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TORQUE CONTROL IN THE KAPPA TIGHTENING SYSTEM

The Stanley Kappa system is intended to be an affordable and easy-to-use DC electric system for tightening threaded fasteners. The goal was to deliver a robust assembly system with precise torque control comparable to today's state-of-the-art DC assembly systems, but at a lower price point.

In our efforts to meet our goals, we considered several choices for the Kappa torque control method. Today's most accurate DC assembly systems use a torque transducer to continuously monitor the dynamic torque delivered to the fastener during the tightening process. The controller electronics monitor this dynamic torque signal to control the precise shut-off point. In our efforts to reduce the overall system costs, Stanley considered several alternative torque control methods.

CLUTCH:

One choice was to simply use our mechanical clutch directly from the CT pneumatic tool line. This would provide torque control comparable to that of our pneumatic tools, but this concept was rejected based on its complexity, its weight, and its need for manual torque adjustment.

BASIC CURRENT CONTROL:

Some manufacturers have eliminated the torque transducer altogether in their low-cost DC electric systems. Instead of measuring the actual dynamic torque delivered to the fastener during the fastening process, they measure the power consumption of the motor. The most basic example simply monitors the electric current used by the motor, and when this current reaches a certain level, the motor is shut off.

The problem with these so-called "current controlled" systems is that the flow of current into the motor is not directly related to the torque delivered to the fastener. Many other factors can affect this relationship.

First, as the temperature of the motor increases, less torque is produced for a given amount of current. Shutting off the tool at a preset current level will produce less torque when the tool is hot.

Secondly, the inertia of the rotating parts within a tool, combined with the response time of the control system will cause torque overshoot that is not at all related to the amount of current used by the motor. The amount of torque overshoot can be negligible when the tool is operated at a slow speed or on a soft joint, but it will be higher when the tool is at a high speed or on a hard joint. Simply measuring the current into the motor will not differentiate between these conditions.

A third factor is the efficiency of the entire gear system. While a torque sensing transducer will automatically compensate for any change in efficiency of the planetary gear system, a system based on current control would need re-calibration as the efficiency of the gear system changes throughout the life of the tool.

ADVANCED CURRENT CONTROL:

Some competitive systems employ a comprehensive software algorithm to integrate several other factors to arrive at a more accurate estimation of torque. Sensing the motor temperature allows compensation for the difference in torque output with changing temperature. Operating the system in a “learn mode” on a specific test joint while sensing the joint rate and then reducing the tool’s speed to a level where the torque overshoot produced by the rotating inertia becomes negligible, can help reduce the effects of inertia and can reduce torque overshoot. But this is only effective on production joints that are consistently similar to the sample joint. When these systems are used on production joints of varying torque rates, they fail to meet expectations. And when used on multiple joints of different torque rates, they require a joint type selector, which adds cost and complexity to the fastening system.

One of the basic requirements of the ISO 5393 test method for torque capability over a wide range of joints is that tools be tested on both hard and soft joints without any adjustment to the control system. Systems that must “re-learn” or have control parameters changed for either type of joint will violate this basic requirement of this industry standard performance test.

Advanced current control systems can help compensate for some of the shortcomings of the basic current control method, and under certain conditions, can actually produce fairly consistent torque control. But data from these systems can not be used to document process control capability because the data is merely a target, or a calculation based on a number of measured properties, not the actual dynamic torque delivered to the fastener. When compared to a reference master torque transducer, the indicated torque can differ substantially from the actual torque. Some tool users who purchased these systems have rejected them once they realized this deficiency.

For all of these reasons, Stanley decided that a current control system was not the preferred torque control method for the Kappa system.

STANLEY’S KAPPA SYSTEM:

After considering these alternatives, Stanley selected the benefits of using a torque transducer as the heart of the torque control system for the Kappa fastening system. It was clear that the simplest, most direct and most accurate torque control method had to be based on actual measured torque.

To make the system more affordable, the Kappa has features targeted at error-proofing applications rather than at the fully networked data collection applications served by other Stanley DC electric systems. The Kappa confirms tightening to within the specified torque limits and enables bolt counting for Poka Yoke process control.