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THE STUDY AND DESIGN OF SEMIAUTOMATIC EQUIPMENT FOR THE CLOSING OF SHOCK ABSORBERS THROUGH THE ROLLING METHOD

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Abstract: *The main method for the closing of shock absorbers is rolling. For the achievement of the distortion of the end of the reserve cylinder, in order to reach the residual force (the clasp force of the inner packet by the closing torus of the reserve cylinder) recommended, a well defined force has to be developed, depending on the diameter and the thickness of the tank tube that is to be deformed and the size of the crimping addition. The objective of this paper is the study and design of semiautomatic equipment for the closing of shock absorbers through the rolling method of shock absorbers with a wide range of tank tube lengths, and also of the functional structure of the equipment with the shifting/settlement of the damper in the sertization process.*

Key words: *the rolling method of shock absorbers, functional structure of the equipment.*

1. ROLL SEAMING PROCESS. INFLUENCE FACTORS

Fig. 1 presents the crimping method of the reserve cylinder, in which the limitation of the length of the sealing stroke is done at the head of the stroke by a mechanical cam for the crimping addition as max and as min.

Thanks to that fact that the tube interior elements dimensions chain is a sum of the dimensional tolerances that vary from a shock absorber to another, according to the constructive documentation, between the minimum and maximum limits, and the tolerance of the interior dimension of the reserve cylinder varies between minimum and maximum limits too, an roll seaming stock value results, which is comprised between the values resulted according to the formula (1):

$$a_{\max} = L_{T\max} - L_{I\min} \qquad (1)$$

where: $a_{\max}$ = maximum roll seaming stock; $L_{T\max}$ = maximum value of the length of the interior dimension chain of the reserve cylinder, at tolerance fields upper value; $L_{I\min}$ = the sum of the interior elements values (valve body, pressure tube, guide way and closing garniture) at the tolerance fields minimum value.

The distortion process of the reserve cylinder has to stop at the proper time, so, through the distortion and its maintenance in this position a prescribed residual stress is achieved.

In order to distort the reserve cylinder, so we can achieve the recommended residual force, a well defined power (related to the diameter of the reserve cylinder that must undergo the distortion and the size of the roll seaming stock) has to be developed. In order to control the sealing phenomenon of the bumpers, the distortion process and the factors that influence the quality of the roll seaming by closing the interior elevation chain (in the limits of the recommended residual force) have to be controlled.

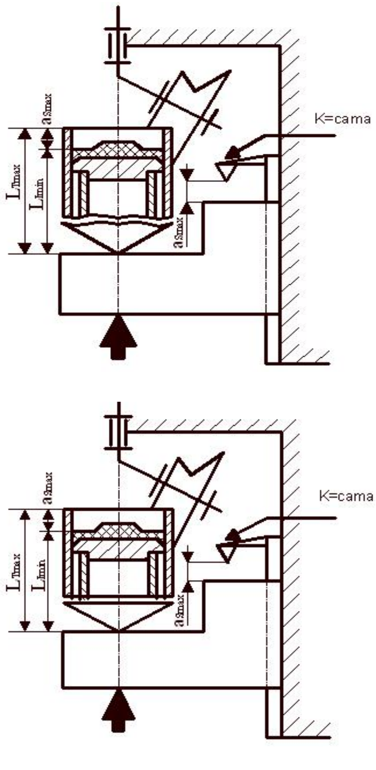


Fig. 1. Limitation method for the sealing at the head of the stroke on a mechanical cam.

The influence of the resulted power loss from the following factors is considered unimportant: mechanical factors (frictions in theroll seaming machine guid wais), the mechanical characteristics of the material that is undergoing the roll seaming proces (diferent specific elongation) and as well as other factors with a smaller value (Friction betwen rollers and reserver cylinder). Mechanical work developed by the hydraulic engine and consumed in order to distort the reserve cylinder is directly proportional with F [N] – the distortion force in the covered as space (2):

$$P = L / t = F \times as / t = p \times A \times as / t = p \times A \times v \quad (2)$$

where:

as – the distance covered from the beginning of the distortion process until the end of it;

p – the pressure from the hydraulic engine;

A – the area of the hydraulic engine's piston;

V – *as* / *t* being the optimum distortion speed.

Analyzing the 2[nd] formula, we can come to the conclusion that: in order to achieve the imposed residual stress we need an expenditure of energy in a well defined time gap *t*. The result being an uncollapsible assembly obtained through the mechanical distortion of the cylinder; the operation can be accepted as a roll seaming operation of the reserve cylinder.

