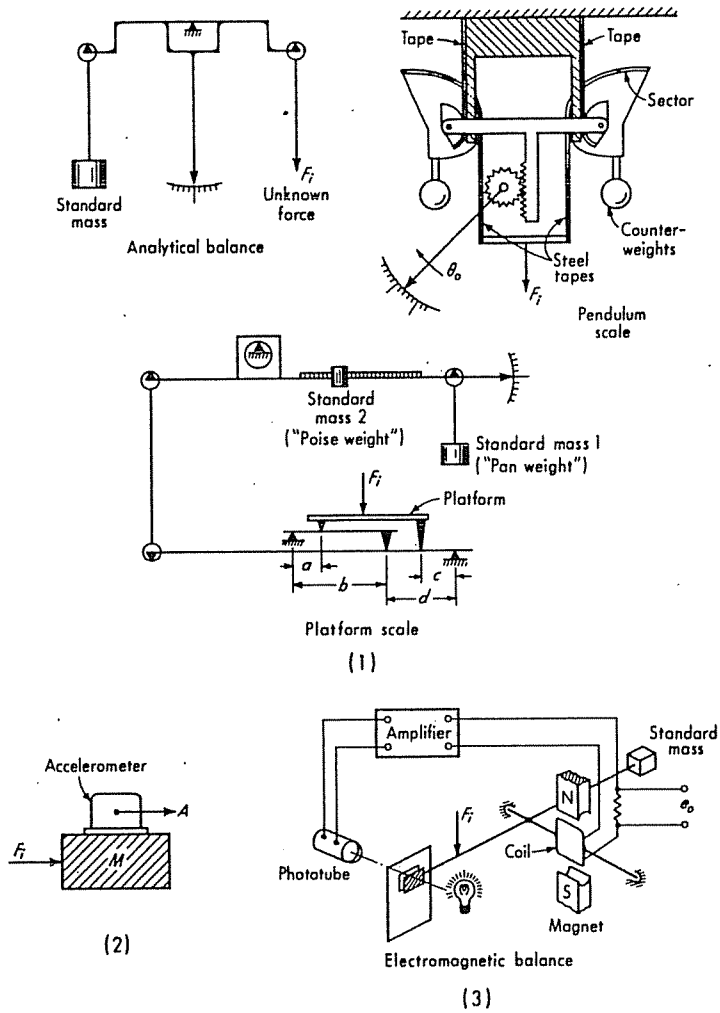
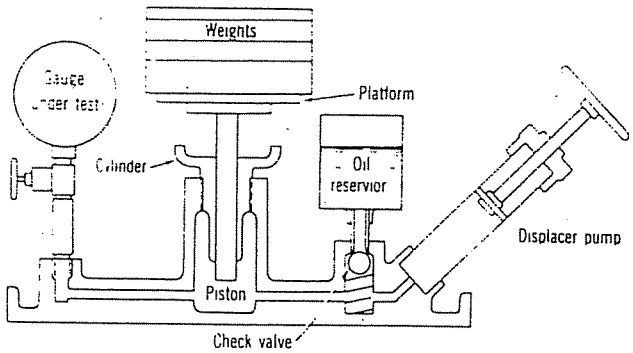
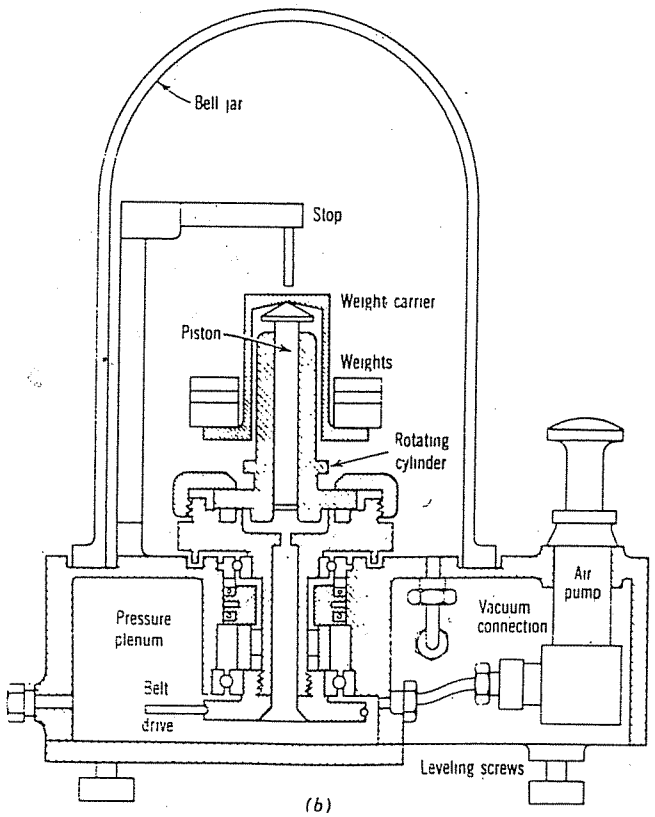


