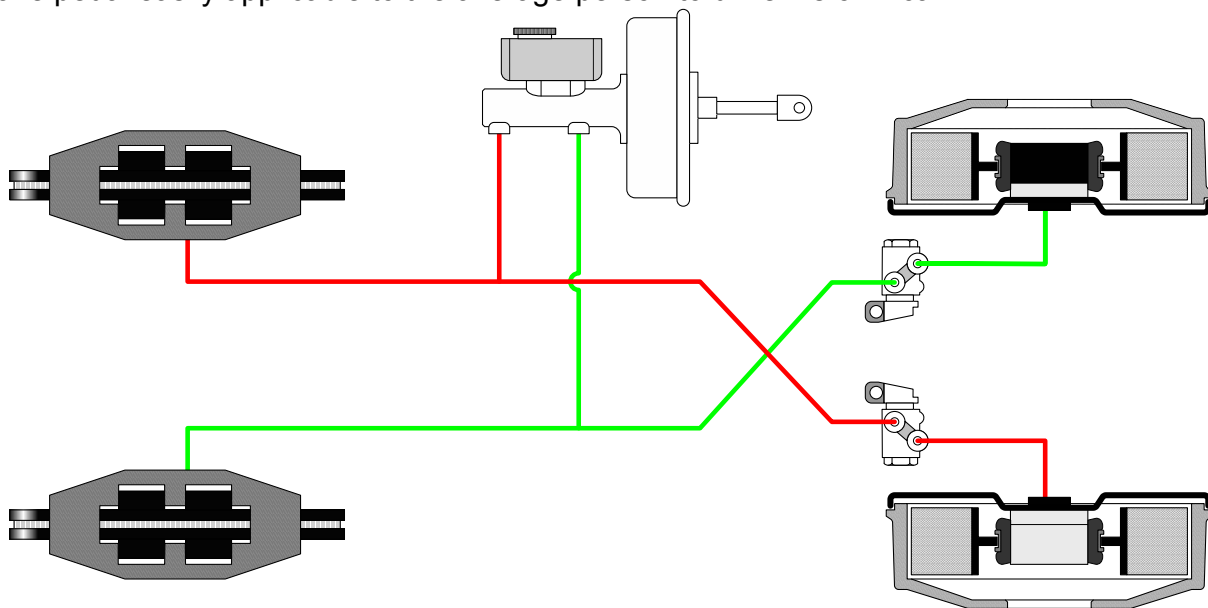


Metelli's Components for hydraulic brake system and clutch: when the guarantee of a perfect seal must be absolute

The hydraulic brake systems: basic concepts

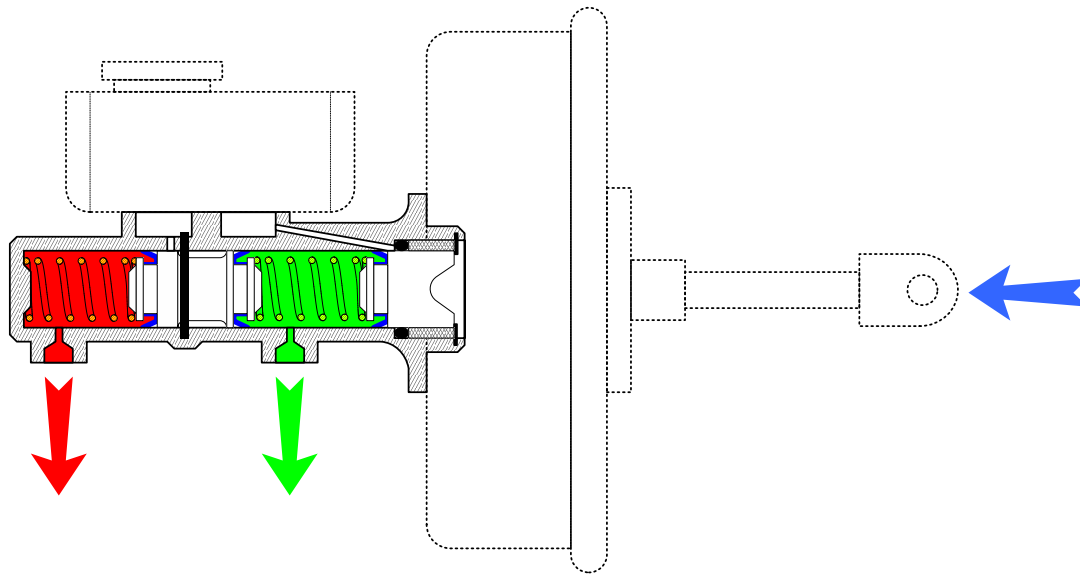
Speaking about automotive, all brake systems are today all hydraulic, this basically means that the means to deliver the that we use to press the brake pedal to the brake calipers or brake cylinders, is a fluid; more specifically we are talking about a specific hydraulic oil that can withstand the high temperatures that can be reached in the brake systems.

