AIR GENERATION, TREATMENT & DISTREBUTION 2nd part

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Pneumatics and Hydraulics

Review of the last lecture

- Air preparation
- Pressure level
- Air compressors
- Compressor types
- Flow regulation
- Reservoirs
- Air dryers

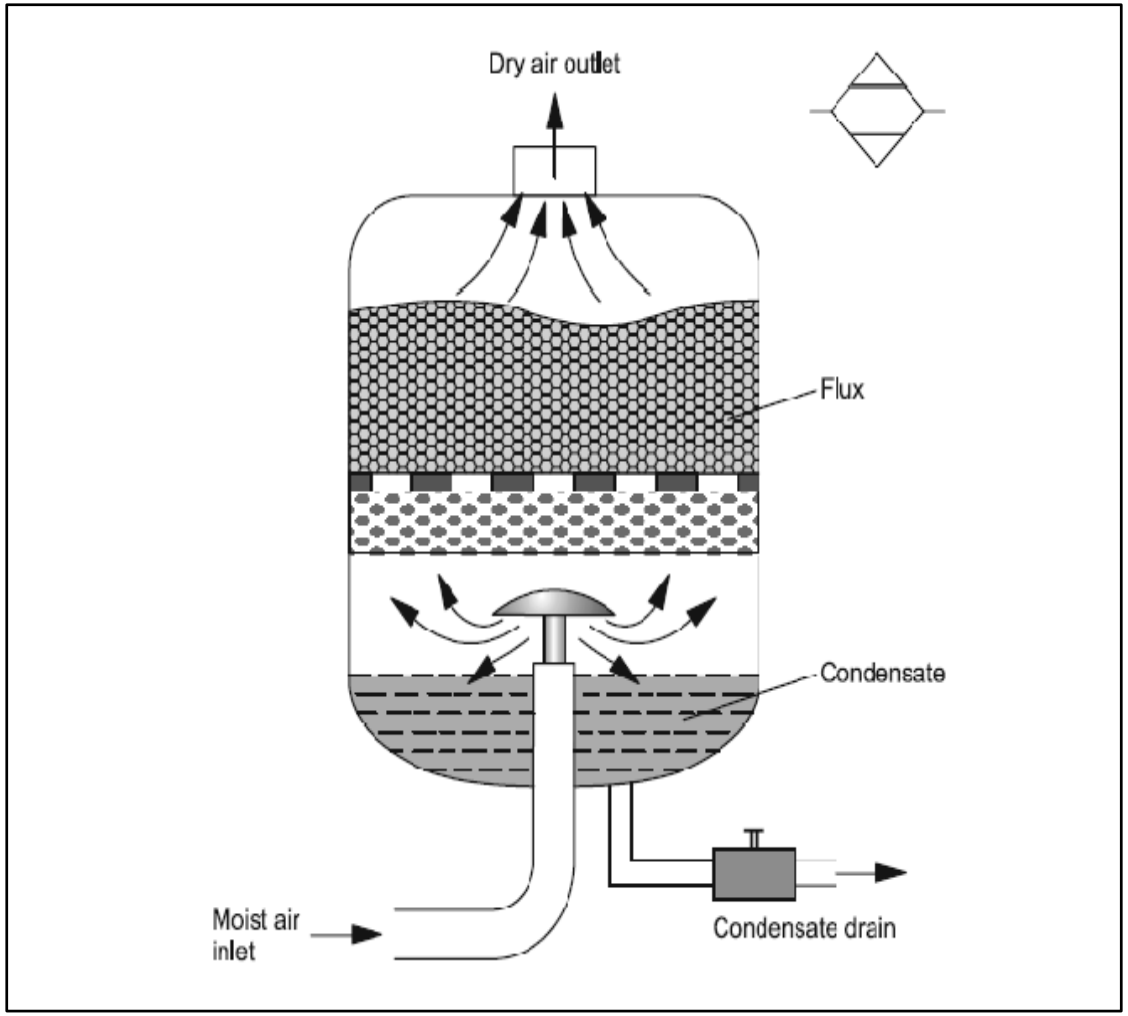
outline

- Air distribution
- Sizing pipe systems
- Flow resistance
- Pipe material and Piping layout
- Water separators and service units
- Compressed air filter
- Compressed air regulators
- Compressed air lubricator and removing oil
- Maintenance of air service units

Air distribution

In order to ensure reliable and trouble-free air distribution, a number of points must be observed, these includes:

- Primarily the correct sizing of the pipe system
- The pipe material
- Flow resistances
- Pipe layout and maintenance.



Sizing pipe systems

- In the case of new installations, allowance should be made in all cases for extension of the compressed-air network.
- The main line size determined by current requirements should therefore be increased to include an appropriate safety margin.
- Plugs and shut-off valves allow extension to be carried out easily later.
- Losses occur in all pipes due to flow resistances.
- Flow resistances are represented by restrictions, bends, branches and fittings.
- These losses must be made up by the compressor.

