TURBINE TIPS
Turbine Tips provided by **Pond and Lucier, LLC.** ®
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Fairchild Millivolt Flame Detectors

Applies to: General Electric MS5001L & LA gas turbines, circa 1967 - 1969.

Why does my turbine "flame out" when it reaches full speed/no load?

GE gas turbines manufactured in the late 1960s utilized a thermocouple flame relay manufactured by ***Fairchild Electro-metrics***. This was not, in reality, a flame detector. It was an exhaust heat detector that "simulated" flame. See Figure 1 below. The device took the averaged exhaust temperature (TX) to determine if flame must exist in the combustors.

Note: It received the same signal that goes to the GE/MAC temperature control amplifier. If TX value exceeded 500 degrees Fahrenheit as the turbine was accelerating, it determined that ***"flame"*** must be present. In short, this was an indirect measurement; more modern turbines utilize ultra-violet flame detectors (even some MS5001LA machines) that measured the ultra-violet light inside combustors. ***Edison*** made these later scanners.

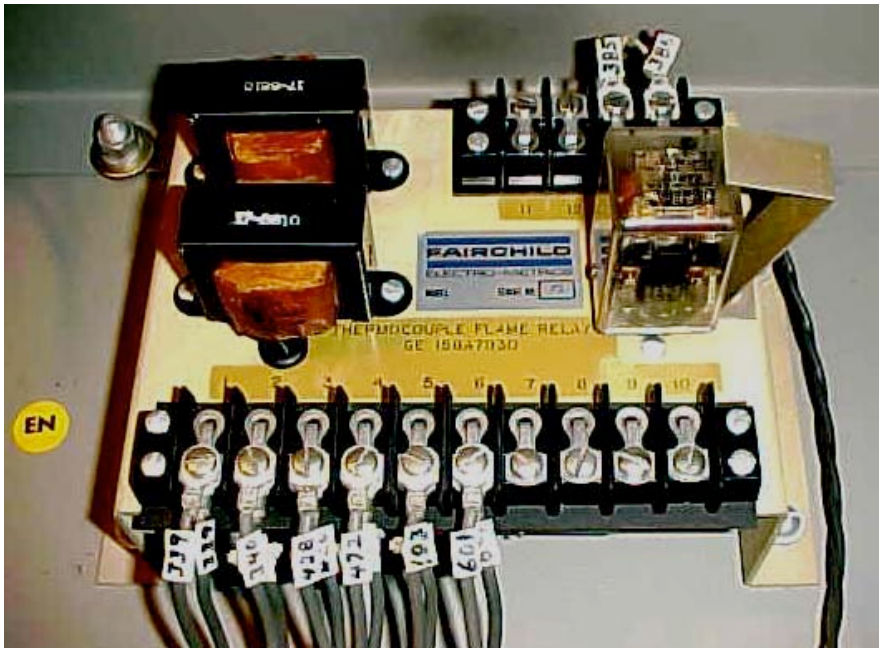

Fig. 1: Panel-mounted Fairchild Millivolt Flame Detector (GE drawing 158A7930)

The ***Fairchild*** thermocouple flame relay should be calibrated to acknowledge that ***"flame"*** is present when the millivolt signal equivalent to 500 ºF (22.6 DC millivolts) is sensed. Loss of flame, on the other hand, should trip the gas turbine if the temperature drops below 300 ºF after the turbine reaches operating speed. This presents a problem for this type of flame detector, because the "drop out" of relay 20FD is about 475 ºF. This problem is noticed when the turbine reaches operating speed and fuel is cut back as it goes on governor control. At full speed, no load (***FSNL***, 5100 rpm), sometimes the exhaust temperature drops to about 450 ºF, which would ordinarily cause a ***"flameout."***

To prevent flameouts, ***Fairchild*** installed a speed relay (called 14FD) behind the panel. This relay would sense the turbine speed from the turbine's tachometer generator. An adjustment resistor is used to ***"bias downward"*** the dropout point of relay 28TC. In short, the relay was adjusted to pick up at
500 ºF but drop out at 300 ºF, well below the temperature expected at ***FSNL***. Thus, this biasing would obviate a tripout when the turbine reached operating speed.

