Self-inflating Tire System

Central tire inflating system

The idea behind the CTIS (Central tire inflating system) is to provide control over the air pressure in each tire as a way to improve performance on different surfaces. For example, lowering the air pressure in a tire creates a larger area of contact between the tire and the ground and makes driving on softer ground much easier. It also does less damage to the surface. This is important on work sites and in agricultural fields. By giving the driver direct control over the air pressure in each tire, maneuverability is greatly improved.

Another function of the CTIS is to maintain pressure in the tires if there is a slow leak or puncture. In this case, the system controls inflation automatically based on the selected pressure the driver has set.

A wheel valve is located at each wheel end. For dual wheels, the valves are typically connected only to the outer wheel so the pressure between the two tires can be balanced. Part of the wheel valve's job is to isolate the tire from the system when it's not in use in order to let the pressure off of the seal and extend its life. The wheel valve also enables on-demand inflation and deflation of the tires.

An electronic control unit (ECU) mounted behind the passenger seat is the brain of the system. It processes driver commands, monitors all signals throughout the system and tells the system to check tire pressures every 10 minutes to make sure the selected pressure is being maintained.

The ECU sends commands to the pneumatic control unit, which directly controls the wheel valves and air system. The pneumatic control unit also contains a sensor that transmits tire-pressure readings to the ECU.

An operator control panel allows the driver to select tire-pressure modes to match current conditions. This dash-mounted panel displays current tire pressures, selected modes and system status. When the driver selects a tire-pressure setting, signals from the control panel travel to the electronic control unit to the pneumatic control unit to the wheel valves. When vehicles are moving faster (like on a highway), tire pressure should be higher to prevent tire damage. The CTIS includes a speed sensor that sends vehicle speed information to the electronic control unit. If the vehicle continues moving at a higher speed for a set period of time, the system automatically inflates the tires to an appropriate pressure for that speed.

This type of system uses air from the same compressor that supplies air to the brakes. A pressure switch makes sure the brake system gets priority, preventing the CTIS from taking air from the supply tank until the brake system is fully charged.
Here is what happens on the road: The electronic control unit tells the pneumatic control unit to check current pressure and either inflate or deflate the tire to the pressure selected by the driver. If the system determines that inflation is needed, it first checks to make sure that brake pressure reserves are where they should be; if they are, it applies a slight pressure to the wheel valve to allow inflation. If the tires are overinflated, the system applies a slight vacuum to the wheel valve. When the pneumatic control unit reads that the appropriate pressure is reached, the valve closes.

In this illustration, you can see the pathway that the air travels for inflation or deflation once it gets to the wheel. The tubing runs from the vehicle’s air compressor through the wheel hub and then to the tire valve. The "quick disconnect fitting" allows the tire to be separated from the CTIS system for removal or servicing. (This diagram also shows the Hummer’s run-flat feature, which allows the tire to continue supporting the vehicle even when it will not hold any air.

**Tire Maintenance System and AIRGO**

Dana Corporation's Tire Maintenance System (TMS) is a "smart" system for tractor trailers that monitors tire pressure and inflates tires as necessary to keep pressure at the right level. It uses air from the trailer's brake supply tank to inflate the tires.

The system has three main components:

- **The tire hose assembly** provides the air route to inflate the tire and has check valves so that the air lines and seals do not have to be pressurized when the system is not checking or inflating the tires. This cuts down on wear and tear on the seals.

- **The rotary joint** is comprised of air and oil seals and bearings and connects the air hose from the non-rotating axle to the rotating hubcap. Its air seals prevent leakage, and the oil seal prevents contamination. The rotary hub also has a vent to release air pressure in the hubcap.

**Hummer self-inflating tire system: At the wheel**

Source: Roadranger
The manifold houses the pressure protection valve, which makes sure the system doesn't pull air if the brakes' air supply is below 80 psi. It also houses an inlet filter to keep the air clean, a pressure sensor to measure tire pressures and solenoids that control airflow to the tires.

Like the CTIS, this system also has an electronic control unit that runs the entire system. It performs checks to make sure the system is operational, notifies the driver via a warning light on the trailer (visible through the rear-view mirror) if a tire's pressure drops more than 10 percent below its normal pressure and performs system diagnostics.

