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How Planter OEMs Can Provide Row Control to Help Users Improve Yields

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As farmers strive to increase yields and reduce expenses, increased attention is being paid to overplanting. Advances in global positioning systems (GPSs) and computing technology are making it practical for original equipment manufacturers (OEMs) to design planters to automatically turn individual rows off as they enter areas that are already covered, or marked not to plant. A major challenge for OEMs is developing a compact, reliable and economical method to engage and disengage the seed meter drive from the planter transmission when commanded by the controller. An integrated solution consisting of a wrap spring clutch and a right angle helical gearhead has been developed to address this need. The new integrated solution is completely electromechanical, eliminating the need for a pneumatic power source. Its compact envelope reduces integration costs and leadtime. The new solution is completely sealed from the elements to provide the reliability needed for farming applications.

Overplanting wastes seed and lowers yield

Farmers have long been aware that they are losing money by double planting on end rows and point rows and around terraces, and by planting unsuitable areas such as waterways. With seed corn at $200 a bag the amount of money wasted in dropping seed where it is not needed is substantial. Another concern is that double planted areas often run out of moisture and nutrients, resulting in yield loss. Some farm equipment OEMs have addressed this concern by providing the operator with the ability to manually turn off sections of the planter. This approach provides significant benefits, however, it places an additional burden on the operator, and controlling planting at the section rather than the individual row level still wastes a considerable amount of seeds.

A key enabler for automated control of planters is recent advancements in GPS technology that make it relatively easy to generate a coverage map of a field. Automated guidance of agricultural vehicles was originally primarily developed to relieve the operator from the need to make continuous steering adjustments. For example, parallel trackers help operators visualize their position with respect to previous passes and a lightbar positioned in front of the operator tells the operator whether or not he or she is on track and, if not, indicates the correction that needs to be made. More advanced systems provide the ability to automatically steer the vehicle. The earliest GPS systems were designed specifically for the task of vehicle steering, but newer systems provide features to collect spatial data such as application data and coverage maps to operate variable rate controllers. Additional features spread the cost of the system among several tasks while increasing efficiency in multiple areas of the crop production program.

Rapid adoption of automated control

In recent years, there has been rapid adoption of automated control for sprayers applying fertilizer and chemicals. A number of companies offer automated control of the three to five sections that most sprayers are divided into, and a few companies have introduced or are working on providing control at the individual nozzle level. Seed planting represents a natural extension of this technology, particularly as grain prices and the cost of seeds has risen. OEMs have begun working on upgrading planters to automatically control individual row units while planting. The basic idea is to automatically turn rows off as they enter covered areas, or areas that are marked not to plant on the coverage map. This requires that the GPS system be integrated with a control system that compares the planter's location to the coverage map, and sends a signal to disengage a clutch integrated with the seed meter drives at appropriate times.

Normally the seed meters for the individual rows are driven by flexible cables through a gearhead. Controlling the seed meters requires that for each row a clutch be added that can engage or disengage the power from that row's seed meter. From a mechanical standpoint, this application requires that the seed meters be turned on and off with very little delay in order to deliver seeds exactly where they are needed without overplanting. From a standpoint of reducing the development, manufacturing and operating costs, the drive system should be as small, light and power-efficient as possible. The rigors of operating in the farming environment of course require a very rugged design and one that is protected from the elements.

Up to now, the normal approach has been to retrofit pneumatically-powered clutches to existing seed meter gearheads so that individual rows can be turned on and off. One weakness of this approach is that a pneumatic power system needs to be added to the planter. This adds cost and weight, as well as another type of power system that needs to be maintained and supported over the life of the equipment. Pneumatic systems also consume power whether or not they are being used. The use of a separate clutch with its own enclosure also increases the size and weight of the installation. In many cases, extensive modifications will have to be made to install this type of device such as cutting and re-welding the frame.

Application of wrap spring clutches to row control

Thomson is the world's largest supplier of wrap spring clutches (Deltran brand) and also a major supplier of gearheads (Micron brand). The company recently took advantage of its capabilities in these two areas to integrate a wrap spring clutch and gearhead into a single enclosure to provide a complete row control solution for planter OEMs.

The basic wrap spring clutch consists of three elements: an input hub, an output hub, and a spring whose inside diameter is slightly smaller than the outside diameter of the two hubs. In its basic form, the wrap spring clutch operates as an overrunning clutch. When the input hub is rotated, the spring wraps down to engage the two hubs. If the input is stopped or reversed, the spring unwraps to release the output hub, allowing the load to overrun. The greater the force of rotation, the more tightly the spring grips the hubs. The torque capacity of the spring clutch is a direct function of the diameter of the hub and the tensile strength of the spring.

The addition of a stop collar and a control tang on the spring lets the output hub start and stop while the input hub spins. Stop collars come with one or more stops, up to 24/rev or 15° between stops. The control tang anchors to the stop collar, which surrounds the spring and hubs. An external mechanism engages a lug on the stop collar OD. Halting the collar unwraps the spring and releases the output hub. The arrangement applies no braking to the output hub.

