THE IMPLEMENTATION OF A PROGRAMMED CONTROL SYSTEM FOR THE TRANSPORTATION OF RAW MATERIALS IN A FNC

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ABSTRACT

Within the technological flow in a FNC are taking place several highly complex processes which should be very carefully monitored in order to obtain diversified recipes and continuous improvement of the products quality. One of the most important activities in a FNC is the transportation of raw materials between the different workstations.

This article presents the possibilities of implementing automatic control equipment for the transport activities which are taking place in a FNC by designing some devices based on electronic contactors which allow the operators to transmit switching start or stop signals to the engines which control the horizontal conveyor belts and the vertical elevators in case of detecting problems in their normal rhythm of functioning, so that any possible losses of raw materials to be maximum limited. [7,8]

INTRODUCTION

When they get inside the FNC, the raw materials used in the manufacturing process are unloaded in special places called reception stations where the quantitative reception (weighing) and the qualitative reception (taking samples) are made. From here, the raw materials will be transported through a series of redler type conveyor belts to the elevator base, i.e. the place of supplying the devices transporting the raw materials to the manufacturing facilities of compound feed. [1, 7, 8]

The redler belt is an electromechanical horizontal conveyor (Fig. 1 a and b) consisting in a series of connected links forming a closed chain, which is then put into a horizontal movement by an electric motor (Fig. 2) and a speed reduction unit.

a

b

Fig. 1 – Horizontal conveyor with a metal chain transport system

The elevator is a vertical transport device for raw materials, made of two vertical pipings with rectangular cross-section through which is moving a conveyor belt on which are mounted cups of transport at equal intervals.

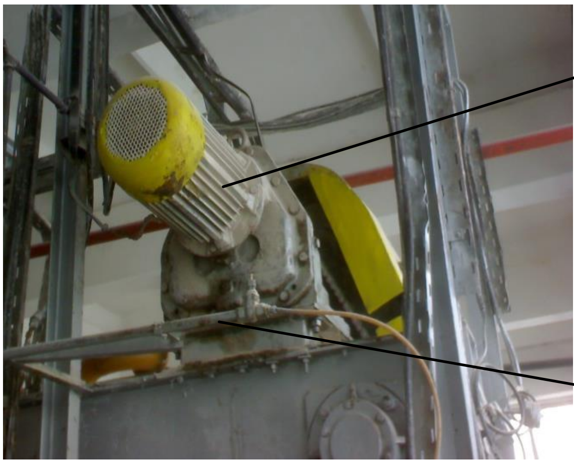

Fig. 2 - Motor driving of a horizontal conveyor and the compressed air column which operates on the shiber

MATERIAL AND METHOD

The main technical problems that may occur quite often during the technological flow are related to the majority of raw materials transport, milled product transport and the transport of the final product to the delivery bunkers [5, 7, 8].

These technical problems were the blocking of the conveyors, the elevators, the screw conveyors, and the pneumatic conveyor, all because of metallic objects or other kind that may accidentally occur in the product mass.

Any disruption of the normal course of the activities in the mixed fodder production process causes significant losses of time and money, with immediate consequences on the factory performance and productivity. [5]

In order to not stop or to hinder the production process, the following methods were applied:

1) The transport of raw materials made with Redler type conveyors and the elevators to work after a scheduled kinematics, i.e. at the startup will work the last section of the transport flow, then the last but one section and, at the end, the first section of the transport route to avoid agglomeration of raw materials along the route;

2) The elevators to be protected by an electronic surveillance system of charging that will stop, in case of breakdown, the running of the upstream conveyors;

3) The limitation of power supply for the first conveyor through a special device called shiber.

Supplying the production facilities of different mixed fodder with raw materials recipes with the necessary quantities is a mandatory and necessary condition for the proper development of the technological flow activities [10].

The raw materials supply system for the studied FNC consists of:

a) two horizontal conveyors;

b) a vertical elevator.