The optimum, at the time of the roll seaming, being dependent of many objective factors and it is difficult to control for each shock absorber. The values of the parameters that influence the quality of the roll seaming are experimentally determined. The determination is being done upon the factors that can be modified

Stress and distortions at the reserve cylinder of the shock absorber during the sealing process/method through rolling (ANSYS LS-dyna program). The tank tube is being considered fixed in the lower part and stressed in the upper part. The stress are the pressures applied on the upper/exterior part by the drive force *F* = 15000 daN of the bumper between the roll seaming rolls, and on the lower part by the medium residual force within the bumper F_R = 700 daN.

The tank tube of the bumper was shaped with the help of the CATIA program, after which it was imported in the ANSYS program (Fig. 2).

2. INFLUENCE FACTORS OF THE DISTORTION PROCESS

The size of the roll seaming stock from experimental determination we can conclude that the stock accepted by the roll seaming method through rolling can be comprise between 3 and 6 mm; under the 3 mm value the distorted material over the closing garniture is unsatisfying from the mechanical resistance at the traction force point of view (the distorted material is insufficient, this could lead to tensile yield of a roll seaming in the case of pull axial stress and an shiftless of shock absorber encasing).

Over that value of 5 mm the material is acting unfit during the roll seaming (leads to a non-steady roll seaming -folded- thanks to the fact that the material takes undefined geometrical shapes at the exit from the contact with the active surface of the rolls; leads to the creation of unsealed spaces between the garniture and the reserve cylinder).

It is recommended that the value of the roll seaming stock be comprised between 3 and 5 mm, related to the reserve cylinder's diameter and the thickness of its wall.

For a shock absorber that has the thickness of the reserve cylinder of 2 mm of the unprocessed pipe in the roll seaming area with an exterior diameter of Ø 42 mm of the soft material N.B.K.St 52-3, with a specific alongation of 24%, an optimum roll seaming is obtained with an roll seaming stock of 4.5 mm, a pressure discharged by the hydraulic group of 70 bar and a distortion time of 3.5 s including the time from the start of the roll seaming feed until the contact with the reserve cylinder rolls.

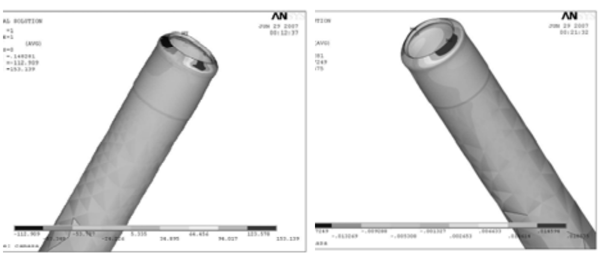
Measurements have been conducted on a definite lot of shock absorbers and the residual force from the interior of the roll seaming shock absorber has been experimentally determined, respecting the optimum values of the sealing packages clasping process as being comprised between 15000 N - 19000 N.

Chart 1 (Fig. 3) presents the value scattering of the stress developed during and after the roll seaming process on a definite shock absorber lot.

3. THE INFLUENCE OF THE ACTION SYSTEM'S ADJUSTMENT ON THE SIZE OF THE DISTORTION POWER OF THE TANK TUBE

According to formula (2), at an optimum pressure of 70 bar with an hydraulic engine having a piston with a diameter of 100 mm, for a bumper with an roll seaming allowance of 5.5 mm, at which the optimal time of deformation energy done is 2 sec, a necessary distortion power of 150 w results, in order to get an efficient roll seaming.

Geometric model of the tank tube Digitization geometric model



Shifting in the XY plane Shifting on the UX direction

Fig. 2. Stress and distortion at the tank tube of the bumper.

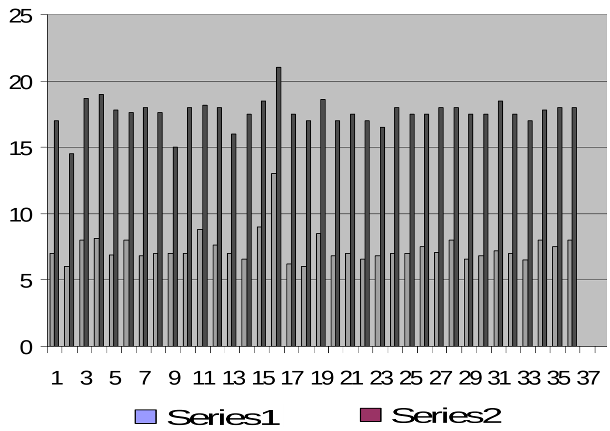


Fig. 3. Delay adjustment control of rolling closeing.

