Computerized System for a Steering Box Testing Stand with Automatic Data Record and Report Issuing

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Abstract: *Assisted steering systems are present in almost all modern vehicles even in the small class and compacts. Besides driver discomfort due to mechanical wear, these systems can produce unwanted effects such as: environmental contamination with hydraulic fluid and reduction of car's steering assistance. A defective steering box will no longer respond to driver's manoeuvres and can lead to potential life threatening situations due to traffic accidents.*
Main subject of the paper is describing a computerized testing stand designed for a steering box testing stand. This facilitates quick and easy testing of steering boxes before and after maintenance / repairing operations. The computerized system that authors propose can be used for upgrading existing steering box testing stands. Main system equipments are: data acquisition board, electronic transducers for pressure, flow, torque, temperature, speed and displacement, a servomotor for steering box driving and an inverter for dynamic speed control of a hydraulic pump. The authors have also designed a computer software that allows testing stand's full functionality, such as testing sequences control, testing data record in a database and automatic testing report issuing (including printing).
The computerized testing system that the authors describe can automatically determine the current state of the sealing elements of the hydraulic directional valve of the steering box through measuring the oil flow during testing. The testing report contains records regarding pressure values at travel ends and in an intermediary position having the rod blocked, as well as oil temperature, torque value at hydraulic directional valve's shaft during manoeuvres, steering box serial number, testing operator name and testing company name.
The computerized system for steering box testing provides the user with a friendly interface that allows simple and fast testing of steering boxes of vehicles. The system can be used as a part of a new testing stand or as an upgrade for an existing one. Main beneficiaries are vehicle repair workshops or companies specialized in maintenance or repairing hydraulic assisted steering boxes.

Keywords: *computerized test, transducers, steering box, DAQ system*

1. Introduction

Assisted steering systems are present in almost all modern vehicles even in the small class and compacts. Besides driver discomfort due to mechanical wear, these systems can produce unwanted effects such as: environmental contamination with hydraulic fluid and reduction of car's steering assistance. A defective steering box will no longer respond to driver's manoeuvres and can lead to potential life threatening situations due to traffic accidents. One of the causes of failure of hydraulic assisted steering boxes can be hydraulic fluid contamination with impurities [1].
Main subject of the paper is describing a computerized testing stand designed for a steering box testing stand. This stand facilitates fast and easy realization of the tests for steering boxes, before and after maintenance / repairing operations. The computerized system that authors propose can be used for upgrading existing steering box testing stands.
Main beneficiaries can be vehicle repair workshops or companies specialized in maintenance or repairing hydraulic assisted steering boxes.

2. System description

The system contains several sensors for parameters of interest to test the steering boxes. The transducers used are: a pressure transducer 0...160 bar (11), a flow transducer 0.18...18 l/min (10), a rotary encoder for step by step motor (18), a torque transducer 0...500 Nm (17) and a force transducer 2000 daN (20). Connecting transducers to the computer was done through a data acquisition board [2] from the National Instruments, model NI USB-6211 (22). In **figure 1** can be seen the location of the various transducers in the scheme of test stand. To control the speed of the pump from test stand, via a variable speed drive in order to adjust the flow, was used an output of analog signal 0…10V, from data acquisition board. Another analog output of data acquisition board is used for voltage control of driver of the stepper motor which drives the rotary valve of steering box. The hydraulic installation is located behind the front panel of stand for testing of steering boxes (Fig.2). The stand is equipped with a section for testing of pumps for power steering, which has not been drawn in this scheme.

