Powertrain Components and Systems

For Commercial Vehicles
Performance, Comfort, Environmental Protection: Powertrain Components and Systems for Commercial Vehicles

The demands placed on suppliers are undergoing change at a fundamental level. Suppliers are increasingly expected to integrate components into complex systems – a task that can only be mastered in close developmental partnerships with the vehicle manufacturers. In the future, fuel consumption, emissions, weight, and installation space will continue to be lowered, while at the same time performance, safety, and driving comfort will rise. To achieve these objectives, innovative solutions and new products are essential.

And here is where ZF Sachs takes responsibility and demonstrates its expertise in integrated systems to provide overall solutions to the requirements posed. In developing and manufacturing new products and technologies, it resolutely pursues a systems approach to generate significant progress. Together with ZF Friedrichshafen AG, it can provide solutions to the demands that will be placed on overall systems in the future.

Clutch Systems

Single and twin-disc clutches from ZF Sachs meet the challenging requirements of modern commercial vehicles. Efficient detailed solutions to increase the service life, improve resilience in rough usage, or achieve greater comfort contribute noticeably to the economic operation of commercial vehicles.

- Clutch Disc
- Clutch Facings
- Clutch Cover
- Releaser
- XTend® Wear Compensation
- Twin-Disc Clutch
- Power Take-Off Clutch (PTO)

ConAct® / XAct Pneumatic Clutch Actuation

Reliable clutch actuations and automations suitable for everyday use can be implemented on the basis of an electronically controlled pneumatic cylinder.

Dual Mass Flywheel

If the torsional damper of the clutch disc is not sufficient to damp engine vibrations in critical engine speed ranges, the dual mass flywheel ensures outstanding vibration decoupling.

Torsional Damper

Pure torsional dampers behind the combustion engine are used principally if there is no separating and drive-off clutch in the powertrain.

DynaDamp

In particularly critical applications, conventional torsional dampers can come up against their limits. In this case, the DynaDamp with its high decoupling qualities is the right vibration damper to choose.

HRTD Belt Pulley Torsional Damper

Based on the technology of the tried and tested dual mass flywheel for passenger cars, the HRTD damps vibrations in the belt drive, thus protecting belts and auxiliary drives.

Clutch for Auxiliary Drives

The multi-disc clutch ensures a reduction in fuel consumption by activating and deactivating auxiliary drives to meet demand. It is already in successful use today in air compressors of trucks.

Torque Converters

There is no longer any contradiction between a high level of driving comfort and economical operation thanks to optimal hydrodynamic efficiency, the torque converter lock-up clutch, and outstanding vibrational decoupling. Torque converters from ZF Sachs are in use particularly in applications requiring frequent start-ups and maneuvering.
The ZF Sachs commercial vehicle modular clutch system offers the perfect clutch for every vehicle from light-duty delivery trucks through city buses and coaches up to heavy automated construction site dump trucks. Single and twin-disc clutches from ZF Sachs for push- and pull-type actuation for SAE-1 to SAE-3 bellhousing sizes ensure a high level of cost effectiveness.

The demands placed on modern clutch systems are high: rapid and reliable disengagement and engagement of the torque flow, pleasant and ergonomic operation, maximum service life without loss of comfort, and vibrational damping using the smallest possible installation space. The clutch is exposed to many highly dynamic influences. In particular, the system-related wear of the clutch facing leads to changes in the force and travel conditions, which must be considered in the clutch design. Last but not least, the clutch is an overload protection device intended to protect the valuable powertrain as a whole.

Crucial to the cost-effectiveness of a clutch system are the interplay of all components and control of the system interfaces in the design. Particularly in the area of commercial vehicle components, ZF Sachs has decisive advantages due to decades of experience in development partnerships with all leading manufacturers.
**Clutch Disc**

The clutch disc, at the engine/transmission interface, is one of the most heavily stressed components in the powertrain and consists of the toothed sliding hub, the torsional damper, and the clutch facings with cushion springs. The level of the engine torque to be transmitted determines the disc diameter as well as the dimensioning of the torsional damper.

The significance of the torsional damper is constantly rising since it is the tuning element for optimizing the torsional vibration properties of the entire powertrain. Thanks to its sophisticated modular system, ZF Sachs is able to equip commercial vehicles with the optimal clutch for every type of requirement.

