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Antilock Braking System and Its Advancement

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Abstract - *Antilock braking system (ABS) is one of the safety feature provided by automobile industry. Due to the use of this safety feature, braking distance of vehicle is reduced as well as stability of vehicle is increased. Due to the use of ABS tyre efficiency is also increased as there is less friction in between road and tyre. However this system does not work effectively for adverse road condition. To overcome this disadvantage automobile industry recently come up with the new advancement known as electronic brake-force distribution (EBD). Electronic brake-force system works efficiently even if road conditions are adverse i.e. icy, watery etc. It also reduces braking distance and increases stability of vehicle by just adding functionality in control unit.*

Key Words: **Antilock braking system, Electronic brake-force distribution, Electronic control unit.**

1.INTRODUCTION

To fulfil different government norms which are set for environment protection and to satisfy ever increasing needs for safety and comfort, ECU is used. Initially before era of electronics, mechanical setting takes place to fulfil requirements. But, doing mechanical settings is very difficult task. For doing these settings some physical parameters need to be considered. e.g. Pressure, temperature, etc. As development has taken place in electronics area processing on such physical signals has become easy. Sensor senses physical parameters and give those signal as input to transducer. Transducer converts physical signal into electrical signal (either voltage or current). Now processing on these signals is easy. Hence concept of Electronic Engine has arisen.

1.1 Electronics Engine

Electronic engine is having Electronic Control Unit (ECU) as added part with mechanical engine. Sensors are placed on mechanical engine to give input to ECU. ECU gives output to actuator which changes working of mechanical engine. Fig. 1.1 shows concept of Electronic Engine.

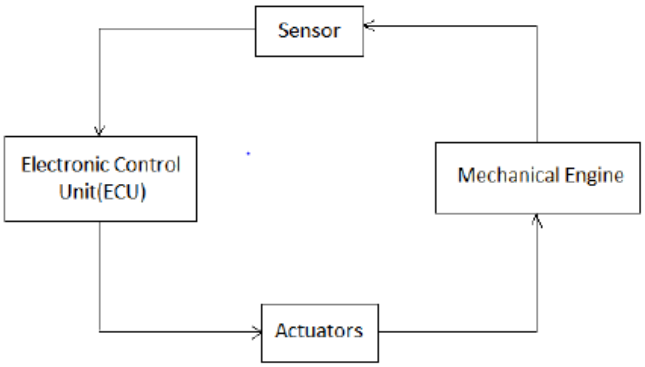

Fig-1: Concept of Electronic Engine

ECU is having microcontroller, memory, etc. Microcontroller is used for processing on ECU input signals. Memory is used to store some lookup tables, reference value tables and some temporary values. ECU is embedded system which uses hardware along with software. For microcontroller, software code is present and according to the code, operation of engine takes place. Hence software of ECU plays a very important role in electronic engine. Electronic engine includes following electronics parts:

1.1.1 Electronic Control Unit (ECU)

Electronic control unit (ECU) is brain of electronic engine. ECU is embedded system consists of both hardware and software. Microcontroller is main hardware which plays important role. Software is written for microcontroller to control overall operation of engine. ECU is having input/output pins which are connected to sensors and actuators.

1.1.2 Sensors

A sensor is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. For example, a mercury thermometer converts the measured temperature into the expansion and contraction of a liquid which can be read on a calibrated glass tube. There are different types of automotive sensors, they are as follows,

- Temperature sensor
- Oil pressure sensor
- Hall effect sensor
- Wheel speed sensor

1.1.3 Actuators

An actuator is a type of motor that is responsible for moving or controlling a mechanism or system. It is operated by a source of energy, typically electric current, hydraulic fluid pressure or pneumatic pressure, and converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment. There are various types of actuators used, and are as follows

- Hydraulic actuator
- Pneumatic actuator
- Electric actuator
- Thermal or magnetic actuators
- Mechanical actuator

1.2 Braking System (Mechanically Operated)

- A hydraulic brake circuit has fluid filled master and slave cylinders connected by pipes.
- When you push the brake pedal it depresses a piston in the master cylinder, forcing fluid along the pipe.
- The fluid travels to slave cylinders at each wheel and fills them, forcing pistons out to apply the brakes.
- Fluid pressure distributes itself evenly around the system.
- This system totally works mechanically, no electronic part is included in the system.

