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Design Features and Materials of Brake Chambers and Cylinders with Spring Energy Accumulators

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The brake chamber (TC) is the executive body of the pneumatic brake drive and is designed to convert the energy of compressed air into a force that drives the brake mechanism. The basis of its design is a movable element that perceives the pressure of compressed air and acts on the output rod of the executive body. There are two main types of movable elements: a piston and a diaphragm. Depending on the type of movable element, two types of the pneumatic actuator executive body are distinguished, respectively: a cylinder inside which the piston moves, and a chamber in which there is a movable membrane.

The chamber and cylinders are the executive organs of the direct-acting drive, since they create a braking force when compressed air is supplied.

The main components of the brake cylinder (Fig. 1.1) are: cylinder 1 with mounting elements 6, piston 2 with seal 5, rod 3, pivotally connected to the wheel brake drive device, spring 4 for returning the piston to its original position when releasing compressed air.

When compressed air is supplied to the inlet, the pressure acts on the surface of the piston and the latter moves. In this case, the piston 2 acts on the rod 3 and through it transmits the force to the drive device of the brake mechanism. When the compressed air is released from the cylinder, the piston, together with the rod, returns to its original position under the action of the cylinder return spring and the wheel brake pull springs. Atmospheric air is sucked into the outer cavity of the cylinder through the outlet.

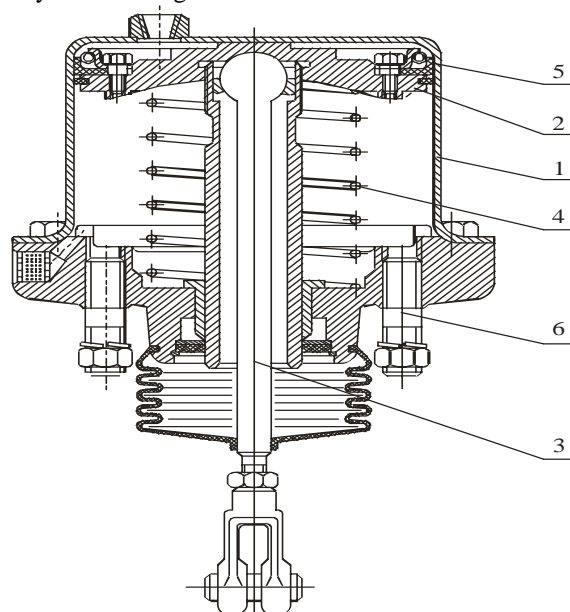


Figure 1.1 Typical design of the brake cylinder

There are two features in the operation of brake cylinders:

- the stroke of the cylinder rod depends on the gap in the brake (between the pads and the drum) and is a variable value; in addition, the end of the rod must move along a circle whose radius is equal to the shoulder of the wheel brake adjustment lever;
- the brake cylinder is located outside and its internal cavity, in which the piston moves, must be protected from contamination by solid particles in the atmospheric air (dust, dirt, moisture, etc.).

To protect the brake cylinders from contamination, they are provided with hermetic protective covers of large size. The sealing of the piston in the cylinder is achieved by installing a cuff 5 on the piston, fixed to the piston with screws and pressed against the cylinder mirror by an annular spring, as well as a felt O-ring that removes dust from the cylinder mirror. The rod can rotate around its ball head when the piston moves. To prevent dust from entering the cylinder, there is a filter and an oil seal that closes the gap between the cylinder cover and the piston guide together with the cover. The cylinder is attached to the brake bracket with two studs.

The main parts of the brake chamber (Fig. 1.2) are the housing 1 and the cover 2, between which the membrane 3 is clamped along the outer diameter; the disc 4, resting on the middle part of the membrane, rigidly fixed on the rod 5, which is pivotally connected to the wheel brake drive device by a fork 7; the diaphragm return spring 6; the protective cover 8. The camera is installed on the brake parts or the chassis of the car by means of bolts 9.

When compressed air is supplied to the inlet I under the chamber membrane, the pressure acts on the surface of the membrane and bends its middle part. The disc 4 perceives the pressure force, moves and transmits it through the rod 5 to the wheel brake drive device. When the compressed air is released from under the diaphragm 3, it, together with the disc 4 and the rod 5, returns to its original position under the action of the return spring 6 and the pull springs of the brake pads. There are practically no rubbing parts in the chamber and, therefore, friction losses are minimal.

