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A Review on Automobile Safety Technology in ABS

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Abstract- **The purpose of this project was to evaluate the educational level of the WPI community on automobile safety devices and develop an interactive medium through which visitors can establish a better understanding of the technology. An interactive video presentation and museum exhibit were constructed together to educate the community on the criteria of history, purpose, and functionality for several major automotive technologies. The presentation component incorporated pictures, videos, and diagrams to portray the educational material about each technology, while the actual exhibit includes physical components from each category to aide in visualization of these devices. This project produced positive feedback from various members of the community as well as several recommendations for future renditions of this project.**

I. INTRODUCTION

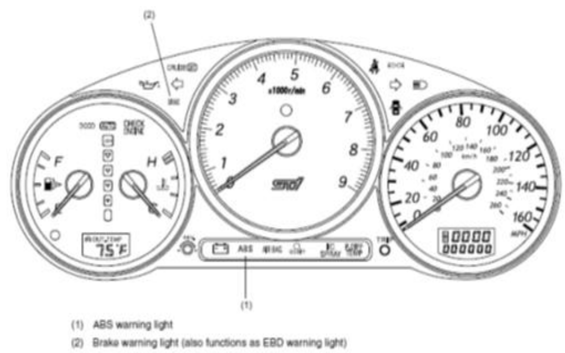
First developed for aircraft use in the 1950s, Dunlop’s Maxaret became the first ABS system to be widely used in the aviation world. This system effectively decreased stopping distances and eliminated tire bursts on aircraft landings. It wasn’t until the 1970s when ABS systems became a mainstream in the automotive industry. Chrysler along with Bendix Corporation is credited amongst the first to introduce a computerized all-wheel antilock brake system called “Sure Brake” and was implemented on the 1971 Chrysler Imperial.1

II. SUBSYSTEM OF ANTILOCK

BRAKING SYSTEM (ABS)

Wheel-Speed Sensors

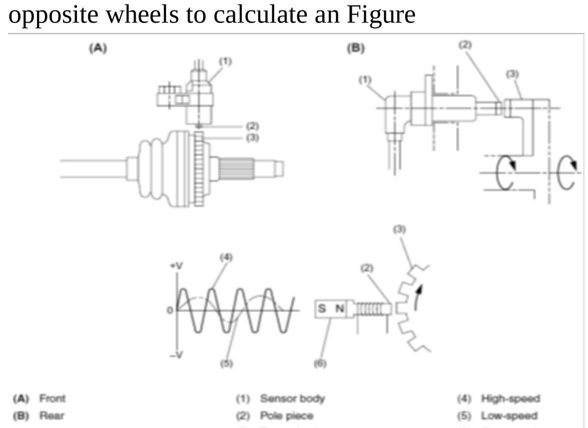
ABS in BMW Bike



Car Dashboard Indicating ABS

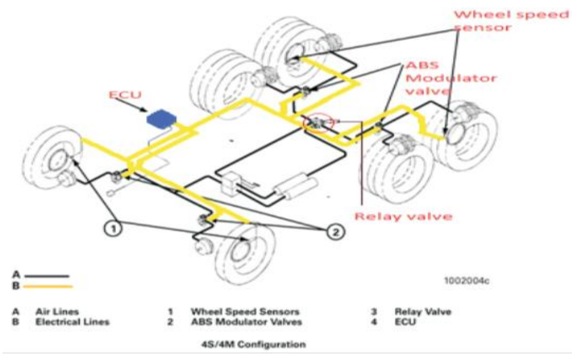
Each of the ABS wheel speed sensors detects the speed of the corresponding wheel. The sensor consists of a permanent magnet, coil and tone wheel. The magnetic flux produced by the permanent magnet changes as each tooth of the tone wheel(which rotates together with the wheel)passes in front of the magnet’s pole piece. The changing magnetic flux induces voltage sat a frequency corresponding to the wheel speed.