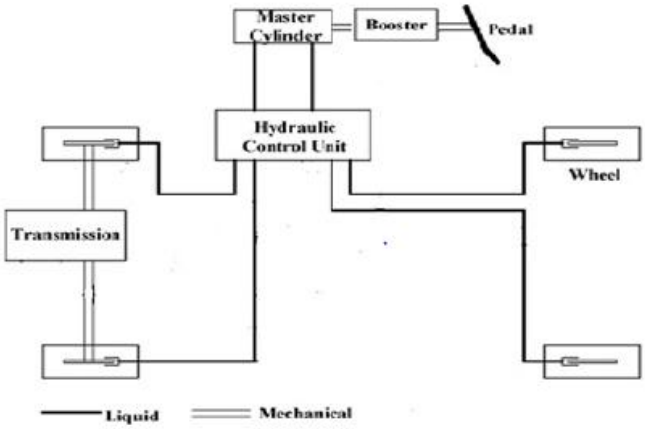

Fig-2: Block Diagram of Mechanically operated braking system

Mechanically operated brake system has many disadvantages such as

- Stopping distance is more.
- While hard braking, vehicle loses its stability.
- Slipping chances of vehicle are more.
- Due to the less effectiveness chances of accidents are more.

Hence it becomes important to develop a safety feature which works automatically. Without electronics atomization could not possible, so for providing such safety features electronic engine has came into functionality of vehicle.

1.3 Braking System (Electronically Operated)

By using electronic engine, automobile industry has come up with new safety feature known as antilock braking system in late 80's. With the help of this functionality stability of vehicle has increased as compared to conventional braking system as well as braking distance has reduced.

2. Antilock Braking System:

An **anti-lock braking system** or **anti-skid braking system** (**ABS**) is an automobile safety system that allows the wheels on a motor vehicle to maintain tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. It is an automated system that uses the principles of threshold braking and cadence braking which were practiced by skillful drivers with previous generation braking systems. It does this at a much faster rate and with better control than a driver could manage.

ABS generally offers improved vehicle control and decreases stopping distances on dry and slippery surfaces; however, on loose gravel or snow-covered surfaces, ABS can significantly increase braking distance, although still improving vehicle control.

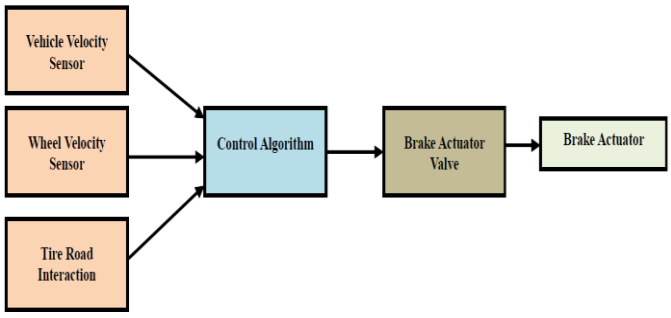

Fig-3: Block representation of an ABS

2.1 Working:

- Typically ABS includes a central electronic control unit (ECU), four wheel speed sensors, and at least two hydraulic valves within the brake hydraulics.
- The ECU constantly monitors the rotational speed of each wheel; if it detects a wheel rotating significantly slower than the others, a condition indicative of impending wheel lock, it actuates the valves to reduce hydraulic pressure to the brake at the affected wheel, thus reducing the braking force on that wheel; the wheel then turns faster.
- Conversely, if the ECU detects a wheel turning significantly faster than the others, brake hydraulic

pressure to the wheel is increased so the braking force is reapplied, slowing down the wheel.

- This process is repeated continuously and can be detected by the driver via brake pedal pulsation. Some anti-lock systems can apply or release braking pressure 15 times per second.
- Because of this, the wheels of cars equipped with ABS are practically impossible to lock even during panic braking in extreme conditions.

