DC Generators Instead of Breaks

Pritam Sanyal
Department of Electrical Engineering
Institute of Engineering & Management, Salt Lake Electronics Complex, Kolkata-700091, India

Abstract— To stop an automobile and to slow down an automobile, we often use breaks [2]. There are various types of breaks but most of them have common mechanism, they use friction to convert the kinetic energy into thermal energy but instead of that we can store that energy by regenerating [1] it with a dc machine [3].

Keywords: DC Generators, Breaks

I. INTRODUCTION

As we all know that energy can't be created nor be destroyed. So, from the law of conservation of energy, we can write,

$$E_{rotational(old)} = E_{frictional} + E_{rotational(new)} \quad (1.1)$$

$$E_{rotational(old)} = E_{generated} + E_{rotational(new)} \quad (1.2)$$

Where, $E_{rotational(old)}$ is the initial rotational energy of the wheel, $E_{frictional}$ is the frictional loss of energy due to breaks, $E_{rotational(new)}$ is the final rotational energy of the wheel and $E_{generated}$ is the amount of energy generated by the DC machine.

Considering all other losses equal to zero. The main idea is to store the energy, so comparing (1.1) and (1.2) we can say that,

$$E_{frictional} = E_{generated} \quad (1.3)$$

II. CALCULATION

Let m be the mass of the system, $\boldsymbol{\omega_1}$, $\boldsymbol{\omega_2}$ be the initial and final rotational velocity of the wheel, Δw is the amount of work done .As we know that change in kinetic energy is equal to the amount of work done, so from that we can state that .

$$\left(\frac{1}{2} m\omega_1^2 - \frac{1}{2} m\omega_2^2\right) = \Delta w \quad (2.1)$$

So in (2.1) $\left(\frac{1}{2} m\omega_1^2 - \frac{1}{2} m\omega_2^2\right)$ is the change in kinetic energy, where $\frac{1}{2} m\omega_1^2$ is the initial kinetic energy of the wheel and $\frac{1}{2} m\omega_2^2$ is the final kinetic energy of the wheel. As we lower the velocity of the wheel so $\omega_1 > \omega_2 \geq 0$.Let F_f be the force required to lower the velocity of the automobile in d distance so, $\Delta w = F_f * d$(2.2). We know that, $\omega_i = 2\pi n_i$ (2.3) where i =1, 2 and n_1 is initial speed of the wheel in revolution per second and n_2 is the final speed of the wheel in revolution per second. We know that $\tau = r * F_f$(2.4) where τ is the amount of torque generated and r is the radius of the wheel. In a DC machine let, Φ =

Useful flux per pole, P = Total number of poles, Z= Total number of conductors in the armature [3], n= Speed of rotation of armature in revolution per second = Speed of rotation of wheel in revolution per second, A = Number of parallel paths in the armature between brushes of opposite polarity and I_a be the armature current. Therefore $\frac{Z}{A}$ = Number of armature conductors in series for each parallel path. Then,

$$E_{generated} = \frac{nP\Phi Z}{A} \quad (2.5)$$

$$\tau = \left(\frac{1}{2\pi}\right) * \left(\frac{E_{generated} * I_a}{n}\right) \quad (2.6)$$