Electronic Control Unit (ECU) The work of ECU is to receive, amplifies and filter the sensor signals for calculating the speed rotation and acceleration of the vehicle. ECU also uses the speeds of two diagonally opposite wheels to calculate an Figure



Electronic Control Unit (ECU)

estimate for the speed of the vehicle. The slip of each wheel is obtain by comparing the reference speed with the individual wheel. During wheel slip or wheel acceleration condition signal server to alert the ECU. The microcomputer alert by sending the trigger the pressure control valve of the solenoids of the pressure modulator to modulate the brake pressure in the individual wheel brakecylinder. The ECU reacts to a recognized defect or error by switching off the malfunctioning part of the system or shutting down the entire ABS.



4S/4M Configuration

Int. J. Mech. Eng. & rob. Res. 2014 sahil jitesh, 2014

Hydraulic Pressure Modulator/Hydraulic Control Unit The Hydraulic pressure modulator is an electro-hydraulic device for reducing, restoring and holding the pressure of the wheel by manipulating the solenoid valve in the hydraulic brake system. ABS hydraulic modulator unit contain the valve, solenoid and piston. Under hard braking condition, this assembly controls the holding and release of the different hydraulic brake circuit. During the normal condition the standard braking system used. Whenever hard braking situation occur, the system sense the change in the rotation of the speed sensor and decide whether to holder release pressure to a brake circuit. A tire has its best traction just before it begin to skid, once it begins to skid a portion of traction and steering will be lost.

Figure 5: Hydraulic Control Unit

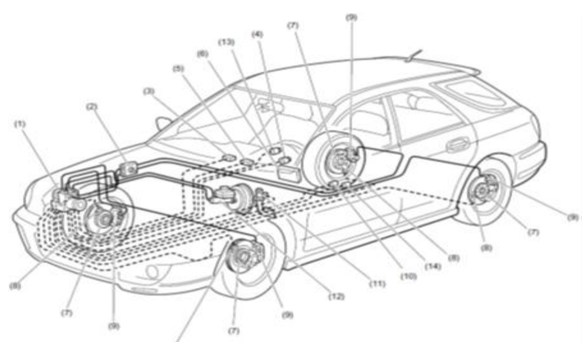
ANTI-LOCK BRAKE TYPE

Different schemes of anti-lock braking system uses depending upon the types of brakes use. Depending upon the channel (valve) and number of speed sensors the antilock brake reclassified.

Four Channel, Four Sensor ABS It is a more preferable type, the speed sensor on all the four wheels and contain separate valve for all four wheels. By using this setup, the controller monitors each wheel individually to make sure it is achieving maximum braking force. Three Channel, Three Sensor ABS

This type of system is can be found commonly in the pickup trucks with four wheel ABS, on each of the front wheels there is valve and a speed sensor, and one valve and one sensor for both rear wheels. The speed sensor for rear wheels is located in the rear axle. To achieve the maximum braking force, this system provides individual control to the front wheels. The rear wheels, however, are controlled together; they are both have to start to lock up before the ABS will active on the rear. With the help of this system, it's possible that one if the rear wheels will lock during atop, reducing brake effectiveness. One Channel, One Sensor ABS This Arrangement can be seen in a pickup trucks and heavy trucks with rear wheel ABS. It consist one valve, which operate both rear wheel, and one speed sensor located in the rear axle. This is quite similar as the rear end of a three channel system. The rear wheels are monitored together and they both have to lockup before ABS starts its action. In this system there is also probability that one of the rear wheels will lock, results reducing in brake effectiveness. This system is easy to identify, usually there will be one brake line going through a T-fitting to both rear wheels.