The action levers geometry (pedal), the strength of the servo amplifier, the piston's section of the pump, of the brake cylinder and of the brake caliper are so sized that is normally possible to reach the necessary force on the friction material, starting from a pressure exerted on the brake pedal easily applicable to the average person to drive his own car.



Precisely because the braking system is one of the most important security installations in the vehicle, it must comply with strict regulations approval.

In order to satisfy safety requirements, the brake system is built "split", in fact any brake system consists of two physically separate circuits that share only the brake master cylinder, which, however, is designed and produced to have two completely separate oil chambers.



These design features are such that in case of a system's part failure, remains nevertheless possible to slow down and stop the vehicle.

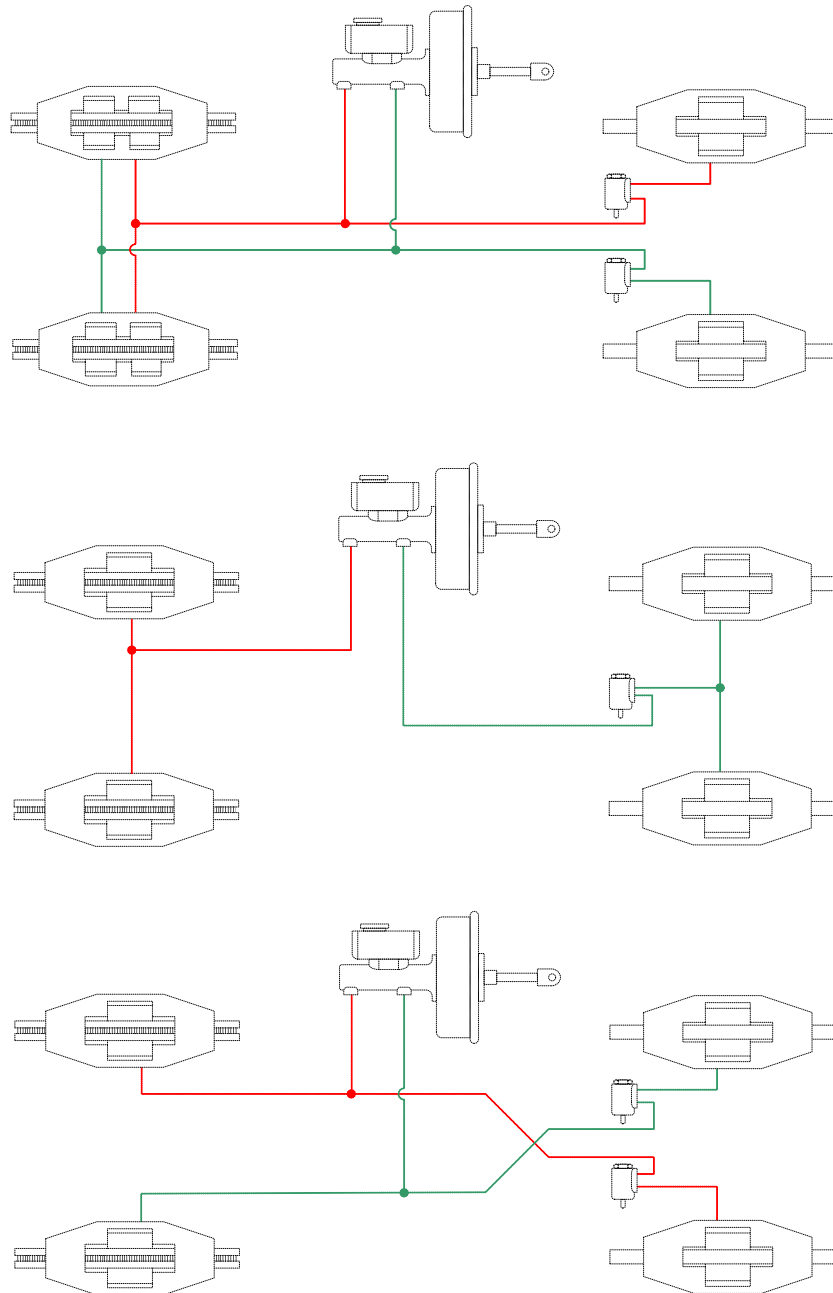
All the brake system is functional to carry at the calipers (or at the brake cylinders in case of brake drums) the brake fluid with enough pressure in order to push with adequate force the friction material against the discs or drums.