**Benefits**
- The modular design with different torsional damper sizes permits individual tuning to every application.
- Approved for engine torques up to 3,500 Nm.
- Special cushion-spring technology for high drive-off comfort.
- Optional predamper to combat noise problems during idling.

**Clutch Facings**

Friction facings are the crucial element for a stable and well definable transmission of driving power. With very few exceptions, such as in racing, tractors, and a few regional markets, organic facings are used for dry clutches. In this way, demands for a high friction coefficient, comfortable drive-off and gear-shifting, as well as a long service life – if treated correctly – can be met. Special requirements are placed on heat resistance: If the friction surface temperature exceeds 300°C, the clutch begins to slip (fading) together with an increasing damage of the friction material.

The commercial vehicle clutch facings from ZF Sachs meet all requirements concerning wear, friction coefficient, comfort, burst resistance, and fading stability in an outstanding manner.

**Benefits**
- High, constant coefficient of friction.
- Smooth engagement performance.
- High heat resistance (fading).
- Low wear rate.
- High speed stability.
- No deformation tendencies.
- Environmentally compatible in production and materials.
- Clutch facings for all applications available.
- Approvals from all big vehicle manufacturers.

**430 GTZ clutch disc with 232 mm torsional damper**

The cushion spring ensures a prolongation of the engagement travel and thus, enables a smooth drive-off.

**S 620 C clutch facing**

The clutch facings consist of organic bonding agents such as rubber and synthetic resin substrate fibers made of glass and synthetic materials, also reinforced by brass, which are wound, compacted and baked in a complex process. The facings are usually riveted or bonded on to cushion springs. These cushion springs between the facing and the clutch disc ensure smooth and comfortable clutch engagement. All facings used by ZF Sachs comply with the EU Directive 2000/53/EG (free of Pb, Cd, Hg, Cr(VI)) and are produced without toluene or chlorinated organic solvents.
The clutch cover is screwed to the flywheel and, when engaged, transmits the engine torque to the clutch disc via the housing, the tangential leaf springs and the pressure plate. For the dimensioning of the clutch cover, important factors such as the heat capacity of the pressure plate as well as the clamp load and release load of the diaphragm spring are considered.

Diaphragm springs are belleville springs with integrated actuating levers, the diaphragm spring fingers. The housing and the pressure plate are connected by riveted leaf springs, the so-called tangential leaf springs. Due to their pretensioning, they lift the pressure plate when the clutch is released.

The diaphragm spring ensures high operating comfort with its shape, material and well-tuned characteristics. The clamp load of the diaphragm spring determines the maximum transmittable engine torque as well as the necessary release load. The diaphragm spring characteristic is designed so that clutch-facing wear cause the clamp load to rise at first and, as wear increases, to fall again. When the facing reaches its minimum thickness, the clutch starts to slip slightly. However, the vehicle can still be driven without trouble. This ensures that the clutch can be replaced before downtimes occur.

Since the facing temperature is a crucial factor in the facing wear, it is important for a cost-effective service life that the friction heat is conducted quickly through the mass of the pressure plate.
The classic releaser transmits the force of the static release fork to the diaphragm spring, which is rotating at engine speed. The release bearing must absorb high axial forces. In push-type actuation systems, the releaser rests on the tips of the diaphragm spring, but in pull-type systems, the releaser must be locked accordingly, which makes assembly somewhat more complex.

Dust and deposits are a particular hazard for the highly-stressed release bearing. ZF Sachs has therefore developed effective protection mechanisms to minimize vehicle downtimes caused by damaged releasers.

Benefits
- For pull-type and push-type clutch actuation systems
- The bearings are equipped with contact seals as well as a lifetime lubrication and are maintenance-free
- The use of a plastic slide bush eliminates the need to grease the sliding seat
- The bearings are self-centering to compensate for axle offsets

The quality and service life of clutch facings have increased considerably, but even if treated carefully, they are by their nature subject to wear. Extending the service life is not just a matter of making the facings thicker, however, because the maximum possible stroke performed by the diaphragm spring imposes a limit on this in practice. The decrease in facing thickness has a crucial influence on the load conditions in the system. The diaphragm spring changes its position, which means that the release and clamping loads increase and therefore also the necessary pedal effort.

XTend® meets this challenge by decoupling facing wear from diaphragm spring movement: The facing reduction is registered every time the clutch is engaged. When the clutch is released, the adjustment ring rotates and the diaphragm spring returns to its original position so that the system is again set to the optimum installation point.