Sizing pipe systems

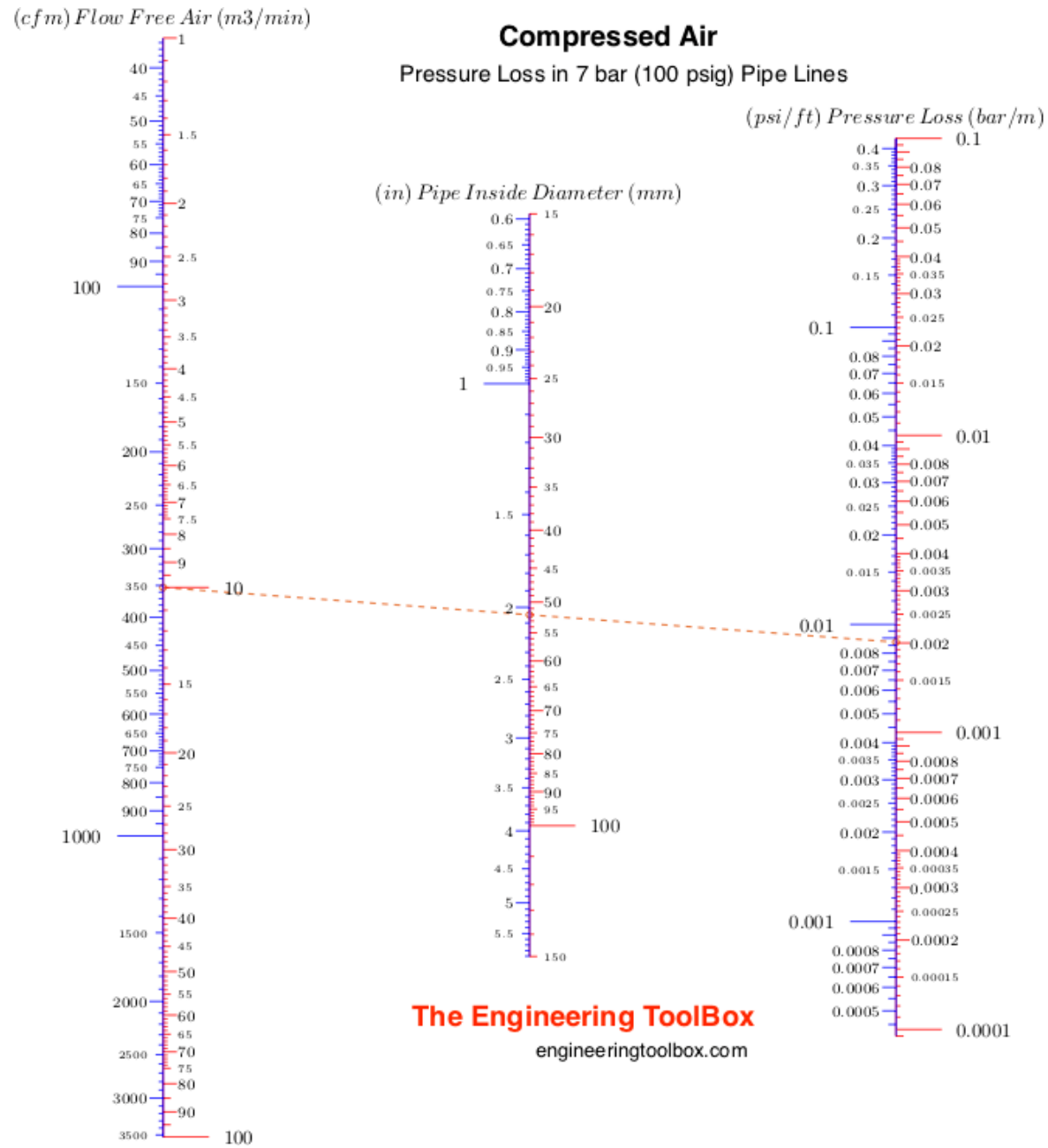
- The pressure drop in the entire network should be as small as possible.
- To be able to calculate the pressure drop the total pipe length must be known.

$\Delta P = \frac{7.57\, q^{1.85}\, L\, 4}{d^5 P}$, q is the air volume flow rate, L is the pipe length, d is the inner diameter of the pipe and P is the initial pressure.

- For fittings, branches and bends, equivalent pipe lengths are determined.
- The choice of the correct internal diameter is also dependent on the operating pressure and delivery of the compressor.
- Selection is best made with the aid of a Nomograph.

Compressed Air

Pressure Loss in 7 bar (100 psig) Pipe Lines



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Flow resistances

- Any influence or change of direction within the pipe system means interference with the air flow and thus an increase of the flow resistance. This leads to a continuous pressure drop along the pipe system.

- Since branches, bends, adapters and fittings are required in all compressed air networks, this pressure drop cannot be avoided but can be considerably reduced by routing pipes favorably, choosing suitable materials and assembling the fittings correctly.

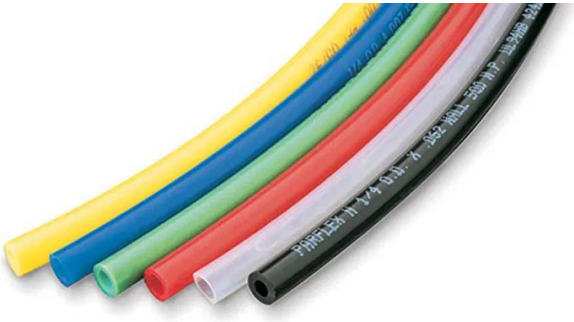
Pipe material

The choice of suitable pipe material is determined by the requirements placed on a modern compressed-air network:

- Low pressure losses
- Freedom from leaks
- Resistant to corrosion
- Capability of system expansion.