All, or at least most, of the brake systems installed in modern motor vehicles are now designed and manufactured in two typical configurations:

- ❖ the first configuration, the most widespread, uses 4 brake discs, one each wheel, due to the performances of almost all vehicles, front discs (and sometimes not only those) are always self-ventilating discs
- ❖ the second configuration, on vehicles belonging to the range of city cars and mainly for cost reasons, involves the usage of drums for the rear axle instead of brake discs and often, due to the low energy involved, the front discs are even not self-ventilating (being these cars generally lighter and slower so the energy we need to dissipate is much lower)

The case of the real system diagrams is different, there are several types that differ mainly for the different "philosophies" that create a dual system.

The detailed design features are different, but the common aim of these various schemes is to obtain the most effective and balanced braking even in the case of failure of a portion of the system.



The heart of the entire system remains the master cylinder that physically feeds the system with the oil pressure. It's the only common component of the entire system, and it is clear how essential it is the absolute guarantee of its trouble-free operation.

His failure is the only case in which the entire plant may lose functionality, each shrewdness (both at the designing stage and during the production process) should be put in place to prevent this.



Calipers and brake cylinders perform the opposite operation; receive oil with adequate pressure and move its pistons to press pads and brake shoes against discs and brake drums. Although the mode of operation is exactly the opposite, design requirements and technical features are quite similar, the main body has a chamber with pressurized oil to the ends of which are the pistons with the appropriate seals ensuring any leakage absence.



The oil pressure pushes on the piston's walls generating the mechanical force that moves the friction material.

The materials of our products

When pressures are so high as in the case of braking systems, the use of materials of exceptional quality is essential to produce components with a guaranteed reliability.

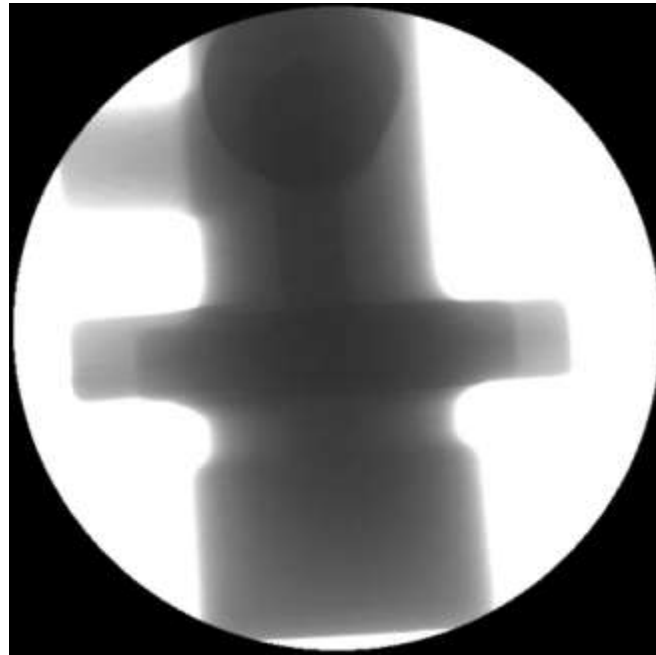
Is the use of materials of known origin and 100% certified composition enough to get the right components?

Absolutely not, the process of converting raw materials into castings or extruded profiles from which are then made our products, it is essential to run according to the best casting techniques or extrusion.

