

1.3.1 GENERAL

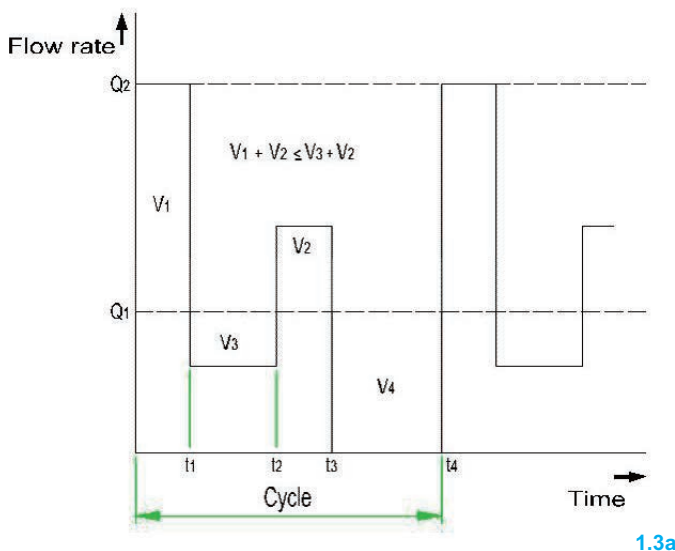
It is not possible to design an optimum hydraulic system in economic and technical point of view that does not involve the use of hydropneumatic accumulators. From an economic point of view, the use of hydropneumatic accumulators usually leads to a reduction in equipment and operating costs (energy savings) and dimensions of the plant. From a technical point of view, the use of an accumulator may become relevant or appropriate to carry out certain functions, such as increase reliability, improve overall efficiency, extend the lives of the plant components and eliminate secondary phenomena (noise, development of heat).

The hydropneumatic accumulators used in order to: save on the pump power to be installed in the case of variable demand for oil, supply power in emergency situations or during working stages requiring a high power even for short periods, shorten the working cycles, drive the secondary circuits as volume compensators when there are variations of pressure and temperature, maintain the pressure in the closed circuits, compensate for the losses, recover the braking energy, as a tank of fluid under pressure, separate the fluids, such as replacement of springs and damper for shocks and pulsations absorbing. Here below, we describe some applications in more detail.

1.3.2 ACCUMULATION OF ENERGY

The graph (cyclograph) of the power required by a plastic injection machine shown in Chart 1.3a shows that, with a high rate of injection into the mould, the maximum power is required only for a short time. Without a compensation system, the pump should be sized for peak power, even if requested for a few moments.

Once used an accumulator, the power (and thus the flow rate) of the pump can be instead fixed according to the average absorption. In the early stages of the working cycle when the needs of system flow rate is less than the pump one, this fills the accumulator. When you need the maximum flow rate, the difference in comparison with the pump supply is taken from the accumulator.



1.3a

Advantages:

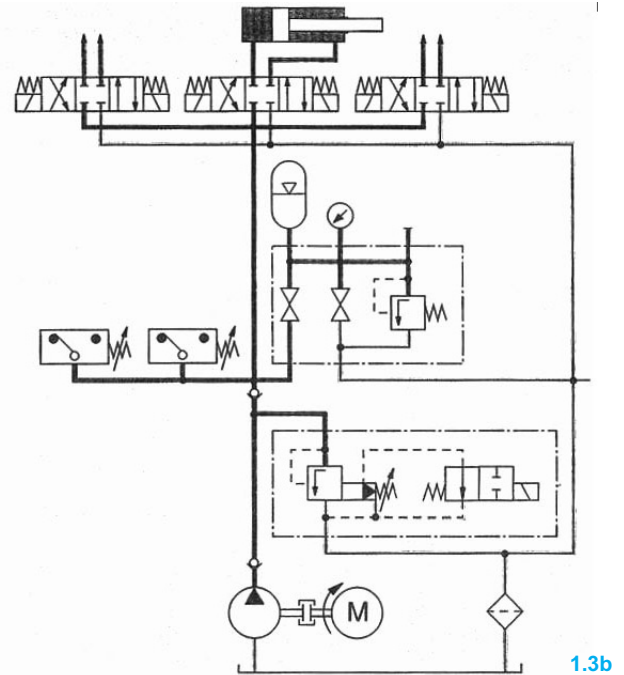
- use of lower capacity pumps
- lower installed power
- less heat generation
- easy maintenance and installation

- for certain applications: damping the peaks and pressure pulses, with consequent longer life time of the components.

