TURBINE TIPS
Turbine Tips provided by Pond and Lucier, LLC. ®
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Subject: Variable Displacement Fuel Pumps for Gas Turbines

Applies to: General Electric gas turbines

Types of pumps:

OilGear "Type N" pump (radial piston) for MS5001L and LA
OilGear "Type B" pump (radial piston) for MS5001M (nicknamed: Mary)
New York Airbrake pump (axial piston) for MS5001N (nicknamed: Nancy)
Dennison pump (axial piston) for MS7001B

Overview:

General Electric applied ***variable-displacement*** fuel pumps on gas turbines during the late 1960s and early 1970s. Hundreds of turbines were shipped during this era between the Northeast Blackout of 1965 and the Arab Oil Embargo that began in late 1973. After 1973, the standard changed to the Roper (gear pump) or Warren (screw pump), which has lasted for over a quarter century. The ***constant-displacement*** gear or screw pump configuration applied a Young & Franklin bypass valve along with a Roper flow divider with speed pickups to measure flow.

There were two types of variable-flow pumps: ***radial*** piston and ***axial*** piston. ***OilGear*** made the former and ***NY Airbrake*** and ***Dennison*** made the latter. The ***OilGear*** pumps for the **MS5001L or LA** machines (with Fuel Regulators) were referred to as the "Type N" pump; later ***OilGear*** versions for the Speedtronic Mark I were the "Type B" version. The "Type N" used hydraulic signals from the Fuel Regulator (VCO and CCO) to operate, with the lubricity of the fuel for the internal pump bearings; the "Type B" version, however, had its own internal pump to provide the working fluid from the fuel to operate the electronic servo and slideblock.

Fig. 1- OilGear Fuel Pump

The ***NY Airbrake*** was used on some **MS5001N** gas turbines installed form 1971-73. Later model "Nancy's" used the Roper system with a bypass valve. The ***NYA*** pump had an axial-piston configuration. A high-pressure hydraulic pump was driven off the accessory gear to provide fluid to operate the Abex-Atchley servovalve. The Speedtronic Mark I system had a driver card (SSVA) to drive the twin coils of the servovalve. Two linear variable differential transformers (LVDT) were used to measure pump stroke. The Roper flow dividers were freewheeling, tandem-mounted units that operate without speed pickups.

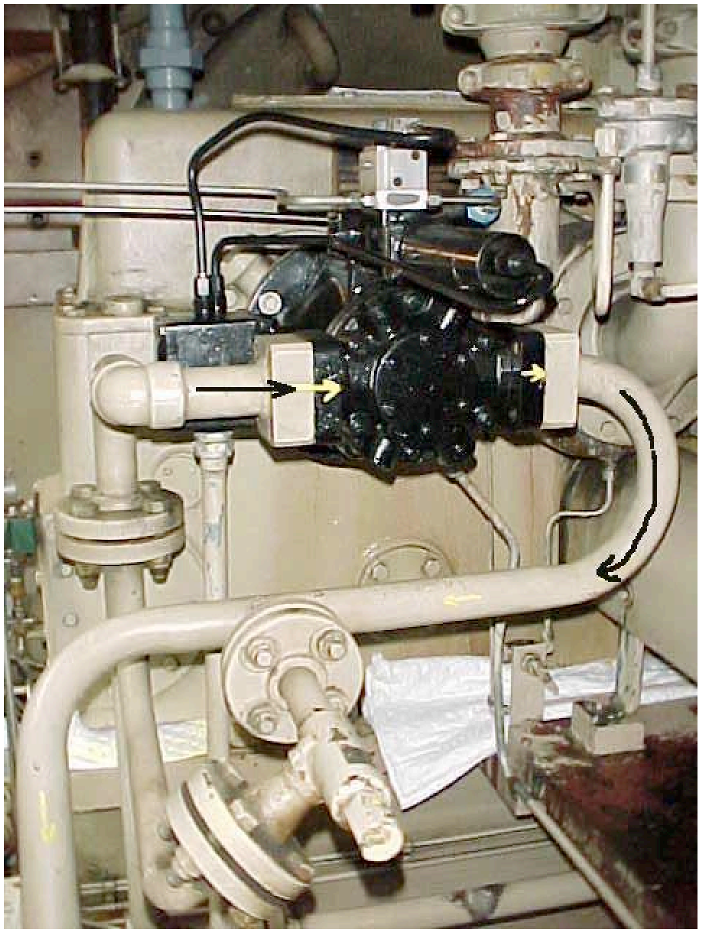

Fig. 2: NY Airbrake Fuel Pump

On the **MS7001B**, a ***Dennison*** fuel pump was typically used.

With positive-displacement pumps that are driven by the accessory gearbox, fuel flow is a function of two variables: **turbine speed (NHP)** and the command signal (**VCO** pressure or **VCE** volts, as applicable).

