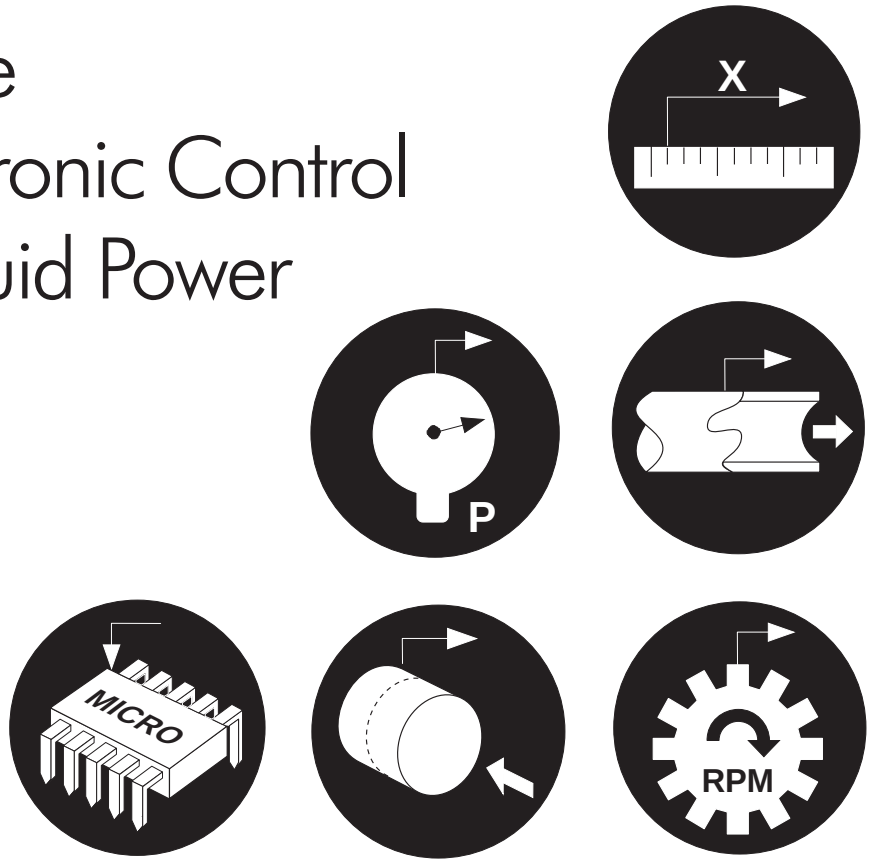
Your Guide to the Electronic Control of Fluid Power



The members of the National Fluid Power Association (NFPA) have prepared this application as an introduction to the electronic control of fluid power. The application and components described here are representative — electrohydraulics and electropneumatics can be effectively utilized in countless processes, and components are available in many different sizes and configurations.

NFPA's manufacturers invite you to contact them for additional information.

National FLUID POWER Association®

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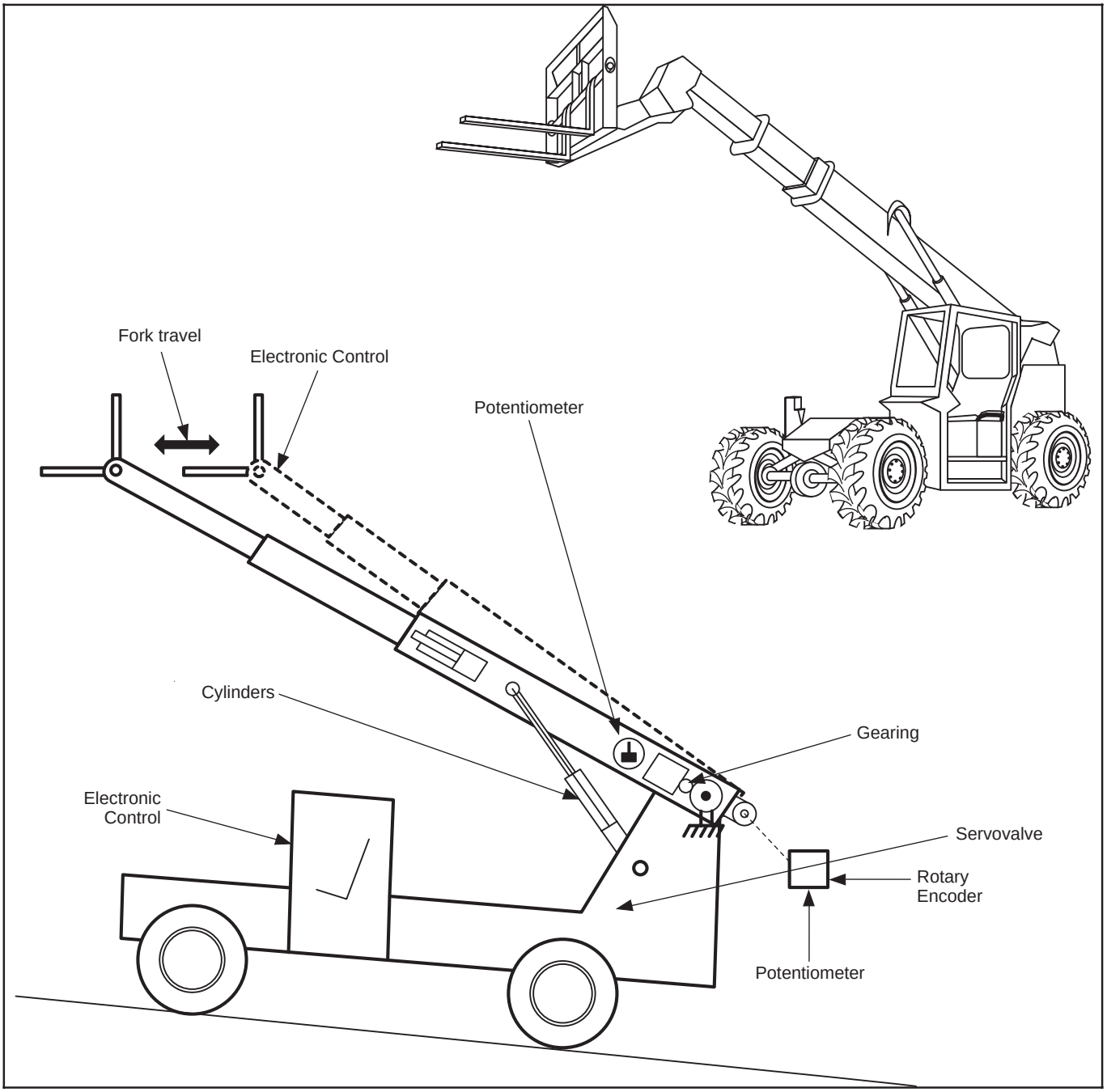
Electrohydraulics at Work