Figure 5.2 Basic force-measurement methods.



(*a*)



(*b*)

FIGURE 15.1 Various deadweight piston gauges. (*a*) High-pressure hydraulic gauge. (*b*) Low-pressure gas gauge. (*Source:* After ASME PTC 19.2 [37].)

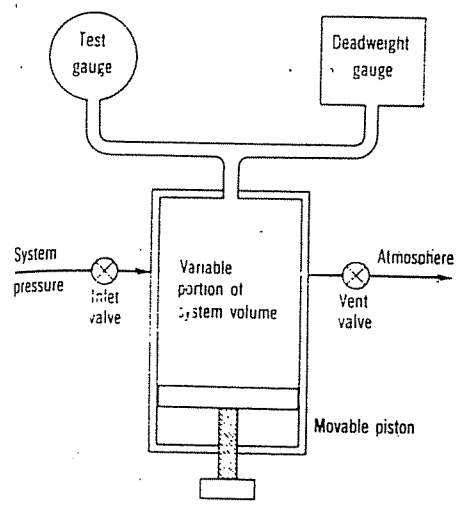


FIGURE 15.2 Pressure–volume regulator to compensate for gas leakage in a deadweight gauge. As gas leaks, the mass and hence the pressure decrease. As the system volume is decreased, the pressure is reestablished according to $pV = MRT$.

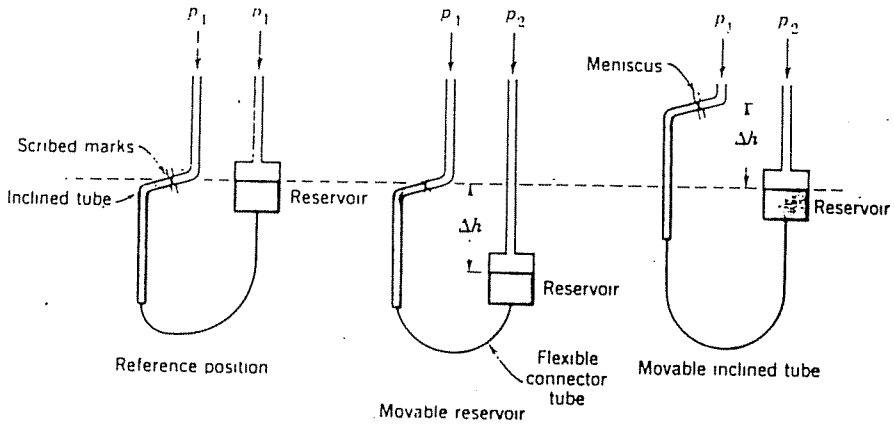
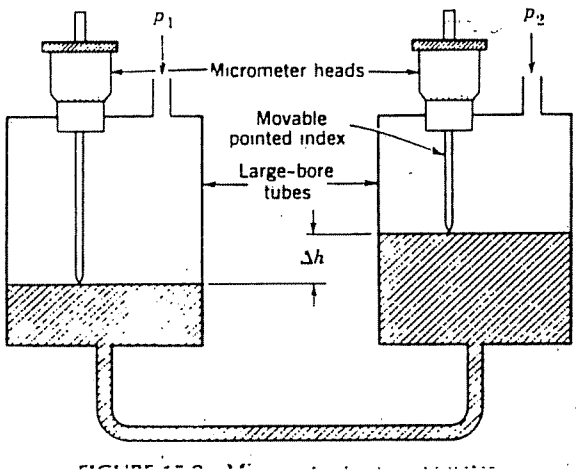