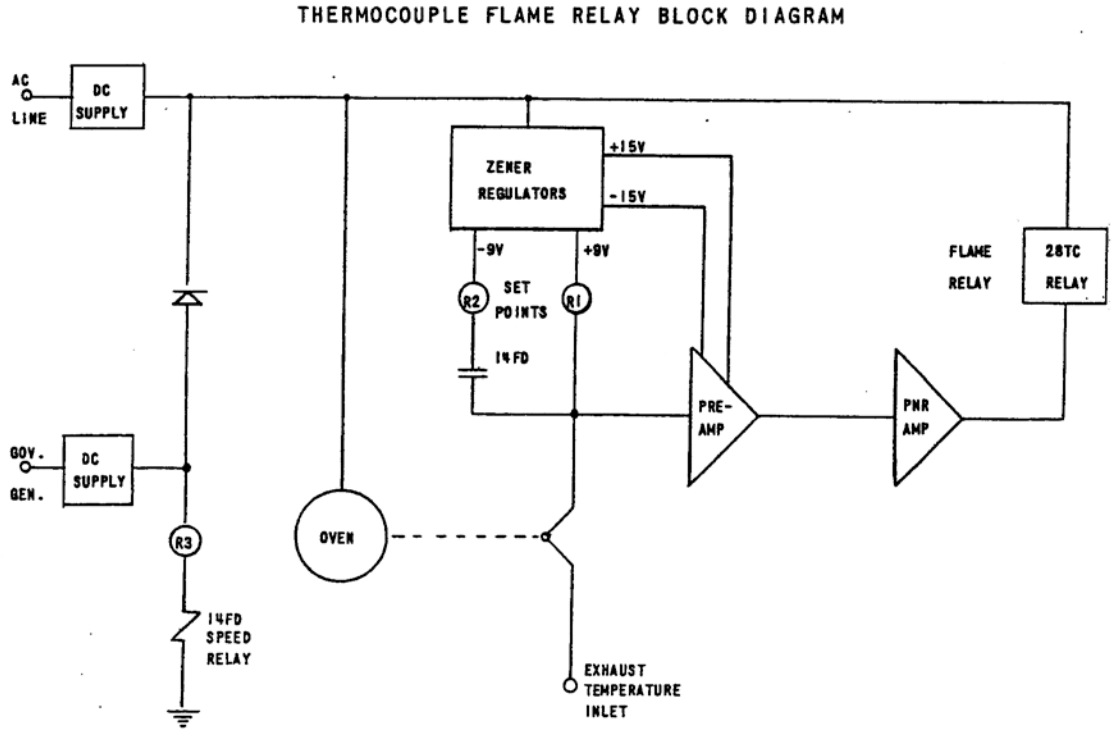

Fig. 2: Fairchild Thermocouple Relay Block Diagram

If your turbine is tripping out at ***FSNL***, it may be that **14FD** has failed to energize (NOT picked up) when the turbine reaches approximately 3500 rpm. This is approximately 105 AC volts on the fuel regulator's tachometer generator. It is also possible that the coil on relay **14FD** has failed. Relay failure is difficult to detect because it is located behind the panel. See the chart below

28TC Flame Detector	Condition (Temp or Millivolt)	Comments
28TC energizes (Pick up)	400 ºF (approx. 11.0 DC millivolts)	14FD is de-energized. Resistor: **R1**
28TC de-energizes (Drop Out)	375 ºF (approx. 9.6 DC MV)	If 14FD does **NOT** energize, 28 TC will drop out at this temperature.
28TC de-energizes (Drop Out) Drop Out "biased down"	300 ºF (approx. 7.9 DC millivolts)	Use resistor **R3** to adjust 14FD pickup at 3500 rpm (105 VAC on tach generator). 14FD energized, then adjust resistor **R2 28 TC** for drop out of 28TC 300 ºF.

See your Turbine Electrical Elementary sheet 11 for details on the wiring of the ***Fairchild*** unit. The wiring is shown in the upper left-hand corner of the print.