All these devices from the conveyors route are operated by three phase motors with a star delta starter. In the next figure (Fig. 3) it is presented the route taken by the raw materials, from the initial supply bunkers (storage) to the supply bunkers of the mills and production facilities of mixed fodder [2, 6, 8].

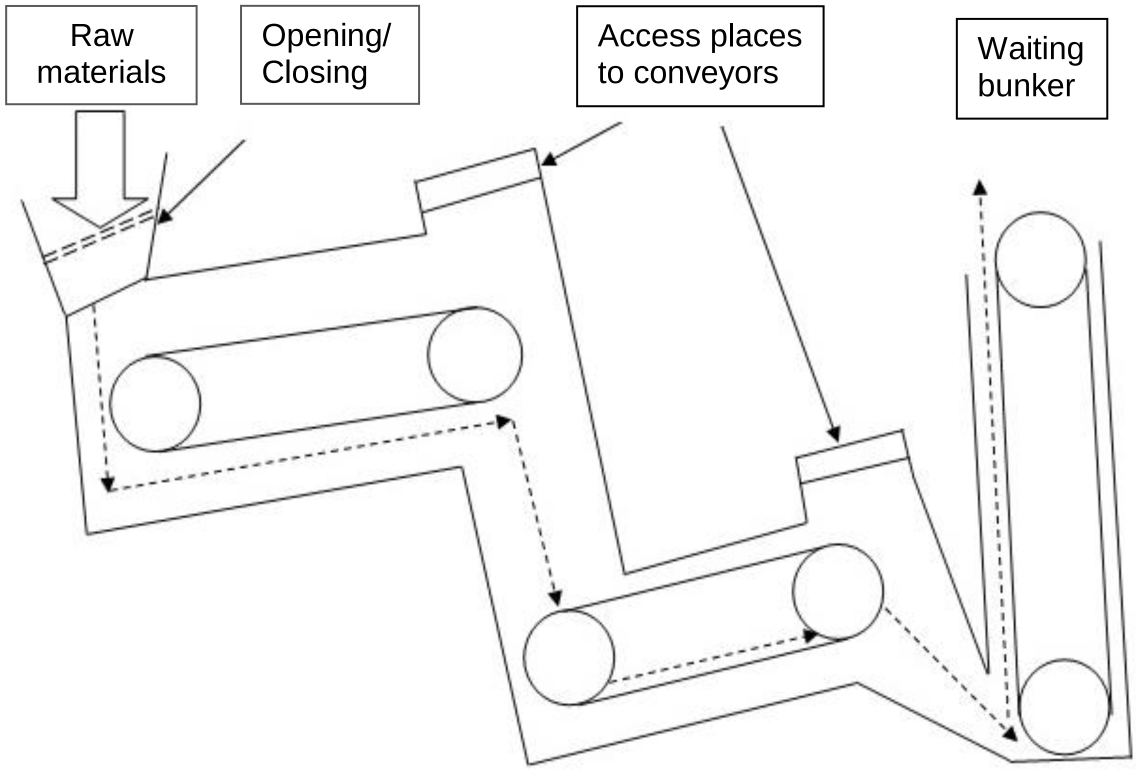

Fig. 3 - Transport of raw materials to bunkers [8]

We note the motors and the contactors as follow:
- Ev line contactor of elevator
- Tr1 contactor of the motor which operate the conveyor 1
- Tr2 contactor of the motor which operate the conveyor 2

It is initially considered that all dipoles serially connected with the coils of the Ev, Tr1, Tr2 contactors include possible contacts, which will be noted with P (start button contacts) and O (stop button contacts). For these motors and contactors, we can describe certain work functions, which allow the electronic implementation of control and activities automatic tracking schemes.

