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A REVIEW ON CONSTRUCTION OF VACUUM BRAKING SYSTEM

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ABSTRACT: A vacuum brake is a braking system employed on trains and introduced in the mid 1860s. Vacuum brakes are first used in place of the air brake in railway locomotives. This braking system uses a vacuum pump for creating vacuum in the brake pipe. The integral construction of the brake cylinder uses this vacuum reservoir for the application of brakes. Nowadays most of the light vehicles are fitted with vacuum-assisted hydraulic braking system where vacuum is created from the engine which reduces the driver effort on foot pedal. The vacuum braking system was modified from above said reasons and the same was tested for implementation in both light and heavy vehicles. In this work, vacuum is created and used for the application of brakes. The system operation is somehow similar to air braking system. The main difference with air brake system is that vacuum is used instead of compressed air.

Key words: Air braking system, Heavy vehicle, Hydraulic brake , Light vehicle, Vacuum braking system.

I. INTRODUCTION

Brakes are mechanical devices which increases the frictional resistance that retards the turning motion of the vehicle wheels. In vacuum assisted hydraulic brake system, a constant vacuum is maintained in the brake booster by the engine. When the brake pedal is depressed, a poppet valve opens and air pushes into the pressure chamber on the driver's side of the booster. Vacuum braking system uses the vacuum for the application of brakes. From articles written by Paul Konig for the Pinewood Stock to Miniature Railway Society newsletters. The majority of locos used on the Pinewood railway have used mechanical braking systems, both on the loco and the driving trolley / tender, to bring a train to a halt as and when required. With the requirement to run longer trains, for example the six carriage trains at our Santa Specials, the effectiveness of these systems can be reduced as the weight of all the passengers and coaches becomes many times heavier than the loco and its driver. Vacuum brakes are therefore being developed for the Pinewood passenger carrying mitigate this problem by applying brakes on all the carriage wheels.

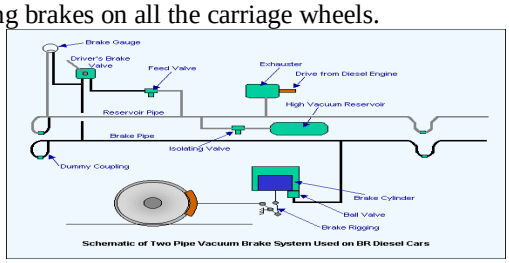

Figure 1: Vacuum braking system

II. PRINCIPLES OF OPERATIONS

A vacuum braking system comprises a method of evacuating the air from a pipe running the length of the train, the 'train pipe' (either using a steamloco motive's "ejector" or an electrically driven vacuum pump) to create a vacuum, and a method of destroying this vacuum. The brake system is arranged so that when the vacuum is created the brakes are pulled off; but when it is destroyed the brakes are applied. This has the advantage of being fail-safe, i.e. in the unlikely event that a pipe was to break (for example, if a passenger coach became detached from the loco) the air introduced to the coaches brake system would destroy the vacuum applying the coach's brake automatically and bringing the coach to a controlled stop.

