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Detection of Brake Failure by Automatic Indicator Using Sensors and Microcontroller

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Abstract : The braking system is one of the most essential components of an automobile. The aim of this work is to create a safe braking system with brake failure indicator. Brake failure occurs mostly because of cut in liner and worn out of brake shoe. It consists of two sensors of which one is connected with the brake shoe and the other with the brake liner. The signal from both the sensors are delivered to a microcontroller. The sensor senses signal to the microcontroller when the brake shoe is worn out and also if the brake liner is cut. The microcontroller analyses the signal and operates the corresponding indicator. It there is no defect anywhere, green indicator glows and the red indicator glows if there is a problem with brake shoe or brake liner. If the brake failure occurs while the vehicle is running, automatically an alternate brake will be operated by the microcontroller. This system plays a major role in the safety by preventing unnecessary accidents. Our project guides in indicating the status of the brake, facilitating the user to identify and limit the chances of malfunction.

Index Terms - Brake failure, Microcontroller, Sensors

INTRODUCTION:

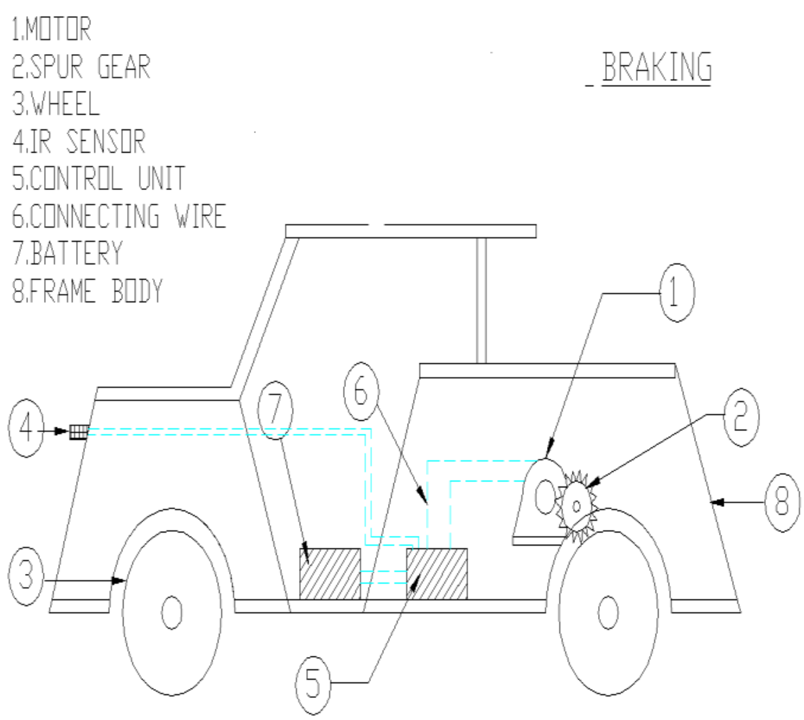
The basic function of a brake in a power transmission system is to stop and/or hold the load. There are many reasons to use brakes which are mostly related to improved productivity or safety. Brakes are frequently used to control deceleration, provide accurate positioning, or increase cycle rates, thereby improving productivity. Brakes can also be used for tensioning. The so called "fail-safe" type brake* like the cost-effective Stearns spring-set electrically released disc brake has an added feature. Because the brake is set by shutting off electric power, it will automatically set when there is a power failure.

There are many types of braking systems that can be used with a power transmission system. Each of these types can be placed into one of the following categories:

- Internal braking
- External braking

Internal braking systems generate torque by converting the electric motor into a braking device. Internal brakes use electrical switch gear and electronic circuitry to perform the braking.

BLOCK DIAGRAM



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A **brake** is a mechanical device which inhibits motion. The rest of this article is dedicated to various types of vehicular brakes.Most commonly brakes use friction to convert kinetic energy into heat, though other methods of energy conversion may be employed. For example regenerative braking converts much of the energy to electrical energy, which may be stored for later use. Other methods convert kinetic energy into potential energy in such stored forms as pressurized air or pressurized oil. Eddy current brakes use magnetic fields to convert kinetic energy into electric current in the brake disc, fin, or rail, which is converted into heat. Still other braking methods even transform kinetic energy into different forms, for example by transferring the energy to a rotating flywheel [1].