Keeping the value of the power steady in order to maintain the distortion capacity of the machine, in case the roll seaming allowance is changing so it can obtain the same roll seaming effect, a distortion time variation results according to Table 1.

Analyzing the resulted values, we can come to the conclusion that, in order to keep count of the size of the roll seaming stock, we have to continuously compensate the value of time in which the necessary mechanical work in being consumed.

Taking into consideration the fact that the variation of the roll seaming stock is a hard to control variable because it has different values for each shock absorber, that depend on dimensions of component parts of shock absorbers, one of the solutions that can be adopted is the compromise on the clasp force of the interior package by the reserve cylinders surface ring, as in the residual force from the interior of the shock absorber.

This residual force is, at a constant adjustment of the roll seaming machine, variable from a field of forces given by the supported limits of the component elements of the compression.

The shock absorber looses the characteristics he has to maintain through the destroying of the interior dimension chain in the case of crushing of the elements, over the supported value (destroying or distortion).

The minimum value of the residual force is given by the maximum value of the axial component at the traction to which it is undergoing during the performance of the shock absorber, without the destruction of the interior elements.

The method presented in Fig. 2 does not assure the guaranty of steadiness of the pre-stress force at the stroke done by the shock absorber from a point called START until it reached STOP (Fig. 4).

The value of these points is a permanent constant, determined and known (in this case the factor "value of the dimension chain" mentioned before has no significance regarding the sealing of the shock absorber).

The rod gauge, which is acting on a limitative cam which transmits an electric impulse to the delay system of the active stroke is measured as follows: the time in which the shock absorber moves on its active stroke and gives the rapid withdrawal command.

The active stroke has the same value every time, the residual force is constant and in the limits of the constructive documentation of the shock absorber.

4. DESIGN ELEMENTS OF A SEMIAUTOMATIC EQUIPMENT FOR BUMPER SEALING THROUGH THE ROLLING METHOD

According to the presented details the way of approaching in conceptia utilajului are la baza the method of temporal adjusting of the sealing by rolling. Because the active stroke has always the same value, the remanent force is constant and in the limits of the prescribed documentation regarding the constructive-functional data of the shock absorber.

The roll seaming equipment contains a stand with a vertical guide column, hydraulic pressure-actuated, which insures the motion cycles: quick approach-roll seaming thrust-quick relief.

Table 1

Distortion time variation

Roll seaming stock asert [mm]	Power *P* [W]	Presure *p* [Pa]	Surface *A* [m^2]	Time *t* [s]
5×10^{-3}	150	7×10^{6}	785×10^{-5}	1.8
4.5×10^{-3}				1.64
4×10^{-3}				1.46
3.5×10^{-3}				1.24
3×10^{-3}				1.09

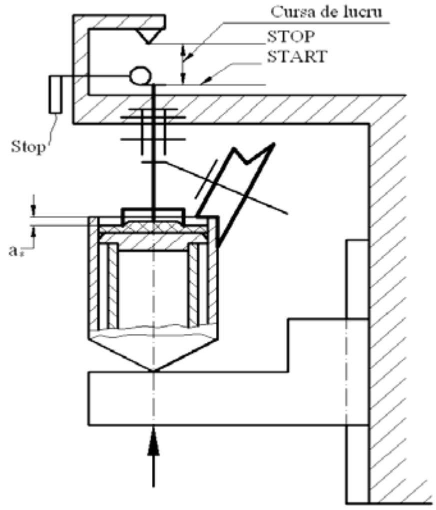


Fig. 4. Stroke done by the shock absorber from a point called START until it reached STOP.

The rotation leading motion is performing of roll seaming had, actuated of adjustable speed motor. Lead/programming is for a semiautomatic character of service.

Shock absorber's characteristics:
- Cylinders exterior diameter .... 38...42 mm
- Wall thickness .... 1....2.5 mm
- Rod diameter .... 12...18 mm
- Lenght of the exterior cylinder .... 200...500 mm
- Lenght of the rod over the tube .... max 180 mm

Technical characteristics of the machine:
- Work posts .... 1 post
- Installation beat .... 3 parts/min
- Work manner .... semiautomatic
- Driving .... electro-hydraulic
- The preclasp force of the shock absorber package ...... 500..2000 daN
- Maximum axial force .... 15000 daN
- Installed electric power .... 5 kW

The component subassembly of the equipment is presented in Fig. 5, it works in a semiautomatic regime with the following faze sequence:

- Shock absorber anchoring/clasp
- Lifting of the mobile system with a quick approach speed
- Lifting of the mobile system in a work regime
- Descent and standing for gauging
- Descent with a quick withdrawl speed
- Shock absorber removal.

