Ain Shams University
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Improving Performance of a Hydraulic Brake System for a Passenger Car

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(Automotive)

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy in Mechanical Engineering (Automotive).

The work included in this thesis was carried out by the author at the department of Automotive Engineering, Faculty of Engineering, Ain Shams University.

No part of this thesis has been submitted for a degree or a qualification at any other University or institute.

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SUMMARY

The passenger cars are provided with a brake system to secure safe control in the car movement during operation. Problems causing loss of control may occur, which this are main cause for road accidents. Braking action has been improved by using (ABS) systems and control pressure valves. Improvements are still going on in this respect.

In this research, a new trend is introduced using one load sensing valve for each wheel of the rear axle, instead of one valve for the whole axle, with the aim of controlling the brake fluid pressure of each wheel according to its load.

To evaluate this new trend the behavior of a vehicle was studied under different operating conditions. A mathematical relation relating the valve outlet pressure to each wheel of the rear axle and the load applied on it was deduced.

Experiments were conducted on a passenger car (FIAT 128) equipped with different sensors to measure the hydraulic pressure, the displacement of rear suspension and the wheels speed; Data were collected by a data acquisition card connected to a computer.

The experimental results proved the validity of the deduced mathematical relation and indicated an enhancement of braking performance using a separate load sensing valve for each wheel. Improvement in brake efficiency was about 25%, and the stopping distance was decreased by about 20 % for the studied condition.

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LIST OF SYMBOLS

a distance from vehicle center of gravity to the front wheels center [m]

A_{mc} master cylinder cross-section area [cm^2]

b distance from vehicle center of gravity to the rear wheels center [m]

B_f brake factor

F_{xf} brake force on front axle [N]

F_{xr} brake force on rear axle [N]

F_{xlf} brake force on front left wheel [N]

F_{xrf} brake force on rear right wheel [N]

F_{xrl} brake force on rear left wheel [N]

F_{xrr} brake force on rear right wheel [N]

$F_{xf,\max}$ maximum brake force on front axle [N]

$F_{xr,\max}$ maximum brake force on rear axle [N]

F_y centrifugal force [N]

F_{zf} vertical force on the front axle [N]

F_{zr} vertical force on the rear axle [N]

F_{zlf} normal force on front left wheel [N]

F_{zlr} normal force on rear left wheel [N]

F_{zrf} normal force on front right wheel [N]