Cost-effective due to longer service life:
In contrast to the conventional clutch, the wear volume of the facings can be considerably increased. This substantially increases the service life.

Operating principle of XTend®

- Adjustment ring
- Toothed slide
- Toothed washer
- Hold down spring
- Stopper
- Pressure plate

XTend® provides a system where the facing wear is compensated by a reduction of the facing area, which is registered with each engagement of the clutch. When the clutch is released, the adjustment ring rotates and the diaphragm spring returns to its original position so that the system is again set to the optimum installation point.

MFZ 430 XTend clutch cover with KZISZ-5 releaser

- For pull-type and push-type clutch covers
- Independent of cushion-spring or diaphragm-spring characteristics
- Completely exchangeable with conventional clutches
- Maintenance-free
- In series production since 2001

Economical through the avoidance of clutch changes
- All forces in the system remain constant, no rise in release load in the event of facing wear
- Axial installation space for the facing wear has to be reserved
- For pull-type and push-type clutch covers
- Independent of cushion-spring or diaphragm-spring characteristics
- Completely exchangeable with conventional clutches
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Releaser XTend® Wear Compensation
Twin-Disc Clutch

Heavy vehicles, rough terrain – the clutch is subject to extreme loads here, where drive-offs on extreme gradients and frequent maneuvering can be part of the daily routine. Long slipping times on the clutch generate heat, which increases wear on the facings to a disproportionate degree.

With twice the number of friction surfaces and a greater heat absorption capacity, a twin-disc clutch can “keep cool” and protect its friction facings even under difficult conditions. The intelligent ZF Sachs intermediate-plate control mechanism also ensures reliable interruption of the power flow for both discs when disengaging the clutch. And distributing the engine torque over two torsional dampers effectively reduces the noise level in the powertrain.

Benefits
- Long service life thanks to large facing volume and high thermal absorption capacity
- Excellent separating properties thanks to the intermediate-plate control mechanism and a common hub for the two discs
- Two torsional dampers offer high potential for decoupling vibrations
- Suitable for engine torque levels of up to ~ 3,800 Nm
- Lower life-cycle costs due to longer service life and avoiding maintenance costs for clutch replacement
- Good automation capability thanks to especially smooth torque build-up

Intermediate-plate control mechanism

Power Take-Off Clutch

Auxiliary drives allow the engine torque to be used for other jobs than just driving the vehicle. Typical use cases are drives for cement mixer drums, fire extinguisher pumps, compressors, and cable winches.

The GMFZ 430 N PTO clutch is designed for continuous operation and high power transmission up to the full engine torque. The auxiliary drive is operational from the start of the engine and can be operated when the vehicle is stationary or moving. The power transmission to the auxiliary drive is independent of the vehicle clutch.

For agricultural and construction machines, special double clutches with cast housings and independent operation of the vehicle clutch and the power take-off are available.

Benefits
- For use with gearboxes with engine-dependent auxiliary drives, e.g. ZF NMV 221
- The auxiliary drive can be operated independently of clutch actuation, both in stationary and moving vehicles
- Power take-off via the auxiliary drive possible up to maximum engine torque
- Integrated, two-stage torsional damper in auxiliary drive reduces vibrations
- Also available as a twin-disc clutch
- Also available in other sizes
Reliable clutch actuations suitable for everyday use can be implemented on the basis of an electronically controlled pneumatic cylinder. Conventional clutch control requires drivers to do a lot of work. They have to exert high pedal loads and concentrate on gear selection, engine speed, and clutch engagement points. Deviations from “ideal operation” lead to increased clutch wear, or in the worst case, to clutch failure. For safety reasons, therefore, conventional clutch systems have to be generously dimensioned in order to ensure vehicle mobility even in the event of incorrect operation. Furthermore, the usual hydraulic systems contain a large number of components, with every interface increasing the risk of failure.

ZF Sachs has replaced the common fork type actuation with clutch force boosters, and the fork and releaser with a pneumatic release cylinder concentric with the transmission input shaft.

ConAct® is suitable for fully automatic operation and clutch-by-wire applications. In the application with automatic transmissions, the system automatically determines (from data from the CAN bus on engine and transmission speed as well as the position of the accelerator pedal) the ideal release position – even for challenging driving situations such as maneuvering, starting on an incline with a heavy load, or starting on a slippery surface. Controlled by the vehicle’s electronics, the solenoid valve regulates the clutch actuation by means of the ConAct® slave cylinder.