III. FIGURES

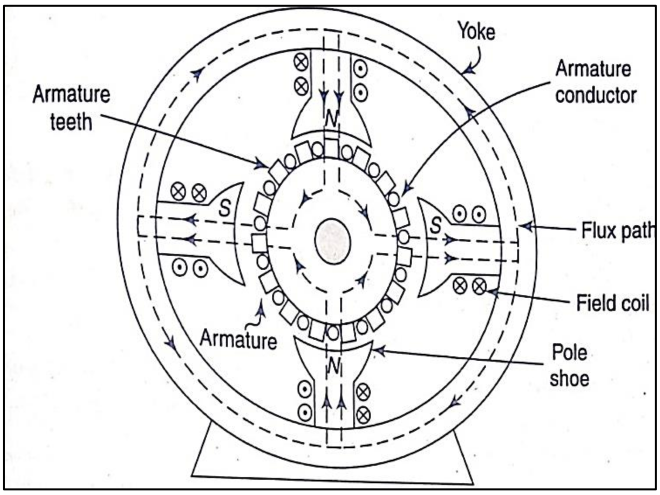

Fig. 3.1: Magnetic flux path of a four pole DC generator

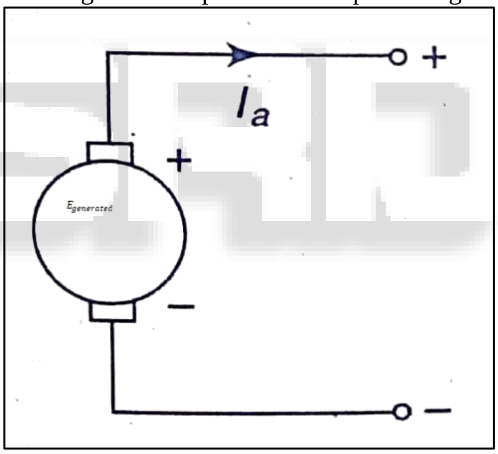

Fig. 3.2: Equivalent circuits of the armature of a DC generator

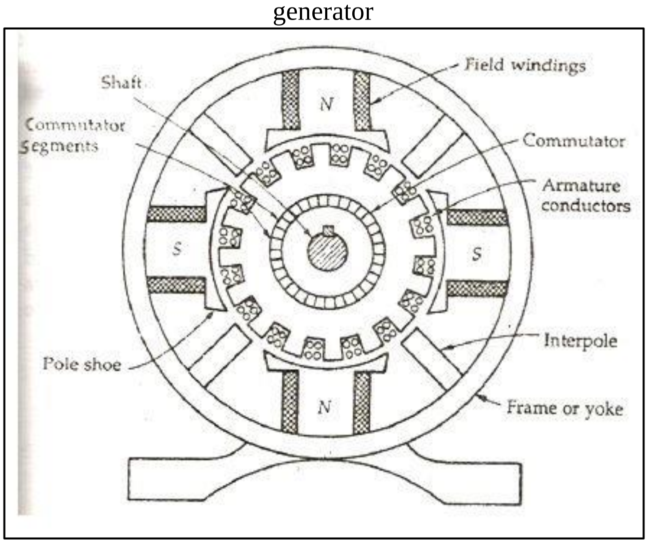

Fig.3.3 Cross-sectional view of a four pole DC generator

IV. Procedure

So, as we know the mass of the system and ω_1 is the initial velocity and ω_2 is the desired final velocity, so we can calculate the change in kinetic energy which is equal to the amount of work done from (2.1). We want to lower the velocity in d distance, so from (2.2) we can calculate the amount of force (F_f) required. Then we can calculate the net torque applied on the wheel from (2.4). As ω_i is known to us from (2.3) we can calculate the revolution per second of the wheel (n_i) which is equal to the speed of rotation of armature in revolution per second. As Φ, P, Z, A are the parameters of a DC machine, the parameters can be measured for a particular DC machine and I_a can be measured by connecting a ammeter in the circuit. So $E_{generated}$ can be calculated from (2.5) and from (2.6) we can have the amount of torque applied on a DC machine. Here we are considering copper losses [3], iron losses [3] and mechanical losses [3] of a DC machine are equal to zero. A gear is to be placed on the head of the shaft of a DC generator. Another same type of gear is to be fitted on the axle of the wheel of the automobile. When breaks are applied, these two gears come in contact together and reduce the extra energy (which is the cause of extra speed of the wheel) of the wheel by converting it to a regenerated energy by a DC generator.

V. Conclusion

We can thus purposefully use the generated energy by a DC machine which is being generally wasted nowadays. This mechanism is quite cheap and environment friendly and with the help of this technique, we can also reduce the thermal energy generated when brakes are used for decelerating an automobile.

References

[1] Garden, H., HowStuffWorks, Auto, Systems and Brakes, 2020. *How Regenerative Braking Works*. [online] HowStuffWorks. Available at: <https://auto.howstuffworks.com/auto-parts/brakes/brake-types/regenerative-braking.htm> [Accessed 28 April 2020].

[2] Day, A., 2014. *Braking of Road Vehicles*. 1st ed. Butterworth-Heinemann, pp.215-258.

[3] Chakrabarti, A. and Debnath, S., 2019. *Basic Electrical Engineering*. ISBN (13 Digit): 978-93-5316-297-9 ISBN (10 Digit): 93-5316-297-1, McGraw Hill Education (India) Private Limited, pp.7.51-7.78.