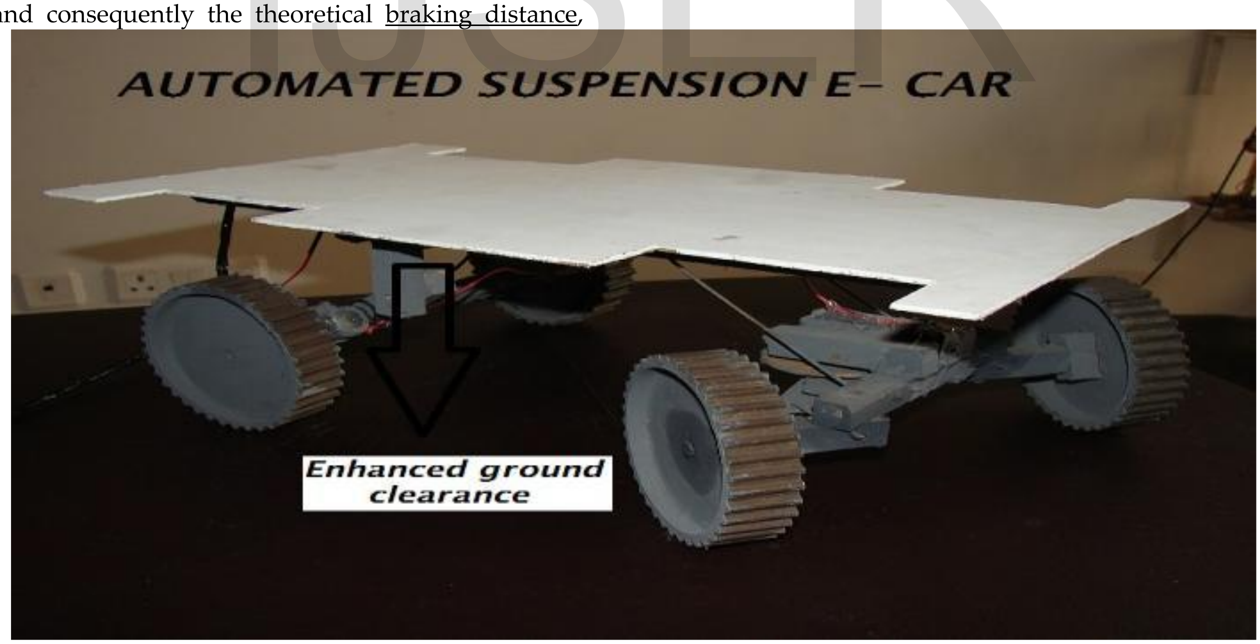
Brakes are generally applied to rotating axles or wheels, but may also take other forms such as the surface of a moving fluid (flaps deployed into water or air). Some vehicles use a combination of braking mechanisms, such as drag racing cars with both wheel brakes and a parachute, or airplanes with both wheel brakes and drag flaps raised into the air during landing.

Since kinetic energy increases quadratically with velocity ($K = mv^2/2$), an object moving at 10 m/s has 100 times as much energy as one of the same mass moving at 1 m/s, and consequently the theoretical braking distance, when braking at the traction limit, is 100 times as long. In practice, fast vehicles usually have significant air drag, and energy lost to air drag rises quickly with speed.

Almost all wheeled vehicles have a brake of some sort. Even baggage carts and shopping carts may have them for use on a moving ramp. Most fixed-wing aircraft are fitted with wheel brakes on the undercarriage. Some aircraft also feature air brakes designed to reduce their speed in flight. Notable examples include gliders and some World War II-era aircraft, primarily some fighter aircraft and many dive bombers of the era. These allow the aircraft to maintain a safe speed in a steep descent. The Saab B 17 dive bomber used the deployed undercarriage as an air brake[2].

Friction brakes on automobiles store braking heat in the drum brake or disc brake while braking then conduct it to the air gradually. When traveling downhill some vehicles can use their engines to brake.

When the brake pedal of a modern vehicle with hydraulic brakes is pushed, ultimately a piston pushes the brake pad against the brake disc which slows the wheel down. On the brake drum it is similar as the cylinder pushes the brake shoes against the drum which also slows the wheel down.



Demonstration of ground clearance of suspension car

TYPES:

Brakes may be broadly described as using friction, pumping, or electromagnetics. One brake may use several principles: for example, a pump may pass fluid through an orifice to create friction:

- **Frictional brakes** are most common and can be divided broadly into "shoe" or "pad" brakes, using an explicit wear surface, and hydrodynamic brakes, such as parachutes, which use friction in a working fluid and do not explicitly wear. Typically the term "friction brake" is used to mean pad/shoe brakes and excludes hydrodynamic brakes, even though hydrodynamic brakes use friction. Friction (pad/shoe) brakes are often rotating devices with a stationary pad and a rotating wear surface. Common configurations include shoes that contract to rub on the outside of a rotating drum, such as a band brake; a rotating drum with shoes that expand to rub the inside of a drum, commonly called a "drum brake", although other drum configurations are possible; and pads that pinch a rotating disc, commonly called a "disc brake". Other brake configurations are used, but less often. For example, PCC trolley brakes include a flat shoe which is clamped to the rail with an electromagnet; the Murphy brake pinches a rotating drum, and the Ausco Lambert disc brake uses a hollow disc (two parallel discs with a structural bridge) with shoes that sit between the disc surfaces and expand laterally.