The installation of hydropneumatic accumulators allows substantially saving energy.

For the systems with very strong instantaneous or short-term absorptions or short operating cycles, the only economic solution is represented by the hydropneumatic accumulators.

1.3.2.1 MORE USERS WITH DIFFERENT ABSORPTION



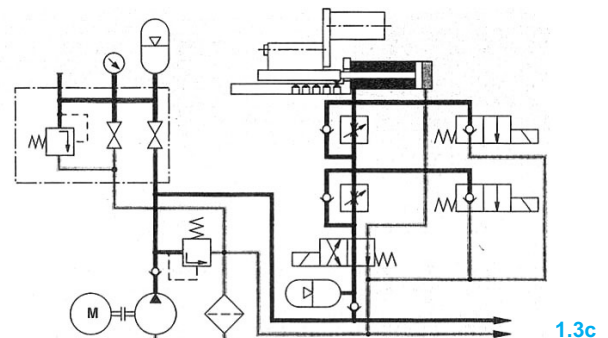
1.3b

Fig. 1.3b: circuit diagram for the accumulation of energy of a plastic injection machine

1.3.2.2 REDUCTION OF THE TIMES OF THE WORKING CYCLES (EXAMPLE, TOOL MACHINES)

Thanks to the hydropneumatic mounting directly next to the user, the inertia of the fluid column is exceeded more quickly than if all the fluid must be set in motion by the pump.

So you get a faster start-up and also the accumulators compensate the instantaneous differential absorptions of the single users.



1.3c

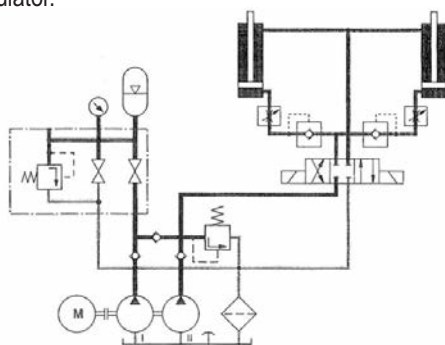
Fig. 1.3c: circuit diagram for the accumulation of energy of a tool machine.

1.3.2.3 REDUCTION OF THE APPROACH TIMES

The rational performance of the pressing and printing cycles demands for rapid empty strokes in order to make more time available for the phase of work under high pressure.

During progressing under empty, the fluid is simultaneously delivered by the low pressure pump, the high pressure pump and the accumulator, so as to achieve high speed.

At the end of the approach stroke, the pressure increases, the check valve closes and only the high pressure pump delivers to the activator a reduced flow rate but at high pressure, while the low pressure pump charges the accumulator.



1.3d

Fig. 1.3d: circuit diagram for the reduction of the approach time of a press.

1.3.3 RESERVE OF FLUID (SAFETY)

Using the accumulator as a safety device in normal operation of the system, it does not act as an energy source, although it is always connected to the pump.

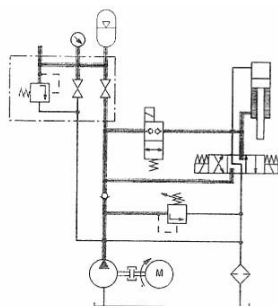
If the accumulator is equipped with a high quality separating element, the accumulated energy can be stored almost indefinitely and is always available when needed.

