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STUDY REGARDING THE DRIVING DESIGN OF THE STRETCHING SYSTEM
OF BELT CONVEYORS WITH HIGH OUTPUT ROLLERS

STUDIE TÝKAJÍCÍ SE NÁVRHU HNACÍHO NAPÍNACÍHO SYSTÉMU PÁSOVÉHO
DOPRAVNÍKU S VYSOKÝM VÝSTUPNÍM VÝKONEM KLADKY

Abstract:

The main component of the conveyor is the rubber mat, which, driven through specific methods, ensures the transport of the excavated mass. The use of this type of transportation at optimal parameters depends on the correct stretching (tensioning) of the rubber mat. This is achieved with the help of a stretching gear with carriage (jointed to the stretching drum) with engine - driven cable.

Abstrakt:

Hlavní složkou dopravníku je gumová podložka, řízená specifickou metodou, zajišťující dopravu vytěžené hmoty. Používání tohoto druhu dopravy při optimálních parametrech závisí na správném napětí gumové podložky. Toho je možné dosáhnout pomocí napínacího zařízení (připevněno na napínacím bubnu) s motorem - řízený kabelem.

1 INTRODUCTION

The stretching of the rubber mat can be done by two methods. The easiest and most efficient stretching method is the stretching with the help of a counter-weight. The second method implies the use of a stretching gear with carriage (jointed to the stretching drum) with engine - driven cable. The engine receives the rotation command into one sense or the other from a control system that adjusts the tension in the mat. This method is used where gravitation loop cannot be applied. This type of stretching gear of the belt mat is an integrant part of the main sub-assembly of the conveyor; the driving station and it has two main important functions:

❑ It ensures the pre-tensioning of the belt by providing the adherence force between the mat and the driving drums;

❑ Due to the stretching length of approximately 9 m, on the fixed driving stations, and 17 m on the mobile driving stations, the possibility of taking over the length differences due to the vulcanization processes suffered by the rubber mat.

Studies carried out on the stretching forces involved in various operating modes of conveyors (starting, normal working, braking) for different degrees of loading of the conveyor (empty, half loaded, full) indicate very wide variations (1…3 times) in the strain in the mat. If taking into consideration the costs, the mat represents approximately 40% of the value of the conveyor and its rational

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exploitation becomes a first order requirement. From this point of view, the design has certain short-ages, as it only allows maintaining the strains around the maximum selected value; therefore, there shall always be a permanent over-straining in the mat, and this aspect is unjustified for most of the time (approximately 80% of the total working time). As an automated design, it only performs a bi-positional adjustment (all-nothing) of the strain in compliance with to one input value (the measured force). In addition, the current design presents certain disadvantages, namely that if the strain drops below the minimum threshold value (during automated operation) it does not command the stretching of the belt, but the stopping of the conveyor, which involves the stopping of the entire chain of belts located upstream the conveyor.

2 THE CONTROL OF THE STRETCHING SYSTEM

For the considered study case, we proposed a command scheme of the belt stretching devices with a process computer, presented in figure 1.
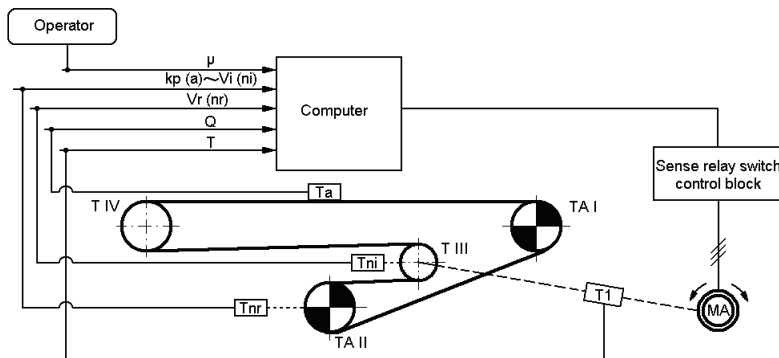

Fig. 1 Command flow chart for the automated stretching gear

2.1 Operating mode

The operating mode of the entire assembly observes with the following algorithm:

❑ the choice of the friction coefficient μ. It is manually adjusted by the supervisor with the help of a manual wrench;

❑ the choice of starting factor K according to the predicted starting system. It is manually adjusted by the supervisor with the help of a manual wrench or by the programmer;

❑ the establishment for the minimum and maximum values of T_2, normal starting for $Q_{max}=6500$ m^3/h and $v=6$ m/s;

