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Analytical Representation of Torque Characteristics In Repulsion Motor on Basis of Basic Theory of Magnetism..

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ABSTRACT: *It is a simple method to determine the production of Torque in Repulsion motor based on the basic Theory of magnetism. The Torque Characteristics of the motor is developed by shifting the brushes position of Repulsion motor. In this case – desires to shifting the angle of brushes, to study, how the torque will be developed with concept of the Theory of the magnetism and also to explain torque characteristic of the Repulsion motor as developed for various position of brush shifts corresponds to the practical curve of the said motor. The Torque Characteristics can successfully determine and as well as its performance.*

KEYWORDS: *Torque, analytical aspects of Torque production, Geometrical analysis of Torque.*

I. INTRODUCTION

It is constructed with the way :-

1) Stator winding of the distributed non-salient pole type housed in the slots of a smooth – cored stator or it may call split- phase motor and wound for four, six or eight poles.
2) Ii A rotor carrying a distributed winding either Lap or Wave system and is connected to the commutator.
3) Commutator may be one or two types as usual on which brushes press horizontally.
4) Carbon brushes are housed to the holders and ride against the Commutator and it acts to conduct current through the armature winding.

II. METHODOLOGY

The direction of flow of alternating current in the exciting or stator winding, it creates an N-pole at the Top and the S-pole at the bottom. By this action alternating flux is produced to the stator winding which induces emf in the armature conductors by transformer action. The direction of the induced emf can be found by **Lenz's Law**. However, the direction of the currents in the armature depends on the position of the short-circuited brushes. The armature becomes an electromagnet with N-pole on its Top directly and under the main N-pole and with an S-pole of the bottom directly over the main S-pole. By this face-to-face positioning of main and induced magnetic pole, no torque will be developed, but two faces of repulsion on the top and bottom act along y-axis indirect opposition to each other. When magnets are approaching from each other a null zone is created and as result to avoid the motor is getting to a halt.

When brushes are placed at right angles to the stator poles and short-circuited. Each brush is at the mid-point of its transformer winding. As the total emf in the two windings is the same and the windings are connected in parallel, each point must be at the same potential. The brushes short-circuited two points at the same potential. So, no current passes between the brushes. As a result there is no current in the rotor or armature winding so no flux is produced by the armature windings and also no torque is developed. Brushes in Geometrical Neutral plane is shown in the Figure 1.

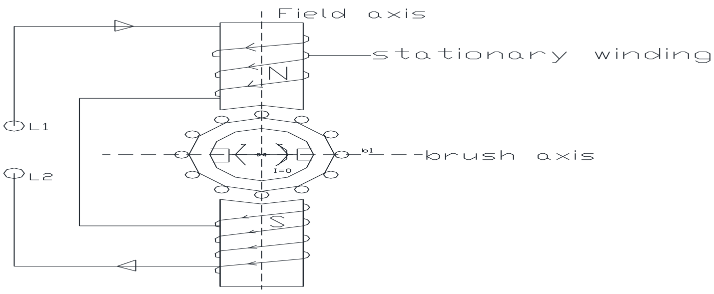

Figure 1: *Brush in Geometrical Natural Plane*

It is to work like an open-circuited transformer. When current of the motor is low, then the impedance of repulsion motor is high. This brush position by which the motor is performed the above stated condition is called the high impedance or open-circuited or neutral and at this condition no torque develops. This brush position is called the Soft neutral position. As a result to fail to rotate. The brush axis is parallel to the field axis as a result angle between the flux and brush axis is zero at this condition no torque is developed.

The speed-torque characteristics of single phase repulsion motor are shown in the Figure 2.

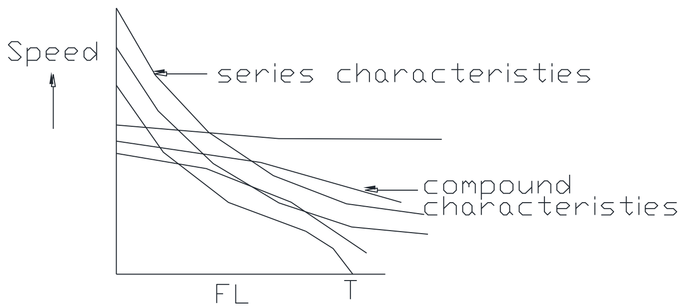

Figure 2: *Speed-Torque Characteristics of Single Phase Repulsion Motor*

The following symbols are used in this experimental works such as :-
Alpha = α, Beta = β, Gamma = γ, Delta = σ, Epsilon = ℮, Theta = Ө, Psi = ψ, Rho =ρ, Pi = π, Sigma = ∑ , Phi = φ , Nu = γ and Lambda = λ