The work functions can be described in the following way:

f(Tr1)=f1(P,O,Tr1,Tr2,Ev) for the first conveyor (Tr1)
f(Tr2)=f2(P,O,Tr1,Tr2,Ev) fr the second conveyor (Tr2)
f(Ev)=f3(P,O,Tr1,Tr2,Ev) for the elevator (Ev)

It can be noted that these functions, which describe the activity of the conveyors and the elevator, depend on 5 work variables (command), thus we have 25=32 work possibilities for each function. Some work variables are:

P = start button
O = stop button
Tr1 = heat protection for conveyor 1
Tr2 = heat protection for conveyor 2
Ev = heat protection for elevator

Initially, the operation is in repose, all contacts are not activated and all dipoles serially connected with the contactors coils are non-conductive, and it can describe the work functions as follows:

$$f1(0,0,0,0,0)=0; \quad f2(0,0,0,0,0)=0; \quad f3(0,0,0,0,0)=0. \qquad (1)$$

When the start button P is activated, only the contactor coil Ev (elevator) must be charged, so that the first time will work only the elevator, which can be seen in the last section of the transport chain:

P=1 şi f1(1,0,0,0,0)=0;
f2(1,0,0,0,0)=0; (2)
f3(1,0,0,0,0)=1

Immediately after the contactor coil Ev charging, it attracts (it takes the value Ev=1) and it charges the elevator motor and this is how the starting conditions of the transport chain are created, regardless of the start button P status ("0" or "1"):

f1(1,0,0,0,1)=0 ; f2(1,0,0,0,1)=0 ; f3(1,0,0,0,1)=1
f1(0,0,0,0,1)=0 ; f2(0,0,0,0,1)=0 ; f3(0,0,0,0,1)=1 (3)

Immediately after the power supplying of the contactor Ev, the impulse (timed) for power supplying the contactor Tr2 is given, starting the second belt located next to the elevator:

f1(1,0,0,1,1)=1 ; f2(1,0,0,1,1)=1 ; f3(1,0,0,1,1)=1
f1(0,0,0,1,1)=1 ; f2(0,0,0,1,1)=1 ; f3(0,0,0,1,1)=1 (4)

In turn, after being power supplied, the contactor Tr2 will generate an impulse (timed) for the power supplying of the contactor Tr1:

f1(1,0,1,1,1)=1 ; f2(1,0,1,1,1)=1 ; f3(1,0,1,1,1)=1
f1(0,0,0,1,1)=1 ; f2(0,0,0,1,1)=1 ; f3(0,0,0,1,1)=1 (5)

After the activation of the contactor Tr1, all three contactors will remain powered and will work until the activation of the stop button O. This stop button (O) has a leading role in the functioning of the transport chain in case of breakdown, therefore it is required that in the case when both buttons (P and O) are activated, i.e. when the P button is accidentally pressed while the O button is active, the system must stop. The first horizontal belt will stop first (Tr1=0):

f1(1,1,0,1,1)=0 ; f2(1,1,0,1,1)=1 ; f3(1,1,0,1,1)=1
f1(0,1,0,1,1)=0 ; f2(0,1,0,1,1)=1 ; f3(0,1,0,1,1)=1 (6)

The stop of the contactor Tr1 will cause the switching off of the contactor Tr2 too:

f1(1,1,0,0,1)=0 ; f2(1,1,0,0,1)=0 ; f3(1,1,0,0,1)=1
f1(0,1,0,0,1)=0 ; f2(0,1,0,0,1)=0 ; f3(0,1,0,0,1)=1 (7)

After stopping the motor Tr2, the elevator motor Ev will stop too, being able to describe the functions as follows:

f1(1,1,0,0,1)=0 ; f2(1,1,0,0,1)=0 ; f3(1,1,0,0,1)=0
f1(0,1,0,0,1)=0 ; f2(0,1,0,0,1)=0 ; f3(0,1,0,0,1)=0 (8)

When the above situation is fulfilled, the transport system is completely stopped, therefore, at that point, the button O can be released. [7, 8]

It is required that the button O to be actuated until the entire transport chain is definitely out of work. Otherwise, the return of the button O to the off position "0" would lead to the condition (4).