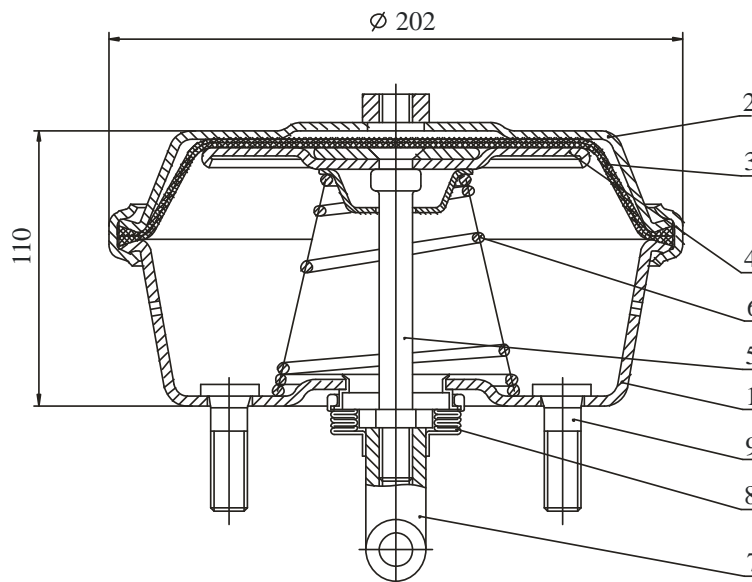


Figure 1.2 Typical design of a flanged brake chamber with a rubber-fabric membrane (notation in the text)

Due to the absence of significant friction forces, the spring force in the chamber can be significantly less than in the brake cylinder. Studies have shown that the losses in the brake chamber of modern design do not exceed 2% of the force on the rod. The dimension of the brake chamber is set by the active area of its membrane, measured in square inches. In international practice, cameras of the following dimensions (types) are used): 9, 12, 16, 20, 24, 30 and 36. However, the actual area of the membrane is variable and depends on the movement of the brake chamber rod.

The membrane is made of high-quality rubbers, and to strengthen it inside the structure there is a gasket made of durable cotton fabric. The membrane must have a high strength and a great ability to repeated deformations. It must

remain operational in a wide temperature range (from 213-223 to 353 K) and have a high durability (at least 0.5-1.0 million operating cycles) and wear resistance at the point of contact with the disc 4.

For brake chambers, protection from external contamination is less critical than for brake cylinders, since they can damage the membrane. Therefore, in many cases, the central hole for the rod in the lid, which is made of a deliberately large diameter, taking into account the curvilinear movement of the rod, is closed with a corrugated protective cover put on the rod. Failure of the membrane due to a violation of its integrity is associated with the loss of the functional purpose of the chamber. This can lead to adverse consequences when operating vehicles. Therefore, research is needed to develop new types of composite materials with adjustable indicators of deformation and strength characteristics and durability. Brake chambers are currently used on the vast majority of cars with pneumatic drive. Their advantages are: no friction losses and high efficiency, due to small resistance forces; low wear and high durability, low initial insensitivity; simplicity and low labor intensity of industrial production and maintenance.

Brake chambers are inferior to brake cylinders in almost only one thing: the force on the chamber rod depends on the stroke of the rod and drops sharply when a certain value is exceeded. Manufacturers of brake chambers are constantly working to eliminate this drawback.

Thus, in the chamber designs developed over the past 20-30 years, the thickness of the membrane has been significantly reduced (from 5 and 6 mm to 3 and 4 mm) while maintaining its strength, the shape of the lid has been improved, the deformation and strength characteristics of the membrane material have been improved. At one of the stages of this work, a new type of camera appeared – a roto-camera. It uses a twisting membrane, as a result of which it seems to combine the advantages of the brake chamber and the cylinder – the absence of friction and a large stroke. However, the durability of such membranes turned out to be significantly lower than that of conventional membranes, due to insufficient parameters of the composite materials used, as a result of which they did not become widespread.

Therefore, it is necessary to conduct research on the creation of composite materials based on thermoplastics for the manufacture of membranes of a new design that has the ability to change shape depending on air pressure. The development of such a material will allow us to develop a new design of the brake chamber with high reliability and durability.

An important element of the brake chambers is the return spring of the membrane, the elastic characteristics of which largely depend on the functional characteristics and the service life of the chamber. The spring is made of alloyed spring steels and subjected to special types of processing-polishing and heat treatment. To protect the spring from abrasive effects, it is painted. This technology provides, as a rule, a given spring resource. However, given the special importance of brake chambers for ensuring traffic safety, it is necessary to develop special coatings for springs that guarantee a given service life. Such coatings can be composite based on polymer matrices containing inhibitors of corrosion and mechanical wear, because it is shown that modifying thermoplastics with inhibitors reduces the wear of the tribosystem, and processing metal samples with corrosion inhibitors significantly increases their resistance to alternating deformation.

The operational life of automotive units is significantly affected by the corrosive effect of the environment, which causes damage to all metal elements made of carbon steels. Local corrosion foci reduce the resistance of elastic elements to alternating deformations, cause damage to the sealed housing and loss of functional characteristics of shock absorbers and brake chambers.

Thus, when designing a new generation of automotive units that ensure the safety of the vehicle, it is necessary to use composite polymer materials with specified performance characteristics: deformation and strength, resistance to alternating loads, temperature changes and aging. Therefore, it is necessary to study the features of the operation of products made of polymer composite materials in automobile units of various types in order to ensure their not only technical characteristics, but also modern requirements for safety and comfort of movement.

At the same time, research is needed to find optimal design and technological solutions that will allow achieving a synergistic effect.

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