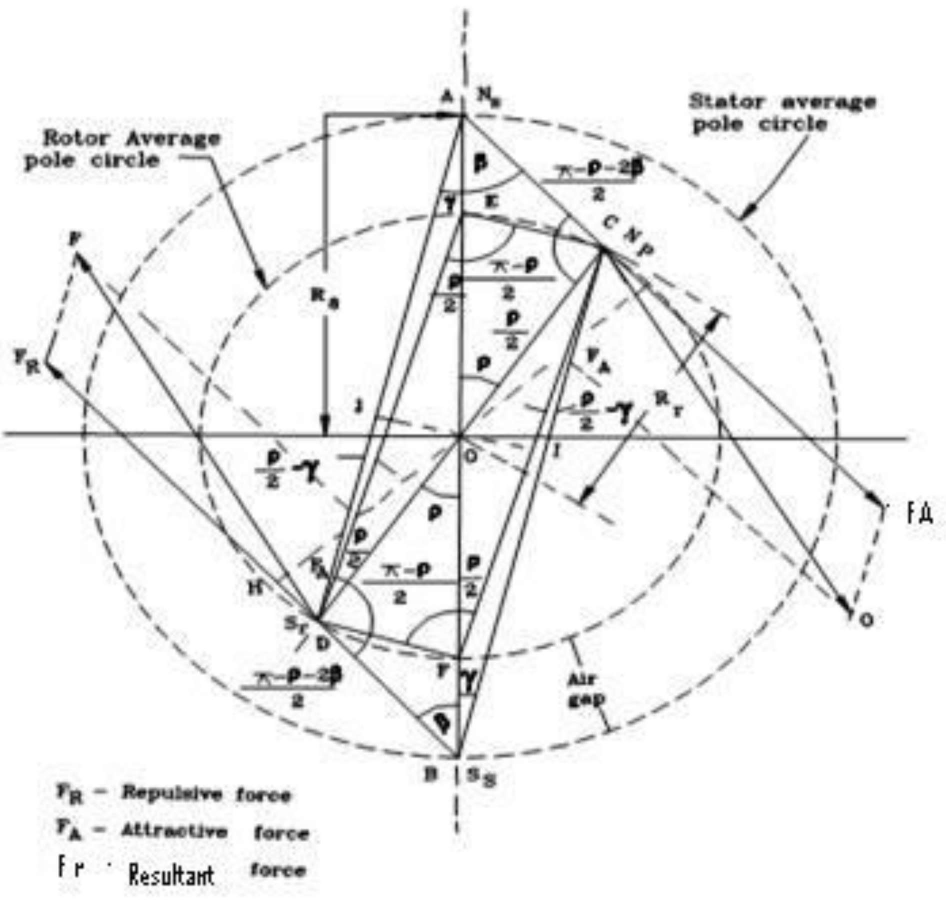

Figure 3: *Geometrical Analysis of Torque in Repulsion Motor from Basic Theory of Magnetism*

The Figure 3 shows the different forces of attraction F_A and repulsion F_R are developed between the instantaneous magnetic poles formed, an angular positions of such poles and the coupling forces which are described below:

AE = FB = 2 ro, EC = FD = r_1, CF = ED = r_2, AC = BD = r_3, BC = AD = r_4, OE = OF = Rr, OE = OF = Rr, AO = OB = Rs,

r = 2 ro = Rs – Rr , L AOC = L BOD = e, L OAC = L OBD = β, L OAD = L OBC = γ, L ECF = L FDE = π/2,

L ACE = L BDF = π/2 - β - e/2
L OEC = L OCE = L OFD = L OI $\frac{\pi - e}{2}$
L OFC = L OCF = L ODE = L OED = e / 2 ,
L ADE = L BCF = e / 2 - γ
L OCG = L ODH = e +β, L OCI = L ODJ = e - γ, OG = OH = Rr Sin (e + β), OI = OJ = Rr Sin (e - β),
In angle AOC or angle BOD

$$\frac{r_3}{\text{Sin } e} = \frac{Rr}{\text{Sin}\beta} = \frac{Rs}{\text{Sin }(e + \beta)} \qquad (1)$$

Again, In Angle AOD or angle BOC

$$\frac{R_4}{\text{Sin }(\pi - e)} = \frac{Rr}{\text{Sin }\gamma} = \frac{Rs}{\text{Sin }(e - \gamma)} \qquad (2)$$