RESULTS AND DISCUSSIONS

For this case were considered only the situations from the logical sequence of operations which take place at the startup and the shutdown, the rest of the situations being equal to "0", thus not leading to the modification of the transport chain control scheme.

According to the presented facts, the work functions f1, f2 and f3 can be implemented as follows:

f(Tr1) = P•O!•Tr1!•Tr2•Ev **U** P!•O!•Tr1!•Tr2•Ev **U** P•O!•Tr1•Tr2•Ev **U**
U P!•O!•Tr1•Tr2•Ev = O!•(Tr1!•Tr2•Ev) **U** (Tr1•Tr2•Ev)=O!•Tr2•Ev (9)

f(Tr2) = P•O!•Tr1!•Tr2•Ev **U** P!•O!•Tr1!•Tr2•Ev **U** P•O!•Tr1!•Tr2•Ev **U**
U P!•O!•Tr1!•Tr2•Ev **U** P•O!•Tr1•Tr2•Ev **U** P!•O!•Tr1•Tr2•Ev U
U P•O•Tr1•Tr2•Ev **U** P!•O•Tr1•Tr2•Ev = Ev(O!•Tr1! U Tr1•Tr2) (10)

f(Ev) = P• O!•Tr1!•Tr2!•Ev! **U** P•O!•Tr1!•Tr2!Ev **U** P!•O!•Tr1!•Tr2!•Ev **U**
U P•O!•Tr1!•Tr2•Ev **U** P!•O!•Tr1•Tr2•Ev **U** P•O!•Tr1•Tr2•Ev **U**
U P•O!•Tr1•Tr2•Ev **U** P•O•Tr1•Tr2•Ev **U**P!•O•Tr1•Tr2•Ev **U**
U P•O•Tr1!•Tr2•Ev **U** P!•O•TR1!•Tr2•Ev = O!•Tr1!•Tr2(P **U** Ev) **U** (Tr1•Ev) (11)

where: the sign "!" put after Tr1, tr2, O, P, Ev means that the logical value is negated.

The representation of the structural expressions in the relations (8), (9) and (10) about the work functions f1, f2 and f3, leads to the following operating electric scheme of a raw material transport train for the technological flow in FNC (Fig. 4).

