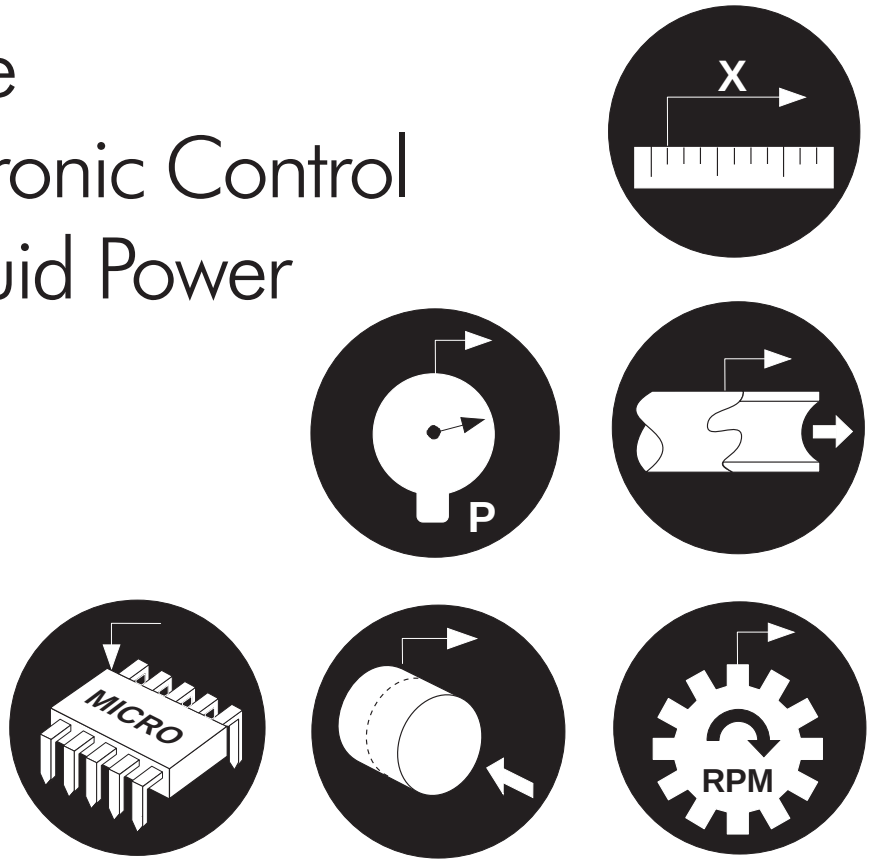
Your Guide to the Electronic Control of Fluid Power



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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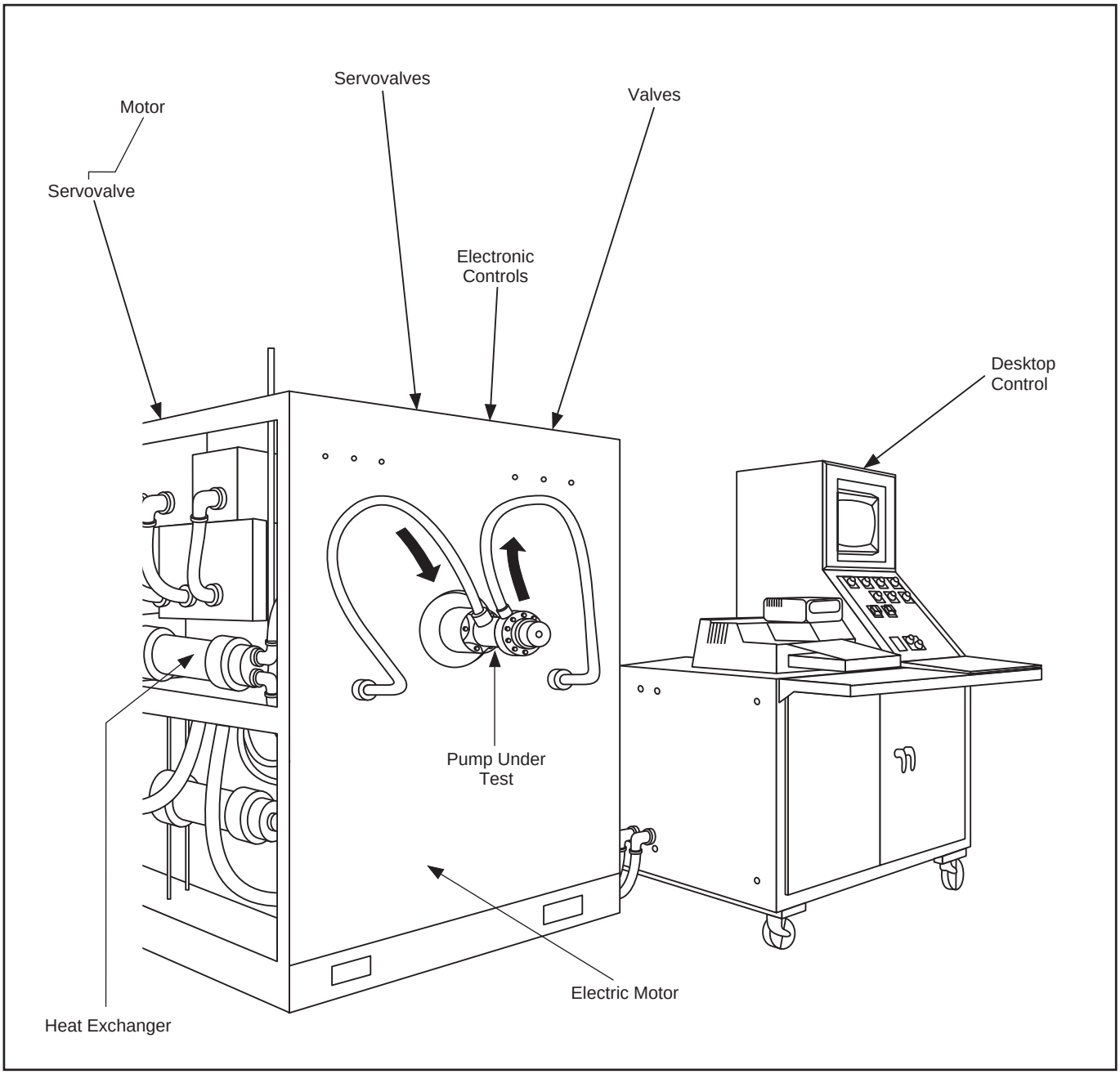
Electrohydraulics at Work