Safety devices on the accumulators are used for emergency operation on the hydraulic plants, to ensure the performance of certain functions in the event of failure, such as:

- closure of bulkheads, valves, exchanges
- switching on of gate valves
- switching on of power switches
- start-up of rapid switching off systems

1.3.3.1 EMERGENCY DRIVE

In an emergency, for example due to power failure, the presence of an accumulator allows carrying out one or more output and/or return strokes. Fig. 1.3e shows the circuit diagram of an emergency drive: in case of power failure, the spring returns the valve to its resting position, making the connection between the accumulator and rod side chamber with a consequent return of the cylinder.



1.3e

Fig. 1.3e: circuit diagram of an emergency drive.

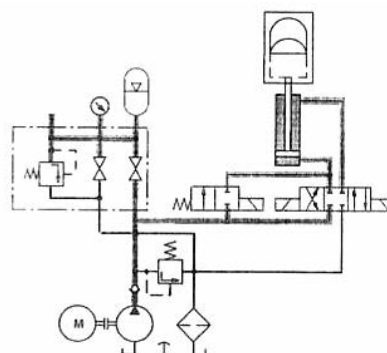
Another case of emergency drive based on the accumulator is the completion of a working cycle already begun, despite the failure of a pump or a valve.

Advantages of the emergency drive with accumulator:

- immediate availability of stored energy
- indefinite energy conservation
- no operator fatigue
- immediate response
- maximum security with low maintenance.

High short-term oil absorption during failure

With the circuit of Figure 1.3f, the output of the cylinder, in case of pump failure, is guaranteed by the accumulator.



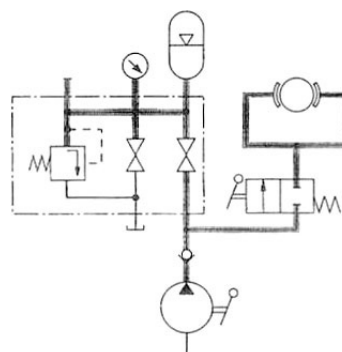
1.3f

Fig. 1.3f: output of the cylinder in case of damage to the pump.

1.3.3.2 EMERGENCY BRAKING

The hydraulic accumulator is used to operate the emergency drive of the brake and the doors of funicular railways, cableways, special vehicles etc. The accumulators charge (closed circuit) is performed with a motor pump in proper workshop or with a pump.

Often the emergency brake circuit is passive: in case of failure, the braking is automatic by effect of a spring, while in normal conditions the brake cylinders are kept open by the pressure of the accumulator that operates contrary to the spring.



1.3g

Fig. 1.3g: emergency brake for cableway

1.3.3.3 EMERGENCY LUBRICATION

To maintain intact the lubricating film in the bearings, they must be constantly fed with oil, so the lubrication points should always be under pressure. In case of failure of the lubricant pump, the presence of an accumulator keeps the pressure up until the stop of the machine or until any auxiliary lubrication pump restore the required pressure.

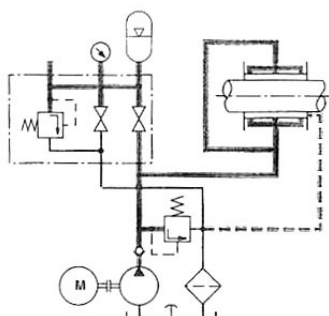
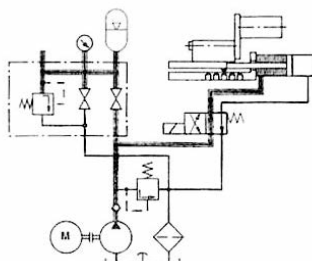


Fig. 1.3h: emergency lubrication for bearings.

1.3h

1.3.3.4 OPERATING SECURITY

The lack of voltage during the operation of a machine may cause costly business interruptions. The accumulators allow the completing of the production cycle started.



1.3i

Fig. 1.3i: operational safety circuit.