- **Pumping brakes** are often used where a pump is already part of the machinery. For example, an internal-combustion piston motor can have the fuel supply stopped, and then internal pumping losses of the engine create some braking. Some engines use a valve override called a Jake brake to greatly increase pumping losses. Pumping brakes can dump energy as heat, or can be regenerative brakes that recharge a pressure reservoir called a hydraulic accumulator.

- **Electromagnetic brakes** are likewise often used where an electric motor is already part of the machinery. For example, many hybrid gasoline/electric vehicles use the electric motor as a generator to charge electric batteries and also as a regenerative brake. Some diesel/electric railroad locomotives use the electric motors to generate electricity which is then sent to a resistor bank and dumped as heat. Some vehicles, such as some transit buses, do not already have an electric motor but use a secondary "retarder" brake that is effectively a generator with an internal short-circuit. Related types of such a brake are eddy current brakes, and electro-mechanical brakes (which actually are magnetically driven friction brakes, but nowadays are often just called “electromagnetic brakes” as well).

Characteristics

Brakes are often described according to several characteristics including:

- **Peak force** – The peak force is the maximum decelerating effect that can be obtained. The peak force is often greater than the traction limit of the tires, in which case the brake can cause a wheel skid.
- **Continuous power dissipation** – Brakes typically get hot in use, and fail when the temperature gets too high. The greatest amount of power (energy per unit time) that can be dissipated through the brake without failure is the continuous power dissipation. Continuous power dissipation often depends on e.g., the temperature and speed of ambient cooling air.
- **Fade** – As a brake heats, it may become less effective, called brake fade. Some designs are inherently prone to fade, while other designs are relatively immune. Further, use considerations, such as cooling, often have a big effect on fade.
- **Smoothness** – A brake that is grabby, pulses, has chatter, or otherwise exerts varying brake force may lead to skids. For example, railroad wheels have little traction, and friction brakes without an anti-skid mechanism often lead to skids, which increases maintenance costs and leads to a "thump thump" feeling for riders inside.

- **Power** – Brakes are often described as "powerful" when a small human application force leads to a braking force that is higher than typical for other brakes in the same class. This notion of "powerful" does not relate to continuous power dissipation, and may be confusing in that a brake may be "powerful" and brake strongly with a gentle brake application, yet have lower (worse) peak force than a less "powerful" brake.
- **Pedal feel** – Brake pedal feel encompasses subjective perception of brake power output as a function of pedal travel. Pedal travel is influenced by the fluid displacement of the brake and other factors [3].
- **Drag** – Brakes have varied amount of drag in the off-brake condition depending on design of the system to accommodate total system compliance

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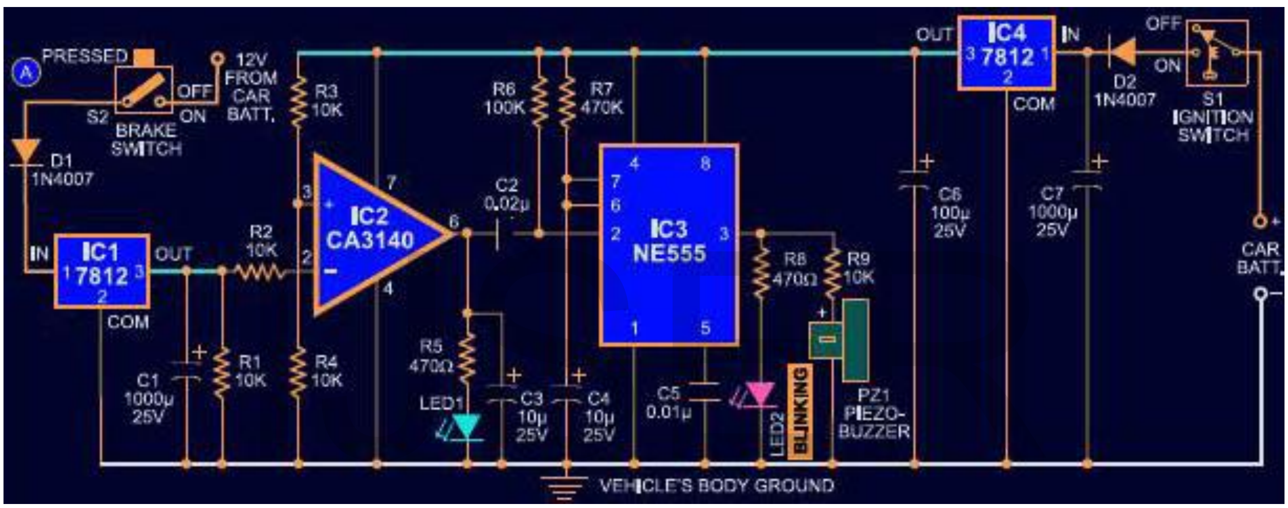
and deformation that exists under braking with ability to retract friction material from the rubbing surface in the off-brake condition.

