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METHOD AND INSTALLATION FOR VERIFICATION ON RIG, THE EFFICIENCY OF TRIM CORRECTOR EQUIPMENT, ACHIEVED WITH ORIGINAL ROMANIAN TRIM ACTUATORS

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Abstract: *The paper show the method and installation conceived to adjust and verify on rig, the efficiency of trim corrector equipment, made with the original Romanian shock absorbers with cylindrical pneumatic trim actuators - patent application PCT/EP2016/061515, belonging to the first author. The trim actuators are controlled with electro-pneumatic equipment realized according to a solution from the nominated patent application. For simplicity, the installation uses a traction-compression machine between whose ferries is fitted the shock absorber equipped with the pneumatic actuator, it being linked to the three-way valve that realize the connection with air compressor or with atmosphere, function to the wanted floating force. The method is to verify the actuator capacity to realize wanted buoyant force at different elongation, thus assuring possibility to put the vehicle in wanted body ground clearance, for any vehicle load state.*
Keywords: *shock absorber, pneumatic actuator, trim corrector, traction-compression machine, buoyant force, ground clearance.*

1. ON THE ROMANIAN SHOCK ABSORBER WITH CYLINDRICAL TRIM ACTUATOR

Comparative to the known air lifting solutions realize with rubber sleeve/ bellows the new Romanian solution create a controllable buoyant force under the damper dust shield, by sliding closing the area between dust shield and outer cylinder and filling it with compressed gas/air at proper pressure.
The new solution is more compact, reliable and resistant at high pressure, thus having possibility to fully eliminate the steel spring, his function being full taken by the air spring device.
Figure 1 [2] shows two samples of shock absorber with cylindrical trim actuator, realized for rear suspension of Logan MCV car. The elements from Figure 1 are presented in Table 1.

Table 1: The components of shock absorber with cylindrical trim actuator

Pos.	Elements	Pos.	Elements
1	Shock absorber outer cylinder	9	Annular piston
2	Bump cup	11	Sliding sealing element
3	Rod	12b	Pneumatic cylinder
4	Stopper buffer on compression	15	Quick valve
5	Gripping pads	17	Gasket
6	Washer	18	Special Washer
7	Self-locking nut	20	Centering element
8	Gripping bushing	21	Wiper element

The shock absorber with actuator for trim adjustment (1b), is realized from a standard shock absorber (1) whose replaces the dust shield (12a) with a pneumatically cylinder (12b) whose lid is fasten on the rod (3) and sealed against it with a gasket (17) fastened between the cylinder lid and the special washer (18), the cylinder (12b) being sliding sealing in bottom part by a seal element (11) fitted in a channel from annular body (9) fastened at their turn to the outer cylinder of shock absorber.
The annular body contains the same a centering element (20) and a wiper element (21).
The elements (1) ÷ (8) are taken from standard shock absorber, only elements (9), (11), (12b), (15) being specific for the actuator integrated on the damper.
The cylinder (12b) replaces the original dust shield (12a) equipped the standard shock absorber.

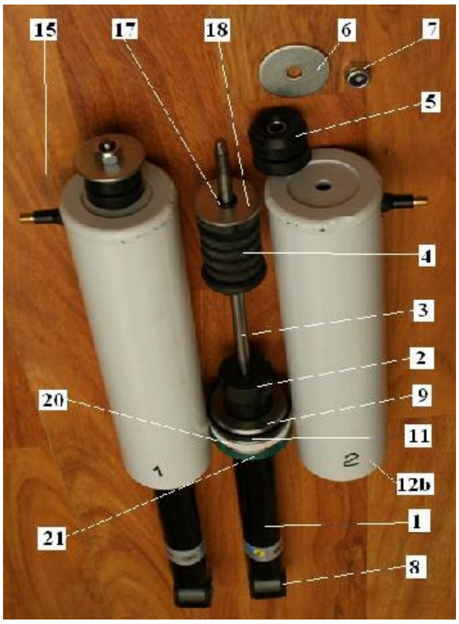

Figure 1: Two samples of shock absorber with cylindrical actuator for trim adjustment [2]

2. EQUIPMENT FOR VEHICLE AXLE TRIM CONTROL AND CORRECTION

2.1. Block diagram of the trim control for an axle

The equipment for vehicle axle trim control and correction consist of mechanically-pneumatically executive equipment and of command and control equipment.
Figure 2 show the block diagram of the trim command and control equipment, for a vehicle axle, the specific elements being presented in Table 2.