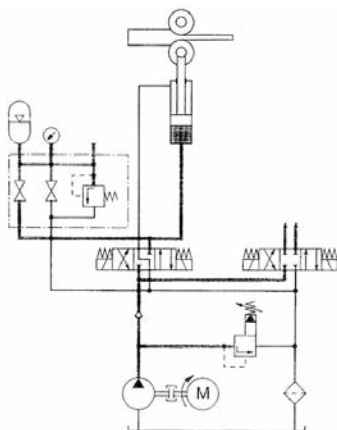
1.3.4 FORCES COMPENSATOR

With the accumulators forces or movements can be compensated. This need arises when, during a continuous working process, i.e. rolling, may occur obliquely positioning of the forming rolls as a result of variables resistances by the material to be laminated. Thanks to the balance of the rolls, you get a uniform thickness.

Fig. 1.3l shows the circuit diagram for the balance of the rolls of a rolling mill, comprising an accumulator with its safety block.

Advantages:

- mild compensation of the forces and, therefore, less load on the foundation and frame
- savings of counter weights and thus reduction in weight and dimensions of the plant



1.3l

Fig. 1.3l: balance of the rollers of a rolls mill

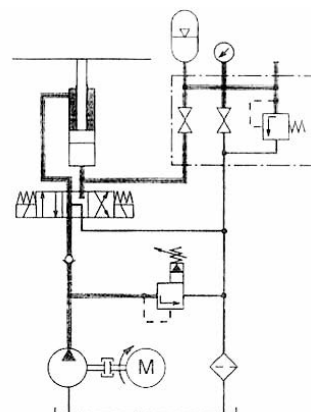
1.3.5 COMPENSATION OF LEAKAGES

The compression force exerted by a hydraulic cylinder can only be maintained by compensating the inevitable losses due to system leakage.

The accumulators are particularly suitable for this purpose. Fig. 1.3m shows a scheme of a system of compensation for a leak, through which, when the pump is stopped, the leakage losses are replenished by dispensing oil from the accumulator to the piston side chamber of the cylinder. The pump starts only when the pressure falls below a predetermined value and charges the accumulator.

Advantages:

- intermittent pump operation
- less heat generation, resulting in lower operating costs
- longer life of the plant.



1.3m

Fig. 1.3m: leak compensation

1.3.6 CUSHIONING

In the hydraulic systems, pressure oscillations can occur when the flow conditions vary for reasons related to the operation of the system; i.e.

- uneven distribution of the pump
- presence of systems including masses and resilience (i.e. valves pressure balancing device) or instantaneous connection of circuit branches at different pressures
- switching on of regulation and interception valves with short opening and closing
- switching on or off of pumps.

These phenomena can cause variations in flow rate or pressure, which may have adverse effects on the life of components.

According to the conditions of formation, the pressure oscillations can be divided into impulsive (pressure peaks) and periodic (pulses).

To prevent that the functioning of the system is compromised, you should evaluate, already during the design phase, the amplitude of these oscillations and provide appropriate measures of damping.

While there are several options to reduce the pressure fluctuations, in hydraulic systems are particularly suitable certain types of accumulators. To meet the requirements of the machines in terms of performance and speed of the cycles, while ensuring a limited noise, it is advisable to install an accumulator with appropriate features as a shock absorber in order to:

- reduce the flow rate fluctuations caused by the operation of the machine and their transmission to the mechanical structures that act as resonant bodies and convert them to noise
- extend the life of the machine.

1.3.6.1 FLOW RATE FLUCTUATIONS OF PUMPS

The volumetric pumps produce more or less pronounced flow rate pulsations, causing noise and vibrations, with danger of damage to the plant. An accumulator mounted near the pump reduces this phenomenon.

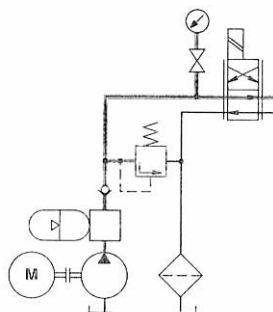


Fig. 1.3n Damping pulsations caused by the volumetric pumps.

1.3.6.2 DAMPING OF PRESSURE WAVES

In most of the hydraulic plants, pressure waves are generated by various components or by the effect of load changes in the system, for example when using the bucket of an excavator.

