THERMOCOUPLE QUALITY

INTRODUCTION

Thermocouples are an important part of any standing pilot system, yet the importance of high-quality thermocouples is often overlooked. This paper reviews thermocouple function and operation, explains how thermocouples wear out, describes the characteristics of a quality thermocouple like the Q340, and explains how replacing thermocouples on each service call is inexpensive insurance for both the homeowner and the service contractor.

THE FUNCTION OF A THERMOCOUPLE

Thermocouples are used on standing pilot furnaces and boilers as part of the safety shutoff system. When correctly mounted in the pilot flame, they generate the electrical current required to hold open the power unit. If the pilot flame goes out or is too small to reliably light the main burner, the thermocouple output drops below the level required for holding the power unit open, and the power unit drops out, closing the safety valve and preventing gas from flowing through the control to the pilot or main burner.

HOW THERMOCOUPLES WORK

As shown in Fig. 1, a thermocouple consists of a copel (a copper-nickel alloy) rod mounted inside a stainless steel shell.

One end of the copel rod is joined to the outer shell; the other end is connected to a copper wire that carries the current generated by the thermocouple to the power unit connector contact. The copel end connected to the outer shell is called the *hot junction*. The copel end connected to the copper wire is called the *cold junction*. When the tip of the thermocouple is properly positioned in the pilot flame, as shown in Fig. 2, the temperature difference between the hot junction and the cold junction is up to 650° F. This temperature difference within the copel element generates electrical energy (in the form of direct current), which flows through the copper lead to the power unit connector contact, keeping the gas control power unit energized.

THE SOURCE

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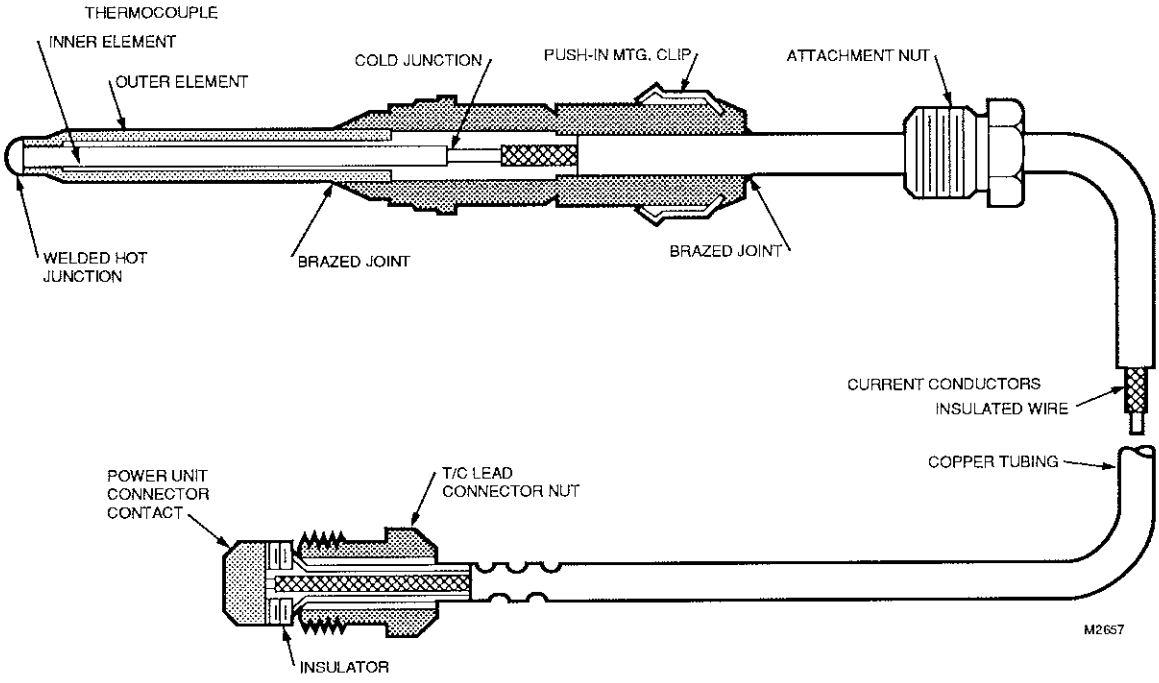

Fig. 1—Typical construction of a thermocouple (Q340 shown).

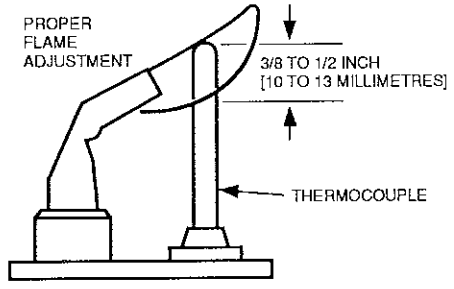

Fig. 2—Proper positioning of a thermocouple within the pilot flame.

WHY THERMOCOUPLES WEAR OUT

The active part of a thermocouple is the copel rod (inside the outer shell) that produces a millivolt output when heated. Over time, the copel rod oxidizes; eventually, as shown in Fig. 3, this oxidation erodes the rod until it becomes very thin, breaks, and no longer provides the necessary electric current.

