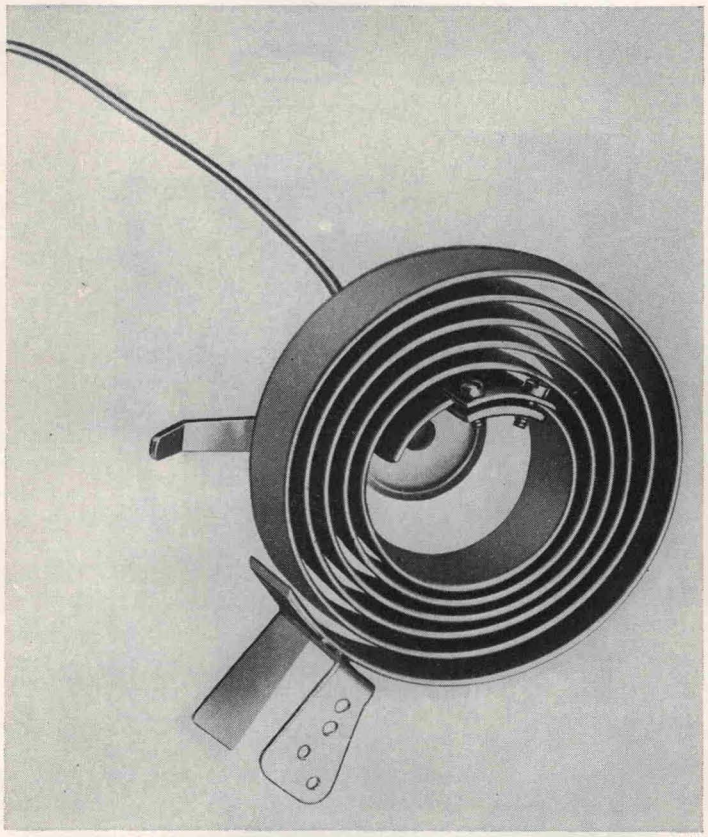

Fig. 4. Spiral pressure element.

Figure 4 shows a spiral and Figure 5 shows a helix. These elements are made from a thin-wall tube which is flattened to produce a long, narrow elliptical cross section. It is then formed into a spiral or helix as illustrated. When the process pressure is applied through the connecting tube, the resulting force tends to uncoil or straighten out the tubing. The rotating motion of the spiral or helix through a suitable linkage arrangement can be used to actuate a pointer or pen arm. The spiral is normally used for pressure ranges from 0–20 to 0–4000 psi, and the helix from 0–100 to 0–100,000 psi. The material used may be bronze, steel, stainless steel, or special alloys.

Figure 6 shows a "C"-type bourdon tube. This also is made from a thin-wall tube which may be flattened a small amount or a large amount, depending on the material and the pressure range. The tubing is formed into a "C" shape, with one end closed and free to move, and the other end fixed and opened to a connecting tube for the process pressure. The force from the applied pressure tends to straighten out the tube, thus producing tip travel. A suitable linkage will transfer this tip travel to a pointer or pen arm. These elements are used for pressures from 0–15 to 0–10,000 psi. The material used is bronze, steel, stainless steel, or special alloys.

Spring-and-Bellows Pressure Elements. Figure 7 shows a cross section of a spring-and-bellows pressure element. The bellows is formed from a length of thin-wall tubing by hydraulic extrusion in a die. This bellows is enclosed in a metal shell which

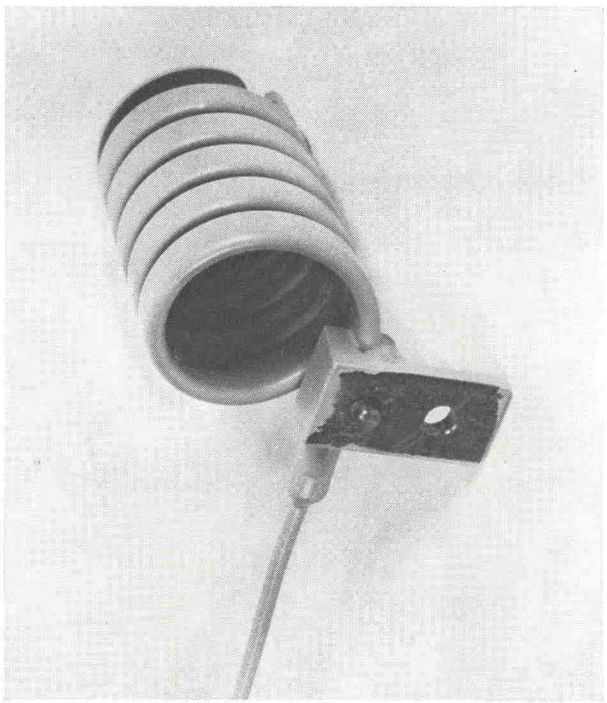

Fig. 5. Helix pressure element.

is connected by tubing to the process pressure. A compression-type spring is mounted inside the bellows resting against its bottom and restrained at the top by a form-fitted nut. A rod resting on the bottom of the bellows transmits any vertical motion of the bellows through a suitable linkage arrangement into a pointer or pen readout. As the process pressure inside the metal shell is increased, the bellows moves vertically upward and compresses the spring. The bellows-spring gradient is small compared to the spring gradient so that the pressure range is a function of the spring gradient only. A spring-and-bellows pressure element can be used on pressure ranges from about 0–5 in. of water to 0–50 psig. The lower pressures require bellows of a larger diameter than the higher pressures. The bellows is usually made of phosphor bronze or stainless steel but can also be supplied in many special metals.

Absolute Pressure Gage Element. When industrial process "low-vacuum" measurements are required, between 0–100 mm Hg and 0–30 in. Hg abs, it is frequently necessary to compensate for the normal variations in atmospheric or barometric pressure. Figure 8 shows a spring-and-bellows element which automatically compensates for the barometric pressure changes. The element includes a double bellows arrangement with both bellows fixed at the top and bottom and the adjacent end of each bellows attached to a movable plate, which transmits the bellows movement through a suitable linkage to a pointer or pen. The upper bellows is evacuated to a near perfect vacuum (absolute zero) and is then sealed off. The process vacuum is applied to the lower bellows, which then tends to collapse (close) the lower bellows, moving the center plate down. If the barometric or atmospheric pressure changes, the upper bellows will expand or contract, depending on any decrease or increase in the barometer. The bellows may be made of phosphor bronze or stainless steel.