The installation of an accumulator protects the sensitive components from pressure waves and, in particular, the pumps.

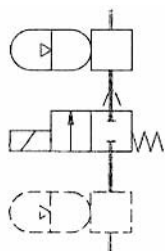


Fig. 1.3o: dampening the pulsations downwards the pump

1.3.6.3 FAST OPENING AND CLOSING OF THE VALVES

By discharging instantly a strong flow rate in the return line generate water hammer, which can damage the heat exchangers and the filters on the return lines.

But even when the fluid in motion is stopped suddenly (i.e. due to an emergency stop), the water hammer can damage the valves, pipes and fittings.

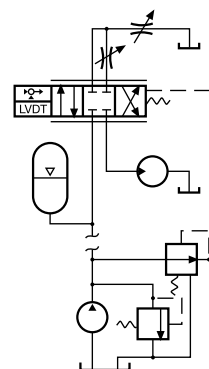


Fig. 1.3p: damping the water hammer.

1.3n

1.3.6.4 HYDRAULIC SPRING

For the damping of shock waves and pressure fluctuations, the accumulator acts as a hydraulic spring thanks to the compressible gas it contains.

The first example below for the application of the "hydraulic spring" is the hydraulic tensioning device of a chain (Fig. 1.3q).

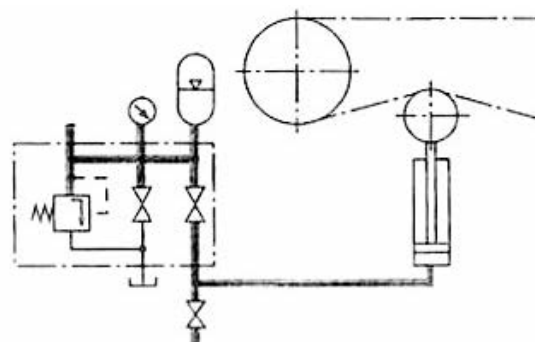


Fig. 1.3q: tensioning of a chain for a tool machine.

1.3q

By installing an accumulator to stretch the chain of a tool machine or a vehicle, you avoid tearing chain transmission to the system.

The second application example of the "hydraulic spring" is the tensioning of the hauling cables and main ones (Fig. 1.3r).

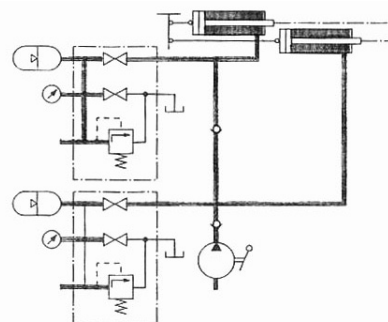


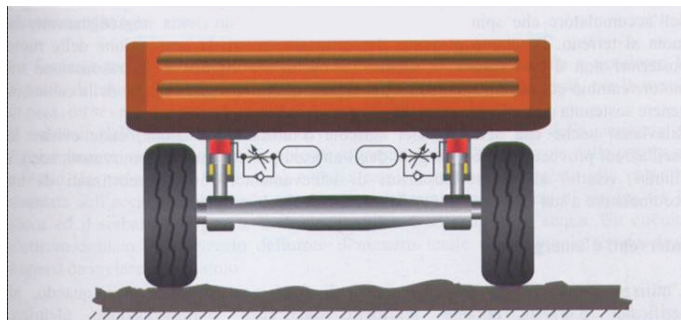
Fig. 1.3r: tensioning of the supporting cables of a cableway.

1.3r

The third application example of the "hydraulic spring" is the cushioning system for vehicles (fig. 1.3s).

It's known that for the smooth operation of the cableways and elevators, small tolerances are required on cable lengths.

The differences in length of the cables caused, in case of cableways, by the strokes up and down and in the case of elevators by the temperature variations or by the inequalities of the loads are compensated by inserting one or more accumulators in the hydraulic circuit.