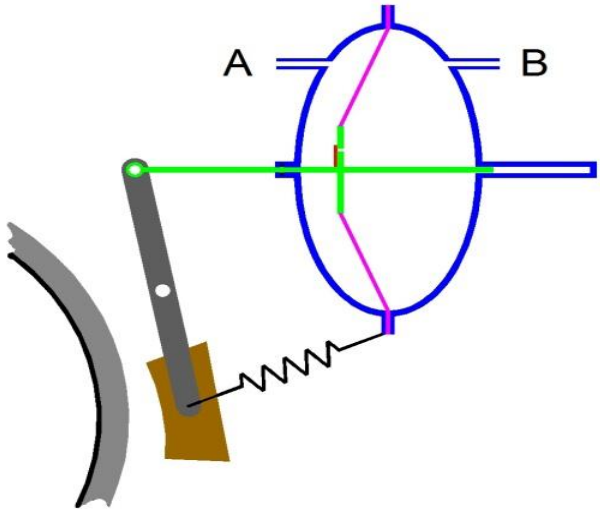

Figure 2: Drawing by Colin gross sketch of a vacuum brake system

This picture may help you understand how vacuum braking works, but please remember that in the "real world" the components will be properly engineered. For example the "small rubber flap" described below would more likely be a nicely built one-way valve ratherthan a bit of rubbercovering a hole .In the drawing, part ofthe carriage wheel isshown at the bottomleft. A brake block(coloured brown) is connected by the lever arm to the brake cylinder pistonDrawiand piston rod (bright green). A weak spring is used to pull the brake blockaway from the wheel, which also moves the piston to the left hand side of thevacuum brake cylinder (coloured blue). Inside the cylinder is a rubberdiaphragm (pink) that seals the piston to the cylinder, dividing the cylinder intotwo halves. The final component (that is rather hard to see) is a small rubberflap (coloured red) that is on the left hand side of the piston. This small rubberflap covers a small hole in the piston. The pipe (A) from the cylinder isconnected to the

locos ejector (or vacuum pump), via the "train pipe" while the pipe (B) goes to a large tank that acts as a vacuum reservoir.

III. CONSTRUCTION OF VACUUM BRAKING SYSTEM

Vacuum braking system consists of brake cylinder, compressor, vacuum reservoir, direction control valve, flow control valve, brake hoses, brake linkages, drum brake and foot brake pedal.

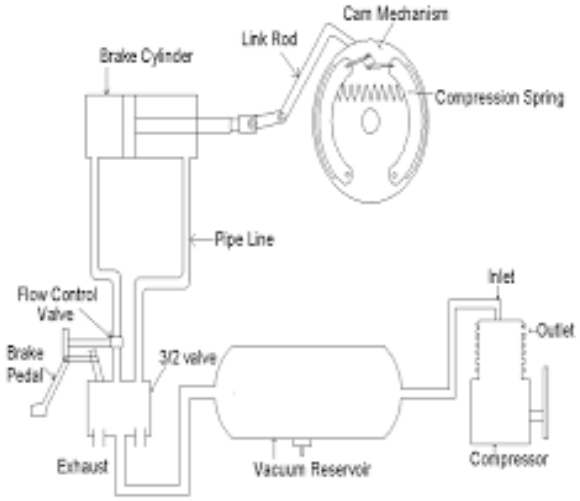

Figure 3 vacuum braking system

IV. DIRECTION CONTROL VALVE

The direction control valve is as shown in figure 4 are used in this works to change the direction of air flow to and from the cylinder. The moving parts in the directional control valve will connect and disconnect internal flow passages within the valve body. This action results in control of airflow direction. The typical directional control valve consists of a valve body with four internal flow passages within the valve body and a sliding spool. Shifting the spool alternately connects a cylinder port to supply pressure or exhaust port. With the spool in the where the supply pressure is connected to passage A and passage B connected to the exhaust passage, the cylinder will extend. Then with the spool in the other extreme position, Supply pressure is connected to the exhaust port, now the cylinder retracts. With a directional control valve in a circuit, the cylinder piston rod can be extended or retracted and work will be performed.

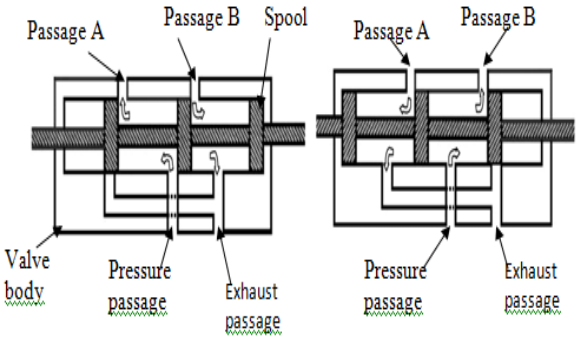

Figure 4: Direction control valve

V. FLOW CONTROL VALVE

A flow control valve is as shown in fig.5 consist of a disc which opens and closes the two way connection between the 3/2 valve and brake cylinder. Operation is similar to that of a butterfly valve, which allows for quick shut off. The disc is positioned in the Y-shaped pipe, passing through the disc is a rod connected to an actuator on the outside of the valve. The need of flow control valve is for partial braking. When the valve is closed, the disc is turned so that it completely blocks off the passageway between the atmospheric path and brake cylinder.