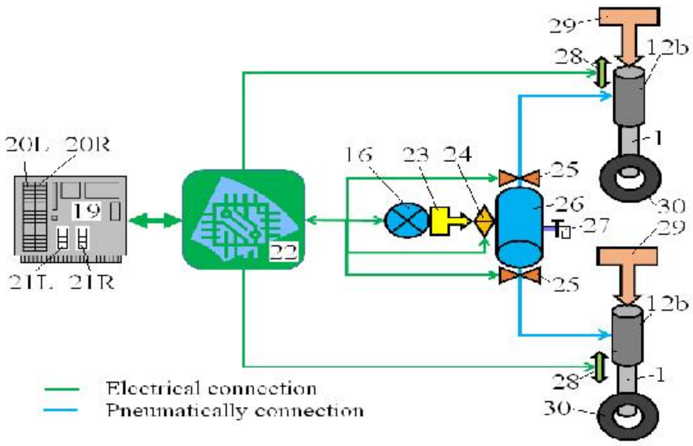

Figure 2. Block diagram of the trim control for an axle

Table 2. Components and block diagram of trim control for an axle

Pos.	Elements	Pos.	Elements
1a	shock absorber	22	integrated control module
1b	shock absorber with actuator	23	air filter
12b	actuator cylinder	24	tank pressure transducer
16	compressor	25	3 way servo-valve
19	command - control panel	26	compressed air tank
20L	clearance display left suspension	27	liquid purge valve
20R	clearance display right suspension	28	displacement transducer
21L	3 way switch- left actuator	29	vehicle body
21R	3 way switch- right actuator	30	axle with wheel

The executive equipment consists of shock absorber equipped with cylindrical pneumatic actuator.
The command and control equipment consist of transducers for displacement and pressure, unit for data analyzing, command and parameters displaying.
The pneumatic cylinders (12b) of shock absorbers actuators are connected to three way servo-valves (25) with air inlet and outlet ports. The actuators are fed directly from an air compressor (16), but preferably from a tank (26).
The air is filtered by an air filter (23), before entering in the tank (26), condense being evacuated by a purge valve (27) fitted on the tank.
The vehicle body ground clearance is evaluated by suspension stroke, measured with linear displacement transducer (28).
Trim adjustment is done by switches (21) with three states, respectively "up", "locked" and "down". Switches (21) is placed on a command and control panel (19), being one for each actuator, switch (21L) for left actuator and switch (21R) for right actuator.

2.2. Block diagram of the of the control algorithm

The panel (19) contains the same a display (20) for each actuator respectively (20L) for left damper with actuator and (20R) for right damper with actuator, which are accorded to indicate each ground clearance.
The switches (21) are connected to the electric-electronic control module (22) which will operate the solenoid valves (25).
Status command "up" will allow the air crossing through the solenoid air intake valve, from the compressor/tank to the shock absorbers actuators. During air intake in the actuators, solenoid exhaust is blocked and actuators rising the vehicle body, increasing the ground clearance.
Status command "down" will allow the passage of air through the solenoid exhaust valve and exit from the shock actuator. During exhaust of air from the damper, solenoid inlet valve is closed and the actuators descend the vehicle body, decreasing the clearance.
Status command "lock" allows keeping the air volume in the actuator, simultaneously blocking both solenoid valves: intake and exhaust.
The solution ensures variable ground clearance (up or down) by driver command from inside the car, stationary or driving, using a control and command panel (19). The user interface displays the current position of ground clearance and available pressure in the air tank.
Information regarding the length of each damper is measured using linear displacement transducer (28), (absolute type), one for each shock absorber. So at any time it is possible to know shock absorbers length and by correlation the current ground clearance.
The air pressure in the tank is measured by a pressure transducer (24).
Air circulation to and from the actuators is controlled by a double solenoid valve (25), with the function of air intake and exhaust, one for each damper.
The operation sequence for the solenoid valve, while modifying the trim, is identical for all dampers and is described in the experimental model.
Air pressurization is achieved by an electric compressor (16), an air conditioning module (23) and a pressurized air tank (26).