Regardless if is cast iron or aluminum, starting only from first class quality rough components guarantees the production of brake pumps, brake cylinders and brake adjusters, being able to successfully withstand the high pressures typical of the brake systems.



As a further guarantee of a starting rough part without imperfections, can be performed X-rays controls in order to check the firmness of the material's structure at the heart of the part even before machining.



The high knowledge in investigating the quality and the structure of the material in general, allows us to create products with a degree of absolute reliability, which is essential when we're talking about components used in safety systems, systems that must ensure their functionality even under the most severe working conditions.

Clutch Components

In clutches hydraulically driven, the clutch cylinder moves mechanically through the oil under pressure coming from the clutch pump located behind the clutch pedal, it uses exactly the same principle of motion of the braking systems.

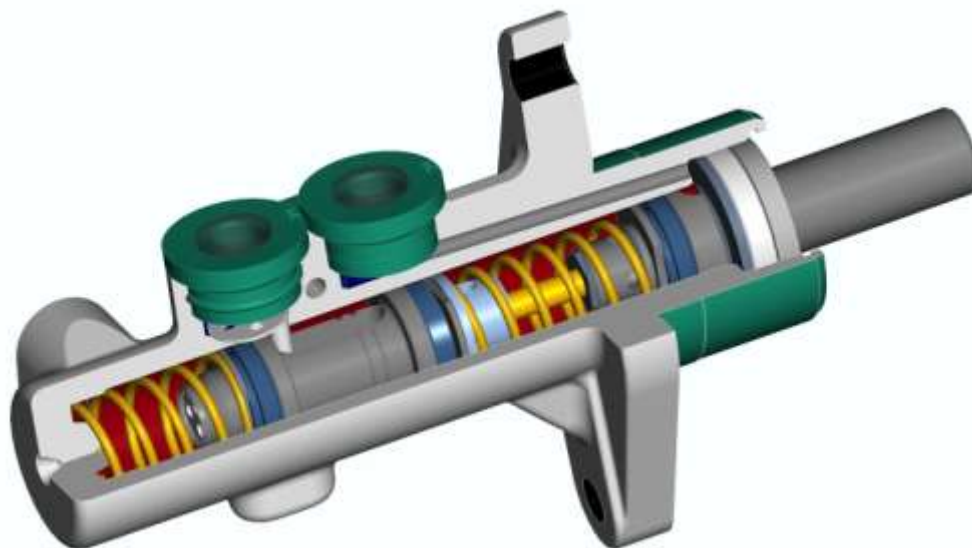
The critical level and the operating conditions of these components are certainly lower, although they retain all the same features of the components of a hydraulic system.



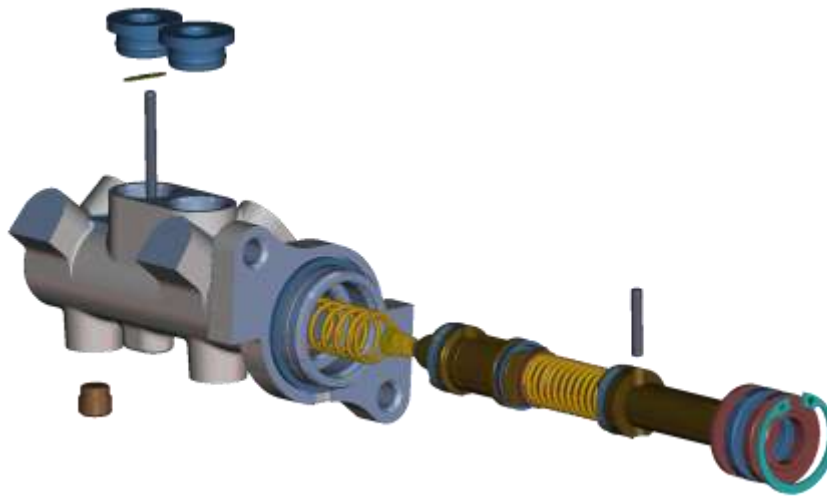
Therefore, regarding clutch components, although as mentioned before, the pressures are much lower (even 10 times) compared to the pressure of a brake system, the care that we put in the production of these components is absolutely the same, in order to guarantee all products trouble free.

