RESEARCH OF DIRECT CURRENT THYRISTOR ELECTRO DRIVE AT PULSATING LOAD

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ABSTRACT

Direct Time electromagnetic and electromechanical effect on transition and quaziestablished processes in direct current tiristor electro drive at pulsating load research has been carried out.

Keywords: thyristor, direct current, electromagnetic, electromechanical

1. INTRODUCTION

Let's consider the process of direct current engine start fed from tiristor convertor at linear change of voltage control for pulsating load case.

Let's work out an equation describing direct current tiristor electro drive work. And in this case let's accept the following assumptions: 1) engine parametres during the transition processes remain unchangable; 2) on the whole range of control voltage change, the curve of rectified voltage is continuous but its pulsation is insignificant and they could ve neglected; 3) engine magnetic flow during the start doesn't change; 4) tiristor convertor of constant time is inconsiderable and it could be unconsidered.

Control voltage is possible to be drawn to the control system by tiristor convertor.

$$U_C = U_{CO} - qt \qquad (1)$$

where Uco – is control voltage corresponding to the thyristor converter closed state; q –is control voltage speed change; t – is time.

Relationship between unlock assembly and thyristor converter voltage control is introduced by linear function:

$$\alpha = K\ U_C \qquad (2)$$

where K –is proportionality coefficient between voltage control and lock angle.

Voltage on thyristor converter outlet in the work of continuous current regime is expressed by:

$$U_{d\alpha} = \frac{1+\cos\alpha}{2}\ U_{do} \qquad (3)$$

where U_{do} – is voltage on thyristor converter outlet at fully open thyristors.

Equation electro moving power in the anchor chain has the form:

$$U_{d\alpha} = K_1\omega + \frac{R}{K_1}M + \frac{L}{K_1}\frac{dM}{dt} \qquad (4)$$

where K, L –are active resistance and anchor inductivity of engine, throttle and transformer.

Equation of moments balance.

$$M = M_{st} + M_{din};$$
$$M = K_2 I;$$
$$M_{CT} = M_1 - M_2\cos(2\varphi+\varepsilon); \qquad (5)$$
$$M_{din} = J\frac{d\omega}{dt};$$
$$\omega = \frac{df}{dt},$$

where – M_{st}, M_{din} –are statistic and dynamic moments, on engine shaft; φ– is rotate angle; ε– is shift angle; W – is shaft rotation angle freguency; i –is engine anchor current; J –is inertion moment.

After a number of equations (1)-(5) trahcformation we'll get differential equation describing direct current tirictor electro drive with pulsating load not discussed (solved) in the evident form concerning moment and engine rotation frequency:

$$T_y T_M \frac{d^2M}{dt^2} + T_M\frac{dM}{dt} + M = \frac{JU_{do}Kq}{2K_1}\sin qkt + M_1 - M_2\cos(2\varphi+\varepsilon) \qquad (6)$$

$$T_y T_M \frac{d^2\omega}{dt^2} + T_M\frac{d\omega}{dt} + \omega = U_{do}\frac{1-\cos qt}{2} - T_M\frac{M_1}{J} + T_M\frac{M_2}{J}\cos(2\varphi+\psi) - T_a T_M 2\omega\frac{M_2}{J}\sin(2\varphi+\varepsilon) \qquad (7)$$

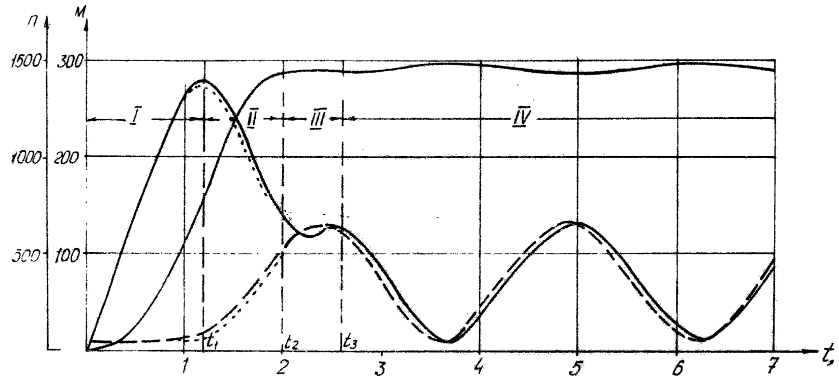
where $T_M = \frac{RJ}{K_1^2}$ - is electromechanic constant time of electro drive;

$T_y(\text{anchor}) = \frac{L}{R}$ – is electromagnetic constant time of electro drive.

For differential equations (6) and (7) solution calculation program has been composed in accordance of which process of direct current engine start of P-62 type, 14 vt, 220 V, 1500 rot/min fed from thyristor converter voltage at statistic load M_{st} = 70-60 cos2φ and linear change of voltage control have been calculated on ECM (electro-calculation machine).

II DECISION

Thyristor converter system start process-direct current engine at $T/T_1 = 0,8$ is illustrated in Fig.1.



Fiq 1. Thyristor converter direct current engine start process system at T/T_1=0,8.

