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Function potential at the rear three point hitch

Since the discovery of the three point hitch the basic mechanical principals involved have barely changed. The application of electronic control circuits offers opportunities of increasing kinematic flexibility and automation potential. At Agritechnica'99 a concept was presented by GKN Walterscheid which was developed in cooperation with the Institute for Agricultural Machinery and Fluids Technology of the TU Brunswick.

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The basic development steps taken since the discovery of the three point hitch in 1925 have been standardisation, the introduction of quick-hitches and electronic controls, as well as the change from integrated lifting cylinders to a more open design [1]. The usual construction of the three point hitch currently is shown in *figure 1*. The lower links are connected by lifting rods to the lifting arms which are, in their turn, fixed to the lifting shaft. The lifting cylinders are activated through a common valve. In general, the control of this valve is managed by an electronic power lift control. Via sensors, the draft power, lower link angle and, in some cases, (through comparison of theoretical and actual travelling speed) the wheel slip, are all measured and processed through the controller. Most able to be influenced by the operator in the controller are position limits, lowering speed and the effects of required position, draft power and wheel slip. Moreover, an important detail for fast transport is nowadays the active surge damping system. In field operations, however, this function plays only a minor role. Normally, the length of the top hitch and the lifting rods are set constant according to the job in hand and the attached implement. These settings determine, along with the position of their attachment points, the kinematic performance of the mounted implement. This system thus only allows an adjustment to be made at certain working points. An increase in operative

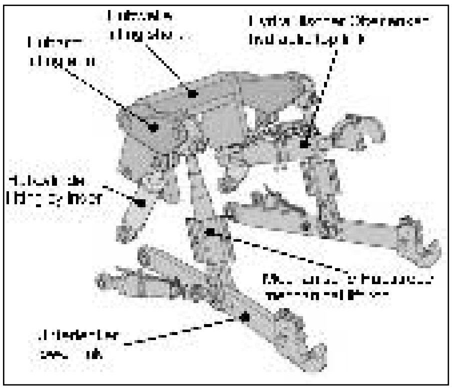

Fig. 1: Design of the conventional power lift

ease is possible through the application of a manually adjustable hydraulic top link or a hydraulic lifting rod.

Potential of a length-adjustable top link

To allow special functions such as parallel or steep mounting (*fig. 2*), dynamic length-adjustment control of the top link is necessary. *Figure 3* shows a solution with integrated length sensor including assessment electronics. Through this accessory the sensor offers optimum protection against mechanical damage. The sensor is exchangeable. In combination with a suitable proportional valve the sensor offers positioning control to a precision of tenths of millimetres. Alongside the storage of reproducible absolute

