industries.

Due to the specific operating conditions, one of the most frequently occurring faults in the operation of MCC is wedging of the traction chain (TC) of the MCC. The consequences of this emergency mode often result in break down of the TC of MCC or in unacceptable AM overheating.

A special turbo muff which is a part of the conveyor's construction is used for protection of MCC and AM in abnormal operation modes. The results, obtained during the years of use of turbo muffs reveal that their efficiency is low [1, 5]. The low efficiency of turbo muffs for protection of MCC and AM against dynamic overloads makes extremely actual the problem for development of new devices for protection.

Effective MCC and AM protection could be realized by realization of fast AM disconnection from the power supply and quickly stopping the rotation of its rotor.

The simplest structural scheme of a protection device includes the following elements:

- Measuring unit (sensor);
- Data converter;
- Execution device;

The paper below uses above structure for analysis of a fast selective protection device of MCC and AM against dynamic overloading.

DATA PARAMETER FOR DYNAMIC OVERLOADING CONTROL IN THE CONSTRUCTIONAL ELEMENTS OF MINING CHAIN CONVEYORS

One of the main causes for dynamic overloading in the constructional elements of a chain conveyor is a wedge in the traction chain of the conveyor. The so described phenomenon is accompanied by a transient process where there are variations of:

• The force in the working chain;

• The torque on the shaft of the driving motor and the gearbox;

• The speed of the traction chain;

• The speed (slip), and hence the value of the consumed electrical current from the AM.

All data parameters above are possible to be used for the realization of a control device that detects dynamic overloading in the elements of a chain conveyor.

It is well known that a decrease in the speed of an AM's rotor is associated with an increase in the value of the stator's current in accordance with the following [1, 3, 4]:

$$I_1 = I_0 + \left(\frac{1}{K_i} \cdot \frac{E_2 . S}{\sqrt{R_2^2 + X_2^2}} \right) \quad (1)$$

, where

I_0 - no load current of the AM;

E_2 - rated rotor e.m.f.;

S - rotor slip;

R_2, X_2 - resistance and reactance of AM's rotor;

K_i - AM's currents ratio coefficient.

Therefore, one of the parameters which is possible to be measured in case of wedging is the intensity (speed) of increasing of stator's current consumed by the AM.

Protection device based on measurement of current's increment should distinguish the signals associated with blocking of the traction chain and respectively signals in case of short circuit and static overloading. All these fault modes are characterized by an increase of the current consumed by the AM.

In case of a short circuit, the first derivative of current at the time is always less than the current increment when the traction chain is blocked. Also, the current increment in case of wedging the traction chain is greater than the current increment in case of static overloading.

To obtain a signal indicating the occurrence of dynamic overloading in MCC's traction chain it is enough to have a current transformer included in one of the phases, supplying the AM's stator winding and a current threshold (relay) device.

DATA CONVERTER

In the development of protection devices it is necessary to set the variation range of the current's derivative at time corresponding to the following fault modes: short circuit - ΔDI_K, traction chain wedging - ΔDI_C, and static overloading of TC of MCC - ΔDI_n (here index D means differentiation of current with time).

The relationship between these threshold ranges must satisfy the expressions:

for $DI_K : \infty > DI \geq DI_1$;

for $DI_C : DI_1 > DI \geq DI_2$; (2)

for $DI_n : DI_2 > DI \geq DI_3$;

$DI_1 > DI_2 > DI_3$

, where . DI_1, DI_2, DI_3 - minimum values of current's derivatives, corresponding to short circuit, traction chain wedging and static overloading of TC of the MCC.

Device working on that principle is shown in Fig. 1. It contains two comparators DA_1, DA_2 with triggering thresholds U_{on1} and U_{on2} ($U_{on1} > U_{on2}$).