III. FUNCTION OF SENSORS AND ACTUATORS



Sensors and Actuators
1. ABS control module and hydraulic control unit (ABSCM & H/U)
2. Two-way connector
3. Diagnosis connector
4. ABS warning light
5. Data link connector (for SUBARU select monitor)
6. Transmission control module (AT models only)
7. Tone wheels
8. ABS wheel speed sensor
9. Wheel cylinder
10. G sensor
11. Stop light switch
12. Master cylinder
13. Brake & EBD warning light
14. Lateral G sensor (STi)

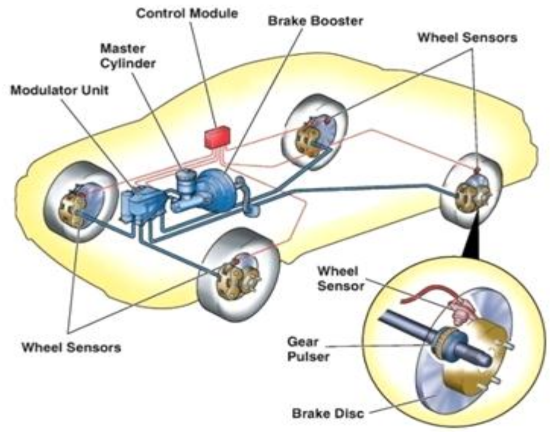
- How it Works – Modern ABS

As with the traditional braking system described earlier, the Antilock Braking System is an additive to provide electronic-computerized control of the braking system. The ABS of modern motor vehicles consists of four main components: The Anti-Lock Braking System (ABS) is a safety system designed to prevent the wheels of a motor vehicle from locking up while braking.

Speed Sensors: This is the primary input mechanism to the antilock braking system by provided the ability for the system to tell when a wheel is about to lock up. These speed sensors are usually contained at each wheel to provide this information.

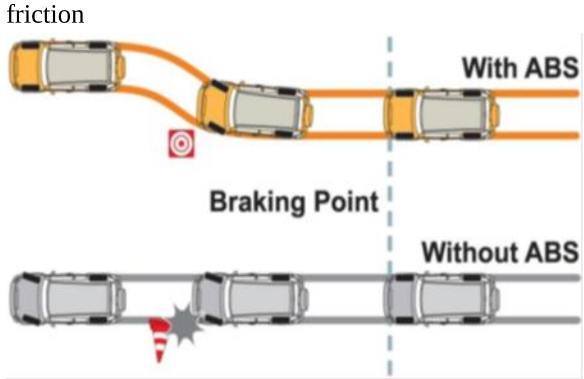
Valves: The valves of an ABS are the primary output mechanisms of the system. The valves are integrated within each brake-line allowing the ABS system to take control of the once driver-dependent braking system. In most systems, each valve has three positions: open, closed, and release. The opened position allows the braking system to function normally as desired. The closed position, blocks the line by isolating the brake from the master cylinder. The release position allows the valve to release pressure from the brake to disengage a locked wheel.

Pump: Another crucial part of the ABS system is the pump unit. In the event that an ABS valve releases pressure from a particular brake line, the pump is required to put that pressure back into the system. Controller: The controller or the Electronic Control Unit "ECU" is the central computer of the ABS system. This computer takes readings from each individual speed sensor to detect a loss of traction in a wheel. In the event that a wheel begins to slip, the ABS controller will then limit the brake force from driver to that particular wheel and in turn activate the ABS modulator which switches the braking valve of that wheel on and off.



IV. IMPORTANTCE OF ABS

Stopping Distance The Stopping distance is a one of the important factor when it comes for braking. Stopping distance is the function of vehicle mass, its initial velocity and the braking force. Stopping distance can be minimize by increasing in braking force (keeping all other factors constant). In all types of road surface there is always exists a peak in friction



