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AUTOMATIC ADJUSTMENT SOLUTION WITH FLUIDIC ELEMENTS FOR THE PNEUMATIC INDUSTRIAL EQUIPMENTS

Adriana COTEȚIU[1], Miorița Ungureanu[2], Dinu Stoicovici[3]
[1] Professor Eng., PhD., [2] Lecturer Eng. PhD., [3] Lecturer Eng. PhD.,
North University of Baia Mare, Faculty of Engineering,
Str. Dr. V. Babes 62A, 430083-Baia Mare, Romania,
acotetiu@ubm.ro; m_ungureanu@ubm.ro;

ABSTRACT
This paper presents the actual solution used by Tamrok Enterprise and a personal solution for the implementation of the digital devices in the pressing strength's control of a pneumatic rotating hammer drill, which is included in the structure of the perforator installation. The monostable element, which was proposed to use, is a special device with an incompressible fluid as supply jet and compressible fluid as command jet
***Key words*:** bistable element, monostable element, automatic adjustment of the pressing force, advance force, pneumatic rotating hammer drill.

1. Introduction

In the assembly of the actions meant to lead to the intense promotion of the technical progress within the mining industry, the extension of the hard works mechanisation is necessary, with a great volume of underground work, as well as the automation of some operations in the extraction process generally, respectively of perforation.

The mechanisation of the basic operations pertaining to the process of digging the haulage ways, represented by; the drilling of the mine holes operation of loading – exhausting of the detritus, plays a very important role in obtaining superior technical and economical indicators of the drilling process. But these are limited by the performances of the drilling machines and supporting installations belonging to the drilling equipment. The low parameters at the drilling operation (which requires a great volume of time and work, small qualitative leaps, harsh conditions and low hygiene of work, lead to a decreasing speed of digging, influencing negatively the efficiency of work. These problems are solved by: the utilisation of drilling installations equipped with high performance drilling machines; the automation of the operations that require continuous supervision of human operator and of the ones that could produce stagnation within the drilling process of the mine holes; the usage of

the drilling installations for the drills support by accelerating the digging speeds (which increase 2-3 times in comparison with the manual drilling) the drilling efficiency and work productivity increase, and the human operator's physical effort is diminished a lot, his activity being reduced at supervision and control from distance. There are many enterprises producing mining equipment, famous by tradition and competitive solutions, which produce a great variety of drilling installations. The necessity of continually increasing the digging speeds, the site and form of the digging profile, the nature of the rocks, the utilisation field extension, the increase of the functioning duration and of the utilisation coefficient, the automation of the operating conditions, permanently generate constructive – functional changes for drilling machines and installations [1], [3], [4].

2. Appreciation concerning the pressure force control, by adjusting the advance speed at drilling installations equipped with pneumatic rotating hammer drills

In order to obtain the best conditions of work and avoid the drill blockage, one of the most frequent damage, which takes time for repairing, different systems of automation were conceived for the operations of the drilling installation. With their help, the force of advance, respectively the speed of the advance mechanism, may be adjusted depending on necessities. By adjusting these parameters, their values are maintained within the limits of obtaining efficiency and increased productivity, if the work quality and the imposed safe are complied with. These systems do not require the continuous supervision of the human operator and can even produce the stopping of the drilling process [1], [2], [6].

The automation systems of the drilling conditions adjustment are divided in two groups:

- systems that function after curves of optimal variation of the drilling parameters, depending on rock characteristics, curves preliminarily established on the basis of some researches;

- systems that automatically search for optimal parameters after a given criterion, called adjusting systems.

The automation adjusting systems are the most used, because they do not require preliminary researches of conditions, because the choice of the optimal conditions is made during the drilling period. These systems have the role to set off due to the additive and parametrical disruptions that interfere during the drilling process, so that the different performances can be attained (production cost, productivity, the usage of a rational charge from the point of view of the loads and the drilling installation). In this sense, the adjusting

system identifies the disruptive sizes of the drilling process by measuring the drill rotation, the moment of the turn, the supplying pressure of the advance rotating engine and corrects the advance forces size and direction, or adjusts the energy and frequency of the percussion through the variation of the mechanism piston run [4], [5].

