THYRISTOR ELECTRO PUMPING UNIT LOOP SYSTEM FOR OIL PRODUCTION

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ABSTRACT

Control electro drive creation necessity allowing to change engine drive rotation frequency smoothly in wide range appears for pumping unit start smoothly and for stress reduce in deep well pumping unit as well.

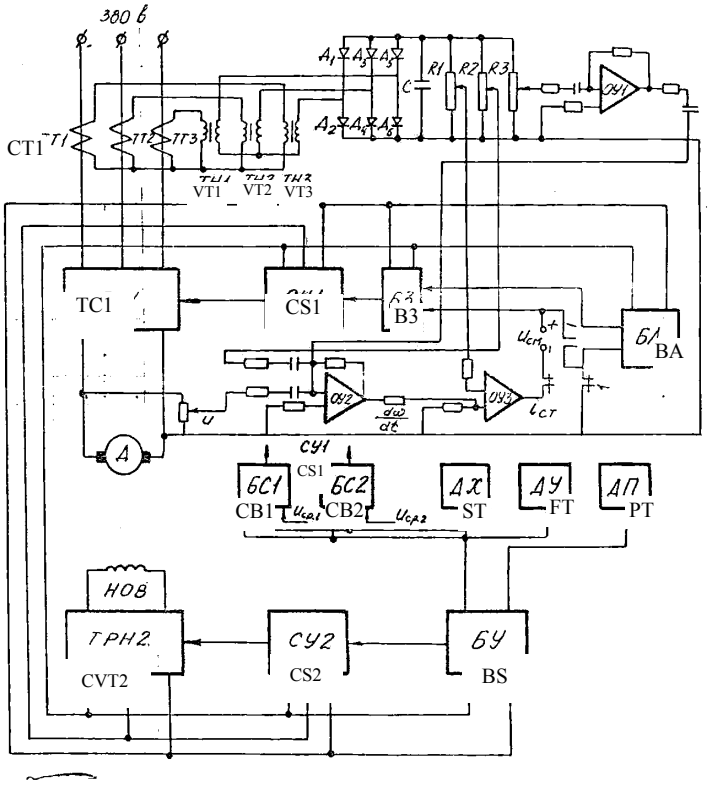
Keywords: thyristor, oil production, controlled electrodrive

I.INTRODUCTION

With the growth of exploitation depths and engine drive capacity of heavy pumping units necessity of in engine rotation frequency change smooth start bridging of pumping wells, engine rotation frequency control during deep well pumping unit work cycle according to the law, allowing to improve separate constructive assemblies working conditions and to increase electro drive and nets electrical indexes for engine rotation frequency increase according to deep well pump wear with the aim to keep constancy of pump feed and for well research on inflow at set optimal regime of formation recovery as well appears (comes out). For these purposes it is more reasonable to use thyristor direct current electro drive system owing large range control which is the best in comparison with the other statistic converters (transformers) electrical indexes and construction simplicities.

II. BODY OF THE TEXT

The worked out thyristor direct current drive system for heavy pumping unit was carried out on direct current engine base and shown (illustrated) in fig.1.



Fiq.1. Pumping unit system of thyristor direct-current drive.

Engine rotation frequency change while plug forming pump wells start with control range 1:2 and engine rotation frequency change during working cycle of deep well pumping unit is carried out, by the effect on anchor engine chain as well but according to the pump wear it takes place by means of effect on engine chain stimulation with control range 2:1.

Automation and protection block of BA drive taking into account manual start, self start and drive protection and device as well supporting smooth well start in time function have been carried out analogically as well as in thyristor alternating current drive systems.

Engine anchor chain of direct current is fed from power converter of TP1 accumulated along three phase bridge of subcontrol scheme. Thyristor lock angle control of thyristor power converter is carried out by means of subconductive control system CS1 built up according to "vertical principle".

For maximum dynamic stress decrease aim in sucker rods feedback system on stress in sucker roads allowing to change engine rotation frequency and rod hanger centre movement in dependence on stress in sucker rods has been used as well. Thus pumping unit transmitter stroke TS spontaneously connected with beam while rods travel up connects with thyristor converter control system of comparison block CB1, but while its travel down- comparison block CB2. Voltage of comparison to comparison block CB1 is given proportional to maximum calculation statistic load on rods, but to comparison block CB2 – voltage proportional to minimum calculation statistic load on rods. Voltage to these block is given simultaneously reducing stress from transmitter in rods TS. As transmitter stress differential transformer is used which is applicable in the oil fields for teledynamometering which is set on front half of walking beam of pumping – unit.