Managing the interaction between various transducers (height, pressure), actuators (solenoid valve), elements of force (compressor) and user interface control will be performed using an integrated control module, of electric-electronic type (22).
The control module is presented in Figure3 and based onto an integrated controller which serves as a programming support for a dedicated software that manages the entire system architecture.
The control module will operate in automatic control mode of "closed-loop" type.
The control algorithm consists of two measurement and control loops.

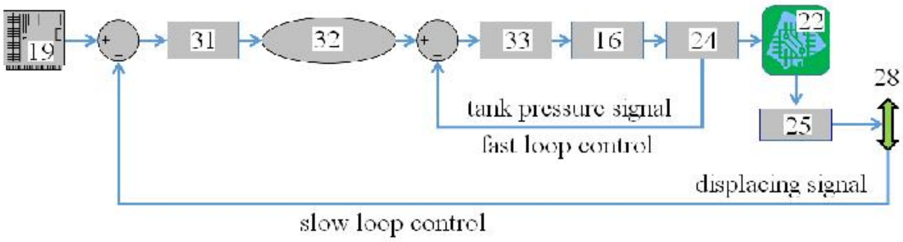

Figure 3. Block diagram of the control algorithm

The first loop does a fast adjustment and manages the pressure in the reservoir by evaluating the pressure transducer and conditioning the activation of the air compressor.
The second loop does a slow adjustment and manages the shock height by evaluating linear displacement of the position sensor, it calculates the needed air tank pressure and does the solenoid valve control.
The fast loop (pressure adjustment) is included in the slow control loop (height adjustment).
Each shock absorber has its own automatic height control loop, managed by the control module in real time.
Changing the shock trim can also be performed during driving the car, which distinguishes this equipment from most systems in the automotive trim adjustment market.
The elements of block diagram from Figure 3 are presented in Table 3

Table 3. Components of the block diagram of the control algorithm

Pos.	Elements	Pos.	Elements
16	compressor	28	displacement transducer
19	command - control panel	31	height regulator
22	integrated control module	32	reference pressure in the tank
24	tank pressure transducer	33	bistable pressure error
25	3 way servo-valve		

3. METHOD AND INSTALLATION FOR THE EQUIPMENT FOR VEHICLE TRIM CORRECTION EVALUATION

3.1. Block scheme of the installation for trim corrector evaluation

The block scheme for the rig designated for trim equipment evaluation is presented in Figure 4.

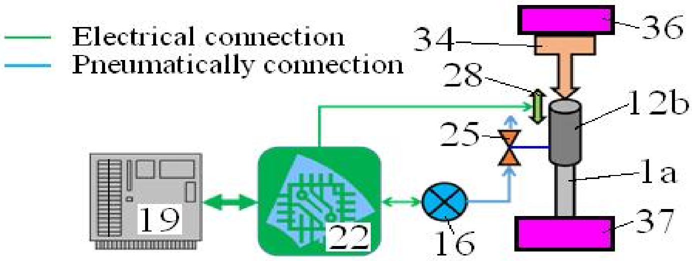

Figure 4. Block diagram of testing installation, for the evaluation the efficiency of the trim correction equipment, for ¼ car model

The installation is realized for testing ¼ car suspension, using a traction-compression machine, between whose clamping jaws is fastened the shock absorber with actuator.
The elements presented in Figure 4 are explained in Table 4.

Table 4. Components of block diagram for shock absorber length control

Pos.	Elements	Pos.	Elements
1a	shock absorber	25	3 way servo-valve
12b	actuator cylinder	28	displacement transducer
16	compressor	34	force transducer
19	command - control panel	36	upper rig cross beam (fixed/mobile)
22	integrated control module	37	lower rig cross beam(mobile/fixed)

3.2. Method for testing on compression machine the vehicle trim control equipment

Using an installation according 3.1, testing method consist in verification the capacity of trim corrector equipment to realize a range of forces at different elongations of trim corrector device, the values being established in advance, function of the device performances desired.
The necessary buoyant force are function of the metallic spring working in parallel with the actuator, some modalities to evaluate it being presented in papers [2] and [3].
The operate mode consist in adjusting the device elongation at prescribed value by compression machine action and adjusting the air pressure to assure desired buoyant force/ forces.