Pipe material

- In selecting a suitable pipe material, consideration must be given not only to price per meter run but also to another major factor, the installation costs. These are lowest with plastics.
- Plastic pipes can be joined 100% airtight by means of adhesives or fittings and can easily be extended.
- Copper, steel and iron pipes have a lower purchase price but must be brazed, welded or joined by means of threaded connectors; if this work is not carried out correctly, swarf, scale, welding particles or sealing materials may be introduced into the system. This may lead to major malfunctions.



Pipe material

- For small and medium diameters, plastic pipes are superior to other materials as regards price, assembly, maintenance and ease of extension.
- Pressure fluctuations in the network make it necessary to ensure that the pipes are mounted securely in order to avoid leakages at screwed and brazed connections.

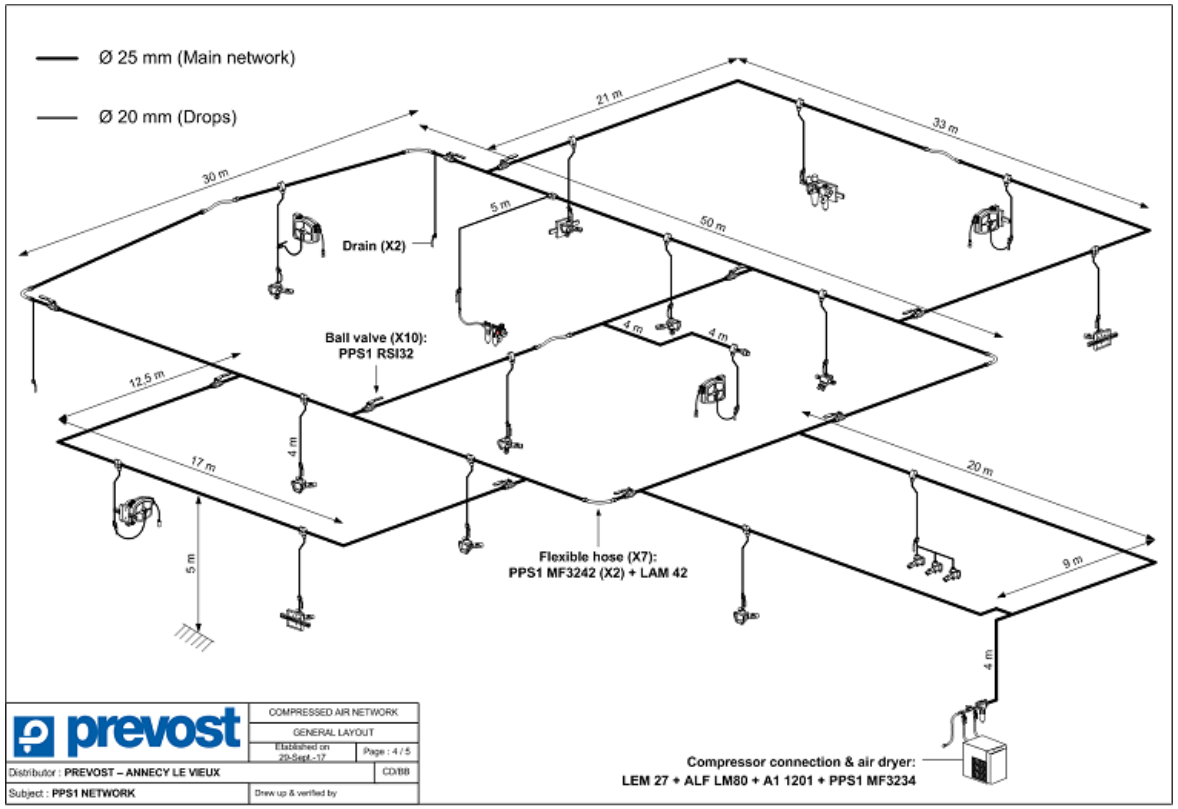
Piping layout

- Apart from correct sizing of the piping and the quality of the pipe material, correct pipe layout is the decisive factor in determining the economic operation of the compressed-air system.
- Compressed air is fed into the system at intervals by the compressor. It is often the case that consumption at consuming devices rises for only a short time. This may lead to unfavorable conditions in the compressed-air network.
- It is therefore recommended that the compressed-air network should be produced in the form of a ring main.
- A ring main ensures largely constant pressure conditions.