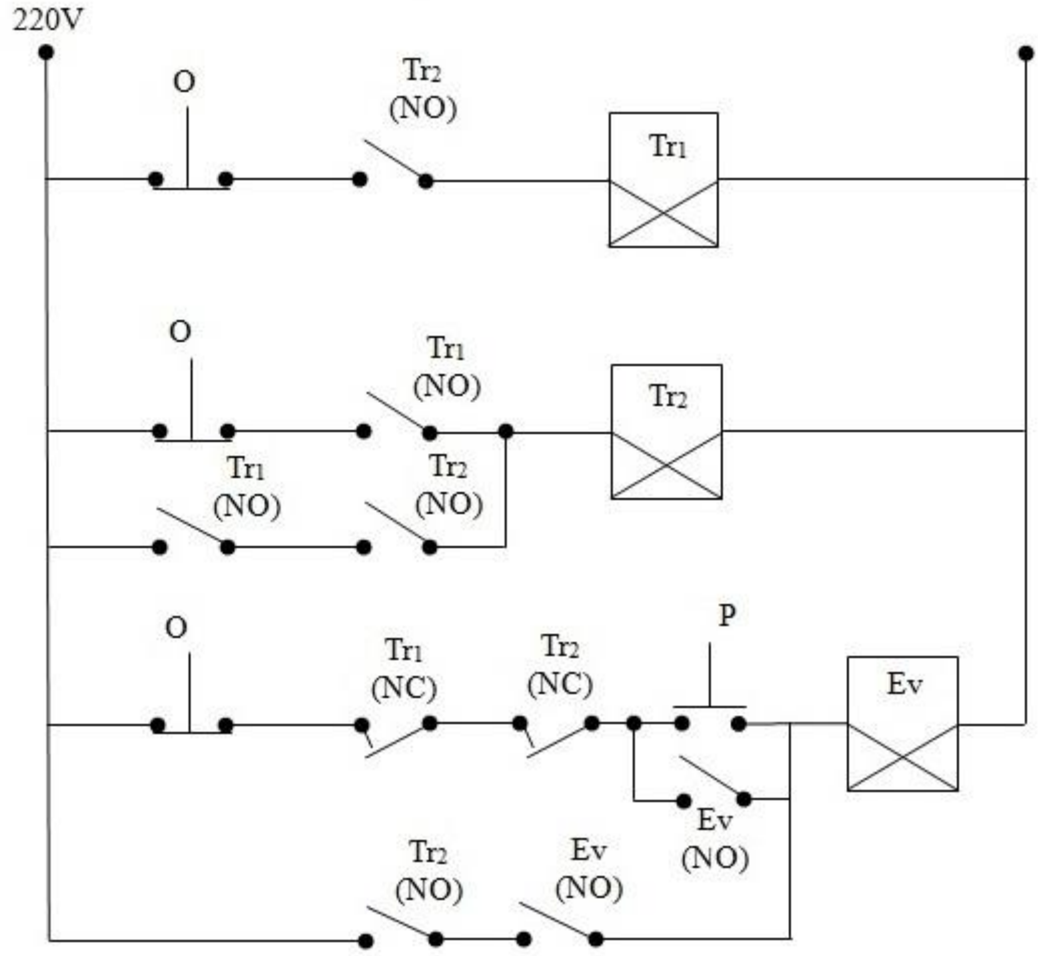

Fig. 4 – The operating electric scheme of a transport train

Following the electrical trails in this schema it can be observed a distribution of the signal generated by the stop button O toward several circuits, when it is desired the shutdown of the entire transport chain, which implies that several connections to the taggers of the Button O must be made.

It can be implemented a simplified version of this operating scheme of the transport train (Fig. 5) in which it can be used only one time the connection to the power off button O and also by a much simpler connection to the contactors Tr1 and Tr2.

Also in this simplified electric scheme it can be highlighted the influence of the contactor Ev in the coupling for the functioning of the conveyors motors, Tr2 and then Tr1.