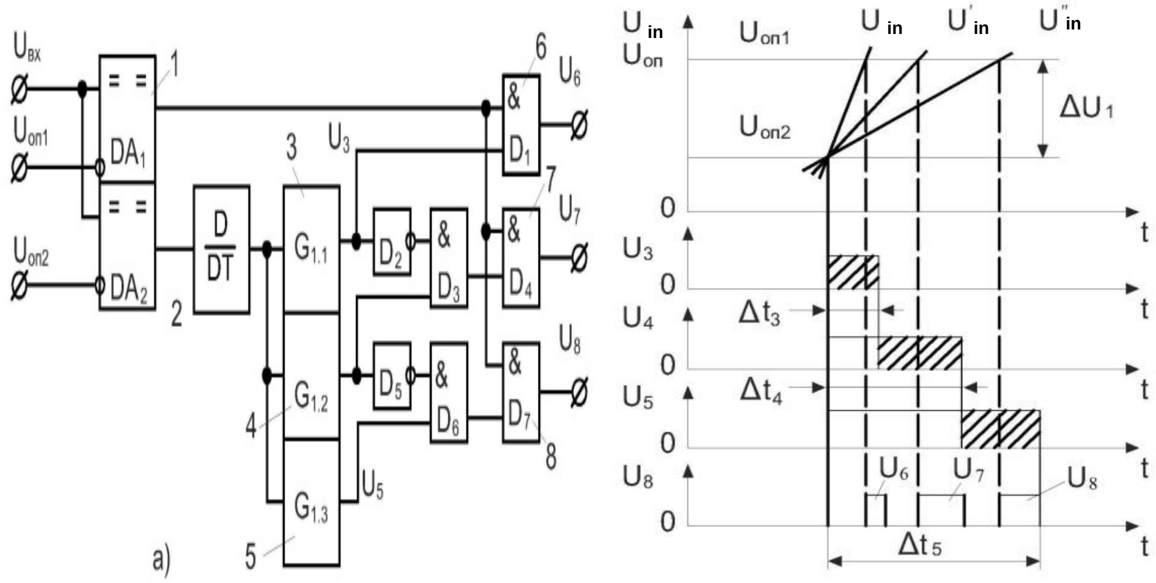

Fig.1 Scheme (a) and diagram of operation (b) of a device for registering of fault regimes in the operation of chain conveyors.

When the input signals, proportional to the current of the protected network, exceed the threshold U_{on2}, the waiting multivibrators G1.1 – G1.3 are turned on and the duration of their impulses (U_3-U_5) are $\Delta t_3 < \Delta t_4 < \Delta t_5$.

Since the triggering threshold of the first comparator is higher than that of the second one, their difference ($\Delta U_1 = U_{on1} - U_{on2}$) can be unambiguously used to determine the assigned increment of the input voltage which is proportional to the current's derivative, controlled by it.

Therefore, the parameters U_{On1}, U_{On2}, Δt_3, Δt_4, Δt_5 in general characterizes the limits of current's derivatives at the time regarding the AM.

$$\frac{\Delta U_{on1} - \Delta U_{on2}}{\Delta t_3} = \frac{\Delta U_1}{\Delta t_3} \equiv DI_1$$
$$\frac{\Delta U_{on1} - \Delta U_{on2}}{\Delta t_4} = \frac{\Delta U_1}{\Delta t_4} \equiv DI_2 \qquad (3)$$
$$\frac{\Delta U_{on1} - \Delta U_{on2}}{\Delta t_5} = \frac{\Delta U_1}{\Delta t_5} \equiv DI_3$$

In that way, an increase in the input voltage from level U_{on2} to level U_{on1}

controlled circuit. This state corresponds to logical “1” for U_6 (fig.1b), which is generated at the output of the AND elements (D1).

The signal for TC wedging is possible to be formed in the presence of impulse U_4 and absence of impulse U_3, i.e. only in the case when the input signal’s intensity of increasing is in the range:

$$\frac{\Delta U_{on1} - \Delta U_{on2}}{\Delta t_3} > DU \geq \frac{\Delta U_{on1} - \Delta U_{on2}}{\Delta t_4} \quad (4)$$

This corresponds to the second equation in (2).

Similarly, the signal for static overload is formed in the presence of a pulse U_5 and the absence of a pulse U_4, i.e. only in the case when the input signal’s intensity of increasing is in the range:

$$\frac{\Delta U_{on1} - \Delta U_{on2}}{\Delta t_4} > DU \geq \frac{\Delta U_{on1} - \Delta U_{on2}}{\Delta t_5} \quad (5)$$

for a time less than Δt_3, would be an indication for a short circuit in the

Taking into account (3), this corresponds to (2).