Ring Main

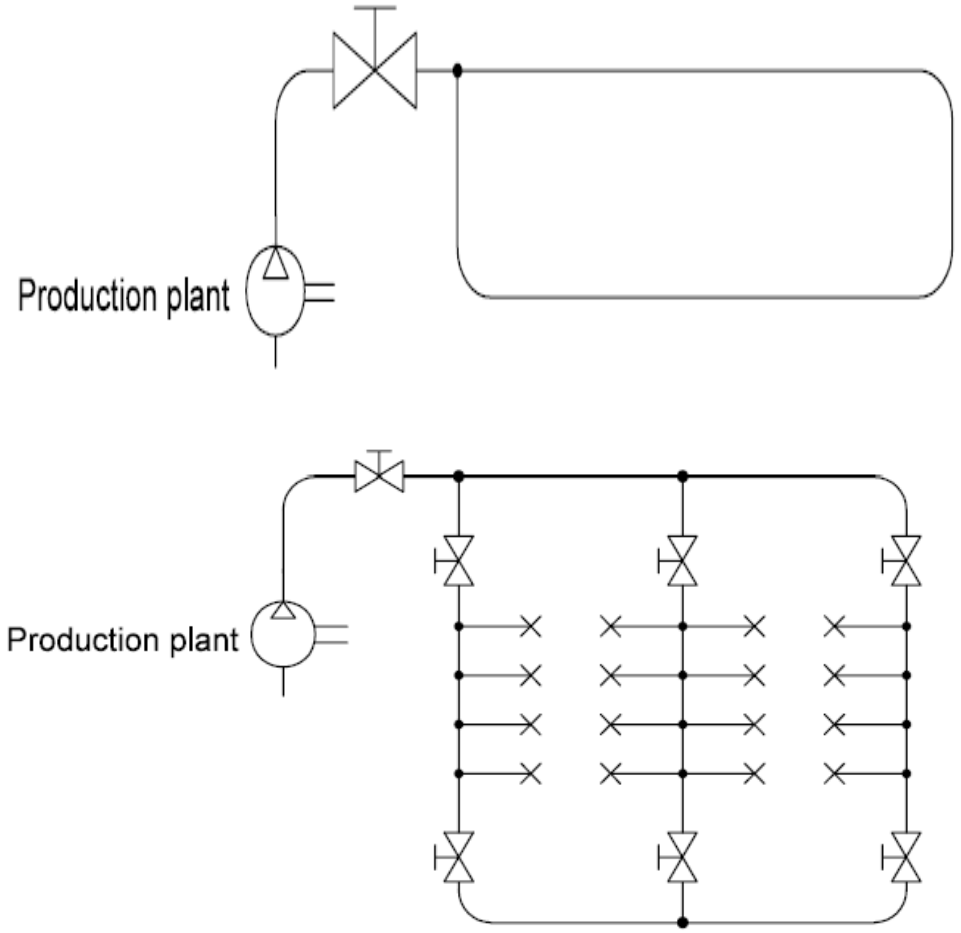
Correct Ring Main System for consistent air flow and pressure to all outlets

Sub-Standard System leads to uneven air flow and pressure at further most outlets



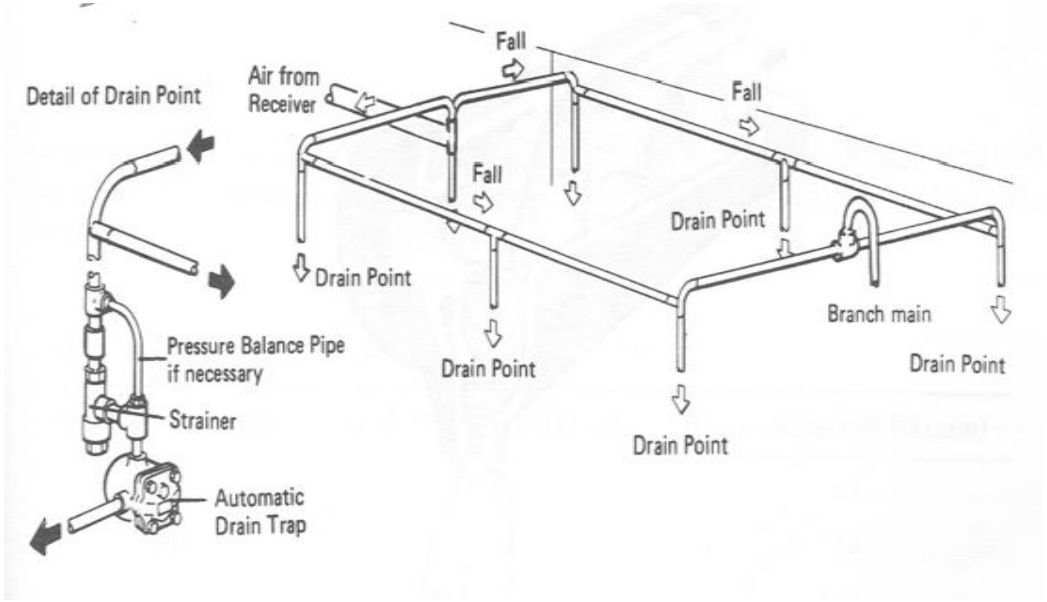
Piping layout

- For ease of maintenance, repair or extension of the network without interfering with the overall air supply, it is advisable to sub-divide the network into individual sections.
- Branches with T-pieces and manifolds with plug-in couplings make this possible.
- It is advisable to fit the branch lines with standard ball valves or shut off valves.