The system performs an initial pressure check and adds air to any tire that needs it. The check valves in each tire hose ensure that the other tires don't lose pressure while one tire is being inflated. After an initial pressure check, the system depressurizes to relieve pressure from the seals. Every 10 minutes, the system pressurizes the lines and rechecks tire pressures.

The system measures tire pressure using a series of air pulses in the air lines. If the target pressure in the line is not reached after a certain amount of time, the system begins inflating the tire(s) until the correct pressure is reached.

**AIRGO System**

The AIRGO system is a constant monitoring system that uses a series of check valves to detect a loss in air pressure.

Unlike some of the other systems, AIRGO doesn't use air from the vehicle's braking system. When air seepage has occurred at any of various points in the system:

1. the system draws air
2. From the vehicle's pneumatic system (not shown) and sends it by way of the vehicle's axles
3. through the axles themselves if they're pressurized or by way of tubing if they're not -- through the hubcap assembly
4. And into the tire requiring inflation.

A warning light, located on the trailer but visible through the driver's rearview mirror, illuminates when the system has inflated a tire.

Since this is a constant monitoring system, which puts a lot of wear and tear on the seals, AIRGO uses carbon-graphite and case-hardened steel for its seals rather than rubber.
Meritor Tire Inflation System

The Meritor Tire Inflation System (MTIS) is designed for use on tractor trailers. It uses compressed air from the trailer to inflate any tire that falls below its appropriate pressure. Air from the existing trailer air supply is routed to a control box and then into each axle.

The air lines run through the axles to carry air through a rotary union assembly at the spindle end in order to distribute air to each tire. If there is significant air-pressure loss, an indicator light informs the driver.

The overall system is made up of a wheel-end assembly and a control module.

Wheel-end Assembly

The wheel-end assembly includes a flexible hose with check valves. The check valves only allow air to flow into each tire; this ensures that while one tire is being inflated, the other tires don't lose air pressure.

This assembly also incorporates a stator (a non-rotating part) inside the axle spindle and a flow-through tee that is attached to the hubcap. The flow-through tee has a dynamic seal to allow rotation while preventing pressure loss when pressurized air passes from the axle to the hub, which occurs through a tube that runs from the stator into the tee.

In the hubcap assembly, there is a vent to make sure pressure does not build up in the wheel end. A deflector shield keeps contaminants such as dirt and water from entering the wheel end.

For axles with hollow spindles, a press plug seals the pressurized axle interior from the wheel end in order to secure the stator.

Controls

The system control module has a shut-off valve to stop air from being sent to the system, as well as a filter to remove moisture and contaminants. The petcock releases system pressure so maintenance can be performed. Like some of the other systems that use onboard air supplies, this system has a pressure protection valve so that it won't pull air if the air supply is below 80 psi. A system
pressure adjustment knob allows for adjustments to the overall system air pressure. A flow-sensing switch activates the indicator light to let the driver know if a significant amount of air is being pumped into a tire, which would indicate a potential puncture.

The Future of Self-inflating Tires

Michelin is working with several other companies to develop an active pressure-management system called TIPM (Tire Intelligent Pressure Management), due to be available sometime in 2005. This system has a compressor that automatically adjusts the pressure in each tire while the vehicle is in operation to compensate for leaks and slow-leak punctures. The driver will be able to adjust the pressure depending on the desired driving mode: comfort, sporty, all-terrain or over-obstacle.

There are at least two other systems in the early development stages that are oriented toward the consumer market the Entire system and the Cycloid Air Pump system.

The Entire Self-Inflating Tire system uses a valve that pulls in air from the atmosphere. It then pumps the air into the under-inflated tire using a peristaltic-pump action. The goal is to constantly maintain a specific pressure.

![Diagram of the Entire system and the Cycloid Air Pump system]

The Auto Pump tire-inflator system by Cycloid has a small, wheel-hub-mounted pump that is powered by the turning of the wheels. When the system's monitor detects a drop in pressure of 2 to 3 psi, it pumps air into the underinflated tire. AutoPump has a warning system that is activated when there is a puncture.
Central Tire Inflation System (CTIS) Technology -
The vehicles also incorporate CTIS technology from Dana’s Tire Management Group. This technology allows the driver to identify the terrain and prompt the system to respond with a tire pressure to match the condition. For example, in rough terrain the driver can push a button inside the vehicle cabin and lower tire pressure, providing the vehicle with a larger “footprint” and improving mobility. Dana has three patents pending on the CTIS technology integrated into the axle wheel end.