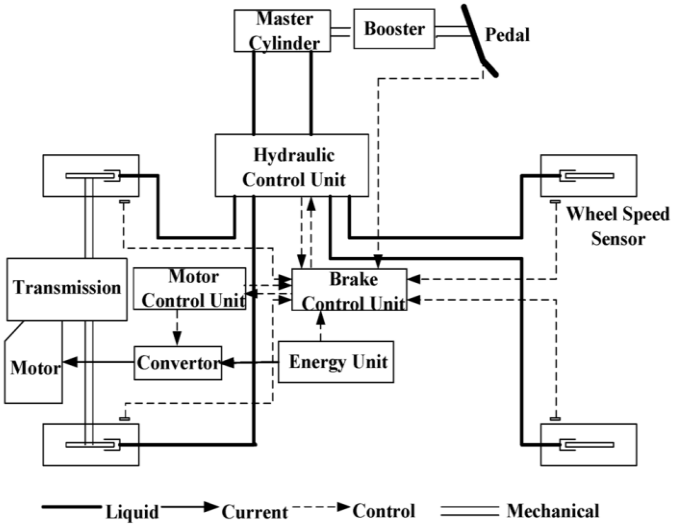

Fig- 4: Working of ABS

2.2 Components:

There are four main components of ABS: wheel speed sensors, valves, a pump, and a controller.

Speed sensors:

A speed sensor is used to determine the acceleration or deceleration of the wheel. These sensors use a magnet and a Hall Effect sensor.

Valves:

There is a valve in the brake line of each brake controlled by the ABS. The majority of problems with the valve system occur due to clogged valves. When a valve is clogged it is unable to open, close, or change position. An inoperable valve will prevent the system from modulating the valves and controlling pressure supplied to the brakes.

Pump:

The pump in the ABS is used to restore the pressure to the hydraulic brakes after the valves have released it. A signal from the controller will release the valve at the detection of wheel slip.

Controller:

The controller is an ECU type unit in the car which receives information from each individual wheel speed sensor, in turn if a wheel loses traction the signal is sent to the controller.

2.3 Advantages

- ABS guarantees stable braking characteristics on all road surfaces, hence avoids overturning of the vehicle.
- ABS reduces friction on wheels and road, thus increases efficiency of tires (up to 30%).
- Vehicle with ABS can be stopped at a lesser distance than a non ABS vehicle.
- Steering control is effective, i.e., vehicle can be steered smoothly while braking. Thus minimizes the accidents.
- A driver without experience can drive ABS vehicle effectively, than an experienced driver on the non ABS vehicle.

2.4 Disadvantages

- Initial cost for ABS vehicle is high.
- Maintenance issues arise as the whole braking system is controlled by engine control unit.
- On concrete roads, the ABS vehicle stopping distance might be needed more.

To overcome disadvantages of antilock braking system automobile industry has introduce an advancement in working of braking system known as electronic brake-force distribution.

3. Electronics Brake Force Distribution

Electronic brake- force distribution system also called as Electronic brake-force limitation is an automobile brake technology that automatically varies the amount of force applied to each of a vehicle's brakes, based on road conditions, speed, loading, etc.

Electronic brake-force distribution (EBFD) is an active vehicle safety feature designed to make braking as efficient as possible. A special function of antilock braking systems (ABS), EBFD makes the amount of brake force applied to a wheel proportional to that wheel's load at the time. Just like how slamming on the brakes makes your body move forward, heavy braking pushes the weight of your vehicle forward onto its front wheels. When this happens, the rear wheels may not have enough weight on them to grip the road. This can cause the rear wheels to begin to spin and eventually lock up. Locked wheels are generally very dangerous because once your wheels lock you lose all steering power. Locked-up back wheels not only increase your risk of fishtailing, but they also force the front wheels to do all the work with only half of the total braking force available (because the other half of your brake force is still being applied – uselessly – to the

locked rear wheels). This can result in longer stopping distances, spinning, and possibly loss of control.

EBFD reduces these dangers by automatically balancing the brake force applied to each wheel according to the overall weight distribution of the vehicle. When your EBFD system senses that one or more of your wheels is at risk of locking, it will reduce the brake force applied to the affected wheel(s), and, if necessary, apply more brake force to wheels that are not at risk of locking. Electronic brake-force distribution is also sometimes also called electronic brake distribution (EBD), or dynamic rear proportioning (DRP).