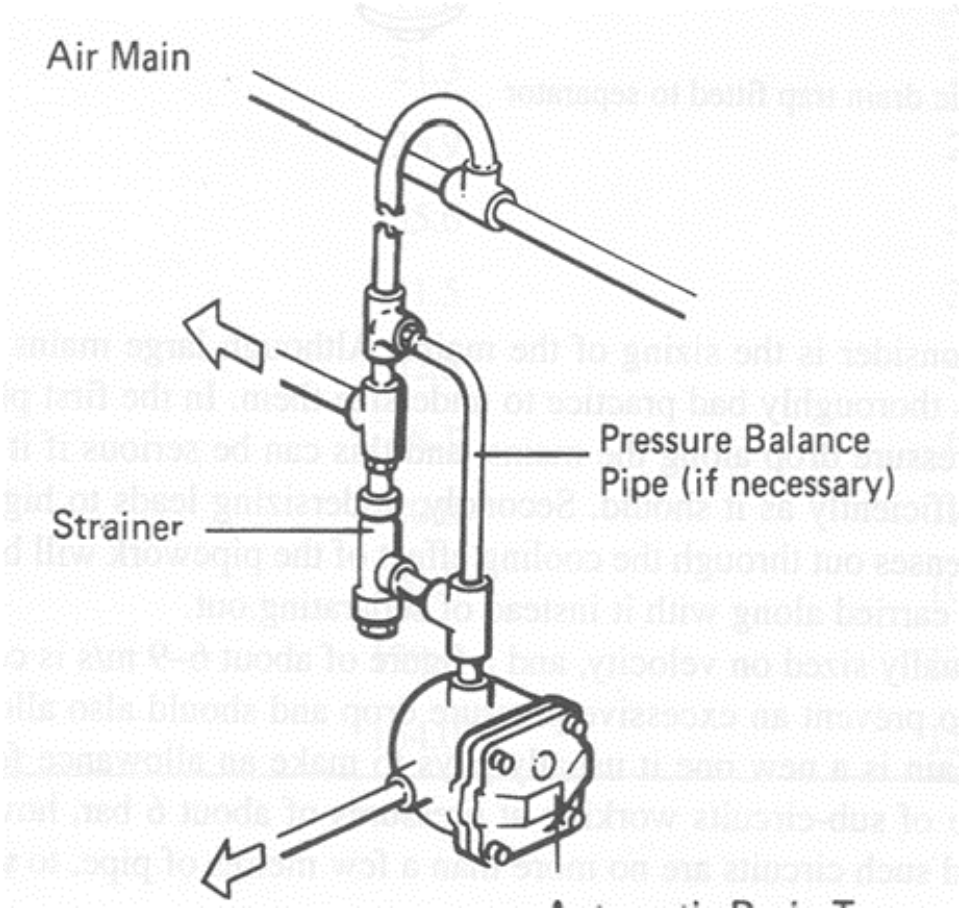
Piping layout

- Despite the best water separation in the pressure generating system, pressure drops and external cooling may produce condensate in the pipe system.
- In order to discharge this condensate, the pipes should be inclined 1-2%; this can also be carried out in stages.
- The condensate can then be discharged from the system via water separators at the lowest point.



Piping layout

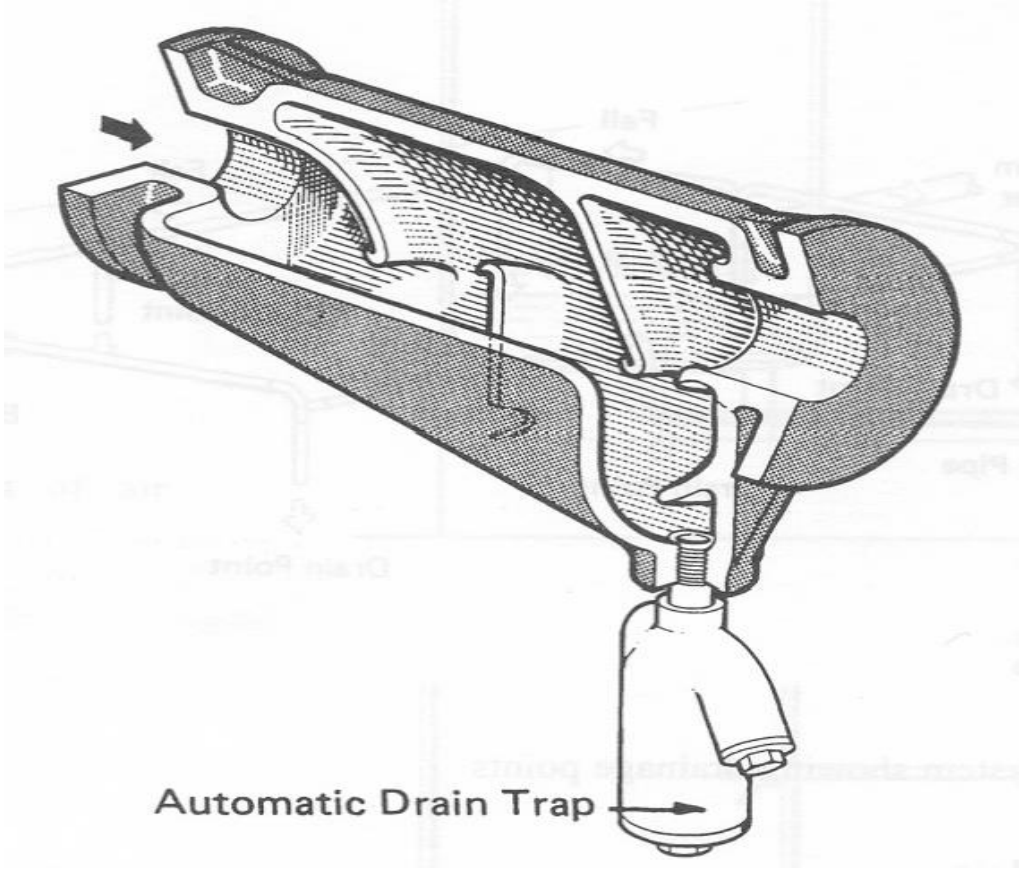
- Any branch line should be taken off the top of the main, to prevent water in the main pipe from running into it, and the bottom of the falling pipe should be drained.



