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Research and Application of Servo Detection Device for Large Load Oil-air Hybrid Shock Absorber

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Abstract: The dynamic performance servo testing device for heavy-duty special vehicles with large load oil and gas hybrid dampers is a special test equipment developed specifically for oil and gas springs. Most of the engineering and special vehicles in China use traditional mechanical damping devices, which often show problems such as limited load-bearing capacity or insufficient vibration-extinguishing efficiency in the process of use. In recent years, the oil and gas shock absorber has attracted much attention, and has become an important development direction of the suspension system due to its excellent performance. In view of the characteristics of heavy-duty special vehicle shock absorber, solve the key problems of large load, high circumference fatigue, durability, etc., and study the dynamic performance servo testing device of heavy-duty special vehicle large load oil-gas hybrid shock absorber with high precision and strong anti-deflection load capability has become a hot spot and difficult point of research.

1. Introduction

Oil-gas springs use gas and liquid as elastic medium and force transmission medium respectively, which have good cushioning and vibration damping effects, and can also adjust the height of the frame, so they are widely used in engineering vehicles. Large load oil-gas hybrid shock absorber servo testing device is a special test equipment developed specifically for testing the performance of oil-gas springs. Most of China's engineering and special vehicles with the traditional mechanical damping device, the use of the process often shows a limited load-bearing capacity or vibration extinguishing efficiency and other problems [1]. In recent years, much attention has been paid to the oil and gas spring dampers, due to the excellent performance has become an important development direction of the suspension system. Its use of oil as a medium, adding part of the gas in the cylinder as an auxiliary, on the basis of hydraulic damping increased the gas medium, thereby increasing the stability and reducing the noise issued by the high-speed flow of oil, but the working principle is still the working principle of hydraulic damping. It was first applied in Germany and Japan on heavy vehicles, and then gradually spread to military special vehicles and engineering vehicles. Foreign application of oil and gas suspension technology has long entered a mature stage, but many technologies belong to the core technology of enterprises, which must rely on our independent

research and development [2].

2. Servo Detection Device to Achieve the Main Function

The main structure of the servo testing device adopts the electro-hydraulic servo dynamic and static fatigue testing machine frame, equipped with special test auxiliaries and control software. The testing device can perform tensile, compression, low circumference and high circumference fatigue tests on the specimen (oil and gas spring), and also has the functions of static characteristics, dynamic characteristics and damping characteristics [3].

The integrated oil and gas spring test stand has the following functions:

(1) Oil and gas spring displacement characteristics test;

(2) Oil and gas spring power characteristics test;

(3) Damping characteristics test of oil and gas springs;

(4) Oil and gas spring stiffness and endurance characteristics test.

3. Composition of the Servo Detection Device

The device is mainly composed of a main unit, servo linear actuator, a set of constant pressure servo pump station, related test software, other necessary accessories, etc (See Figure 1).

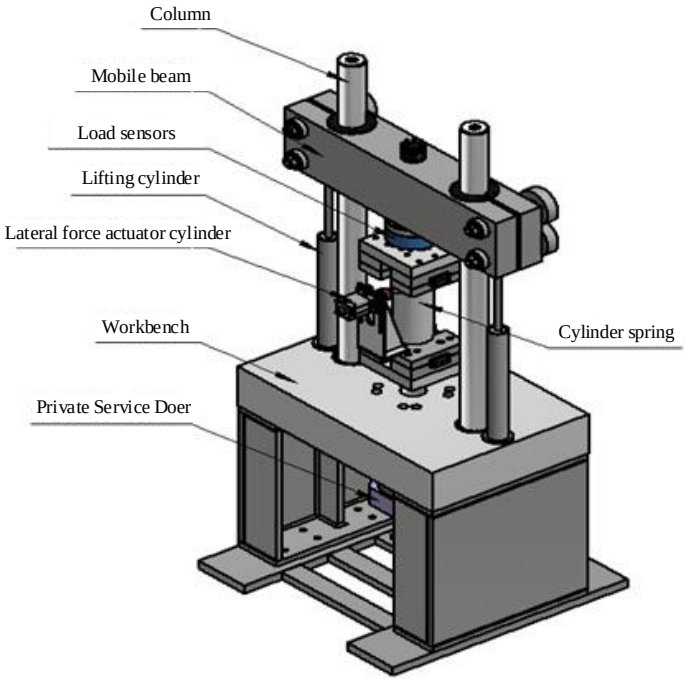

Figure 1: Host model diagram.