Wrap spring clutches provide several advantages over better known friction clutches in planter row control applications. Friction clutches are ideal for motion systems that apply bidirectional torque to a load and also provide a "soft-start" capability because friction can be gradually raised or lowered by varying the voltage to the clutch-control coil. But neither of those capabilities applies to this application. On the other hand, wrap spring clutches are considerably lighter and smaller, and require only 1/10 to 1/5 of the power of a friction clutch for a given amount of torque. Wrap spring clutches also provide faster response than friction clutches by rapidly syncing up loads with the drive motor within a predictable time or rotation angle. Unlike friction clutches that can slip under certain conditions, wrap-spring clutches won't slip when engaged. The reverse logic approach needed for this application was developed by modifying a standard wrap spring clutch so that it is normally engaged and only disengages when the control tang is activated.

Substantial savings can be achieved

The ability to shut off individual rows can generate substantial cost savings. A typical planter working on corn acres plants 12 to 20 seeds per second per row, representing a cost of about 50 cents per second for a 12 row planter. Some estimate that the ability to individually control rows based on a coverage map and GPS data can provide savings of over $2,000 compared to a planter without swath control, and just under $1000 compared to a planter with manual swath control, on an approximately 1400 acre operation. Some estimate that yield improvements are closer to $4,000 in value compared to the planter without swath control, and around $1,500 compared to the planter with manual swath control.

The new ability to control individual rows will help growers reduce seed input costs and eliminate yield drag associated with double planting. Growers will be able to reduce seed input costs by more accurately delivering seeds in the row, on point rows, across waterways and around headlands. An electrically-driven custom solution that integrates a wrap spring clutch and gearhead makes it possible for OEMs to bring these benefits to customers at a relatively low overall cost including design, manufacturing and support. Planter OEMs that take advantage of this technology can provide benefits to their customers that include savings on seed as well as increased yields. As grain prices and seed costs rise, these savings will continue to grow in value.

Sidebar 1 – Leading Farm Equipment Manufacturer Implements Integrated Row Control Solution

One of the worlds leading farm equipment OEMs has implemented an integrated approach to row control on several planter models. The company's new row unit on/off capability will help growers reduce seed input costs and reduce the yield drag associated with double planting. When power is supplied, either manually or by the company's GPS-driven controller, clutches disengage the seed meters and seed flow stops. This approach leaves the operator free to manage tractor and planter functions while the clutches automatically engage and disengage planter row units based on coverage maps and field boundaries.

Thomson provided the OEM with a solution that integrates a wrap spring clutch with a right angle helical gearhead. The style of clutch that was selected provides a very fast response and exceeds industry life requirements with very little cycle-to-cycle variation. The helical gearhead was custom and designed from the ground up. The more commonly used planetary gearhead can handle high loads, faster speeds, and has less backlash but the helical gearhead used here is more compact and less expensive while meeting all the requirements of this application. The integrated solution operates solely on electrical power. Its enclosed construction eliminates contaminants and offers a very simple control interface. The OEM uses low voltage CAN message to send power to the clutches of the rows where planting is to be stopped, and remove power from the clutches of the rows where planting should be resumed.

The farm equipment manufacturer was able to integrate the new row control solution into their planter design with minimal modifications. The ability to design and manufacture the clutch and gearbox as an integrated unit saved money and space. The compactness of the design made it possible to integrate into the planter without having to modify the frame. As a result, the OEM was able to bring the new product to market quickly with relatively low engineering costs. While this design was created specifically for planters produced by one major farm equipment manufacturer, a similar design could be created to meet the requirements of any other planter.

Sidebar 2 – Magnetically Actuated Clutches can Provide Even Greater Control

A Magnetically Actuated Clutch is a variation of the wrap spring clutch consisting of an integral coil and the same three basic elements - an input hub, an output hub and a drive spring – but whose inside spring diameter is slightly larger than the outside diameter of the shaft hub.

This is a unidirectional random start\stop type of wrap spring clutch that does not use the traditional stop collar or an external mechanism to engage or disengage the unit. The driving and disengaging functions of this unit are determined by how long the coil is energized or de-energized. When the coil is not energized the clutch input or output will free wheel in both directions.

Magnetically actuated clutches have an integral control collar that couples to the drive spring that engages the clutch when the coil is energized. When the coil is energized the angular displacement between the drive spring inside diameter and the output hub outside diameter are coupled together transmitting torque to the output shaft. The unit will continue to drive the output shaft until the coil is de-energized. If the coil is re-energized the unit will then drive the output shaft until the coil is de-energized.

This same type of unit can be designed to function as a Reverse Logic clutch. The Reverse Logic function would allow the clutch to drive without the coil being energized. In this configuration, when the coil is energized the clutch would disengage and stop driving.