2.1. Analysis of the solution used by Tamrok Enterprise concerning the automatic adjustment of the pressing force at the pneumatic rotating hammer drills

The schema of the supplying system with hydraulic energy produced by Tamrok is presented in figure 1. This allows the automatic adjustment of the perforator advance force

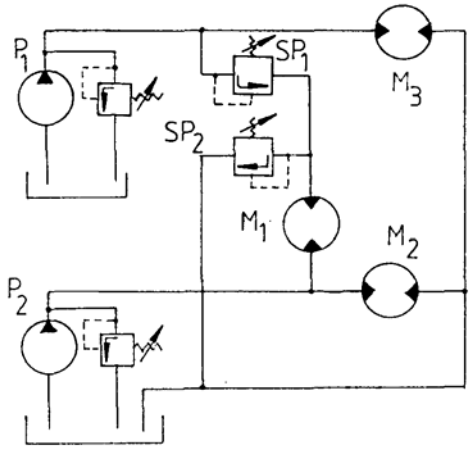

Fig. 1

The automatic adjustment schema of the advance force made by Tamrok

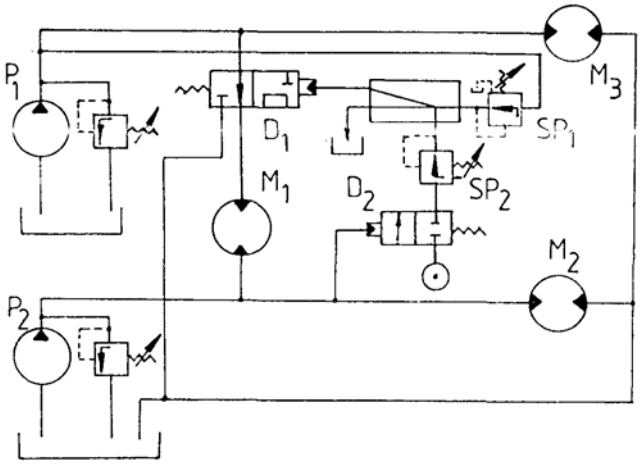

Fig. 2

The automatic adjustment schema of the advance force, with fluidic elements, based on the simplified hydraulic schema made by Tamrok

depending on the rotation of the M_2 engine of drill turn. The schema particularity consists in the fact the return of the working liquid from the advance engine M_1 is connected to the engine supplying circuit pertaining to the drill rotation mechanism M_2. The schema is provided with delivery pump of constant flow P_1 (for the supply of the engine percussion mechanism M_3), hydraulic pump P_2, (for the supplying of the engine rotation mechanism M_2), valve SP_1 for pressure adjustment and engine M_1 of advance mechanism operation. The effective pressure at the advance engine M_1 inputs is on one side determined by the adjusting valve SP_1 and on the other side is given by the pressure from the engine M_2 input the rotation mechanism. As the charge increases on engine M_2, due to the increase of the couple resistant at drilling, the pressure at the engine M_2 input will increase, too and correspondingly, the supplying pressure

of the advance engine M_2. When the hydraulic rotation engine M_2 is overcharged, the pressure at its input becomes greater than the pressure adjusted at valve SP_2. In this case, the oil flow penetrates from pump P_2 to engine M_2 (on the opposite side) and then, through valve SP_2 at return. Thus the inversion of the engine M_1 turn direction is made and consequently the drill retreat, until the recovery of the rotation engine M_2 turn.