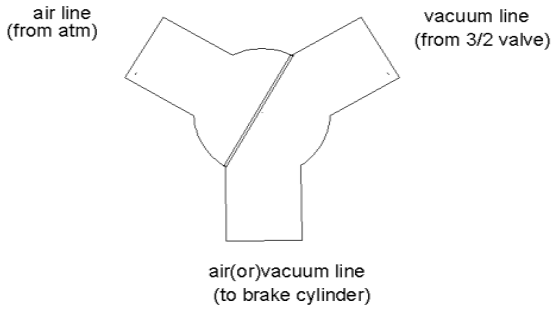

Figure 5. Flow control valve

VI. DRUM BRAKE

Drum brake system may be of either design in practice, but the twin leading design is more effective. This design uses two actuating cylinders arranged in a manner, so that both shoes will utilize the self-applying characteristic when the vehicle is moving forward. The brake shoes pivot at opposite points to each other. This gives the maximum possible braking when moving forward, but is not so effective when the vehicle is in reverse mode. The wheel cylinder and retractor spring of the drum brake is removed and suitable compression spring is fixed. The spring is placed in between the two cups so that it seats properly. The modified drum brake assembly is shown in fig.8. Flat shaped cam is made up of hard steel material is linked to the rectangular shaped plate made up of steel sheet are attached with the top ends of brake shoes. The other face of the cam is joined with L shaped link rod which is mounted with the piston rod end. The principle of vacuum brake is based on the pressure difference created in the actuator i.e. the brake released with a full vacuum and the brake applied with vacuum and spring force. The term “vacuum” is used to describe the region of pressure below one atmosphere of pressure, also referred to as negative pressure. The pressure in the atmospheric is defined as 0.1 N/mm2 and reducing atmospheric pressure to zero pressure creates a near perfect vacuum which is measured as 735 mm of mercury. The brakes are always in released condition with vacuum until the driver pushes the brake pedal. In this condition, position of piston is in cap end of the brake cylinder and cam is twisted for compressing the spring which provides free rotation of drum. When the driver pushes the brake pedal slowly then the flow control valve opens slightly to the atmosphere. Loss of vacuum causes the brake to be applied due to spring force. When the flow control valve opens fully then alternatively the direction control valve lever is moved to forward direction. The

direction of flow is changed and atmospheric air enters through the exhaust port of direction control valve to piston cap end. Due to pressure difference the piston moves backward with vacuum and spring force. The movement of link rod attached with piston rod releases the cam to normal position which makes internal resistances for the brake shoes against drum.

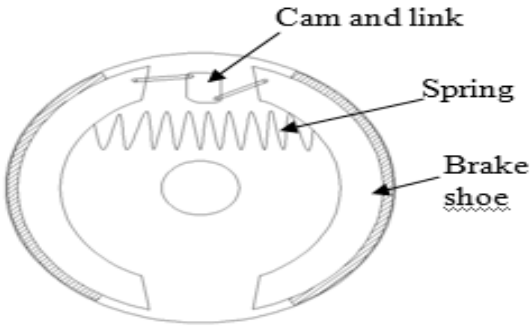

Figure 6. CAM and link mechanism after during brake

VII. CONCIUSION

The design and fabrication of a braking system is a difficult and great task. The application of brakes using vacuum in automobiles was a difficult in the initial stages of the work. But it has been successfully proved that such brake application is possible with fail-safe condition. By implementing this idea on a heavy vehicle, it is better to replace the manually operated direction control valve with solenoid operated direction control valve to reduce driver effort and also it will also work like a brake pedal switch.

The main advantages provide by vacuum braking system are:-

- This system provides fail-safe condition.
- Compressed air can be produced.
- Less noise.

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