In case if voltage from transmitter stress in rods is more than the voltage of comparison while rods travel up or less than transmitter stress while rods travel down then on outlet of comparison blocks appear voltage which stimulate control system CS1 by thyristor converter TC1, reduce engine rotation frequency and with it reduces speed and acceleration of rod hanger center. At the same time maximum stress and stress change amplitude in rods decrease.

In case if voltage taken from transmitter stress is less than voltage of comparison while rods travel up or more than voltage of comparison while rods travel down then engine rotation frequency and consequently the rods movement speed increases which allows to smooth dynamogram of stress in rods and to keep constant the average number of rolling per minute.

For avoiding negative tangential stress and for improving working condition of different constructive deep well pumping unit blocks in this system feedback on hold back statistic composition of engine moment can be used as following: current transformers CT1-CT3 are turned on into the alternating current chain connected though voltage transformers VT1-VT3 to the straightening bridge on the outlet of which voltage is got proportional to engine anchor current. This voltage is given to operational amplifiers OA2, OA3. Operational amplifiers OA1, OA2 function in differentiation regime, but operational amplifiers OA3 – in totalize voltage regime, from the operational amplifier OA1 outlet the voltage proportional to $\frac{di}{dt}$ is given to operational amplifier OA2 inlet where voltage enters simultaneously proportional to the voltage given to engine from powerful thyristor converter U with corresponding polarity. As the voltage in the engine at constant flow equals:

$$U = K_e\omega + ir + L\frac{di}{dt} \quad (1)$$

or in relative units:

$$\omega^* = U^* - i^* - \frac{di}{dt} \quad (2)$$

Where if ω - and *i* – are correspondingly rotation frequency and engine anchor current; r – and L – is correspondingly resistance and anchor chain inductivity; K_e – is the coefficient of electro moving power, then on operational accelerator OA2 inlet. Voltage proportional engine acceleration could be obtained, i.e. $\frac{d\omega}{dt}$. Voltage from operational accelerator OA2 is given to operational accelerator OA3.

From equation of electro drive travel

$$M = M_{CT} + M_{DUN} \quad (3)$$

engine anchor current equals to:

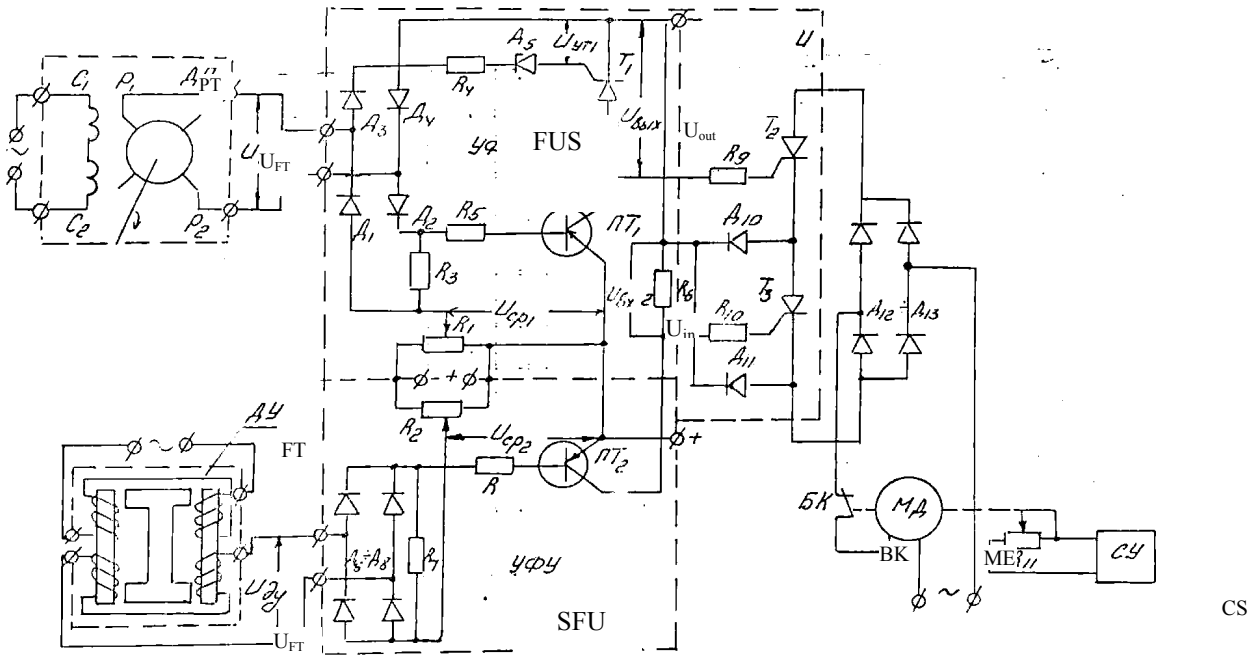
$$I = \frac{M}{K_M} = \frac{M_{CT}}{K_M} + \frac{J}{K_M}\cdot\frac{d\omega}{dt} \quad (4)$$