2.2. Analysis of the fluidic variant concerning the automatic adjustment of the pressure force at the pneumatic rotating hammer drills

The theoretical and experimental study made the fluidic amplifier of bistable fluid, that has the Coandă effect at the basis of its functioning, opened certain perspectives concerning its utilisation possibilities in the schemas of automatic adjustment of the advance force. This one has a construction based on an amplifier model for supersonic compressible fluids, studied by Italian F. Bavagnolli. Its particularity consists in the fact that it uses in operating liquid supply jet and compressible fluid as command jet [3]. The experimental researches it was observed that the presence of the command jet determines only a partial commutation of the power jet, and the loss of the command does not lead to the memorising of the useful signal in the opposite canal, but to a symmetrical flow on the two receiving canals. The described operation characterises rasher a monostable fluid element, a particular case of the bistable element. This explains the reason why we recommend the monostable utilisation in the proposed implementation solution. At the elaboration of the existent variant of automatic adjustment of the advance force, used by Tamrock, and also of the personal solution, with fluid monostable, we started from the following observation: during the perforation a permanent modification of the resistant couple takes place, of rotation of the hammer drill and also of the charge on the rotating hydraulic engine. This leads to the modification of the engine turn and of the pressure in circuit. The variation is noticed by a valve, set in the supplying circuit of the hydraulic engine of drill rotation. This one transmits a command signal in the sense of adjusting of the supply parameters pertaining to the operating engine of the advance mechanism and this adjusts the value of the drill advance speed.

On the basis of the hydraulic schema made by Tamrock, used for the automatic adjustment of the drills advance speed, respectively of the pressure force, presented previously, a variant of automatic control of the same size, with the help of a fluid monostable was proposed. In the new solution, fig. 2, the two pressure valves SP_1 and SP_2 are replaced by a supplier D_1, hydraulically controlled by the fluid monostable element EF. The proposed schema comprises in addition a source of compressed – air, the supplier D_2 and the valves for

decreasing the pressure of the command jet, respectively of the power jet, the fluid element operates with. As the charge increases at the engine of the rotating mechanism M_2, due to the increase of the resistant couple at drill, the pressure at the entrance in the engine M_2 increases and, correspondingly, the supplying pressure of the advance mechanism engine M_1 increases, too. When the rotating hydraulic engine M_2 is overcharged, the pressure at its entrance becomes powerful enough for commuting the supplier D_2, thus the turn direction inversion of the advance mechanism engine M_1 takes place. This ensures the drill retreat from the working front, until the recovery of the rotation engine M_2 turn, when the phenomena take place inversely.

The solution proposed do not exclude the possibility of using a fluid element with jets of the same physical nature (liquid – liquid or gas – gas), which presents stability and better performances during the operation. During the usage of the fluid amplifier of monostable type (with mixed jets or the same nature), as automatic adjusting elements in the pneumatic circuit of the drilling installation, some difficulties appear, due to the fact that they are sensitive to the sonorous oscillation, to the flow and pressure variation, which may appear in the supply networks with compressed air. These problems can be solved by a sufficient screening and equipping of the installation with a buffer reservoir of compressed air, with fluctuations standardisation role. In the experiments made upon three fluid elements, it was not taken into account the fact that, in the automatic adjustment solution presented, the fluid monostable utilisation was proposed, particular case of the bistable studied in the experimental attempts. A correction must be imposed: the choice of a medium angle of 14^0 and complying with the condition $b_{a2} \cong 2b_{c2}$ [3] for the monostable prototype.

3. Conclusions

In this paper is presented the solution used by Tamrok, as well as the personal solution of automatic adjustment of the advance force, with fluid elements, at the pneumatic rotating hammer drills. The solution of fluidic command proposed presents superior advantages to the existing variants, as well as to the automation solutions with electronic components, due to: the safety in operation in hostile environments (explosive and wet atmosphere, as high temperatures). For the practical realisation of an automatic adjustment with fluidic element of those tested within the experimental programme type, for the monostable fluidic amplifier prototype must be chosen a medium angle $\beta = 14^0$, and complying with the condition $b_{a2} \cong 2b_{c2}$ [3]. In the practical realisation of the proposed variants for the automatic adjustment of some seizes characteristic to the perforation process, with the help of the fluidic elements may

appear some difficulties. This depends first of all on the solving of the problems concerning their sensitiveness to sonorous oscillations, to flow and pressure variations from the system, and especially on the economical and financial availabilities of the beneficiaries from the mining industry.

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