1.3s

Fig. 1.3s: suspension system for vehicles

Marching on irregular road surfaces, a vehicle is affected by mechanical stresses, potentially harmful for the body and the chassis.

By installing a hydropneumatic suspension system comprising some cylinders connected to an accumulator, the mechanical stresses are first converted into hydraulic stresses in the cylinders and then are absorbed by the accumulator.

The use of in-vehicle hydropneumatic suspensions:

- reduces the risk of accidents
- extends the life of the vehicle
- allows faster cornering
- keeps the load in the desired position
- reduces stress on material
- reduces the operating costs

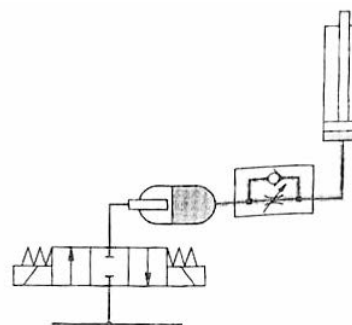
1.3.7 SEPARATION OF FLUIDS

In fluid power systems in which there are two fluids that must interact while remaining strictly separated, as separating element, it is used a bladder or a diaphragm accumulator.

1.3.7.1 SEPARATION BETWEEN AIR AND OIL

In some pneumatic systems, it can be useful to add a hydraulic component when it is required the generation of a high force.

The separation between the pneumatic circuit and hydraulic one is obtained with an accumulator. As in this application the fluid power comes from the pneumatic circuit, the hydraulic circuit does not require a power unit.



1.3t

Fig. 1.3t: accumulator used for the separation of a pneumatic circuit from a hydraulic one.

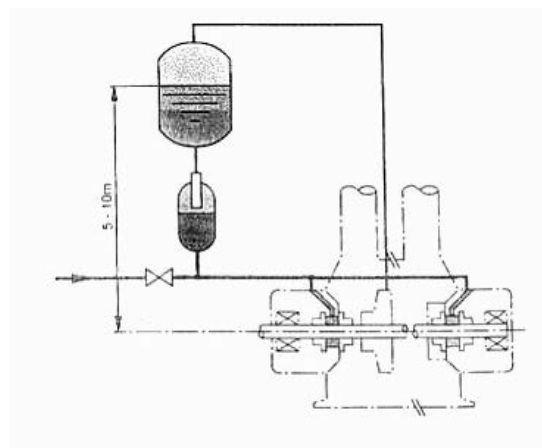
1.3.7.2 SEPARATION OF TWO FLUIDS

In compressors for petrochemical use with floating ring seals, for operational and pollution reasons, the process gas pumped by the compressor should not come into contact with the flushing fluid of the seals.

On the other hand, the operation of this type of seal requires a flushing pressure greater than 0.5 – 1.0 bar with respect to the process gas.

To ensure the overpressure, a tank containing a liquid is installed in an elevated position with respect to the compressor (Fig. 1.3u,) on the surface of which acts the same process gas supplied by the compressor.

To avoid contamination of the process gas, the fluid should have a neutral behaviour with regard to the gas. But, as normally it does not have the lubricity that the floating seals and shaft bearings require, to the seals must be sent a different fluid than the one contained in the tank. The separation between the two fluids is achieved with an accumulator.

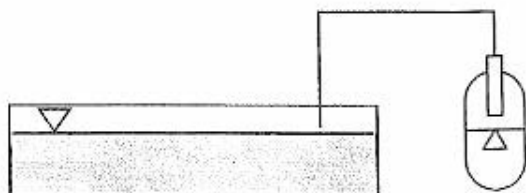


1.3u

Fig. 1.3u: accumulator for the separation of the fluids.

1.3.7.2 SEPARATION OF TWO GASES

In systems that can be damaged by the infiltration of moisture through the tank breather filter, or in the case of pressurized tanks with nitrogen to prevent condensation due to temperature changes, compensation in volume changes is provided by an accumulator (Fig. 1.3v).



1.3v

Fig. 1.3v: accumulator for the volume compensation.

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