EXECUTION DEVICE

One of the most effective methods to stop the rotation of asynchronous motor which drives mining chain conveyors appears to be the mode of induction dynamical braking(IDB) [1, 2, 3]. Compared to the capacitor or the dynamic braking modes, IDB features the ability to create greater initial braking torque and relatively more simple schematic application [2]. The IDB process is carried out relatively simply if the AM is connected to the mains through a power thyristor switch (PTS), as shown in Figure 2.

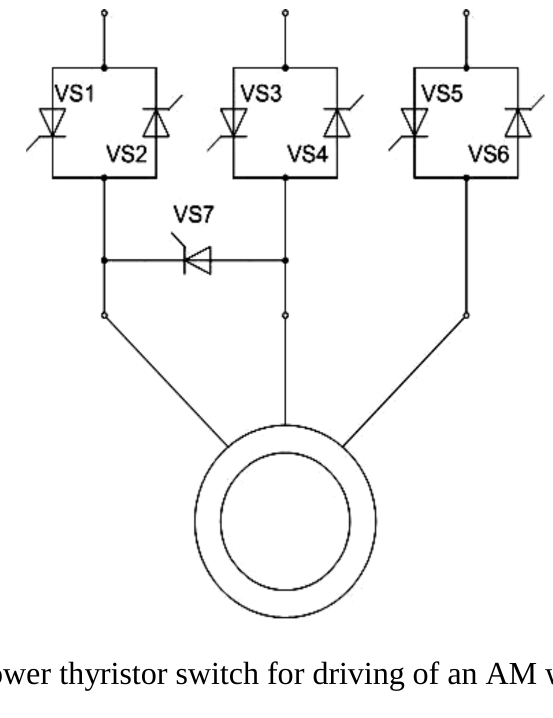

Fig.2 Scheme of a power thyristor switch for driving of an AM with short-circuited rotor

The IDB process of a AM is realized fairly easy if the AM is connected to the mains by P PTS which engages only the thyristors VS1, VS4, VS7, as shown in Figure 3.

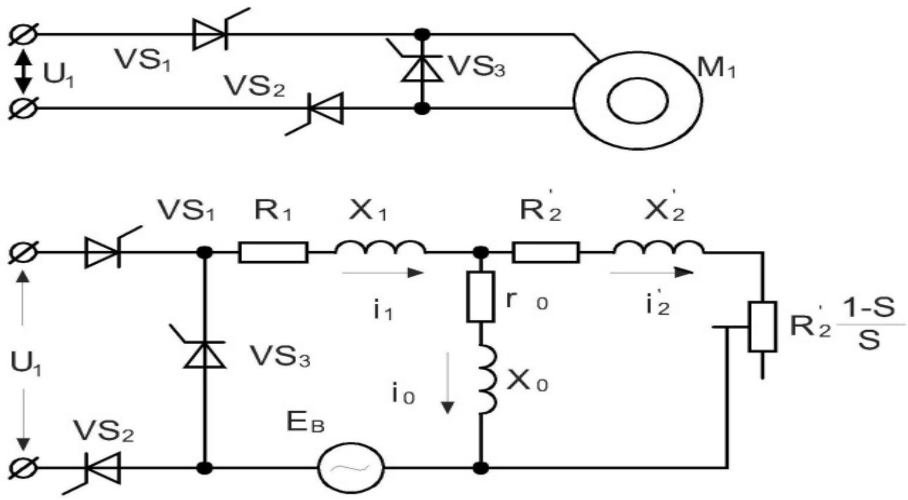

Fig.3. Wiring diagram (a) and equivalent circuit (b) of AM in regime of induction-dynamical braking.

The equivalent circuit of AM in regime of induction-dynamical breaking(Fig. 3b), takes into account the specifics of the processes in the system PTS-AM, the nature of the impact of induced e.m.f. by the rotating AM, the created into the stator electromagnetic field as a result of rotor's current.

CONCLUSIONS

It is shown that there are three specific fault regimes of an AM driving mining chain conveyors (MCC), which are accompanied by an increase in stator's current:

- Short circuit;
- Technological/static overloading;
- Dynamic overloading as a result of blocking/ wedging of the traction chain of the MCC.

The paper has proposed a scheme of a device for selective detection of the occurrence of fault regimes in MCCs as a result of traction chain wedging.

The implementation of the induction-dynamical breaking regime (IDB) provides the opportunity to realize protection of AMs and MCCs against dynamical overloading with the required fast response.

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