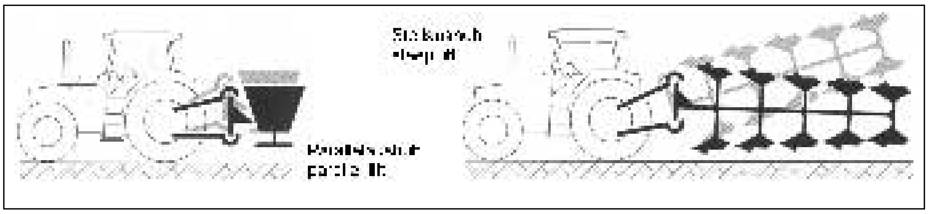

Fig. 2: Conceivable operation-modes with the power lift

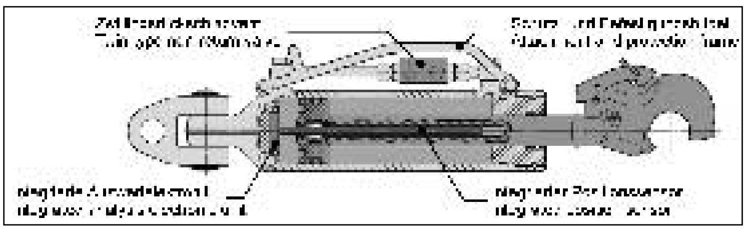

Fig. 3: Hydraulic top link with integrated position sensor

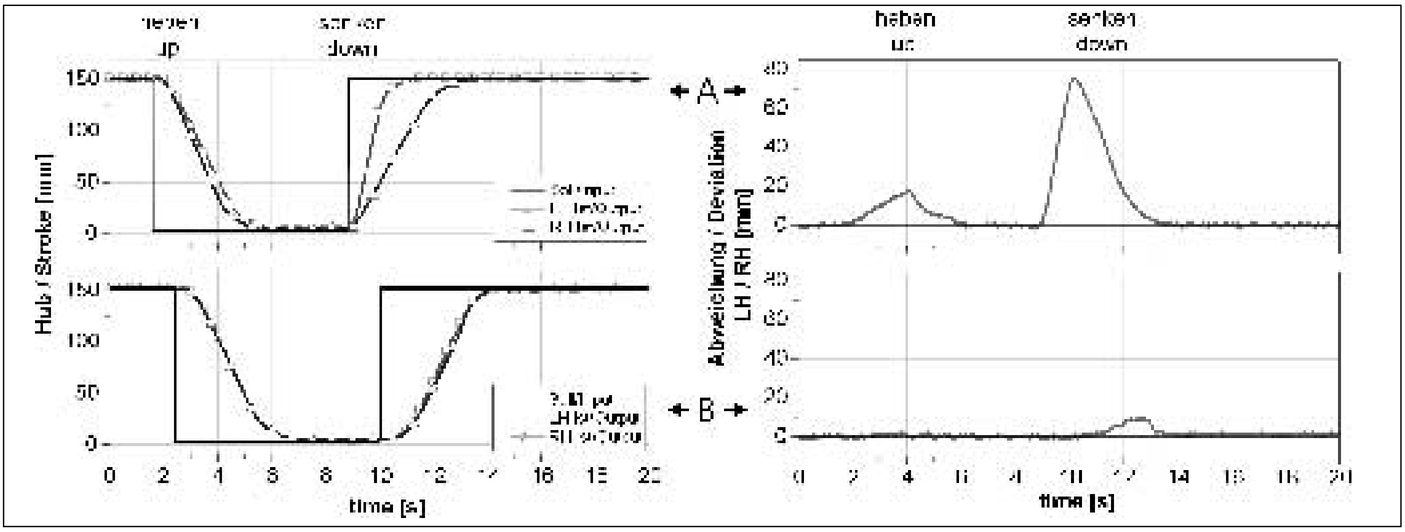

Fig. 4: Step response of the lift rod length and length deviation of left hand lift rod compared to right hand lift rod

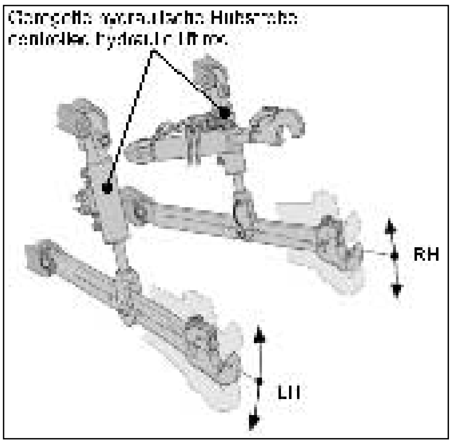

Fig. 5: Modified power lift

lengths, preselection of lengths in association with lower link position is also possible for, e.g., the realisation of parallel mounting.

Potential of length-adjustable lift rods

To further increase the flexibility of the three point hitch, two length-adjustable cylinders can be fitted, each moving a lower link. On the one hand this allows one to do without the fixed attachment via the lifting shaft which considerable relieves the mechanical stress on the tractor rear (*fig. 5*). On the other hand the possibilities of control of mounted implements through the additional movement possibilities is substantially improved in that three-dimensional are thus possible. Attachment and detachment is simplified through the avoidance of tensile stresses between tractor and implement during such operations. The double action cylinder allows precise pressure to be applied on one or both sides. Possible, e.g., is an improvement of the soil-entering behaviour with mounted ploughs through precise adjustments. Within this theme, an important aspect from the point of view of control technology is the tuning and harmonising of the movements of both hydraulic lifting rods .Without appropriate actions, one cylinder moves notable forward when powerful asymmetrical, especially pulling, loads are applied. *Figure 4* shows measurements with a simple position control of both cylinders (measurement A), and with actions for the limiting of the difference in motion caused by the stresses of a 1500 kg four-furrow plough set at maximum working width (measurement B). The temporary differences in length could be substantially reduced and, in this case, there remains further optimisation potential. *Figure 6* shows the deviation of the plough longitudinal axis to the horizontals where the plough is on parallel lift, whereby only the lifting rods are adjusted and the top link automatically follows.

Outlook

The concept presented here opens a further potential for the power lift with, at the same time, a reduction in mechanical. This is a practical step, especially with regard to the general trend towards automation of work procedures and tractor-implement management systems.

Fig. 7: Experimental tractor during field test

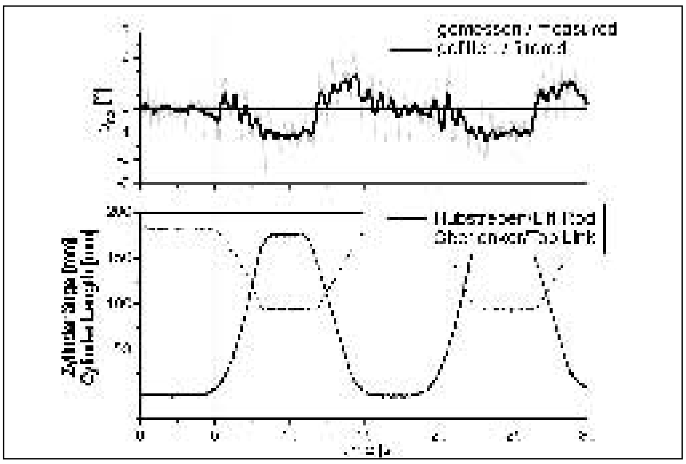

Fig. 6: Measuring of the parallel lift

Literature

[1] *Coenen, H.* und *T. Lang*: 50 Jahre Dreipunktkuppler und mögliche Entwicklungspotentiale. Tagung Landtechnik 1999, Düsseldorf, 1999, S. 395-402