Water separators

- Although the pipe layout suggested above will effectively deal with any water which has collected at the bottom of the main, it can do little to separate out the mist of water droplets which are sometimes suspended in air, particularly when velocity surges occur.

- An excellent way of dealing with this problem is to fit a separator in the main or sub-main.

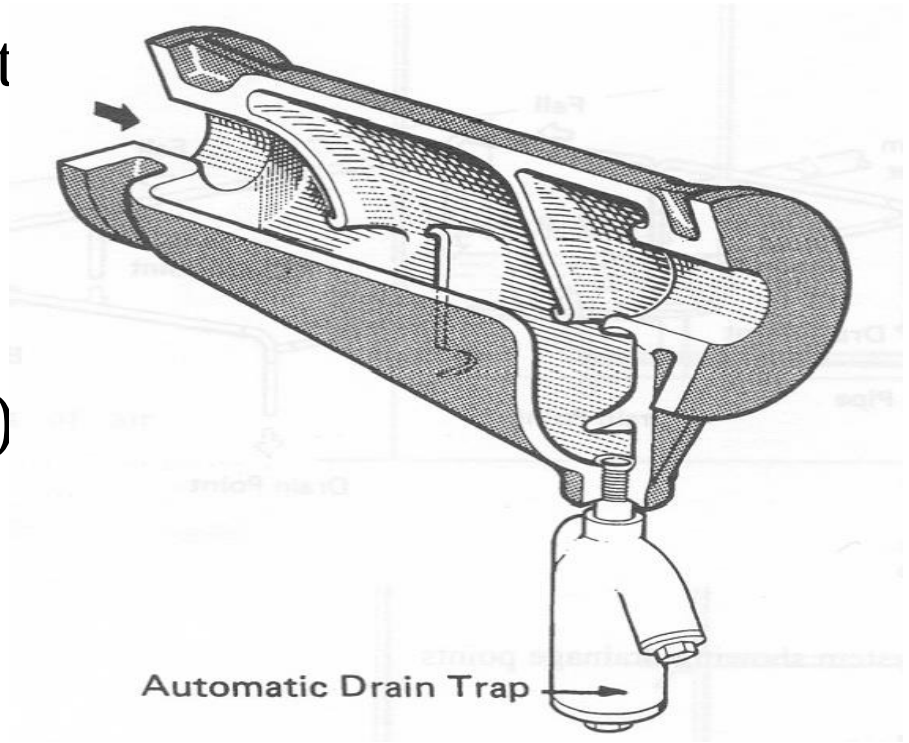


Water separators

- The principle of a separator is to separate out water droplets either by making them impinge on metal plates which are effectively in their path (the air is made to change direction rapidly over a short length) or by centrifugal means.

- A separator illustrating the first principle is shown in the Figure.

- Naturally, the separator requires drainage, and an automatic drain trap should be fitted.



Service unit

- The individual functions of compressed air preparation, i.e. filtering, regulating and lubricating, can be fulfilled by individual components.
- These functions have often been combined into one unit, i.e. the service unit.
- Service units are connected upstream of all pneumatic systems.
- Generally, the use of a lubricator is not necessary in advanced systems. This is to be used for specific requirements only, primarily in the power section of a system.
- Compressed air in a control section should not be lubricated.

Compressed air filter

- Condensed water, contamination and excess oil can lead to wear on the moving parts and seals of pneumatic components.

- These substances can escape as a result of leakage.

- Without the use of filters, for example, products to be processed in the food, pharmaceutical or chemical industries could become contaminated and therefore rendered useless.

Compressed air filter

- The selection of the correct filter plays an important role in determining the quality and performance of the working system which is to be supplied with compressed air.
- One characteristic of compressed-air filters is the pore size.
- The pore size of the filter element indicates the minimum particle size which can be filtered out of the compressed air.
- The collected condensate must be drained before the level exceeds the maximum condensate mark otherwise it will be re-introduced in the air stream.