The pumps and brake cylinders design

As for all our product lines, all brake system components we produce are developed entirely in 3D. Each component is designed to perform its task in the best way.



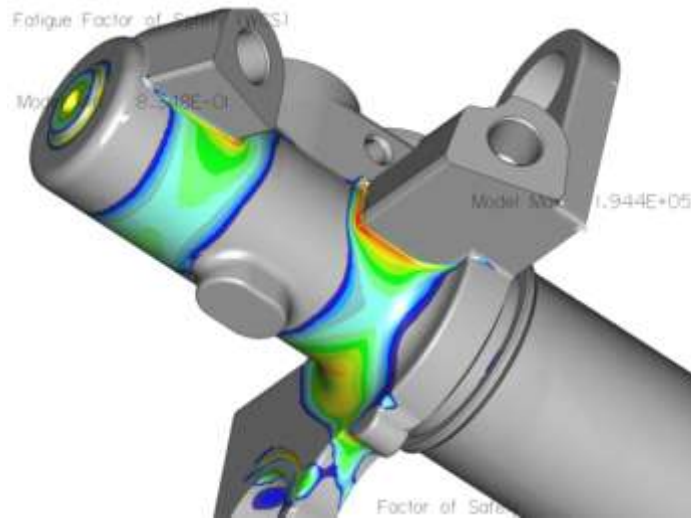
The result is that all projects are fully developed up to the smallest detail, nothing is left to chance: from modeling the raw casting part until the assembly of the entirely assembled product.



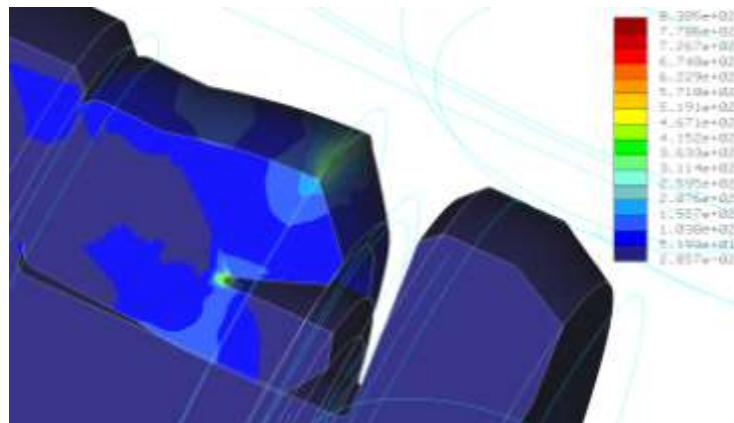
Through the use of software for finite element analysis, on the outer body checks are made to be kept at the maximum pressure test well beyond the maximum working pressure. We simulate the loads on components from the oil pressure.



Our products must not only withstand the maximum possible stresses (still maintaining a good safety margin), but they are also verified against fatigue; before we decide on the project, we can run simulations, fatigue analysis to ensure that our products can withstand properly to a life of over 400,000 simulated braking. Every part of the piece must have an adequate safety factor in terms of residual life.