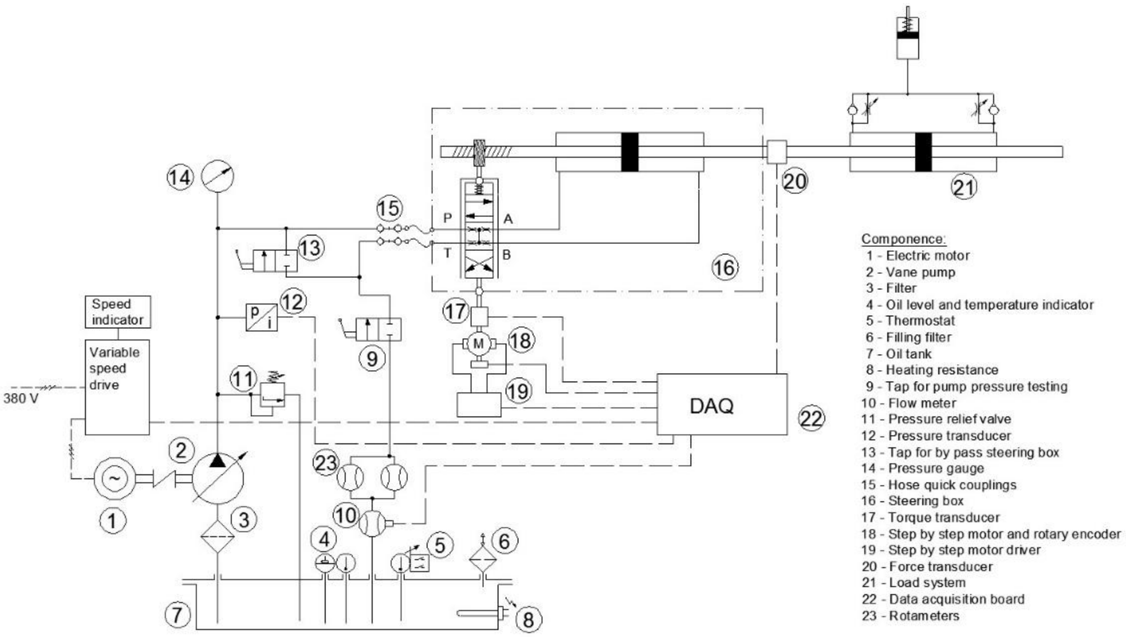

Fig. 1. Schematic of steering box testing stand

Fig. 2. Front panel of steering box testing stand

In **figure 3** it can be seen the mounting plate on which are mounted the contacter which starts the electric motor which drives the pump, a three phase automatic circuit breaker and a variable speed drive for regulating the rotational speed of the electric motor. Also on mounting plate is found the automatic circuit breaker of thermostating system for hydraulic liquid.
The test stand scheme contains a tank (7) for hydraulic liquid on which are mounted the next components: temperature and oil level gauge (4), sheath for thermostat probe (5), electrical resistance for heating (8) and tank venting and filler filter (6). The pump of the stand aspire oil through the filter (3).

In **figure 4** we can see the location of heating resistance, thermostat and connections for suction and return line. In the scheme is also found the relief valve (11) for limiting the maximum working pressure, adjusted to 110 bar, pressure gauge (14), valve (13) for steering box by-pass, valve (9) for testing the pressure raised by the power steering pump from the test stand, plug-in coupling connections (15) for hoses that connect the steering box and steering box for testing (16). The hydraulically assisted steering box is mounted on the test stand by a device equipped with a load system (21) [3] for the steering rod, useful for determining the efficiency of the steering box. For viewing the flow are mounted two rotameters (23).

Fig. 3. Electric enclosure

Fig. 4. Tank connections

3. Performing the tests

Testing is done with a software application developed in LabVIEW that generates test sequences and allows plotting of the test diagrams for steering box. The software communicates through data acquisition card with transducers, variable speed drive for regulating the rotational speed of the electric pump of test stand and with driver for step by step motor that controls the rotary valve of steering box. From the software control panel (fig. 5) can be set pump flow according to the steering box model, the number of pulses per rotation of the rotary encoder and the number of steering wheel turns to move the rod of the steering box from one end to the other end (left-right stroke). At control panel of software it also sets the serial number of the steering box, name of the operator that perform testing, beneficiary of the test report, date and registration number of the test report. In manual regime the rod of steering box can be moved using a cursor from control panel on PC screen, and in automatic regime the software determine the rate of oil leakages at the stroke ends of steering box. Blocking the steering rod by using the load system (21) (e.g. in the middle zone) can determine the leakage flow due to wear of piston seal. In manual regime it can plot a diagram of pressure of the test stand pump, to see if still provide the nominal pressure. On the control panel of the software application there are two indicators for torque at rotation of shaft from rotary valve of steering box and for force performed at the rod of steering box.

In **figure 6** there is a record of the flow of hydraulic fluid lost by steering box at the end of the stroke. If the flow of loss at the end of stroke is above 1.5 l / min is recommended to replace or repair the steering box. A steering box worn, with large internal losses, will lead to disturbance in handling the steering. [4,5]. In **figure 7** there is a record for the pressure raised by the pump of the test stand. After recording the chart of loss of hydraulic fluid for steering box, it can be printed in a report containing identification data from front panel of application and recorded diagram.

Fig. 5. Software panel

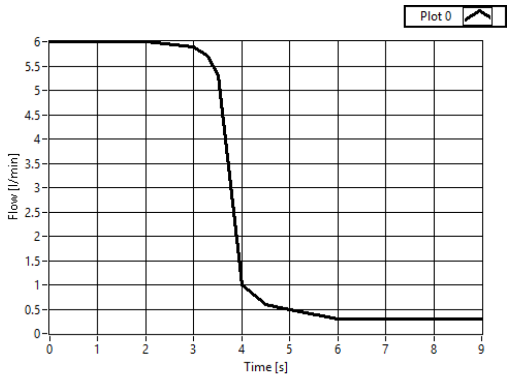

Fig. 6. Flow record

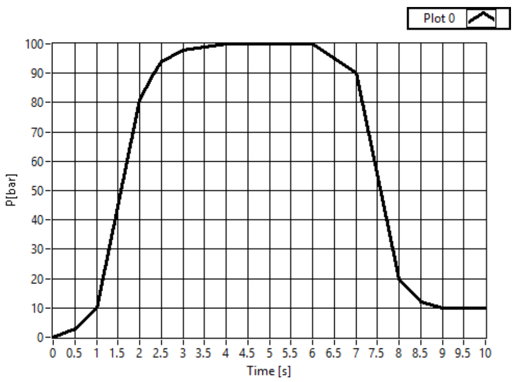

Fig. 7. Pump pressure record

4. Conclusions

The test stand equipped with data acquisition system enables rapid testing of steering boxes and issuing the test reports.

The test stand is equipped with thermostatic circuit for hydraulic fluid in order to ensure identical conditions for testing, regardless of the outside temperature.
The stand allows adjusting operating parameters [6,7,8] and contains a variety of sensors for registering the operating characteristics of the tested steering.
The test stand has an electric motor for driving the rotary valve of hydraulically assisted steering box, which allows automation of testing.
The system can be improved by increasing the degree of automation introducing in the scheme in place of manual valves electrically controlled valves, which can receive commands according to the test sequence.

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