ХАРДУЕР ЗА АВТОМАТИЧЕН КОНТРОЛ НА ХИДРАВЛИЧНИ ПРЕСИ

AUTOMATIC CONTROL HARDWARE FOR HYDRAULIC PRESS

Hilmi KUSCU, Cenk MISIRLI, Erol AKATA, Yılmaz CAN
Trakya University, Faculty of Engineering and Architecture, Dept. Mech. Eng. Edirne
hilmi@trakya.edu.tr, cenkm@trakya.edu.tr, erola@trakya.edu.tr, ycan@trakya.edu.tr

Abstract

For computer controlling of all the functions (stop/start of main engine, up and down of press ram, automatic process start and stop based on computer defined reference stroke and power values) of hydraulic presses used for experiment and test purposes in research laboratory and transferring the test parameters (Force-stroke diagram) to digital environment for examining, some hardware circuits were designed and produced while some others were provided from several companies as sensors and cards. Some modifications and add-ons made on the electric installation so that press could be operated both manually and computer controlled.

On the press used for this experiment, there are four buttons which a couple of them used for start and stop the main engine and the other couple used for lift down and up. Making the system as computer controlling, a two-position switch was mounted to control panel to provide the system operates both manually and computer controlled. Additionally, two each 9 pin connectors added to the control panel. One of them transfers the functions of four buttons to computer and the second transfers the power performed by the press and position of the ram data to computer.

A sensor which converts pressure to current was placed to outside of hydraulic pump to pick up the pressure power enforced by the press. This current data is converted to voltage and transferred to the analog input of I/O card of the computer. Therefore, pressure power data is obtained by using the voltage rate. To get the position data of the press ram, an encoder was mounted to provide signals according to the movement of the ram, so that the movement data proportional to the number of received pulses from encoder is read by I/O card. A relay control card was designed to control the Star/Triangle circuit which is used to start the engine and to let turning on / off the solenoid valves that controls the movement of the ram. Hence, by way of a mounted switch, when the control switched to computer from manual, all the functions of press is controlled safely by computer.

These circuits were applied to a 150 tons press in Mechanical Engineering Laboratory of Trakya University and the experiments completed securely with no error.

Keywords: Hydraulic Presses, Stroke and load sensing, Control circuits

INTRODUCTION

There are two buttons which starts and stops the hydraulic engine on the manually controlled forging press'. For using the forging press, first of all the main engine is started. Then, using the buttons that moves the ram up and down, the position of the ram is situated convenient to the experiment material. To get an idea about the pressure value of the hydraulics given to the piston which is moving the ram can be read on a manometer. During the experiment, it is necessary to keep pressed to the related button, but this brings the risks and creates danger of breaking down or parting away somehow of the part. In addition to this, since the parameters of experiment measured by indirect ways, creates problems to sketch the stroke-power diagram. In this study, it was provided that the controls of all the above mentioned processes transferred to a computer. Moreover, by limiting the maximum power and stroke values, safety of the experiment was set. Another advantage of this study is the possibility of recording the experiment parameters on different files and automatically sketching the stroke-power diagrams for each trial.

MATERIAL VAND METHOD

In this study, a 150 ton power capability, manually controlled hydraulic press was used. There is an oil pump with a maximum capacity of 300 bar operated by an electric engine. The up and down movements of the ram are controlled by two e.a. of 220volt 50Hz solenoid valves via

the buttons [4]. Hence, there are four buttons on the control panel of this modernized forging press (Two of the starts and stops the other two provides the up and down movement of the ram). With this study, a two position switch assembled on this present control panel and new properties added on the forging press. (See Figure 1)

Fig. 1. Control Panel of Forging Press

While the switch is at the manual position, it is possible to control the press with its original control mechanism that is button controlling. While it is at the Automatic position, all controls are performed by computer. Additionally, the link between the press and computer was provided by assembling two e.a. of 9 pin computer connector on the control panel. Connector no. one provides the transmission of the commands to the circuits designed for stopping and starting the main engine and up and down movement of the ram and a relay control card. Via the Connector no. two, the pressure information received from pressure – current transducer and the position information received from the rotation encoder transmitted to the I/O card of the computer.