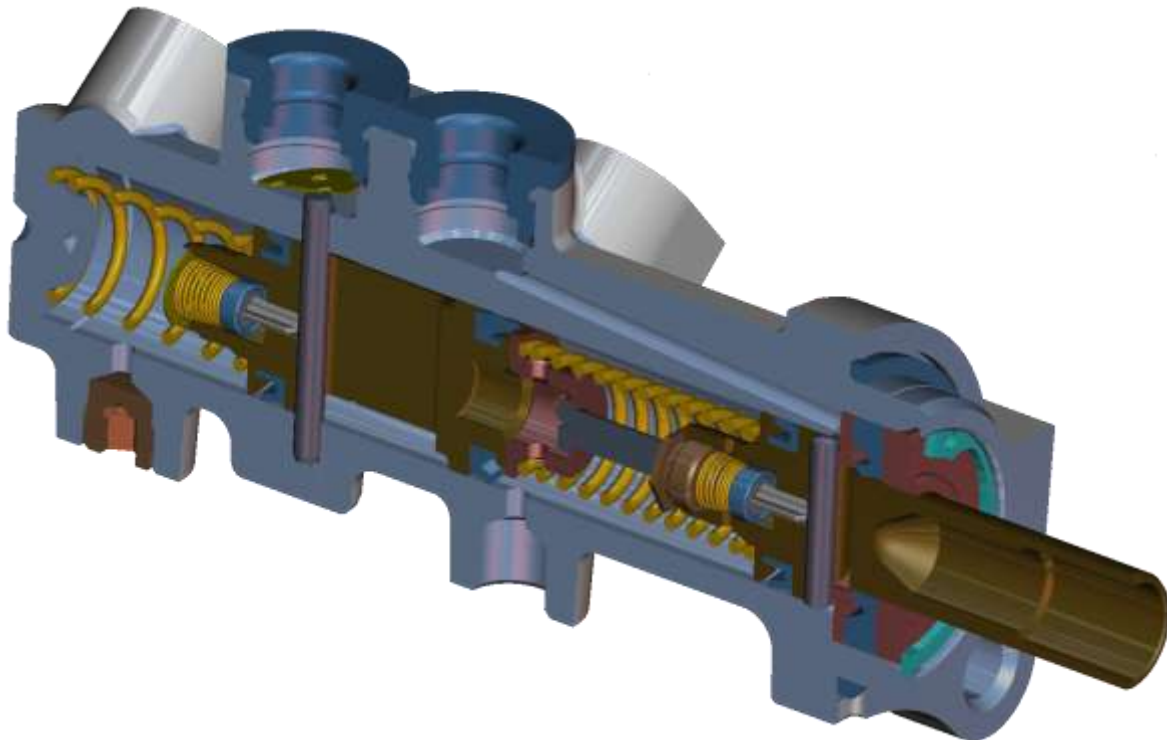
The ability to simulate even on materials such as the rubber seal lip, allows us to carry out preliminary checks on these details, which are key factors to ensure proper sealing of the chamber containing the oil.



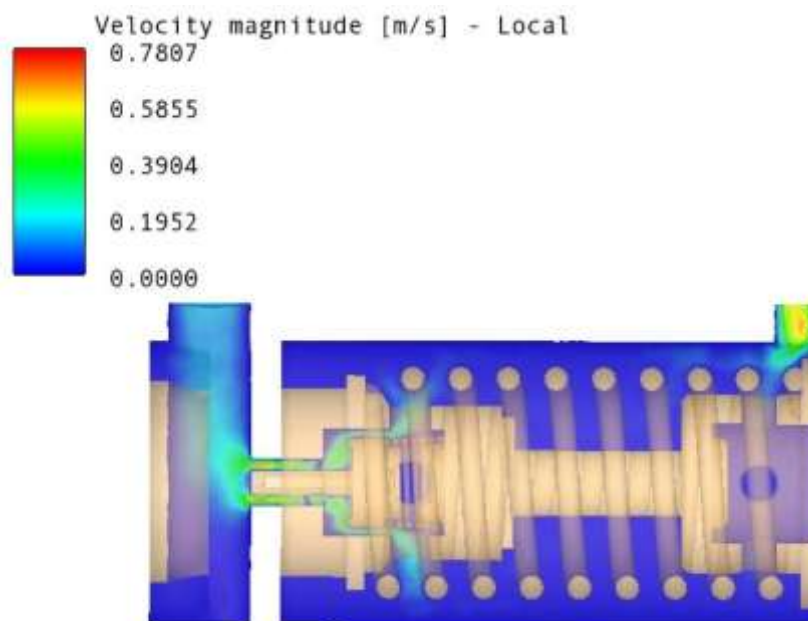
In a time when the electronic has taken an increased role in the mechanics and also in particular in the brake systems, either as passive safety devices like ABS, and active safety features like ESP, the characteristics of a brake systems and in particular master cylinders are increasingly stringent.

These electromechanical devices in fact lead the brake pump to operate under conditions different from those in which the pumps are working in traditional systems, particularly devices such as ESP levying actively the oil from the circuit (and hence from the pump) which must deliver oil by an applied depression without pressing the brake pedal.

The latest generation pumps are much more complex than the equivalent of a few years ago, particularly within the piston are placed valves that can supply oil when the electro-mechanical systems need to operate the calipers or brake cylinders on their own.