3.1. Host Device

The host is a double column frame structure, servo linear actuator is placed inside the host frame. The mainframe beam adjustment adopts hydraulic lifting, hydraulic clamping and elastic release structure, which should ensure the beam is stable and reliable during the test, and also ensure that the beam remains locked in the non-test state. The outer surface of the column adopts electroplated hard chrome treatment, which can effectively increase the column's ability to resist abrasion and corrosion, and increase the beauty of the mainframe's appearance [4].The mainframe of the tester should have

the characteristics of compact structure, free lifting of the beam, high rigidity of the frame, reliable clamping of test pieces, good alignment, easy clamping, etc., and can be equipped with various fixtures and environmental testing devices to expand the test function [5].

1)The beam can be lifted for adjusting the test space, beam adjustment using hydraulic lifting, hydraulic clamping, elastic loosening type structure, to ensure that the test is stable and reliable, while ensuring that the beam remains locked in the non-test state;

2) Beam movement (lifting, locking) by the beam drive module to control the two clamping cylinders and two lifting cylinders work in coordination to complete, the drive module uses a special manual rotary valve control, zero leakage, must ensure the reliability of the test;

3) The installation of the load sensor must be convenient for measuring the test load;

4) The design of specimen clamping, beam movement and emergency stop operation buttons in front of the mainframe table, to facilitate the convenient operation of the tester.

3.2. Servo Linear Actuator

The servo linear actuator is the core component of the tester, and the tester outputs the test force through the actuator. The actuator is built into the lower part of the main machine and consists of the actuator body, hydraulic control module and sensors [6].

1) Actuator using servo linear actuator, using symmetrical four-way servo valve control on the principle of actuator design. The actuator is designed and manufactured by unitized, modularized and standardized development concept, and adopts multi-stage flexible support combination guiding mechanism, which should have the characteristics of low damping, high response, high life and large clearance design. Low starting pressure and no creeping phenomenon.

2) Actuator piston seal should be supported by imported seals, large clearance design, high resistance to lateral force, with high-speed non-sintering self-lubricating characteristics. Combination seal, high pressure seal, low pressure seal and gap leakage tube, actuator assembly to make no oil leakage. The above sealing method can effectively reduce the internal friction resistance of the actuator, improve the test accuracy and actuator life of the test machine. Servo linear actuator frequency response is not less than 100Hz.

3) Servo linear actuator amplitude limit position due to the design of hydraulic buffer zone, to avoid running out of control damage.

4) Actuator external installation should have a precision oil filter by the filtration accuracy of not less than 0.003mm, as well as with the elimination of pulse, energy storage function of the inlet and return oil accumulator, the United States MOOG dynamic testing machine special two-stage electro-hydraulic servo valve hydraulic module. The precision oil filter is installed in front of the electro-hydraulic servo valve, which can effectively prevent the electro-hydraulic servo valve from blockage caused by hydraulic oil pollution [7].

3.3. Constant Pressure Servo Pumping Station

The pump station is mainly composed of base plate, oil tank, oil pump motor unit, valve block, pipeline, cooling system and other parts. Used to provide power for the work of the testing machine [8].

1) The pump station tank adopts fully enclosed design, which can effectively prevent the pollution of hydraulic oil by external impurities entering the hydraulic system. The tank material is made of stainless steel plate, which can effectively prevent the pollution of hydraulic oil caused by metal corrosion;

2) Oil pump, motor unit configuration using tandem double elastic support method to further reduce the pump station noise;

3) The oil pump adopts low-noise linear conjugate internal gear pump. The linear conjugate internal gear pump is characterized as "the oil pump that never wears out" in the hydraulic industry and is used in high, precise and advanced hydraulic systems;

4) High and low pressure soft switching hydraulic module consisting of main relief valve, accumulator, sub main relief valve, sub relief valve and reversing valve, precision oil filter is used to control the output pressure of the pump station;

5) The pump station has the working mode of low pressure start and high pressure switch, which can effectively reduce the impact of the hydraulic system;

6) Pump station configuration inline water cooler (cooling water user-provided), used for hydraulic system cooling;

7) Pumping station equipped with dual electric contact temperature control meter, liquid level control meter; with oil temperature (lower than 10 ℃, higher than 55 ℃), liquid level, oil filter blockage alarm and parking protection function;

8) Pump station configuration hydraulic fittings and high-pressure hose, to ensure that the system is leak-free.

4. The Control Function of the Servo Detection Device

Working schematic and control block diagram refer to Figure 2, 3.

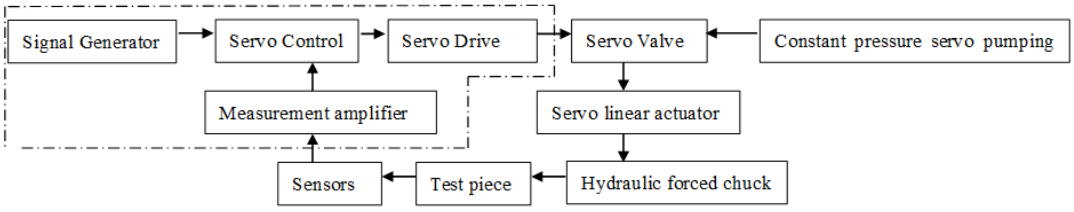

Figure 2: System working principle diagram.