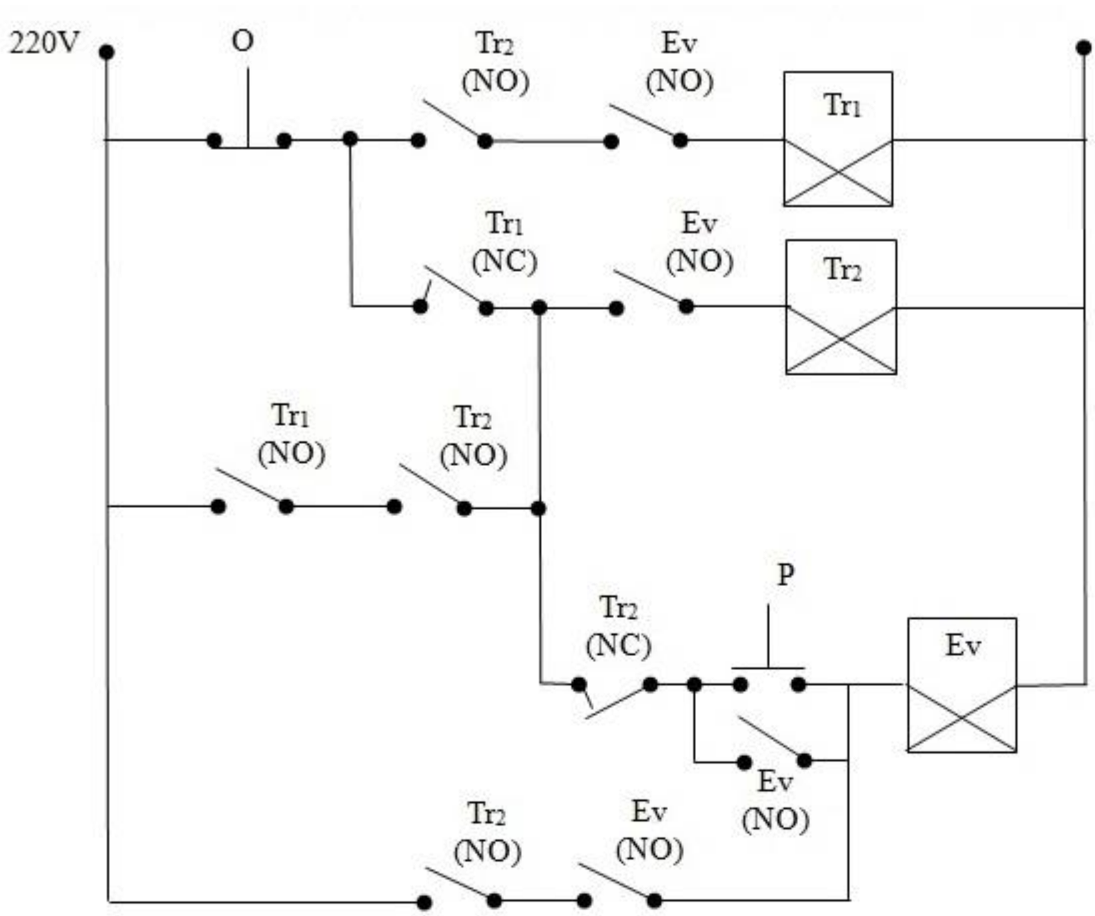

Fig. 5 – The simplified operating electric scheme of a transport train

CONCLUSIONS

The studies and the technical implementations for the problems which may occur during the transport activities of raw materials in a FNC were performed at Provimi Craiova. This is one of the most popular FNCs in our country, having an important role in the production of mixed fodder aimed at beneficiaries in the south of Romania.

By implementing these automatic electronic control devices of the conveyors train kinematics, a number of benefits can be highlighted:

- a significant reduction of time interruption of work flow
- increasing the degree of safety in the operation of transport facilities for raw materials from FNC
- the elimination of almost all losses of raw materials on their transport course from the receiving stations to then mixed fodder production facilities
- the increase of work productivity by providing an automatic control of the conveyors train startup and shutdown
- the improving of the production process and, as an immediate consequence, the increase of the obtained finished products quantities.

Therefore, and because of these new implementations for the automatic electronic control devices of technological flow kinematics, FNC Provimi Craiova obtained productions increasingly better over the past years of activity (Fig. 6).

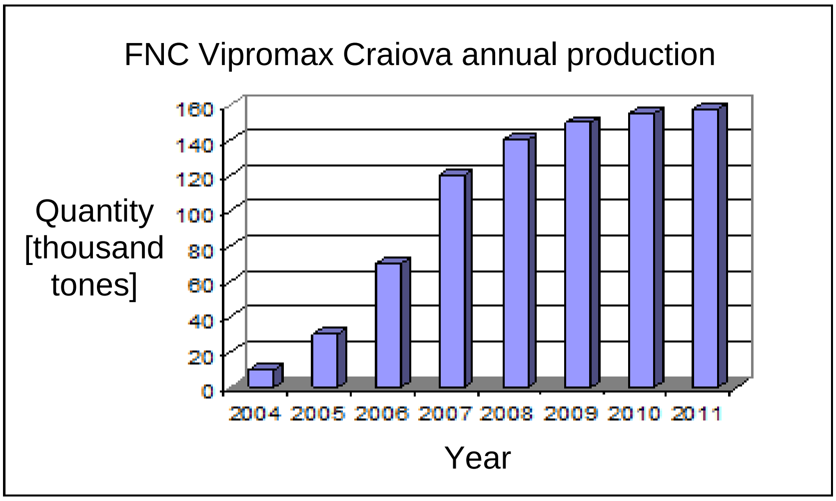

Fig. 6 – The progress of the mixed fodder production at FNC Vipromax Craiova

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