Missile Pump Test



The Problem

Deep in the bowels of each Titan liquid fueled missile is a special constant speed hydraulic pump that powers one stage of the two-stage rocket's flight control system. It is turned by a shaft connected to a turbine in the rocket's exhaust gas stream. The pump has the awesome responsibility of being non-redundant in one of the toughest environments on earth. If the pump doesn't work, the missile goes out of control within seconds.

Consequently, the user has specified an exacting series of tests to be performed on each pump prior to installation in the multi-million dollar launch booster. Until recently, such tests were performed in a manual mode on both the 6-gpm and 18-gpm versions. These manually controlled tests employed a dizzying array of timers, switches, manual valves, solenoid valves, gages, adjustable orifices, temperature probes, motor speed controls

and other devices, to replicate a series of pressure, flow, inlet temperature and pump speed performance tests.

Few technicians were certified to do the tests. It was a cumbersome task because the timers had to be reset manually, and the orifices were difficult to adjust to the precision required. The oscillograph couldn't capture all the data points, and many manual readings had to be taken quickly, within seconds. Confirmation was nearly impossible.

Its Solution

To improve reliability and to allow testing by non-certified technicians, it became apparent that a new testing technique was needed. A computer-controlled testbed was created (see the illustration). It includes a series of sensors for monitoring and control, a servovalve to simulate pump loads, and an advanced data acquisition and recording system.

Each pump moves through many performance simulations: readings of all critical parameters are taken automatically including response time, flow, pressure, pressure drop, temperature and pump rpm. Inlet pressure is varied from a vacuum (induced in the closed hydraulic reservoir with a vacuum pump) to 40 psig (created with pressure from a bottle of compressed nitrogen). The inlet pressures are controlled with electronic proportional pressure control valves that are set with electrical stepper motor actuators that respond to electrical pulses. Inlet temperatures are varied up to 150 degrees F with a heat exchanger whose water flow is controlled with an electronically controlled rapid on-off valve.

The main test cycle lasts five minutes and is repeated 25 times. The pump is cycled through seven levels of flow ranging from nearly full cutoff to nearly maximum output. One special test simulates pump conditions when hydraulic flow and pressure are first established with a ground-based power source, and the tested pump is required to start up against full system pressure and maintain that pressure.

A computer serves as the electronic controller, and the acquisition system typically reads 2000 points of data in five seconds. A high speed memory storage card runs independently of the control function to capture test data, which then is outputted to a standard digital plotter. Controller output is digital, converted to analog current for communications to the servovalve, and to analog voltage for the 50-hp variable speed DC motor that drives the pump on test.

Related Applications

Automated testing of many other kinds of critical pumps and other high-reliability hydraulic components can be done in the manner described for this application. Examples include aerospace hydraulic systems and nuclear power coolant systems.

How Electronics Improved This Application

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

Components Used in Industrial 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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