The mobile vertical shifting/anchoring system (Fig. 6) assures the vertical position and coaxiality of the shock absorber in reference to rollinghead axis during the process.

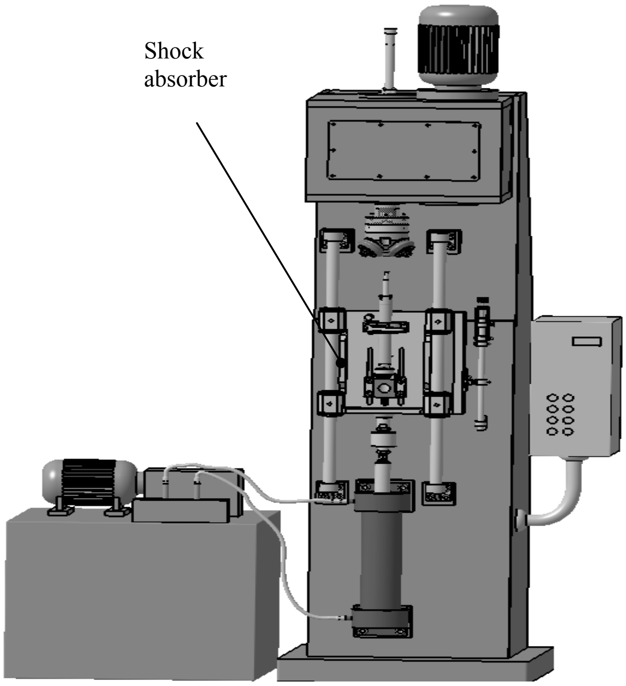


Fig. 5. Equipment for roll seaming closeing of shock absorbers.

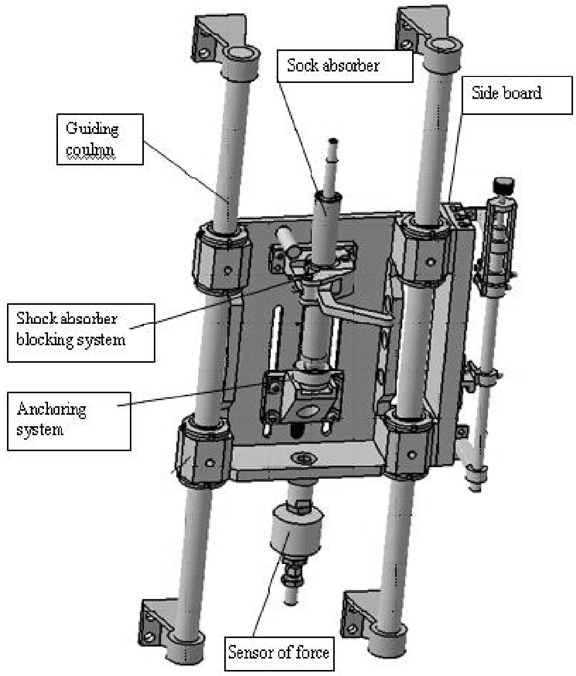


Fig. 6. Vertical mobile anchoring/shifting system.

The mobile vertical shifting/anchoring system (Fig. 6) assures the vertical position and coaxiality of the shock absorber in reference to rollinghead axis during the process. Also, the system has to assure a high rigidity because there is no clearence or radial clattering of the shock absorber during the rolling process.

The mobile system is moving on the vertical direction, being guided by two columns; it is being driven by the linear hydraulic engine which is atached by an overload protection system.

The working unit is made of the punch down head, the revolutions adjusting equipment and the electical driven engine.

The punch down head has the role of disorting by rolling the upper part of the bumpers tube tank. This deformig takes place due to the „flowing" of the material on the profile of the punch down roller. The distortion is made by pushing the bumper with a force F = 1575 daN, betwen the rollers of the punch down head.to whom, due to the friction force and the revelations of the punch down head a rotation around their own axis is imprinted. In this way is possible to perform a closeing of shock absorber with a prescribed rezidual force.

The hydraulic installation is used for:

- bringing the bumper in the position for acomplishing the locking operation;
- acomplishing the closing of the tank tube.

5. CONCLUSIONS

The paper presents an optimisation of the roll seaming method for shock absoerbers reserve cylinders, practiced in the auto industry and the objectifying of that – the semiautomatical equipment – which insures a constant active stroke so that the residual obtained force is constant too and in prescribed limits.

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