Since the cross section of the pressure cylinder is constant and since the pressure is proportional to power, for measuring the power of the forging press, it is enough to measure the pressure of pump exit. To analyze this measured pressure value, a pressure-currency transducer that converts 0-400 bar to 4-20mA which is shown at Figure 2.

Fig. 2. View of the Pressure Transducer

In this sensor, the pressure between 0 – 400 bar is converted to 4-20mA. To transmit this pressure, therefore the power information to computer an AIO-3310 I/O card which is shown at Figure 3 is used by mounting to the PCI slot [3]. To transmit the 4-20mA output signal which is produced by transducer to the analog input of the I/O card, it was converted to 0 – 10 Volt. Therefore, the pressure information is easily read by the computer used by the address of this card.

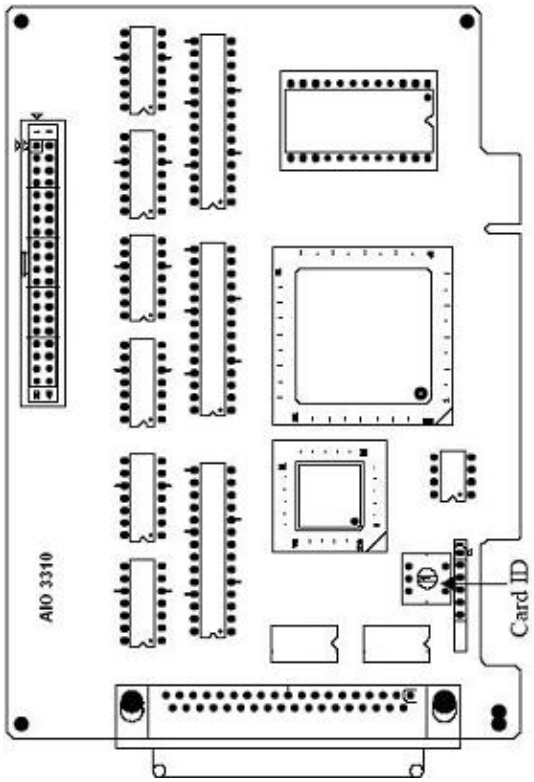

Fig. 3. AIO-3310 Analog/Digital I/O card.

The movement level of the ram is read by way of rotation encoder shown at Figure 4. With a pulling system, (See. Figure 5) the rims dimensioned as of a 2 pulse output would be received at the encoder exit for each 1 mm movement of the ram. This pulse information transmitted to the encoder reading card shown at Figure 6 on the ISA slot of the computer.

Fig. 4.The View of the Encoder which is reading the position information

Fig. 5. The View of Encoder-pulley system

Encoder and card linked to each other as shown at Figure 7. Hence, the position information transmitted to the software via this card

Fig. 6. View of the card which reads the Encoder value

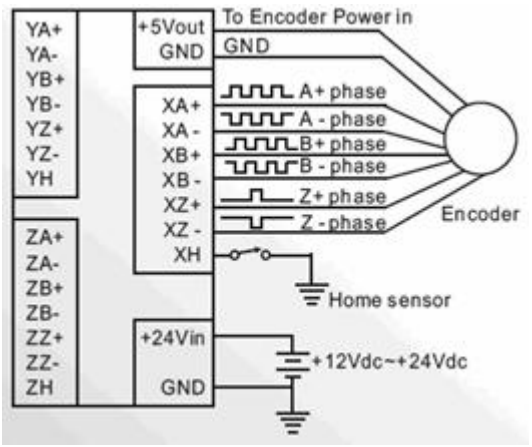

Fig. 7. Encoder connection principle schema

The Relay Control Card shown at Figure 8 was produced to make the outputs produced by the software to control the electric circuits of the forging press [2].