❑ in the output forming circuit appears the stretching order between the two strain values T_2. Through the reaction loop T_T (tension transducer mounted on the metal cable of the stretching winch) the two values are compared. When equaling them, the „STOP" command of the stretching installation is generated;

❑ the belt transducer starts up according to the command scheme of the main actuating. The end of the transit „START" method is picked up by the speed transducer;

❑ the access regarding the transmission of the information towards the flow transducer is un-blocked (belt scale);

❑ the belt conveyor stabilizes in the almost stationary „EXPLOITATION" mode;

❑ according to the values transmitted by the flow and speed transducers, the tension existing in the conveyor is compared to the „MINIMUM" and „MAXIMUM" values afferent to T_2 in the starting case (step 4), commanding the conveyor's de-tensioning or tensioning, according to necessity;

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- when changing the speed method picked up by the speed transducer, the following calculation algorithm is used:
  - The strain for speed and flow values is compared to an optimal value established on the basis of a calculation abstract for the exploitation method
  - If the differences (plus or minus) don't exceed the pre-established threshold values, no command is given for the stretching installation;
  - If not, the tension will be adjusted in the conveyor's mat within the established limits;
- A special case is represented by the skidding phenomenon. Skidding during the „START" method is eliminated through the command scheme of the main actuating, the stretching installation does not act in this case. During the nominal exploitation method, regardless of the method's speed, the information regarding the skidding phenomenon is gathered through the two transducers, the imposed speed transducer Tni and the real speed transducer Tnr. The ration nr/ni is calculated and it must not drop below a pre-established limit value, normally 0.9. If this ratio drops below 0.9 the stretching command is given up to the value maxT2. If the skidding phenomenon persists and it is picked up by the computer through the nr/ni<0.8 ratio, the conveyor's stopping command for „BREAKDOWN" is initiated;

- During the braking method, where T2 has the largest values, the command algorithm is the following:
  - During the natural decrease of speed at a pre-established threshold (normally 0.8 of the method's revolution) the stretching installation's de-tensioning command is initiated to the value T2breaking=maxT2starting;
  - The de-tensioning command acts until the AND LOGICAL conditioned is achieved (revolution 0, tension maxT2starting).

With this step the explanation of the automated driving of the installation is concluded. This algorithm is transposed into the logical scheme presented in figure 2. In this algorithm, it can be noticed the initiation section of the pre-tensioning parameters at the imposed value of T_2 in order to start the conveyor at speed of 6 m/s and maximum flow of 6500 m^3/h. When the conveyor starts, the loading process begins at one end. After a while the flow transducer starts functioning and it measures the flow. The computer calculates Q_{med} for 300 seconds every second. The central line of the algorithm follow the functioning of the conveyor in stationary and exploitation methods at speeds of 6 m/s, 4.5 m/s and 3 m/s, as well as the passing from top to bottom, as value, from one speed to another according to the practical achievement of the decision elaborated by the process computer. The section from the left of the algorithm's central line follows the situation of the transitory breaking method for each type of exploitation at its respective speed, as well as the passing from one speed to another, from top to bottom, as value, according to the fulfillment of the decision elaborated by the process calculator.