Rough Terrain Forklift



The Problem

On the rough ground around building construction, operating a fork lift truck with high reach requires skill and care. One of the most difficult operations in this setting involves inserting loads horizontally onto scaffolds.

Its Solution

Automatic leveling and insertion of the fork was a highly desirable design goal, and engineers from one equipment manufacturer accomplished it with computer controlled electrohydraulics. Only computer control could insure that the boom would extend and lower simultaneously to move the fork horizontally.

In operation, the forks are loaded, and the boom is extended under manual control into position for final horizontal insertion of the load. Then, the operator calls

for automatic control and lets the computer take over. The following discussions are for a simplified, hypothetical design, based on several versions of the actual machines. Only two of the actuators are indicated in the illustration to explain the principles of boom motion.

To produce pure horizontal motion, the boom angle must change inversely to boom length, a function of the tangent to the boom angle. Multiple sensors on the boom send signals to the onboard microcomputer, which makes the calculations and sends commands to the servovalves that feed the working actuators.

Many design challenges had to be met. First, the variable boom length and angle had to be coordinated with true gravity whether or not the vehicle was on level ground. Also, the control had to compensate for bending of the boom with load, and for overshoot and undershoot. Finally, the actuator response had to be calibrated differently depending on the length of the extension to make sure the column of hydraulic fluid remained stable.

Potentiometric resistive sensors are installed on each hydraulic actuator, so that extensions can be controlled quickly and accurately. A ten-turn potentiometer, rotated by a recirculating cable that extends with the boom, senses overall boom length. Driven by the same rotary motion, a fine-resolution optical encoder tracks boom extension more precisely.

Boom angle is accurately measured with an optical rotary encoder attached to gearing at the base of the boom. A pendulum-type inclinometer, sensed with Hall-effect devices, monitors verticality of the rig. Load force at the boom tip is detected with a force sensor.

All of the above are monitored and commanded by the on-board microcomputer. It contains high speed electronic counters to keep track of incremental motions, including velocities, so that angle and extension are known at every instant, and unsafe speeds are prevented. A flashing light in the cab alerts the operator to overspeed conditions.

Related Applications

Electrohydraulic actuators with electronic position sensing, coupled with angle sensors and load sensors, are well suited for applications where lifted loads must be placed strategically. This includes electrohydraulic robots, factory material handling, and manlifts.

How Electronics Improved This Application

- Speed
- Accuracy
- Automation
- Adjustable sequence and timing
- Monitoring and diagnostics
- Standard components

Components Used in Mobile Hydraulic Systems*

Accumulators
Controls (electronic) and Software
Cylinders
Filters
Fittings
Flanges
Fluids
Gauges
Heat Exchangers
Hose
Hydrostatic Drives
Manifolds
Motors
Power Units
Pumps
Pump Drives
Reservoirs
Rotary Actuators
Seals
Shaft Coupling
Shock Absorbers
Switches
Tubing
Valves

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