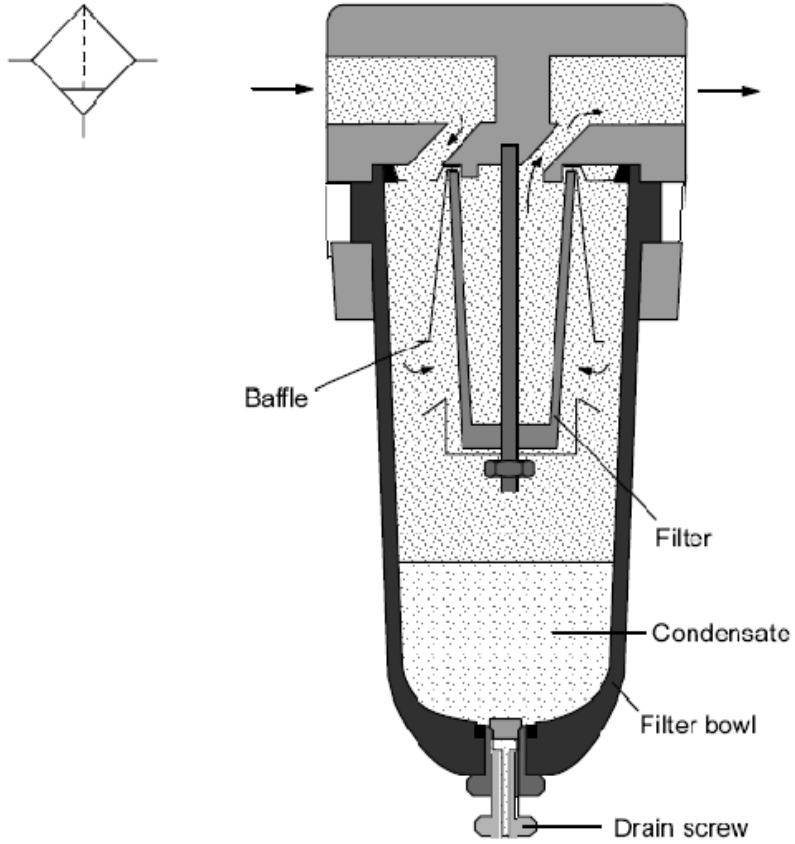
Compressed air filter

- If a large amount of condensate accumulates, it is advisable to fit an automatic drain in place of the manually operated drain cock. However, in such cases, the cause of the accumulated condensate is to be established.

- For example, an unsuitable pipe layout may be the cause of the condensate accumulation.

Compressed air filter

- The automatic drain uses a float to determine the level of condensate in the bowl and when the limit is reached a control piston opens a valve seat that ejects the condensate under air pressure via a drain line.
- If the float reaches the minimum level of condensate, the seat valve is closed, and the process stopped.
- The filter bowl can also be emptied manually.



Compressed air filter

- The compressed air passes through the filter from left to right and is fed through a baffle plate in the filter bowl.
- The effect of the baffle plate is that the air is caused to rotate, and the heavier dust particles and water droplets are spun by centrifugal force against the inner wall of the filter bowl. They then run down the wall of the housing and collect in the filter bowl.
- The air which has been pre-cleaned in this way then passes through the filter element, which filters out the smaller dirt particles.
- The filter element in this case consists of a highly-porous sintered material.
- The degree of separation depends on the pore size of the filter element used.
- Inserts with different pore sizes are available.
- The usual pore sizes are between 5 microns and 40 microns.

Compressed air filter

- A further important characteristic of compressed-air filters is the degree of separation, or efficiency, which indicates the percentage of particles of a particular size which can be separated out.
- The efficiency is quoted for a particle size, e.g. efficiency of 99.99% for 5 microns. With micro filters, 99,999% of particles greater than 0.01 µm can be filtered.

Maintenance

- Depending on the nature of the compressed air available, the air consumption of the components and the filter size, compressed-air filters require a greater or lesser amount of maintenance work.

Maintenance work means the following :

- Replacing or cleaning the filter element
- Draining the condensate
- When cleaning is required, the manufacturer's specifications must be observed concerning the cleaning agents to be used.

Compressed air regulators

- The compressed air generated by the compressor will fluctuate. Changes in the pressure level in the pipe system can adversely affect the switching characteristics of valves, the running times of cylinders and the timing characteristics of flow control and memory valves.

- A constant pressure level is thus a prerequisite for the trouble-free operation of a pneumatic control.

- The pressure reducer or pressure regulator is fitted downstream of the compressed air filter and has the task of keeping the operating pressure constant, regardless of pressure fluctuations or air consumption in the system.

Compressed air regulators

- The system pressure which has proved in practice to be the best economic and technical compromise between compressed-air generation and the efficiency of the components is approximately:

- 600 kPa (6 bar) in the power section and
- 300 to 400 kPa (4 bar) in the control section.

- A higher operating pressure would lead to inefficient energy utilization and increased wear, whereas a lower operating pressure would lead to poor efficiency, particularly in the power section.