- **Durability** – Friction brakes have wear surfaces that must be renewed periodically. Wear surfaces include the brake shoes or pads, and also the brake disc or drum. There may be tradeoffs, for example a wear surface that generates high peak force may also wear quickly[4].
- **Weight** – Brakes are often "added weight" in that they serve no other function. Further, brakes are often mounted on wheels, and unsprung weight can significantly hurt traction in some circumstances. "Weight" may mean the brake itself, or may include additional support structure.
- **Noise** – Brakes usually create some minor noise when applied, but often create squeal or grinding noises that are quite loud.

BREAK FAILURE INDICATOR CIRCUIT DESCRIPTION:

Here is a brake failure indicator circuit that constantly monitors the condition of the brake and gives an audio-visual indication. When the brake is applied, the green LED blinks and the piezobuzzer beeps for around one second if the brake system is intact. If the brake fails, the red LED glows and the buzzer stops beeping.



Brake failure indicator circuit that constantly monitors the condition of the brake and gives an audio-visual indication. When the brake is applied, the green LED blinks and the piezobuzzer beeps for around one second if the brake system is intact. If the brake fails, the red LED glows and the buzzer stops beeping[6].

The circuit will work only in vehicles with negative grounding. It also gives an indication of brake switch failure. In hydraulic brake systems of vehicles, a brake switch is mounted on the brake cylinder to operate the rear brake lamps. The brake switch is fluid operated and doesn't function if the fluid pressure drops due to leakage. The fluid leakage cannot be detected easily unless there is a severe pressure drop in the brake pedal. This circuit

Normally, when the brake is not applied, the output of IC2 remains high and the red LED (LED1) glows. The output of IC2 is fed to trigger pin 2 of the monostable through coupling capacitor C2. Resistor R1 is used for the input stability of IC2. IC1 and C1 provide a ripple-free regulated

senses the chance of a brake failure by monitoring the brake switch and reminds you of the condition of the brake every time the brake is applied.

The circuit uses an op-amp IC CA3140 (IC2) as voltage comparator and timer NE555 (IC3) in monostable configuration for alarm. Voltage comparator IC2 senses the voltage level across the brake switch. Its non-inverting input (pin 3) gets half the supply voltage through potential divider resistors R3 and R4 of 10 kilo-ohms each.

The inverting input (pin 2) of IC2 is connected to the brake switch through diode D1, IC 7812 (IC1) and resistor R2. It receives a higher voltage when the brake is applied.

supply to the inverting input of IC2. IC3 is wired as a monostable to give pulse output of one second. Timing elements R7 and C4 make the output high for one second to activate the buzzer and LED2. Usually, the trigger

pin of IC3 is high due to R6 and the buzzer and LED2 remain 'off.' When the brake pedal is pressed, pin 2 of IC2 gets a higher voltage from the brake switch and its output goes low to switch off the red LED. The low output of IC2 gives a short negative pulse to the m o n o s t a b l e through C2 to trigger it. This activates the buzzer and LED2 to indicate that the brake system is working. When there is pressure drop in the brake system due to leakage, LED1 remains 'on' and the buzzer does not sound when the brake is applied [7]. The circuit can be assembled on any general-purpose PCB or perforated board. Connect point A to that terminal of the brake switch which goes to the brake lamps. The circuit can be powered from the vehicle's battery.
The circuit requires well-regulated power supply to avoid unwanted triggering while the battery is charging from the dynamo. IC4, C6 and C7 provide regulated 12V to the circuit. The power supply should be taken from the ignition switch and the circuit ground should be clamped to the vehicle's body. A bicolour LED can be used in place of LED1 and LED2. if desired.

The circuit uses an op-amp IC CA3140 (IC2) as voltage comparator and timer NE555 (IC3) in monostable configuration for alarm. Voltage comparator IC2 senses the voltage level.

Advantages

- Economical
- Circuit is very simple
- It is not dependent on Fuel level
- Very less power consumption
- There is no necessity of an external battery as circuit uses the battery of the vehicle it self.

Disadvantages

- The break switch stops functioning if there is any leakage of fluid as it is fluid operated
- As battery is used for both car and Brake Failure Indicator circuit, battery charge may reduce.
- This system can only be used for negatively grounded vehicles

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