ConAct® pneumatic slave cylinder

ConAct® is designed for push-type diaphragm spring clutches of sizes MF 395 and MF 430. In the axial length, ConAct® is shorter than conventional systems with a release fork, and all other mechanical actuation components are eliminated.

The pneumatic actuation cylinder can also be used for vehicles with a manual gearbox. The position of the clutch pedal is communicated to the system-integrated control and the clutch is accordingly engaged or disengaged. This permits the elimination of all mechanical and hydraulic connections and a clutch booster.

For the driver, there is no noticeable difference between the XAct system and a conventional clutch. For the fleet owner, however, protection from incorrect operation means fewer clutch changes and thus more profitable vehicle operation.

Benefits

- Reduction in the number of components and the system weight
- The ability to control AMT applications is improved by the low number of friction points and the avoidance of play
- The actuation direction, parallel to the axle, reduces the load on the release bearing
- Release bearing with sealing paste
- Simplified transmission assembly by means of the push-type clutch and the high degree of component integration

ConAct® system design

Clutch automation with ConAct®:
the pneumatic central releaser in combination with an MF 2400 twin-disc clutch. The electronic control enables the clutch overload to be considerably minimized, for example in heavy construction site traffic.

XAct – Clutch-by-wire

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Higher torques and stricter emission controls are leading to an increasing excitation of the powertrain by rotational irregularities. At the same time, the demands are increasing for noise reduction and comfort as well as the protection of the transmission and vibration-sensitive vehicle components. All this requires extremely high-performance torsional damping systems. If the torsional damper in the clutch disc is not sufficient to damp engine vibrations in critical engine speed ranges, the dual mass flywheel ensures outstanding decoupling over the entire rpm range.

The DMF from ZF Sachs decouples engine vibrations in an ideal manner, making rattling and booming a thing of the past. The flywheel mass is divided into a primary and a secondary mass, with the secondary flywheel mounted to the primary flywheel by a bearing that allows it to rotate. A highly efficient, grease-filled spring damping and system operates between the two masses. This means that the resonance speed of the dual mass flywheel – in contrast to conventional clutch discs with torsional dampers – lies below the engine's idle speed. The initial spring stage with a low stiffness rate therefore allows for low resonance speeds shifted outside the critical operational range, so the vehicle runs especially quiet.

The axial space requirements for a DMF with clutch are similar to those for a twin-disc clutch. Thus the DMF can usually be integrated into existing powertrain configurations.
Torsional Damper

Torsional dampers are placed behind the engine as vibrational dampers when the powertrain does not include a separating and starting clutch. The purpose of using a torsional damper is to keep engine torque peaks as well as operational irregularities away from the powertrain and connected units. Thus every commercial vehicle with a powershift transmission or hydrostatic drive has a torsional damper that ensures "peace and quiet" in the vehicle. If the forces operating in the powertrain area were not countered, driving comfort would be noticeably reduced and the powertrain components would also show considerably higher levels of wear. A standard solution today for decoupling torsional vibrations in powertrains is to use a bolt-on torsional damper that builds on the technology in clutch discs with torsional damping.

The torsional damper consists of a set of coil springs positioned in windows that allow a amount of rotary movement between the crankshaft and the transmission input shaft and a friction device. By selecting the right torsional damper size and spring set, characteristic curves can be adjusted to meet the individual needs of specific applications. Vibrational decoupling can therefore be adapted in optimum fashion to the vehicle, and ignition-related rotational irregularities can be reduced. The torsional damper is integrated into the respective installation space by a simple adjustment of the external bolt-on area and by selecting the corresponding spline profile to match the drive shaft.

Benefits
- Enhanced driving comfort and protection for powertrain assemblies due to reduced engine vibrations
- Lower installation space requirements
- Easy to integrate in a wide range of powertrains
- Thermal stability over the entire service life via the use of heat-resistant steel springs
- Superior product quality via the use of large-scale series technology
- Completely recyclable components
- Remanufacturing possible

DynaDamp

For especially critical applications, torsional dampers can reach their limits when the level of rotational irregularities in the powertrain increases. This places increased strain on the powertrain and also causes disturbing noises in the vehicle. Reducing these rotational irregularities is thus a central task in order to protect the powertrain and to increase driving comfort. For these higher demands placed on decoupling torsional vibrations, ZF Sachs’ DynaDamp is the right solution. The DynaDamp torsional damper is available for engines with torque levels of up to 3,200 Nm.