2.2 The skidding phenomenon

The skidding of the mat appears when, due to technical breakdowns, the speed of the mat goes below a certain limit, compared to the speed of the driving drums. As effects, these phenomena are extremely costly, even leading to fires in the drive-heads area. In figure 3 schematically represented the conveyor mat's skidding surveillance device. On the driving drum (2), which regardless of the number of driving engines (1...4) is equipped with an engine, the transducer is mounted (1). On the stretching drum, the transducer (2) is mounted. Bearing in mind the different diameters of the two drums, an adjusting system is required so that for equal peripheral speeds, the transducers should have equal signaling. The two signals are introduced into an adjusting block of which, as a result of processing, the enunciated input commands result.
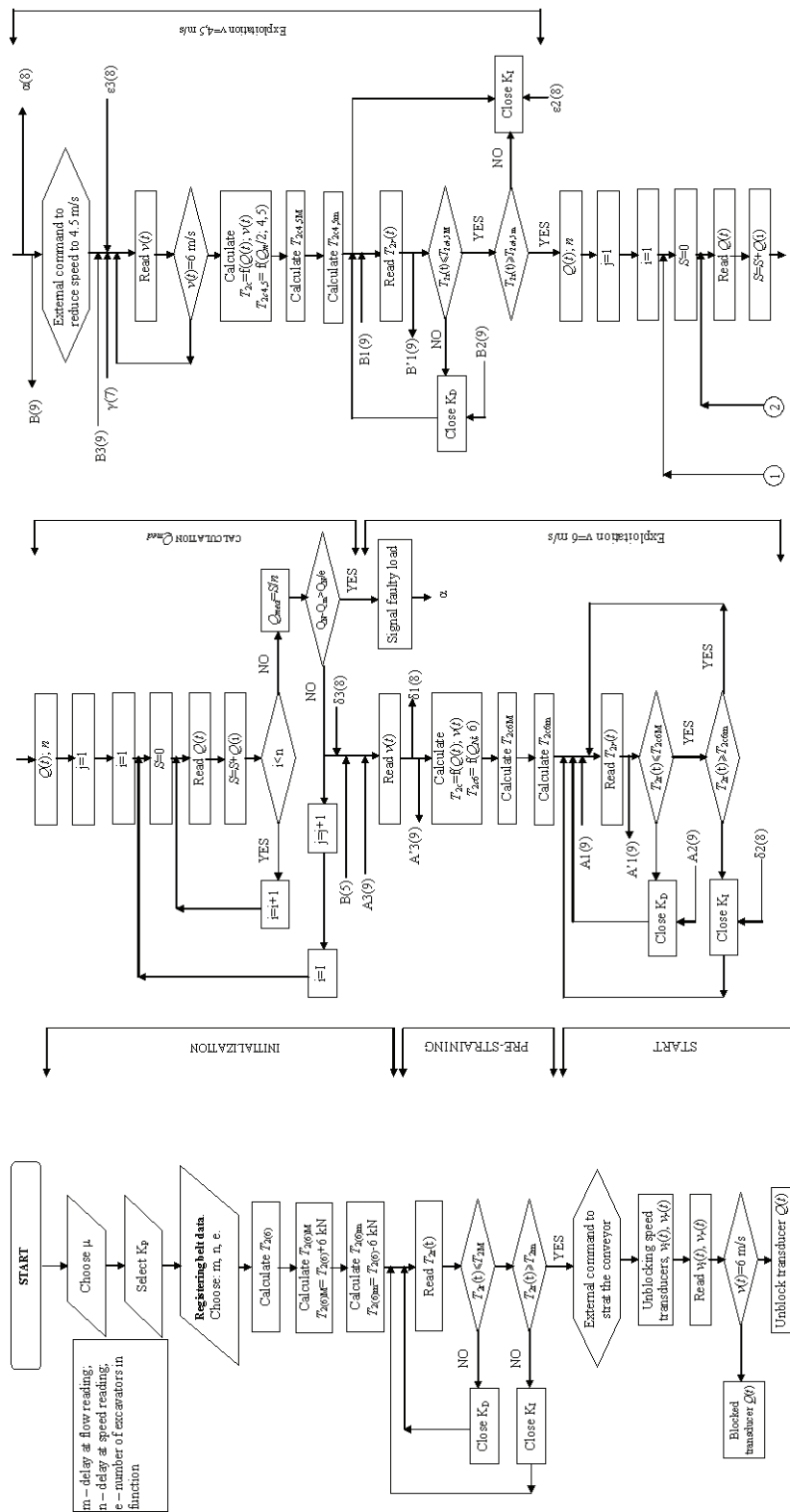
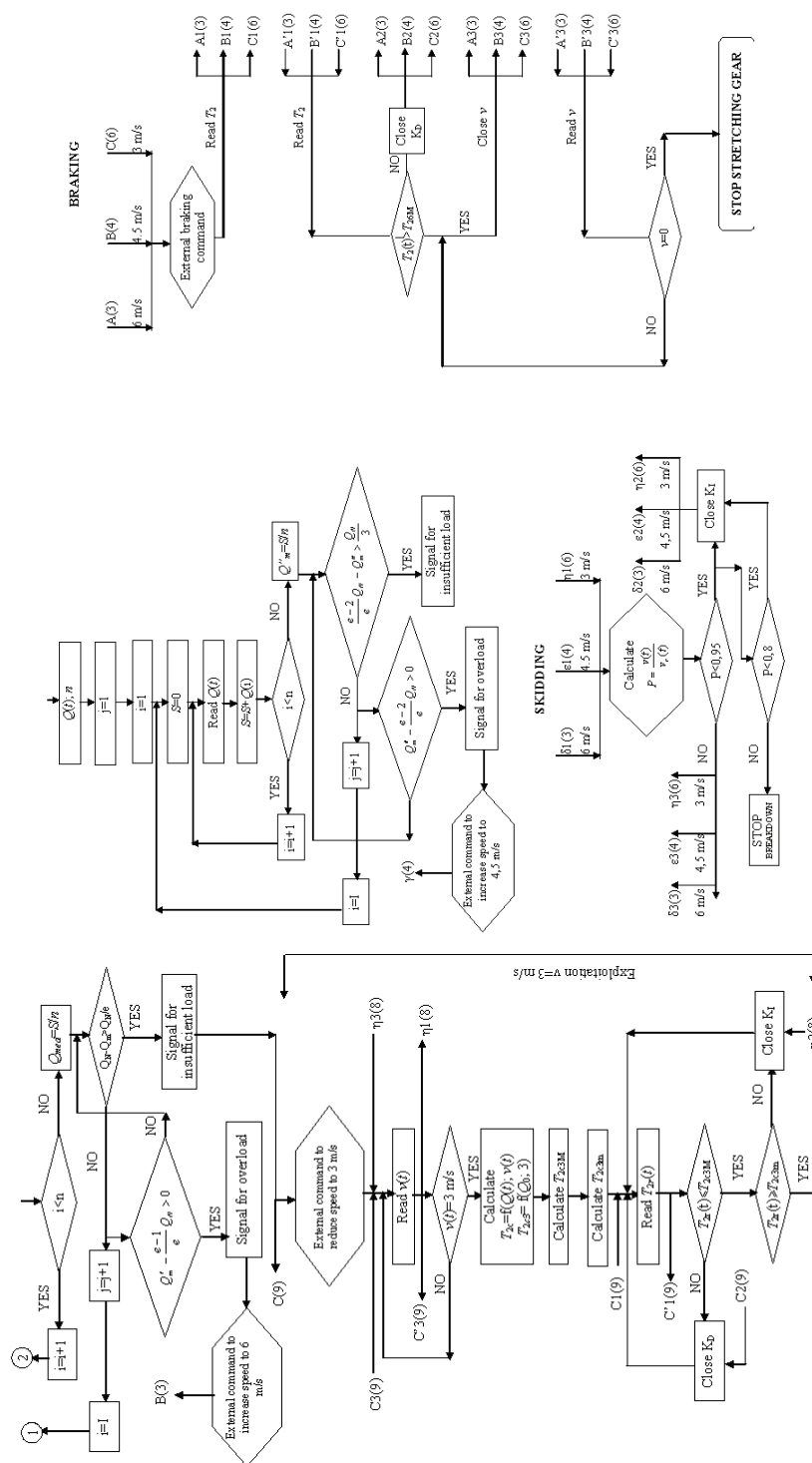**Fig. 2** Logical scheme of the automated driving algorithm of the stretching installation (part 1)