Factors that can improve thermocouple life include:

1. Using a large diameter copel element. A larger element takes longer to oxidize.

2. Minimizing exposure of the copel element to air (the oxidizing agent). Shielding the copel element from air is an effective means of accomplishing this, but to be successful careful manufacturing processes and quality control are important. During fabrication, all parts must be kept clean. This helps assure that the outer shell can be completely fused over the copel element, and that there are no blow holes or pin holes at the hot junction and connector.

3. Regulating the hot junction operating temperature. This is the most important factor in extending thermocouple life, and primarily hinges on properly mounting the thermocouple in the pilot flame. Only the top 3/8 to 1/2 in. of the thermocouple should be mounted in the pilot flame, as shown in Fig. 2, and the pilot flame should be soft and steady. To produce the required millivoltage, thermocouples require a minimum temperature differential between the hot and cold junctions of 400° F. To achieve this differential it may be necessary to regulate the pilot burner pressure for an acceptable pilot flame, since the temperature of the pilot flame is a function of the gas input pressure to the pilot orifice. As a rule of thumb, the life of the copel element is reduced 50 percent for each 100 degree increase in hot junction temperature. A thermocouple with a hot junction temperature of 1400° F, for example, has only one half the life of a thermocouple with a hot junction temperature of 1300° F.

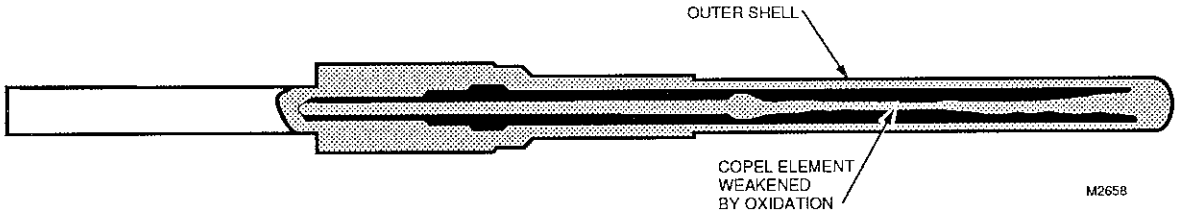

Fig. 3—Oxidation of the copel element within a thermocouple eventually leads to failure.

4. Minimal temperature differential at the hot junction due to main burner cycling. Excessive heat on the thermocouple can be caused by heat radiation from the main burner. In some cases it may be necessary to install a radiant shield to protect the thermocouple from the main burner to prolong life.

WHAT MAKES A QUALITY THERMOCOUPLE?

A quality thermocouple should have three attributes. First, it should have a thick copel element for long life. It's important to note that the thickness of the copel element is internal. When comparing thermocouples, you cannot compare only the thickness of the outer shell. Second, a quality thermocouple should be well constructed. Good quality control during manufacturing is important to assure that the copel is bonded correctly to the outer shell at the hot junction and to the copper wire at the cold junction. If these bonds break, the thermocouple is useless, no matter how thick the copel element is. And third, the thermocouple should be easy to install. While installation is not always considered a *quality* feature, the ease of installation and proper positioning within the pilot flame has a direct relationship to the life of the thermocouple and its performance.

HONEYWELL Q340 COMBINES THE HIGHEST QUALITY WITH UNIVERSAL MOUNTING FLEXIBILITY

The features of a quality thermocouple are all inherently a part of the Honeywell Q340.

The Q340 has a 39 millivolt output and contains many quality features.

1. The stainless steel outer shell that houses the copel element resists the high pilot flame temperatures, retards oxidation, and helps prolong thermocouple life.

2. The copel element is as thick as or thicker than all other thermocouples for residential application.

3. Manufacturing under a very strict quality control process so that the bonding of the hot and cold junctions is extremely reliable.

The Q340 has adapters for universal mounting, and can be installed on screw-in type, clamp type, and push-in type pilot burners. It installs without measuring or adjusting. All that is required to install the thermocouple is to install the proper fitting in the pilot burner and insert the Q340, pushing it into the fitting until it stops. It is always perfectly positioned within the pilot flame.

THERMOCOUPLES ARE INEXPENSIVE INSURANCE FOR HOMEOWNERS AND CONTRACTORS

Thermocouples are low cost items, but very critical to system operation. When making service calls for any reason, the least expensive and best insurance you can provide for the customer and yourself is to replace the thermocouple. By installing a quality thermocouple during every service call:

- — You protect the homeowner from nuisance shutdowns and expensive service calls for thermocouple replacement only.
- — You protect yourself from the likelihood of nonrevenue service callbacks for systems with faulty thermocouples.
- — You help establish your service department with the quality image of getting the job done right the first time.

SUMMARY

Understanding what makes a quality thermocouple can help you decide which thermocouple to stock and carry in your service vehicles. And since thermocouples are a very low cost item that wear out internally, so that you can't tell how much longer they might last or when they might fail, replacing them on service calls always makes sense for both the homeowner and you.

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QUALITY IS KEY

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