Thus, voltage proportional to engine statistic moment could be obtained on operational accelerator OA3 outlet.

By shifting voltage curve received on operational amplifiers OA3 outlet regarding to rod hanger center starting travel on definite angles by means of phase shift device or hold back block, HBB, it is possible to change engine rotation frequency according to the law allowing to reduce stress in different elements of deep well units and to equal load diagram of engine and in this way to increase electro drive and nets electrical indexes as well.

Shift voltage U_{sh} serves for voltage control shift curve corresponding to zero.

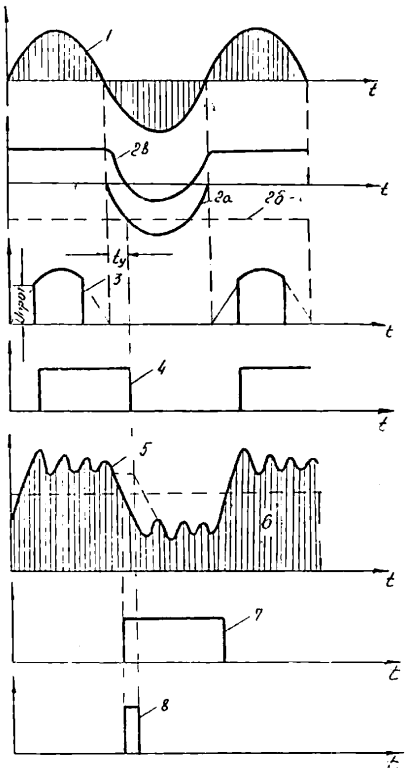
For keeping pump delivery regularity according to its wear in the thyristor electrodrive direct current system position transmitter (PT) and force transmitter (FT) are used (Fig.2)



Fiq.2. Scheme of pumping-unit capacity control according to pump wear.

As position transmitter sine-cosine rotating transformer or selsin fixed on the crank shaft between reducer body and crank is used.

In this case sinusoidal voltage reduced from outlet wrapping of sine-cosine rotating transformer PT and being the function of crank rotate angle (Fig.3 curve l).



Fiq.3. Diagrams of voltage and current elements change of automatic control system by frequency and engine rotation according pump wear.

$$U_{PT} = U_{PT\,max} \mathrm{Sin}Q \qquad (5)$$

changes with frequency corresponding to the pumping unit roll number per minute. This voltage is given to the

divider composed of diodes D1-D4 where from negative subperiod voltage (curve 2a), corresponding to moving time of rod hanger center down enters transistor inlet ПТ1 of fixation unit state (FUS). Comparison voltage U_{C1} is given simultaneously to transistor inlet controlled by potentiometer R_1. Resulting voltage is defined as difference of mentioned voltages (curve 26):

$$U_{tp.1} = U_{pt} - U_{c1} = U_{ptmax}.SinQ - U_{c1} \quad (6)$$

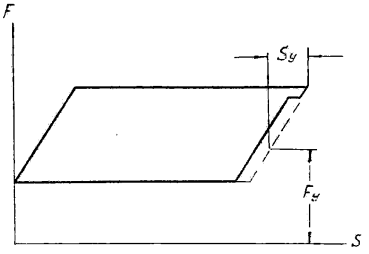
Due to regulated by size voltager U_{C1}, presence hold back transistor lock ПТ1 on time t_y is provided which is required for crank shaft turn to the angle Q corresponding to the unit S_y (fig.4) for each concrete pump off regime. In this case comparison voltage $U_{cp.1}$ is defined according to:

$$U_{cp.1} = U_{Ptmax}.SinQ_y \quad (7)$$

At $U_{CP.1} < U_{pt}$ transistor ПТ1 locks (curve 3) as a result of which voltage U_{outl} (curve 4) fall on resistor R_6 decreases up to zero. Thyristor T_2 existence in transistor collector ПТ, chain protect possibility of opening till the rod hanger center travel down, i.e. when $U_{CP.1}$ becomes more U_{pt}. It is provided by pump off the chain of thyristor regulate T_2 of positive subperiod voltage U_{pt} of turned transformer providing its open state while rod hanger center travel up till the transistor ПТ1 lock moment. Current's existence in the transistor ПТ1 collector chain till its lock moment supplies hold back in the «on» state at negative subperiod voltage control. Stabilitron PS holds back thyristor T_1 open state during the time necessary for obtaining turn transformer voltage for stabilitron value $U_{pt.}$. As a result of this voltage $U_{out.н}$ appears on the unit outlet of fixation state during crank turn from the situation corresponding to thyristor T_2 open state while traveling up till the state suitable to unit S_Y .

Voltage taken from the stress transmitter U_{DY} (curve 5) is given to transistor $ПТ_2$ inlet of stress fixation unit (SFU) where simultaneously comparison voltage $U_{C.2}$ is given at occurring (curve 6) chosen by potentiometer so that transistor $ПТ_2$ opening could take place at voltage U_{DY} reduce till definite value corresponding to unit F_Y size (Fig.4), i.e. at $U_{C.2} > U_{PT}$. Under the influence of resulting voltage:

$$U_{тр.2} = U_{c.2} - U_{Pt} . \quad (8)$$



Fiq.4. Theoretical dynamogram of deep-well pumping unit.

Transistor $ПТ_2$ opens and in its collector chains voltage $U_{outl.2}$ (curve 7) appears and it is simultaneously with the voltage U_{outl} , (curve 4) given to the thyristor T_2 and T_3 control chain of the logical element "N" consequently included into the microengine ME straightened current chain.

Microengine ME begins to rotate displacing movement of the controlled resistance R_{II} and in this way changing control voltage on thyristor converter control system inlet in the case of simultaneously thyristor T_2 and T_3 opening which takes place in the simultaneous opening of thyristors $ПТ_1$ and $ПТ_2$ if the pump fill disappears.

If deep well pump works in the non-fill regime the stress rod hanger center S_F will always be higher the size of F_F and consequently in the open state of transistor $ПТ_1$ transistor $ПТ_2$ will be in the locked state.

Voltage U_{ME} (curve 8) with the length equal to time coincidence of outlet voltages $U_{outl.1}$ and $U_{outl.2}$ curves leads microengine to rotation providing shifting control resistance movement. If obtained impulse duration will not be enough and pump will continue to work with fill up after it, then during the next cycle of deep well pump unit work simultaneous thyristor T_2 and T_3 opening of logical element «N» will take place. And further voltage control movement shift to the frequency increase of driven electro drive will take place and consequently pumping unit rolling number per minute will increase as well. After increase of pumping unit rolling number per minute stress dynamogram form change in rod hanger center takes place and consequently in the voltage curve taken from the stress transmitter change takes place and it leads to hold back of transistor $ПТ_2$ opening and correspondingly T_1 holds back because of keeping $U_{DY} > U_{CP.2}$ (Fig.4 dotted line of curve 5). In this case hold back time while rods traveling down makes up more than the fixed time t_Y corresponding to S_Y unit.

When the regulator movement is shifted till the final state, i.e. deep well pump unit performance reserve is completely used microengine chain is turned off with block-contact and pumping unit in the future will work at limit frequency of engine till deep well pump change.

III. CONCLUSION

The perspective for deep well pumping unit performance, effectiveness increase and for reliability of equipment work led to longitudinal of overhaul period and consequently to oil production cost reduce is the use of controlled electrodrive for pumping unit.

REFERENCE

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