Again, in angle ECF or angle FDE

$$r_1^2 + r_2^2 = (2Rr)^2 = 4R^2r \qquad (3)$$

In Angle AOC or angle BOD

$$r^2_3 = Rr^2 + Rs^2 – 2RrRs\ \text{Cos}e \qquad (4)$$

and In angle AOD or BOC

$$r^2_4 = Rr^2 + Rs^2 – 2RrRs\ \text{Cos }(\pi\text{-}e)$$
$$= Rr^2 + Rs^2 – 2RrRs\ \text{Cos } e \qquad 5)$$

Adding equation 4 and 5

We have, $r_3^2 + r_4^2 = 2\ (Rr^2 + Rs^2)$ (6)

Force of repulsion between Ns and Nr or Ss and Sr is equal to

$$F_R = K_1 \frac{NNs\ Nr}{R_3^2}\ K_1 \frac{Ns\ Nr\ m\ \text{Cos } e}{r_3^2} = K_1 \frac{Srm\ \text{Cos}e}{r_3^2} \qquad (7)$$

Where Nr = Nrm Cos e, Sr = Sr m Cos e,

Nrm and Srm being the induced poles due to Ns or Ss upon Nr or Sr when the angle between the main stator pole axis and rotor brush axis is e.

Similarly, the force of attraction between Ns and Sr or Ss and Nr is equal to

$$F_A = K_1 \frac{Ns\ NrSr}{r_4^2} = K_1 \frac{N\ s\ NsSrm\ \text{Cos}e}{r_4^2} = K_1 \frac{Sr\ Nr}{r_4^2} = K_1 \frac{Ss\ Nrm\ \text{Cos}e}{r_4^2} \qquad (8)$$

Hence, torque produced due to repulsive forces

$$T_R = K_1 \frac{Ns\ Srm\ \text{Cos } e}{\text{------------------}} \times 2\ Rr\ \text{Sin }(e + \beta)$$

r_3^2

And torque produced due to attractive forces

$$T_A = K_1 \frac{Ns\ Srm\ Cos e}{r_4^2} \times 2\ Rr\ Sin\ (e - \gamma)$$

Therefore, the resultant Torque = $T = T_R + T_A$

$$\text{Or } T = K_1 \frac{Ns\ Srm\ Cos e}{r_4^2} 2Rr\ Sin\ (e + \beta) + K1 \frac{Ns\ Srm\ Cos e}{r_3^2} 2Rr\ Sin\ (e - \gamma)$$

$$= K_2\ Rr\ Cos e \left[\frac{Sin\ (e + \beta)}{r_4^2} + \frac{Sin\ (e - \gamma)}{r_3^2} \right]$$

Using equations (1) and (2)

$$T = K_2\ Rr\ Cos e \left[\frac{Rs}{Rr} . \frac{Sin\ P}{r_3^2} + \frac{Rs}{Rr} . \frac{Sin\ y}{r_4^2} \right]$$

$$+ K\ Sin\ 2\ e \left[\frac{1}{R^3_3} + \frac{1}{r^3_4} \right]$$

From angle ACE or BFD

$$R^2_3 = (2r_o)^2 + r_1^2 - 2r_1(2\ r_o)\ Cos\ (\pi/2 + e/2) = (2r_{o)\ 2} + r_1^2 + 2r_1\ (2\ r_{o)}\ Sin\ e/2$$
$$= (r_1 + 2r_0\ Sin\ e/2)^2 + (4\ r_0^{\ 2} - 4\ r_0^{\ 2}\ Sin^{\ 2}\ e/2),\quad \text{Whence, } r^3_3 = [4\ (Rr + r_0)^{\ 2}\ Sin^{\ 2}\ e/2 + 4\ r_o^2\ Cos^{\ 2}\ e/2]^{\ 3/2}$$

Similarly, $r_4^3 = [4\ (Rr + ro)^2\ Cos^2 e/2 + 4ro^2\ Sin^2 e/2]^{3/2}$

Therefore,

$$T = K_4\ Sin\ 2e\ X$$

$$\left[\frac{1}{\{Sin^2 e/2 + \left(\frac{Ro}{Rr + ro.}\right)^2 Cos^2\ e/2\}^{3/2}} + \frac{1}{\{Cos^2 e/2 + \left(\frac{ro}{Rr + ro.}\right)^2 Sin^2\ e/2\}^{3/2}} \right] \quad \text{…. (9)}$$

Assumption Torque resultants are shown on the above expression that the magnetic poles are fixed at the middle of the instantaneous magnets limited dimensions. The characteristics of the Torque have to be obtained by sifting the angle e from – 90° to + 90°. It may be modified and also improved by making small equal strips forming very small poles of equal magnitude displaced through angles of - Θ + Θ and - ψ to + ψ with the poles of centers for Stator and Rotor poles respectively. By sifting of those angles between equal steps to cover the whole magnetic poles angles - Θ + Θ and - ψ to + ψ so as include both Stator and Rotor and also summing up the torques developed due to each Stator and Rotor very small poles.