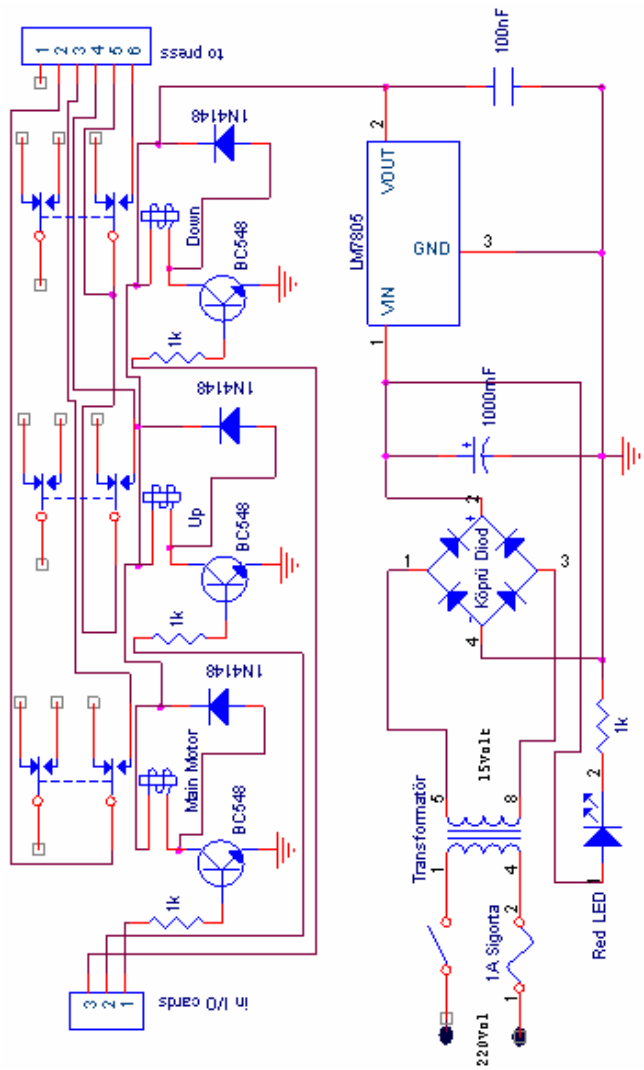

Fig. 8. Relay Control Card

The modifications shown at figures 9a, b, c, d on the existing hardware of the forging press to apply the commands received from I/O card via

this relay card. The view of the relay control card placed in a standard box is given at Figure 10.