The ***Fairchild*** Thermocouple Flame Relay takes an **uncompensated** average exhaust temperature signal (TX) sent from the averaging module, which is the same signal as the GE/MAC temperature control system. The calibration of the detector requires both a millivolt (Type K temperature) source and a Variac variable AC power supply (0 - 150 VAC).

Note: If a separate millivolt signal is used (copper wires), it must be ambient compensated for the temperature measured at the input to the Flame Detector. This signal must be **subtracted** from the input signal (for instance, subtract 1.40 millivolts for 80 deg. F). This is similar to the **GE/MAC** calibration procedure. It is recommended that the ***Fairchild*** and ***GE/MAC*** calibrations be done simultaneously.

The Variac allows for speed relay **14FD** located on the Flame Detector panel to introduce a "biasing" circuit for the drop out of relay **28TC**. This is done because the exhaust temperature at full speed/no load on the gas turbine is about 450 deg. F. By coincidence, this temperature is also the approximate "unbiased" normal drop-out level of **28TC**. Thus, by introducing the circuit associated with **14FD**, the drop-out point of **28TC** is effectively decreased after the turbine reaches approximately 3500 rpm (105 VAC out of the tachometer generator).

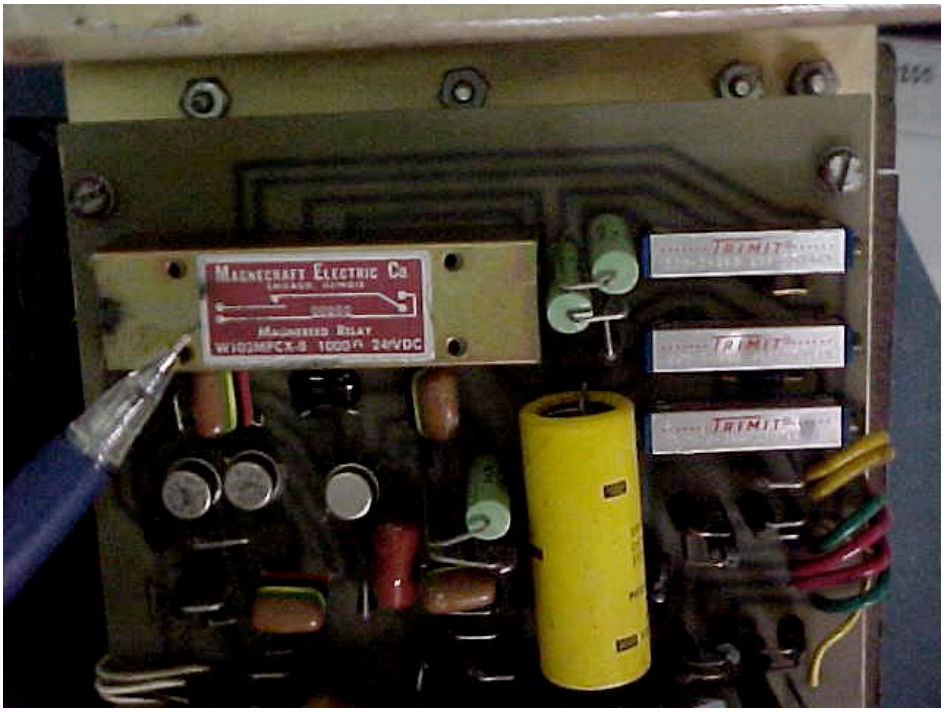

Fig. 3: Pencil pointing to 14FD relay underneath flame detector. Three Adjusting resistors on right.

Note*:** Refer to turbine electrical elementary sheet 8. Notice that a **LOSS OF FLAME** (**28TC** dropout) must be accompanied with an actual ***reduction in speed of speed (14HSY dropout) for an actual turbine trip to occur. This applies to operation at full speed/no load (FSNL) or with the generator synchronized to the power grid. Normally open (NO) contacts of **28TC** and 14HSY are electrically in parallel. They control the coils of 28FDX-1, -2, -3. Relay 28FDX-1 has contacts in the master protective circuit on turbine elementary sheet 4.

For more information on the ***Fairchild*** thermocouple flame relay and technical assistance, contact Dave Lucier of ***Pond And Lucier, LLC.*** ***dave@pondlucier.com***
www.pondlucier.com