On ***Fuel Regulator*** era machines (**MS5001LA)**, a typical relationship would be:

$$\textbf{Fuel Flow (gpm)} = K\,(\textbf{VCO} - 40)\,\frac{(\%\ \textbf{NHP})}{100}$$

K = is a conversion constant = .21 gpm/min/psig
VCO is the command signal emanating from the Fuel Regulator going to the pump servo.
NHP is the turbine speed in percent (ranges from 0 to 100 percent)

For instance, at full speed/no load (FSNL)

$$\textbf{Fuel Flow @ FSNL (gpm)} = .21\,(90 - 40)\,\frac{(100)}{100}$$

Expected Fuel flow @ FSNL = 10.4 gpm

On ***Speedtronic Mark I*** era machines (**MS5001N**), a typical relationship would be:

$$\textbf{Fuel Flow (gpm)} = K' \,(\text{VCE} - 4)\, \frac{(\%\ \text{NHP})}{100}$$

$K' =$ is a conversion constant = 3.27 gpm/min/volt
VCO is the command signal emanating from the Speedtronic panel going to the pump servo.
NHP is the turbine speed in percent (ranges from 0 to 100 percent)

$$\textbf{Fuel Flow @ FSNL (gpm)} = 3.27\,(7.5 - 4.0)\,\frac{(100)}{100}$$

Expected Fuel flow @ FSNL = 11.4 gpm

Fig. 3: Dennison Fuel Pump

Troubleshooting:

Variable-displacement fuel pumps operate similarly. The command signal to the servo unit is the “called for” fuel flow. Linear variable differential transformers (LVDT) measure the stroke of the pump in response to the command signal. The speed of the pump is proportional to turbine speed (NHP) because the turbine drives the pump through the accessory gear box.