The DynaDamp is integrated between the engine and the powertrain, and uses the same technology as the established dual-mass flywheel to decouple torsional vibrations reliably and at a high level. Due to the placement of the torsional damping springs with a large radius, combined with speed-dependent grease damping, the DynaDamp provides a further considerable increase in the ability to reduce rotational irregularities.

Because the spring sets are designed to consist of multiple compression springs, the combination of different springs can enable multi-stage characteristic curves and can thus be adapted in ideal form to individual requirements. This allows vibrational decoupling to be optimally adjusted to individual applications. This in turn greatly reduces ignition-related rotational irregularities.

Benefits
- Multi-stage spring characteristic curves possible
- Speed-dependent damping due to grease filling
- Enhanced driving comfort and protection of powertrain assemblies due to reduced engine vibrations
- Easy to integrate in a wide range of powertrains
- Thermal stability over the entire service life via the use of large-scale series technology
- Completely recyclable components
- Remanufacturing possible

DynaDamp and an MFZ 436 clutch in ZF NMV2000 Engine-dependent auxiliary drive up to 2,000 Nm.
HRTD Belt Pulley Torsional Damper

Belt damage is a common cause of interruptions to bus journeys, resulting in dissatisfied customers and the high cost of replacement vehicles. Based on the technology of the tried and tested dual mass flywheel for passenger cars, the hydraulic belt pulley torsional damper damps vibrations in the belt drive, thus protecting belts and auxiliary drives.

Conventional auxiliary assemblies in the commercial vehicle, such as compressors, are continuously in operation from the start of the vehicle and consume energy. As soon as the compressed-air reservoir tanks are filled, conventional compressors continue to run at a reduced pressure level. With the new clutch for auxiliary assemblies, the compressor is completely separated from the engine by opening the clutch when the cut-out pressure is reached. The multi-disc clutch ensures a reduction in fuel consumption by engaging and disengaging the compressor to meet demand, thus also reducing CO₂ emissions.

The normally-closed design of the clutch ensures that, in the event of a control malfunction, for example, the compressor continues to run and maintains the supply of compressed air.

Clutch for Auxiliary Drives

The unit comprises a pneumatically actuated cylinder and the clutch itself, consisting of a lamella set with three discs. Since the clutch is flooded with engine oil during operation, there is practically no wear.

Benefits
- Avoidance of drag losses by switching off the compressor when not needed
- Savings potential up to 0.5 l fuel per 100 km
- Torque transmission up to 280 Nm
- Normally-closed design as clutch safety concept
- Air pressure range for actuating the clutch: 5...12 bar
- Design with optimized oil cooling and lubrication
- Weight approx. 2.5 kg
- Simple adaptation to compressor and gear train of engine possible

Benefits
- Multi-stage spring characteristics possible
- Low stiffness for outstanding rotational vibrational decoupling
- Stop torque up to 600 Nm to compensate for high loads
- Grease filling for damping and lifetime lubrication
- Maintenance-free
- Cost efficient design via the use of large-scale series parts from passenger car dual mass flywheels
Torque Converters

Applications that require frequent drive-offs, gear shifts, and/or maneuvering – such as city buses, light trucks, or special purpose vehicles – use automated transmissions that require hydrodynamic torque converters to transmit power. A torque converter is a start-up element, a transmission step for speed and torque, and not least of all, a vibration damper. Because loss due to slippage occurs in purely hydrodynamic transmission systems, controlling and regulating these hydrodynamic processes represent a crucial factor for converter efficiency, in addition to a high-performance converter lock-up clutch.

Torque converters from ZF Sachs feature optimum hydrodynamic efficiency. The lock-up clutch, a rigid connection between the impeller and the turbine rotor, ensures that the slippage of the hydrodynamic operation is eliminated and that engine power is transmitted to the drive train without any loss. Maintaining efficiency in this way at higher rpm levels helps to reduce fuel consumption. However, a closed lock-up clutch no longer features the outstanding vibration damping properties of a hydrodynamic system – this task can be performed instead by a torsional damper tuned to the requirements of the respective powertrain.

Benefits
- Greater degree of efficiency
- High hydrodynamic power density
- High-performance comfort
- Optimum vibrational decoupling