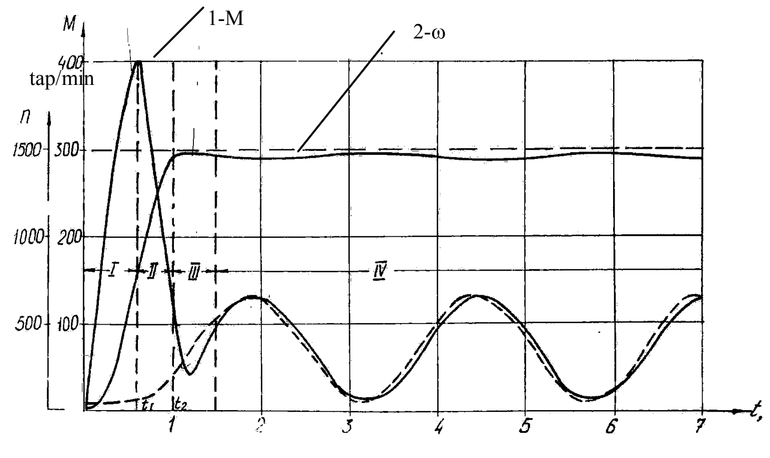
where:

$$T = \frac{\Pi}{\kappa q}$$ -is thyristors lock change period

$$T_1 = \frac{\Pi}{W_{CP}}$$ - is load change period

Here T=2 sec; T_1=2,5 sec; T_M= 0,071; $T_{y(\omega)}$ =0,059.

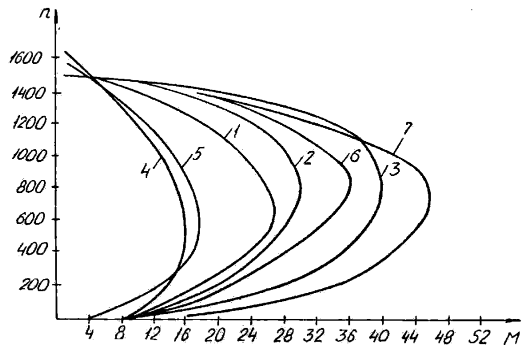
The given system start process is illustrated in fid. 2 for the case T/T_1=0,4.



Fiq 2. Thyristor converter direct current engine start process system at T/T_1=0,4.

Here T = 1 sec.

Mechanical characteristics at direct current engine start with pulsating load and voltage linear change for the following cases are shown in fig.3:



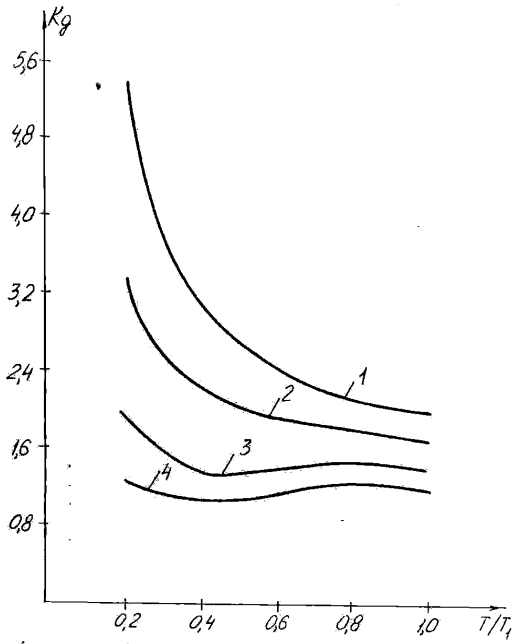
Fiq.3. Direct current engine mechanical characteris-tics while its start with pulsating load and voltage linear change.

Curve 1 – $T_{y(A)}$ = 0,059; T_M = 0,071; T/T1 = 1,0;
Curve 2 – $T_{y(A)}$ = 0,059; T_M = 0,071; T/T1 = 0,8;
Curve 3 – $T_{y(\omega)}$ = 0,059; T_M = 0,071; T/T1 = 0,4;
Curve 4 – $T_{y(\omega)}$ = 0,012; T_M = 0,071; T/T1 = 1,0;
Curve 5 –$T_{y(\omega)}$= 0,020; T_M = 0,071; T/T1 = 1,0;
Curve 6 – $T_{y(\omega)}$= 0,020; T_M = 0,428; T/T1 = 1,0;
Curve 7 – $T_{y(\omega)}$= 0,020; T_M = 0,642; T/T1 = 1,0.

As is seen from the curve with thyristor lock angle change period T reduce with comparison of T_1 load change period start moment increases (curves 1,2,3). At constant of electromechanical constant time of drive with increase of electromagnetic constant time of drive the start moment increases as well (curves 4,5,1).

Start moment analogical increase takes place with the increase of electromechanic constant time of drive at constant of electromagnetic constant time (curves 5,6,7).

Relationship of dynamic coefficient Kg = $\frac{M_{S\max}}{M_{ST\max}}$ from T/T_1 for different values $T_M/T_{y(\omega)}$ at T_M = const, where $M_{S.Max}$. u $M_{St\ Max}$. – are maximum values of start and statistic moments are illustrated in fig..4.



Fiq.4. $K_g=f(T/T_1)$ relationships at direct current engine start with pulsating load and voltage linear change.

Here the curve 1 corresponds to $T_{y(\omega)}$=0,059 sec; curve 2 – $T_{y(\omega)}$=0,033 sec; curve 3 – $T_{y(\omega)}$=0,02 sec; curve 4 – $T_{y(\omega)}$=0,012 sec; curves 1-4 are composed for values T_M=0,071 sec. As is seen from the curves dynamic coefficient at T_M=cost. With T/T_1 decrease it'll increase in larger scale than electromagnetic constant time.

III. CONCLUSION

Direct current of thyristor electro drive research with pulsating load at voltage linear change showed start moment relationship from electromechanical electromagnetic constant time and thyristors lock angle change period ratio to load change period as well.

REFERENCE

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