The modified Torque equation and/ or expression have to be become like that:-

$$T = \sum_{-\Theta}^{+\Theta} \sum_{-\psi}^{+\psi} K'_4\ Sin\ 2\alpha \left[\frac{1}{\{Sin^2\ \alpha/2 + K_5\ Cos^2\ \alpha/2\}^{3/2}} + \frac{1}{\{Cos^2\ \alpha/2 + K_5\ Sin^2 \alpha/2\}^{3/2}} \right] \quad (10)$$

K^4

Where $\alpha = (e + \Theta + \psi)$, and Where $K'_4 = \frac{\text{------}}{n_s\, n_r}$,

n_s and n_r are Nos. of equal strips of poles into which the Stator and Rotor poles are divided. Still further the refined the Torque equation could be obtained if the Stator and Rotor very small poles considered above two equal pole strengths are taken to be different in magnitude due to their different angular dispositions. In this case, the Torque equation and or called expression would be like that:-

$$T = \sum_{-\Theta}^{+\Theta} \sum_{-\psi}^{+\psi} K'_4 \sin 2\alpha \cos \Theta \cos \psi \quad X \quad \left[\frac{1}{\{\sin^2 \alpha/2 + K_5 \cos^2 \alpha/2\}^{3/2}} + \frac{1}{\{\cos^2 \alpha/2 + K_5 \sin^2 \alpha/2\}^{3/2}} \right] \qquad (11)$$

By changes the poles strengths of both Stator and Rotor of the Tiny poles due to their angular displacements from the centre are taken into consideration by taking the cosine components along the central pole axes.

III. RESULT AND DISCUSSION

In this paper present the analytical aspects of the production of torque in a Three – Phase repulsion motor have been studied by using basic theory of magnetism. All models are almost equally for predicting the tongue for various values of displacement between the stator field axis and rotor brush axis. The 2nd and 3rd models are found to be much efficient in predicting the torque and therefore better suited for studying the performance of the machine.

IV. CONCLUSION

Repulsion motor is a type of electric motor that is designed to provide a high level of torque or rotational force upon start up, and to have the capability of easily reversing the direction of rotation. It is an alternating current motor that uses a series of contact brushes which can have a varied angle and level of contact for changing torque and rotational parameters. These motors were widely used in early industrial equipment, such as drill presses until the 1960s that required a large amount of slow rotational force, and in micro-control systems, such as for traction motors on model railroads. While modern electrical circuitry has replaced many repulsion motors with induction motors that have similar control features, the repulsion motor is still used in some fields due to its ability to generate a large amount of torque at slow speeds. These include such applications as printing press drives and ceiling fans, or blowers for environmental controls that have slowly rotating fan assemblies. Variations on the original design of the repulsion motor include incorporating typical induction performance principles into it, such as the repulsion start induction motor, repulsion induction motor, and compensated repulsion motor.

REFERENCES

[1] Dr. S. K. Sen, Rotating Electrical Machines, Khanna Publishers, Delhi ,P- 52.[1].
[2] ARK Research ------------- on magnetic energy Source and shadowing is public domain.[3].
[3] Tesla Autobiography – III. My later Endeavors, The discovery of rotating magnetic field 20.12.2010 at webciti. [3].
[4] The Electrical year Book 1937, published by Emmdott and Company Limited, Manchester, England,
[5] p – 79-82.[4].
[6] All conferences .com, 2010: Electrical Motors: Practical considerations.
[7] http://www.allconferences.com/conferences/2010/20101016004604.
[8] Journal Woodbank Communication Ltd, U.S. Published - 2005 [3].
[9] Chapman, S. J. (1999) , Electric Machinery Fundaments, New York: Mcgraw-Hill [1].
[10] Fink, D.G.(1993), Standard Handbook for Electrical Engineers, New York: Mcgraw-Hill [1].
[11] Fitzerald, A.E., C. Kingsley and S. D. Umans(1963), Electric Machinery, 4th edition, New York: Mcgraw-Hill [1].
[12] Veinott, C. (1959), Theory and Design of Small Induction Motors, New York: Mcgraw- Hill [1].

BIBLIOGRAPHY

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