EBFD is similar in many ways to antilock braking systems (ABS), and the two are usually installed together as shown in fig 5. ABS helps to prevent wheels from locking by sensing the threat of wheel lockage and then releasing and apply the brakes in rapid succession. The difference between EBFD and ABS is that EBFD actually changes the amount of brake-force being applied to any given wheel according to the likelihood of that wheel locking. The added benefit of being able to redistribute brake-force makes EBFD a particularly useful extension of standard ABS setups.

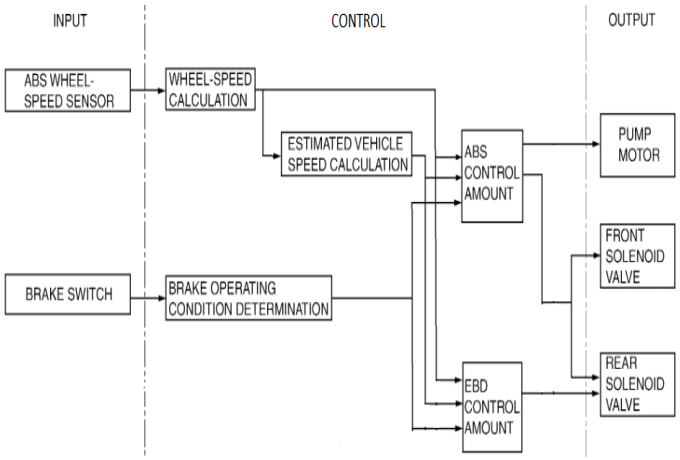

Fig-5: Block diagram of working of EBD

3.1 Working:

- An EBD is a subsystem of the abs and its function is to control the effective adhesion utilization by the rear wheels.
- The Antilock brake force system releases pressure in different brake lines at the time of heavy braking to prevent locking-up.
- The action comes in the form of releasing pressure from the braking circuit when it detects extreme and rapid deceleration in any of the four wheels in order to make sure that the driver maintains control over the steering during panic or emergency braking.
- For example if the wheels of a vehicle are on snow as well as asphalt then in case of emergency braking the ABS will monitor the speeds and eventually the EBD system will release less pressure for wheels on snow and more pressure for wheels on asphalt to prevent wheel lock-up.
- **EBD** work in conjunction with ABS and electronic stability control (ESC) to minimize acceleration during turns.
- **ESC** compares the steering wheel angle and vehicle turning rate using a Yaw rate sensor

3.2 Components:

Speed Sensor:

To determine the slip ratio of a wheel; the EBD system needs two pieces of information: the speed at which the wheel is rotating and the speed of car.

Brake Force Modulators:

Brake force is applied to wheel hydraulically, with brake fuel pump through brake lines.

Electronic Control Unit:

It is a small computer embedded in the antilock braking system. It receives input from speed sensor, calculates slip ratio of the wheel and uses the brake force modulators to apply an appropriate amount of force.

3.3 Advantages:

- It can deduce the car from the slip ratio of the wheels and compensate accordingly in icy or watery road.
- When a truck with heavy loads apply brakes the system become aware of it through its effect on the slip ratio of the tires.

4. Comparison:

Sr. No.	ABS with EBD	ABS without EBD
1	Simultaneously controls individual wheel	It controls cross wheels

2	Vehicle will stop immediately even if it is loaded	Stopping distance of vehicle is more when it is loaded.
3	This braking system is effective in adverse road conditions like snow,	ABS is not effectively work under adverse road conditions.
4	Cost is less	Manufacturing cost is more

Table -1: Comparison of ABS with EBD and ABS without EBD

5. CONCLUSIONS

Automobile industry is growing towards an electronic engine. With the help of electronic engine, manufacturer can able to provide lot of facilities to customers. Antilock braking system (ABS) is one of most important safety feature provided by automobile industry using electronics engine. ABS system helps to reduce braking distance of vehicle, increases tire efficiency and maintain vehicle stability. However there are some disadvantages like its performance get down in adverse road conditions, so to overcome this automobile industry has made new advancement in ABS system known as Electronic Brake-Force Distribution (EBFD). EBFD provides more stability to vehicle under adverse road conditions as well as braking distance of vehicle get reduced as compared to ABS system.

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