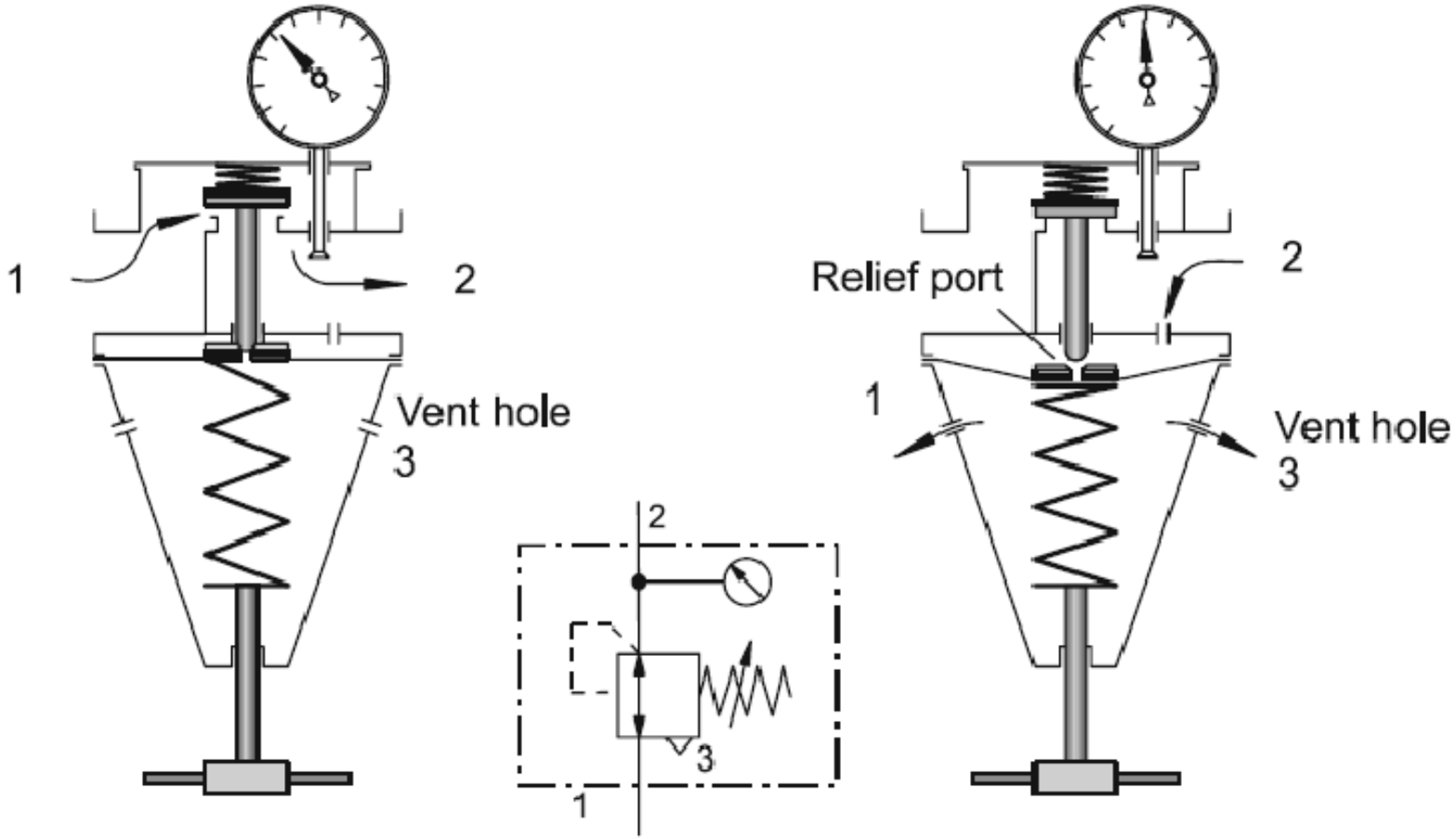
Operational principle

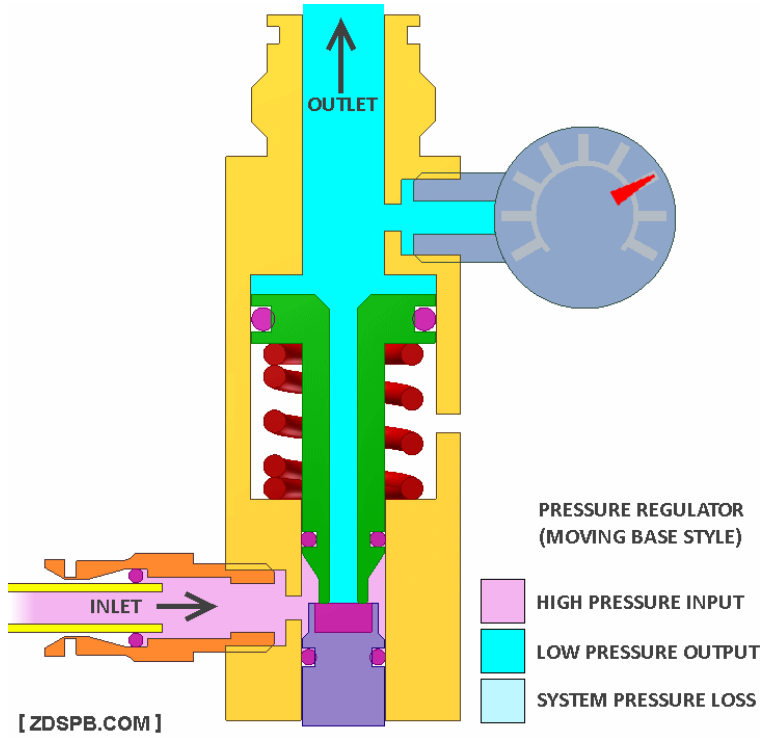
- The input pressure (primary pressure) at the pressure regulator must always be higher than the output pressure (secondary pressure).

- The pressure is regulated by a diaphragm.
- The output pressure acts on one side of the diaphragm and a spring acts on the other side.

- The spring force can be adjusted by means of an adjusting screw.
- When the output pressure increases for example during cylinder load changes, the diaphragm moves against the spring force causing the outlet cross-sectional area at the valve seat to be reduced or closed entirely.
- The centerpiece of the diaphragm then opens, and the compressed air can flow to atmosphere through the vent holes in the housing.

Pressure regulator relieving





Pressure regulator relieving

- When the output pressure decreases the spring force opens the valve.
- Regulation of the preset output pressure is thus a continual opening and closing of the valve seat caused by the flow of air.
- The operating pressure is indicated on a gauge.
- If no air is drawn off on the secondary side, the pressure rises and presses the diaphragm against the compression spring.
- The outlet cross-sectional area at the valve seat is reduced or closed and the flow of air is reduced or cut off entirely.
- The compressed air can continue to flow only when air is drawn off on the secondary side.

Pressure regulator non-relieving