3.3. The realized testing installation

The realized testing installation is presented in Figure 5 and the component elements in Table. 5.

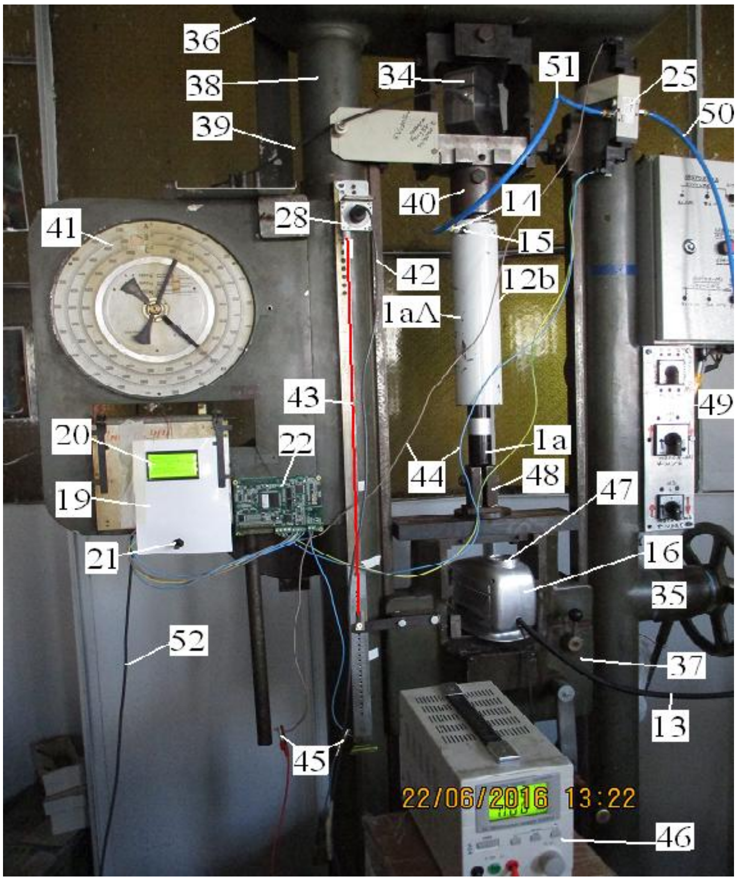

Figure 5. Installation for testing the trim corrector equipment (1/4 car)

Table 5. Components of testing installation

Pos.	Elements	Pos.	Elements
1aA	Shock absorber with pneumatic actuator	37	Mobile cross beam of traction-compression machine
1a	Shock absorber without dust shield	38	Column of traction-compression machine
12b	Pneumatic cylinder	39	Electrical cord of the force transducer
13	Hose	40	Shock absorber upper grip
14	Plug	41	Dynamometer with memory of traction-compression machine
15	Quick valve fitted in pneumatic actuator	42	Electrical cord of the displacement transducer
16	Air compressor	43	Wire rope
19	Command and control panel	44	Electric wires between control module (21) and valve (25)
20	Display	45	Electric wires from 12V source
21	Three way switch	46	12V source
22	Integrated control module	47	Compressor manometer
25	Three way servo-valve	48	Shock absorber lower grip
28	Wire rope transducer	49	Command panel of traction-compression machine
34	Force transducer	50	Air hose connected with compressor air hose (13)
35	Traction-compression machine	51	Air hose linking solenoid valve (25) with quick valve (27)
36	Fixed cross beam of traction-compression machine	52	Electric cord to compressor

REFERENCES

[1] Niculescu, A. I., ¼ car model for suspension trim corrector performances evaluation, Applied Mechanics and Materials Vol. 823 (2016) pp 2005-2010, (2016) Trans Tech Publications, Switzerland, p-ISSN: 1660-9336, e-ISSN: 1662-7482.

[2] Niculescu, A., I., Jankowski, A., Kowalski, M., Sireteanu, T. :On the new concept and advantages of the integrated shock absorber – air spring – "ISAS", Proceedings of the European Automotive Congress EAEC-ESFA 2015**,** pp 93-103, Springer International Publishing**,** ISBN: 978-3-319-27275-7 (Print) 978-3-319-27276-4 (Online)

[3] Niculescu, A., I, Models 1/4 car with trim correctors, International Congress SISOM 2015, Bucharest 21-22 May