Checking the manufacture of cold formed parts

by Walter Vordermark

Knuckle-joint presses are used for the cold forming of semi-finished products such as panels and tube sections to produce finished parts, e.g. wheels. **Figure 1** shows the basic construction of a hydraulic knuckle-joint press whose sequence of movements is controlled by a programmable logic control (PLC).

It is not really feasible to directly measure the forming forces occurring on the pressure ram using force transducers. The modification of the machines would be too complex and a new design incorporating a force transducer in the pressure ram entails the risk of overload and damage to the transducer. There is however a real need for the direct measurement of the forming forces as a means of checking production.

During forming, work hardening occurs in the product as an additional benefit, but if the semi-finished product has been welded, then cracks can arise in the regions of the welded seams during the forming process, causing scrap. Inductive methods for finding this type of crack are not well suited, since they can only detect small cracks and complete sensor arrays must be set up to ensure adequate coverage of possible crack positions.

Reliable diagnosis of cracks, enabling the early rejection of defective parts, can be made by the use of simple equipment for the indirect monitoring of the force pattern in the pressure ram dependent on its displacement. Here the DS 5 Strain Transducer shown in **Fig. 2** is permanently attached to the pressure ram operating the tool and its output signal is passed to an industrial measuring amplifier of the type IG 2612. SP.TA.GR. This amplifier has a tare unit, a peak value memory and a limit switch. It was also modified with the addition of a subtraction stage. With a fault-free forming operation a continually rising force curve is produced as shown in **Fig. 3**. If a crack occurs in the workpiece during forming, the force drops according to the broken line in **Fig. 3** and it then rises again later due to the constant press feed. The travel of the ram is monitored with proximity switches, i.e. the measurement window is opened and closed at the start and stop positions by the PLC. The rise in force can be monitored between preselectable travel positions and a drop in force due to crack formation can be detected.

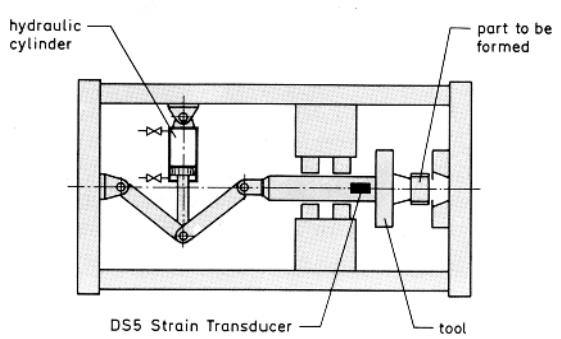

Fig. 1: Simplified diagram of a knuckle-joint press

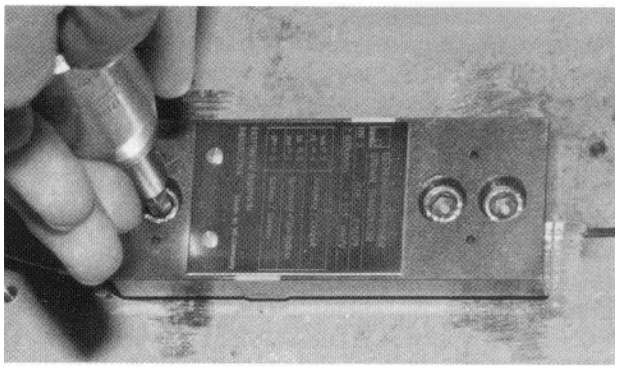

Fig. 2: DS 5 Strain Transducer in measurement position

However, the measurement electronics does not store the complete force-displacement curve, but instead only evaluates a drop in force. As **Fig. 4** shows the force signal is passed directly to the subtraction stage as well as via the peak value storage. With a continually increasing press force the difference between the signals is zero. With a drop in force the memory retains the peak value which has so far occurred and a difference is formed by the falling present value. This difference is monitored by the limit switch.

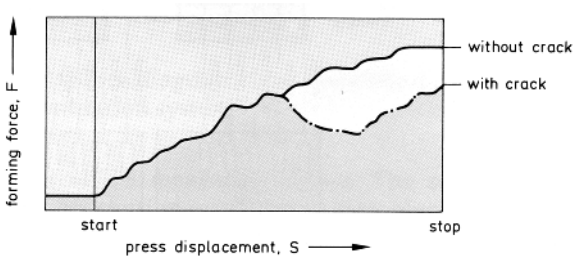

Fig. 3: Force-displacement curve for the pressure ram

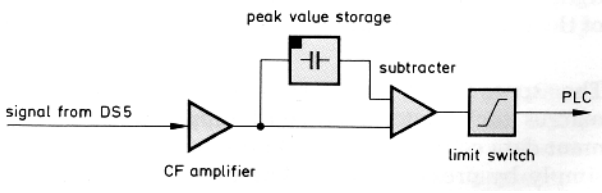

Fig. 4: Block diagram of the signal processing

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