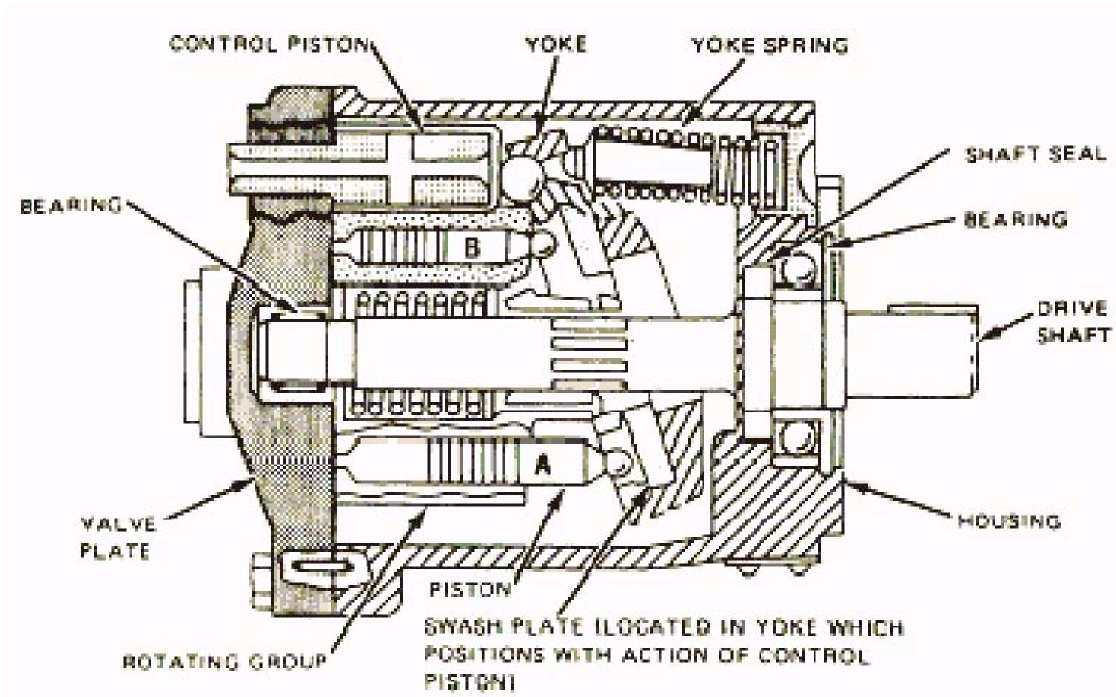

Fig. 5: Cross-section of NY Airbrake Variable-displacement, Axial-piston Pump

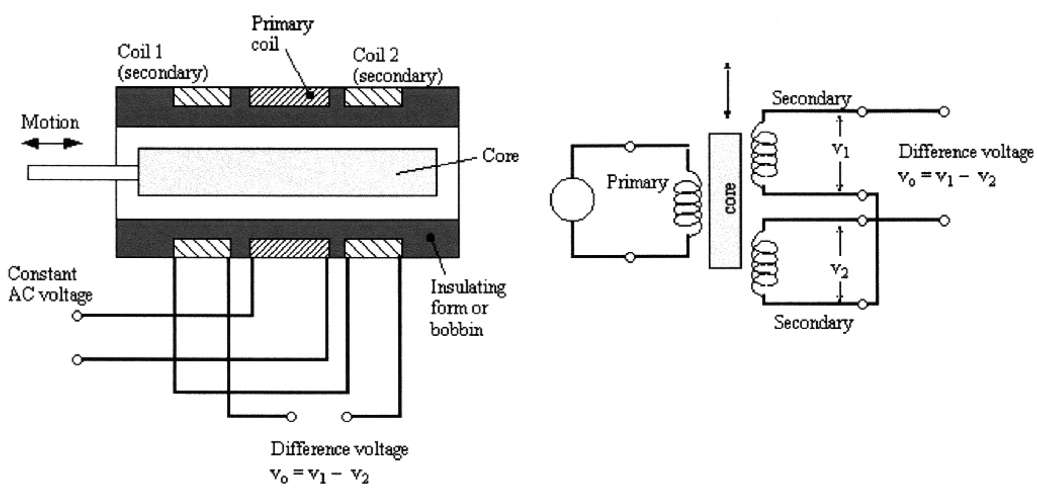

Fig. 6: Typical Pump Stroke Feedback Device: Linear Variable Differential Transformer (LVDT)

For gas turbines having the Fuel Regulator control systems (MS5001L and LA), the schematic below represents the control functions. VCO and CCO pressures are the "brains and brawn" respectively of the system. A feedback spring restores the slideblock to the "null" position after a VCO change. VCO is the signal coming from the Fuel Regulator that tells the pump how much to stroke. Turbine speed (NHP) is used to drive the accessory gear and hence the fuel pump. Again, fuel flow is a function of Variable Control Oil (VCO) pressure and turbine speed (NHP). Whenever either one increases, fuel flow increases (gpm).

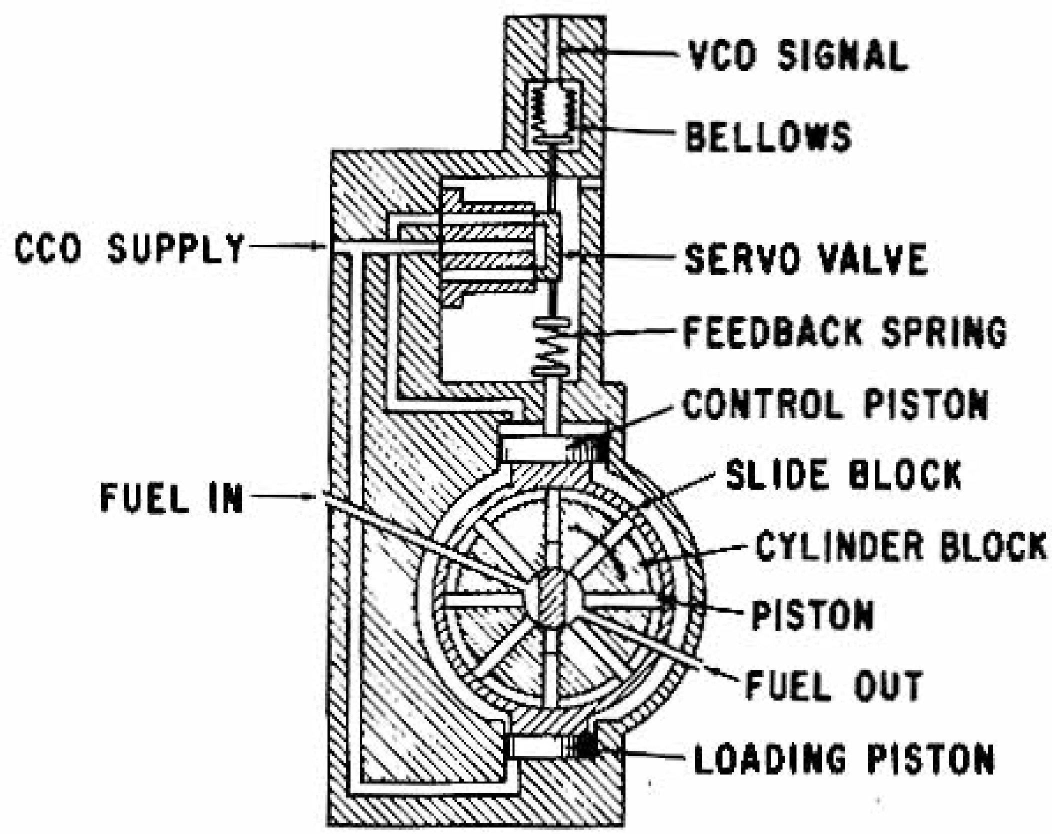

Fig. 7: OilGear Fuel Pump Schematic for MS5001LA machines with Fuel Regulators

Servicing Fuel Pumps:

Variable-displacement fuel pumps need periodic servicing. Depending upon the type of pump and manufacturer, disassembly for cleaning is required every 3 to 5 years. This is especially true for ***peaking*** turbines that do not run for more than a few hundred hours per year. Idle and standby situations can be even more unforgiving than continuous, base load operation for these pumps.

Contact Pond And Lucier if you need assistance troubleshooting or servicing your fuel pumps. See Products on our website regarding reconditioning of your pumps.