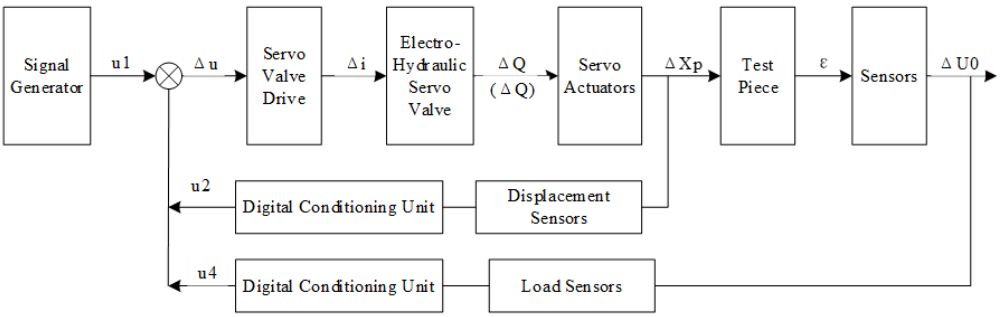

Figure 3: System control block diagram.

The controller is a fully digital controller based on classical PID deviation control, which is a stand-alone controller and communicates with the host computer via Ethernet. Dual CPUs are used for control and data management respectively to ensure the control rate and control accuracy at high frequency and high speed [5]. The control mode can be any control channel conditioner signal such as load, displacement and deformation, etc. Can smoothly switch the control mode in the hydraulic station open state; function generator and the actual control frequency of 0.001-100Hz; control waveforms are: sine, square, triangle, monotonic (ramp), combined wave, etc.; and with a multi-channel digital meter head can display the measurement signal in real time; all operations and settings through the upper computer system software virtual panel to achieve;; User-oriented open DLL, convenient for users to expand or independently program the upper computer software according to

different requirements. The default configuration of the system is the basic test software used to complete the conventional fatigue test and data storage. Optional multi-tasking software is available to provide users with a creative test environment, rich test and data storage methods; fatigue number presetting, fracture stop, limit protection lock stop indication and other functions can be realized. With peak and valley control compensation function to ensure control accuracy. With automatic data storage function; control system provides multiple digital IO interface can complete the software to start the hydraulic station and the introduction of hydraulic related alarm data to facilitate the interlock function during the test [9].

5. Technical Problems Solved

For the characteristics of heavy-duty special vehicle shock absorber, this paper solves the key problems of large load, high circumferential fatigue, durability, etc., and develops the dynamic performance servo testing device with high precision and strong anti-deflection load capacity for heavy-duty special vehicle large load oil and gas hybrid shock absorber applicable to this project, and solves the following key technical problems [10-12].

5.1. Accuracy Enhancement

Shock absorbers are not used to support the weight of the body, but to suppress the vibration when the springs spring up after an earthquake and absorb the energy of the road impact. The spring plays the role of shock mitigation, changing "high energy once impact" into "small energy multiple impact", while the shock absorber gradually reduces "small energy multiple impact". In this case, the static and dynamic force and deformation measurement is better than ±1.0% of the indicated value.

5.2. Dynamic Response Improvement

Dynamic response is subject to the rigidity of mechanical structure, mechanical load, position detector, servo drive, etc., reasonable matching, displacement measurement static, dynamic better than ±0.5% of the indicated value.

5.3. Correlation Parameters Matching Interlock Control

Servo detection device control system is used to complete the conventional fatigue test and data storage. Optional multi-tasking software is available to provide users with a creative test environment and rich test and data storage methods. How to achieve fatigue number preset, fracture stop, limit protection lock stop indication and other functions. With peak and valley control compensation function to ensure control accuracy. Fully realize the matching interlock control of load, displacement and deformation and other related associated parameters.

6. Conclusions

This large load oil-gas hybrid shock absorber servo testing device has been manufactured in Shenyang Zhongzhijie Fluid Control System Co. The maximum dynamic test force: ±500kN; test force measurement range: 5%~100%; measurement accuracy: ±1% FS; maximum amplitude: ±125mm; test frequency: 0.1~10Hz. The market demand for oil-gas hybrid shock absorbers is strong and the market prospect is very promising. The company expects to achieve an annual output of 10,000 heavy-duty oil and gas hybrid shock absorbers, annual sales will increase by 100 million yuan, and the company expects to sell this testing device or technology, annual sales will increase by 30

million yuan, which has achieved good economic benefits.

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