An adequate behavior of active safety systems is thus conditioned by the implementation of the master cylinders to be able to deliver oil quickly enough typical of the reactions of these systems. To ensure that our products are actually able to allow all systems to work properly, we perform fluid flow analysis in these valves; verifying that the losses suffered by the oil pressure, under the worst conditions, are not beyond the values of security, allows us to market products successfully validated that always respond to the stringent requirements of modern braking systems.



Using these design tools, since the early stage of our product design and verification, enables us to design these very important components in the most reliable way, delivering our production departments drawings of a project whom performances have already been simulated, even before the first piece is machined.

The machining

Precision, tight tolerances, surface finishes of the highest level, they are our "brand" better for these products.

When we are in the presence of cylindrical surfaces that contain elements (some of which are rubber parts) that must move one into each other without any jamming and with a coupling that always guarantee a perfect alignment, it is obvious that the quality of machining must be absolute.

On the surfaces of bores, the gaskets must scroll back and forth hundreds of thousands of times, and the oil pressure must be always guaranteed.

To ensure a flawless finishing of the chambers diamond tools are used for machining aluminum parts, while cast iron, which is considerably harder, is subjected to no less than 12 subsequent finishing operations.

The result of this almost maniacal care in the execution of the machining of the chamber, is a level of finish that has a residual surface roughness so low (we are talking about small fractions of a micron) to allow the rubber seals to slide on it for hundreds of thousands of times without being abrasive wear.



Similar concept is applied to the brake pistons manufacturing; the implementation of parts with strict dimensional and geometric tolerances allows both to ensure that the seals seat perform it's task properly, whether the diameter external flow properly within the cylindrical chamber, with no resistance and no jamming in order not to compromise the sealing surface of the oil chamber.

The aluminum pistons are surface treated with hard anodization treatment, which gives them a special high surface hardness, thus ensuring a long life to our products.



Specific seals for each fluid

The hydraulic fluids have the characteristics of extreme resistance to heat and have a composition that make them hygroscopic and chemically very aggressive.

It is therefore essential that the gaskets materials are carefully chosen in order to withstand the oil brake, but not enough.

The two main types of oil that is radically different are what is called glycol-based or silicone-based; for each of these two types of oil having very different chemical basis is essential to use the correct rubber for the construction of gaskets.

A gasket made of a not suitable rubber would in a short time chemically attacked and physical properties of the material would be compromised soon; this will cause the failure of the gasket compromising its ability to make the pressure seal or in some cases, because of its increase in volume, would come to cause hardening of the master cylinder and the inability to run properly.



The geometry of seal is just as important, a poor design leads to ineffective seals, with little fluency, or have an insufficient duration, and then they lose their ability to seal the fluid.

The assembly process

The assembling of our products is made up different machines properly differentiated, depending on the batches dimensions and the product type (cylinder, brake master cylinder, etc.).



Each stage of the assembly process is designed to optimize the timing and quality of the operation, the products are designed with a structure of components that prove to be in complete harmony with this process.



The result is a product designed to be assembled with the best possible guarantee of quality, but never at the expense of performance that must remain at the highest levels. Automatic controls at each stage of the process ensure a constant monitoring of each phase along the assembly line, ensuring a finished product having a quality level without compromise.



Testing

In addition to the usual checks on line, our products are validated with rigorous testing in order to check the absence of any leakage at the maximum pressure test (well above the pressures to which they are subject to operating conditions) and to control the product life.

So-called detonation tests, submit the brake master cylinder at a pressure three times greater than the maximum pressure during working conditions and the products under test must not show any signs of structural failure.

The brake components, especially brake and clutch pumps are located under the hood, this implies that the temperatures where the products they work have a great excursion and can be up to 140 ° C; these temperatures are reproduced in special climatic chambers in order to run tests in the same conditions in which our products have to operate.



The endurance test subjects our components to 400,000 cycles of braking at high pressure; These brakes (made in the most varied temperature conditions) subject the product to an extenuating endurance test, simulating his entire lifetime in a vehicle.



metelli s.p.a.



This will verify that the product characteristics are maintained throughout his potential life, ensuring our customers the certainty of being able to brake safely.

