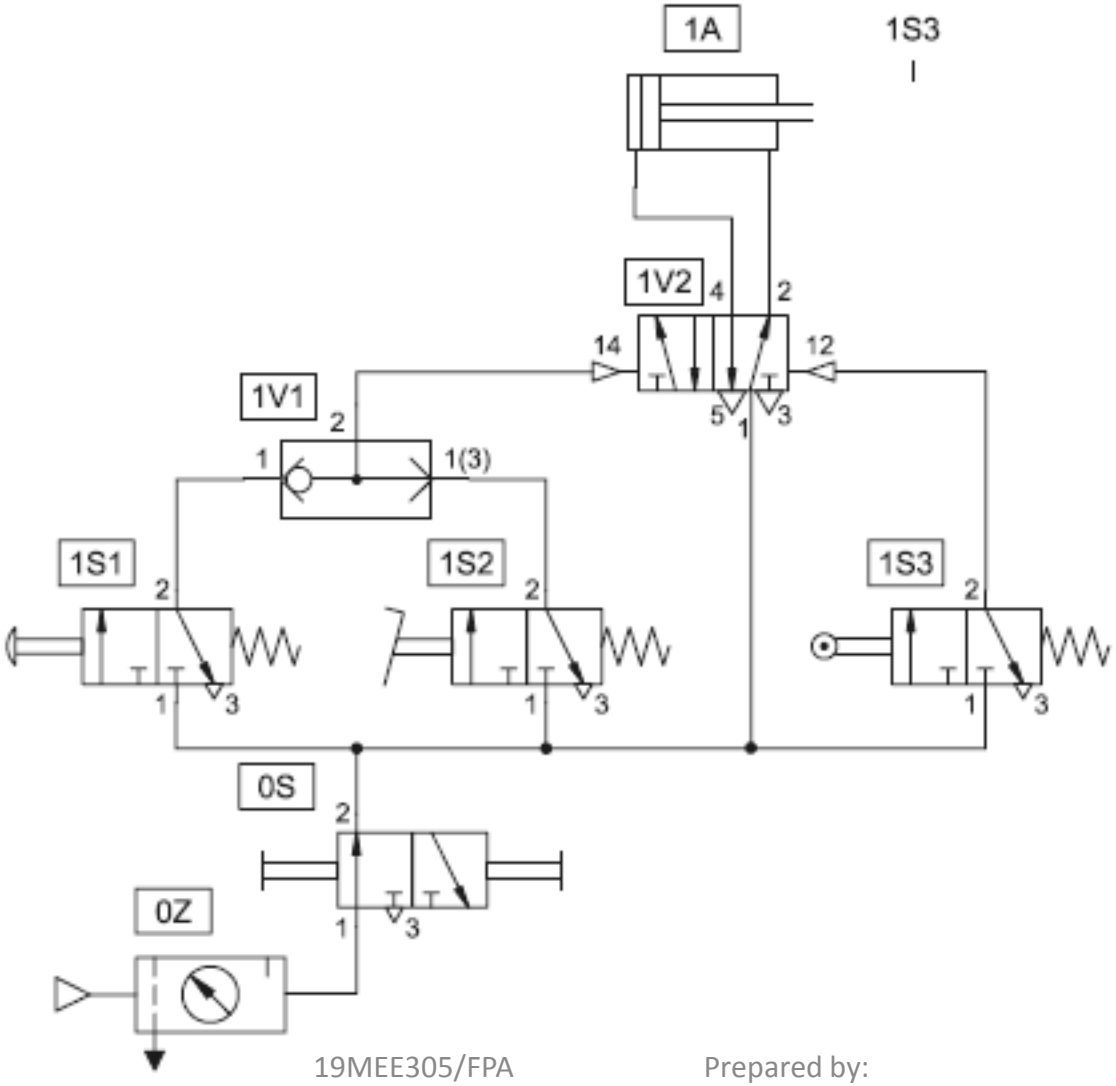
Higher Order Question

- A double-acting cylinder is used to transfer parts from a magazine. If either a push button or a foot pedal is operated, the cylinder is to advance. Once the cylinder is fully advanced, it is to retract to the initial position. A 3/2-way roller lever valve is to be used to detect the full extension of the cylinder. Specify the valves and function of the valves in the circuit.



Solution



- The logic OR operation of the ourtput signals of valves 1S1 and 1S2 is checked by the shuttle valve 1V1.
- Upon operation of either the push button of valve 1S1 or the pedal of valve 1S2, a signal is generated at the 1 or 1(3) side of the shuttle valve. The OR condition is met and the signal is passed to the control port 14 of the valve 1V2.
- The valve 1V2 switches, pressure is applied to the piston side of the cylinder 1A, and the cylinder advances.
- If the actuation (push button or pedal) of the valve is released, the signal at the control port of valve 1V2 is reset. Since valve 1V2 is a double pilot valve (with memory function), its switching position does not change.
- The limit swith 1S3 is actuated, when the piston rod reaches its end position.
- A signal is then applied at the control port 12 of the valve 1V2.
- The valve 1V2 reverses and the piston rod retracts.
- If the limit switch 1S3 is released during retracting, the direction of movement can be changed by actuating the push button or the pedal, even if the piston rod has not yet reached its initial position.