Effect of ABS

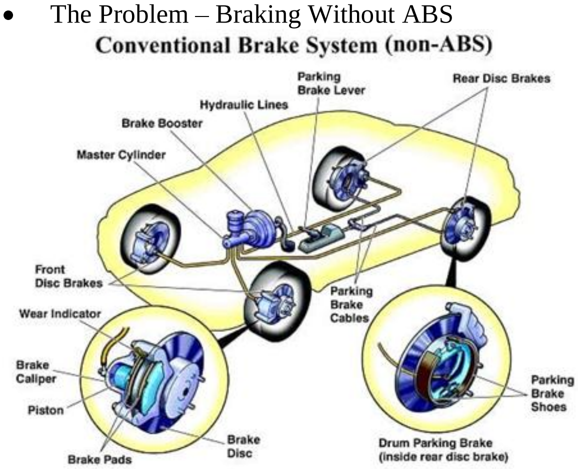
Coefficient. An antilock system can attain maximum fictional force and results minimum stopping distance. This objective of antilock systems however, is tempered by the need for vehicle stability and steerability. Stability The fundamental purpose of braking systemic to decelerating and stopping of vehicle, maximum friction force may not be described in some cases like asphalt and ice (p-split)surface, such that significantly more braking force is obtainable on one side of the vehicle than on the other side. So when applying full brake on both the sides will result yaw or skidding moment that will tend to pull the vehicle to the high friction side and results vehicle instability. Here comes the concept of antilock system that maintain the slip both rear wheels at the same level and minimize two friction coefficient peaks, then lateral force is reasonably high thought not maximized. This contributes to stability ands an objective of antilock systems.

Stability by Using ABS

Steer ability

Good peak frictional force control is necessary in order to achieve satisfactory lateral forces and, therefore, satisfactory steer ability. Steer ability while braking is important not only for minor course corrections but also for the possibility of steering around an obstacle. Tire characteristics play an important role in the braking and steering response of a vehicle. For ABS-equipped vehicles the tire performance is of critical significance. All braking and steering forces must be generated within the small tire contact patch between the vehicle and the road. Tire traction forces as well as side forces can only be produced when a difference exists between the speed of the tire circumference and the speed of the vehicle relative to the road surface. This difference is denoted as slip. It is common to relate the tire braking force to the tire braking slip. After the peak value has been reached, increased tire slip causes reduction of tire road friction coefficient. ABS has to limit the slip to values below the peak value to prevent wheel from locking. Tires with a high peak friction point achieve maximum friction at 10to 20% slip. The optimum slip value decreases as tire-road friction decreases. To prevent this hazardous situation from occurring, a unique driving skill was developed which consisted of “pumping” the brake pedal in the event of a wheel lock-up. This method allowed the driver to maintain some control of the vehicle by releasing and applying the brakes repeatedly, which created a balance of deceleration and steering. Unfortunately, this method of anti-lock braking is far from efficient due to the increase in stopping distance and inability to control the vehicle effectively.

- The Problem – Braking Without ABS



Most automobiles today possess a braking system to help stop the vehicle when it is in motion. The most common method of braking on a motor vehicle is through the application of a brake pad fixed to the vehicle body and a brake disc “Rotor” that is fixed to the wheel in motion. When these two parts come in contact by applying the brake, friction acts upon both parts resulting in vehicular deceleration. Depending on the vehicle’s initial speed and the traction of the wheels on the road, the possibility exists where the friction between the brake-pad and the brake disc become so great that the rotor and the wheel cease to rotate and result in wheel-locking. This phenomenon inhibits the driver’s ability to maintain directional control of the vehicle during wheel lock-up and can result in serious injury from collision.

- The Safety-Restraint System

Along with seatbelts, the airbag is a crucial part of the safety restraint system. The safety restraint system reduces the risk of injury through the absorption of energy exerted through the human body during impact. Upon the moment of impact, the seatbelt retracts any slack to absorb some of the inertia of the human body moving forward. The strength of this force requires the gradual release of the seatbelt as the body moves forward, in which the airbag is deployed to absorb the remaining amount of energy and safely bring the human body to a complete stop without serious injuryThe Anti-Lock Braking System (ABS) is a safety system designed to prevent the wheels of a motor vehicle from locking up while braking.

V. CONCLUSION

With development in a technology in automobiles the braking system is getting more and more advanced. Antilock brakes help drivers to have better control of a vehicle in some road conditions where hard braking may be necessary. In vehicles without antilock brake systems, drivers who encounter slippery conditions have to pump their brakes to make sure they do not spin out of control because of locked up wheels. Antilock braking system coordinates wheel activity with a sensor on each wheel that regulate brake pressure as necessary, so that all wheels are operating in a similar speed range.

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