Fig. 2 Logical scheme of the automated driving algorithm of the stretching installation (part 2)
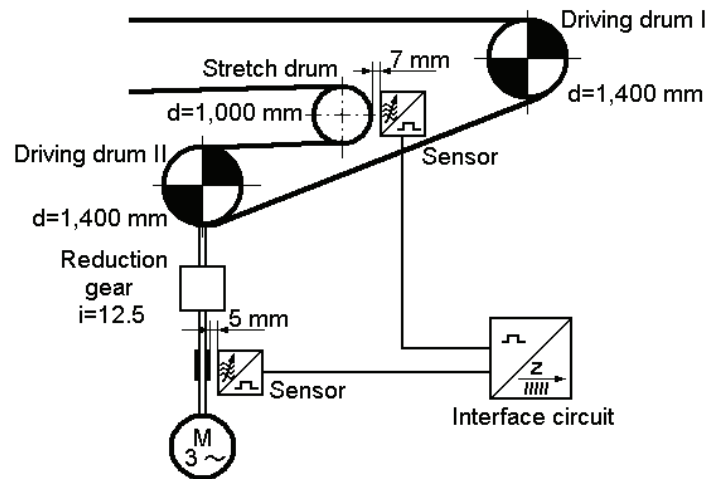
Fig. 3 The main scheme of the conveyor's skidding notification device

3 CONCLUSIONS

❑ When choosing the type of electric engine for driving the stretching device, the proper attention will be given to the specific working methods of the high output conveyors in the lignite quarries (transitory methods of acceleration and breaking, repeated starts);

❑ The analysis of the strain in the mat, according to the main parameters which define it, leads to the significant change of the current command scheme of the stretching device;

❑ The accomplishment of a system of optimal management of the automated stretching process may materialize through the introduction of a process computer; this computer through its terminals will process the information provided by the transducers from along the conveyor belt.

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