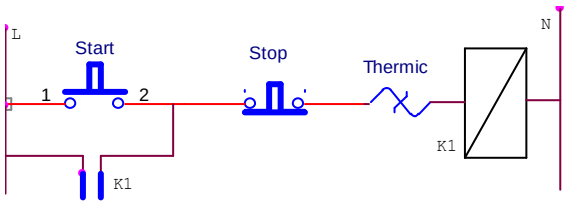

Fig. 9a. Main engine control before update

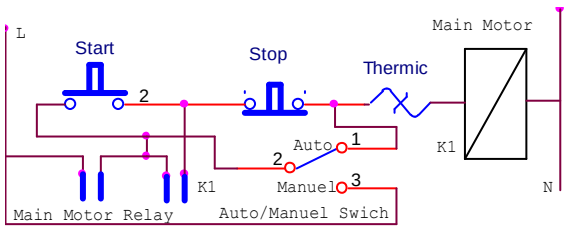

Fig. 9b Main engine control after update

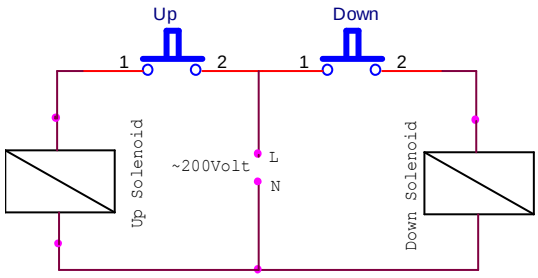

Fig. 9c. Solenoid controls before update

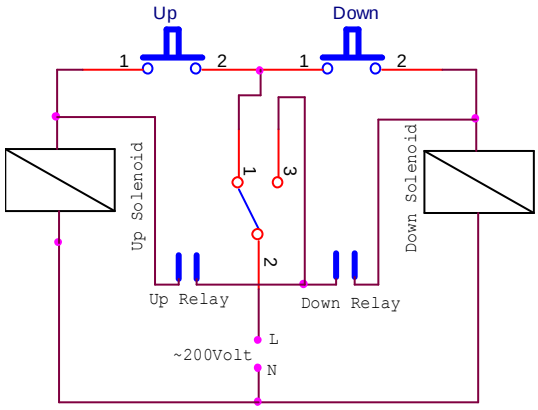

Fig. 9d. Solenoid controls after update

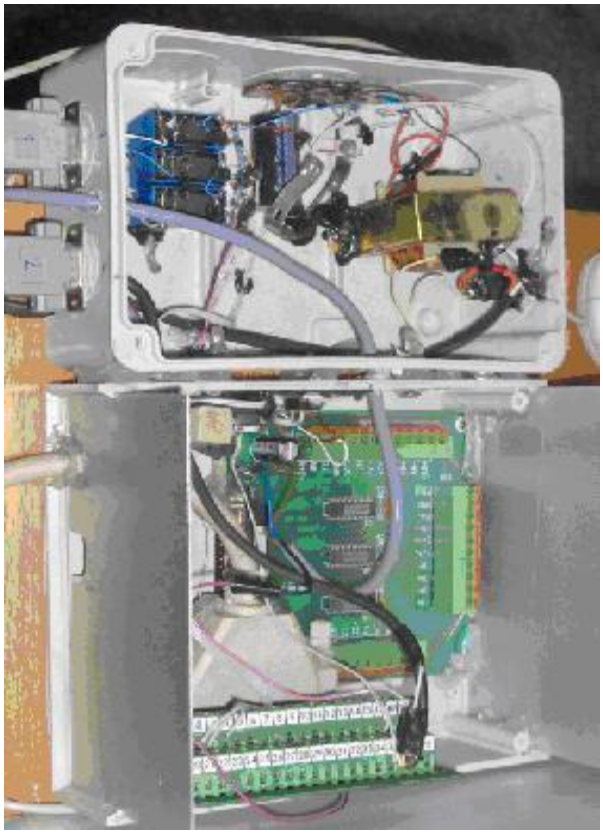

Fig. 10. View of Relay control card

Fig. 11. View of Forging Press After becoming Computer controlled

CONCLUSION

One of the problems encountered in the experiments was the pulses produced by encoder could not be read clearly by the computer. For the solution, by using the operating system of the computer, a real time precedence given to the software controlling the hardware (That is, fro task manager, a real time precedence assigned to

the related application). Additionally, since the electricity installation of the forging press was not earthed well, there were static disturbances which affect the software negatively. For this, a well earthing was performed, an L-C filter added on [1] and the static disturbances reduced to minimum by data cable monitoring.

Since the precision of the analogue I/O card is 6mV, the analogue value difference at the pressure transducer should be 0,5 kN to make readable of the forging press' pressure value for the software. That means, between 0-1500kN interval, the operative precision is at least 50 kg. Since the transducer used in this experiment designed for 0 – 400 bar interval, for more precise experiments, it should be replaced with different pressure transducers.

With this study applied on an existing hydraulic forging press, all functions are controlled by buttons, controlled by a computer precisely. Additionally, the power and stroke values during the experiment transferred to computer environment. Another important property given to the forging press is, safety limits. When the power or the stroke limit values reached, the forging press is stopped automatically.

Since all the hardware are standard, the same experiment can be applied to any other forging press.

REFERENCE

[1] M. ASLAN, Elektronik Devre Uygulamaları, 1999

[2] H. Kuşçu, Büyükbaş Hayvan Beslenmesinde Bilgisayar Kontrollü Otomatik Yemleme Sistemi Geliştirilmesi Üzerine Bir Araştırma, Doktora Tezi, 2002.

[3] http://www.automation.com.tw/

[4] MOTOROLA, Semıconductor Technıcal Data, www.datasheetcatalog.com