FIGURE 15.7 Two variations of Prandtl-type manometer. After application of pressure difference, either the reservoir or the inclined tube is moved by a precision lead screw to achieve the null



15.3 Micromanometers

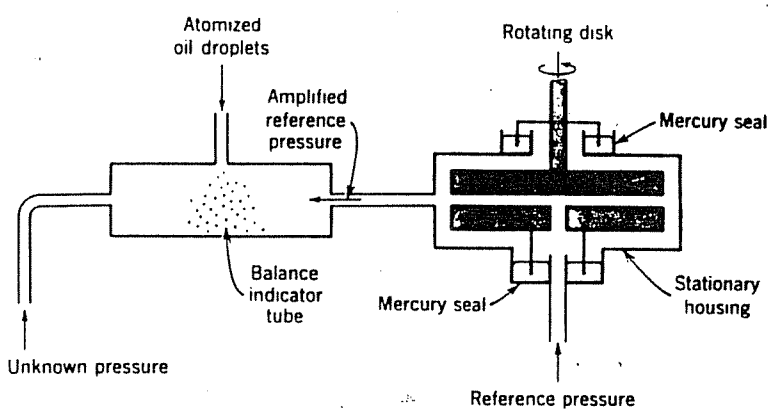


FIGURE 15.9 Air-type centrifugal micromanometer. (*Source:* After Kemp [13].)

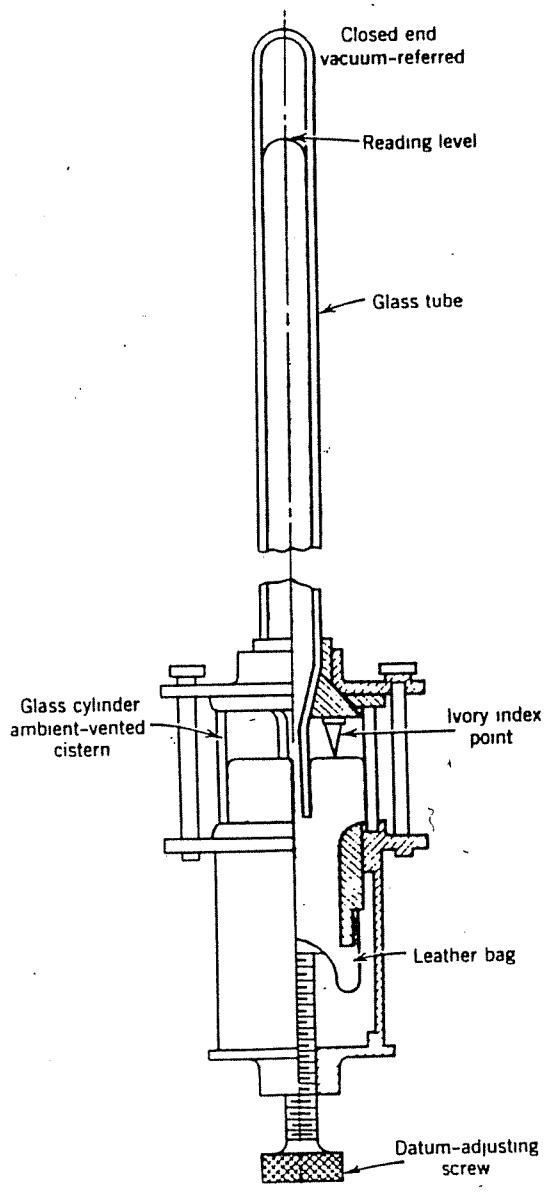


FIGURE 15.11 Fortin-type barometer. (*Source:* ASME PTC 19.2 [3].)

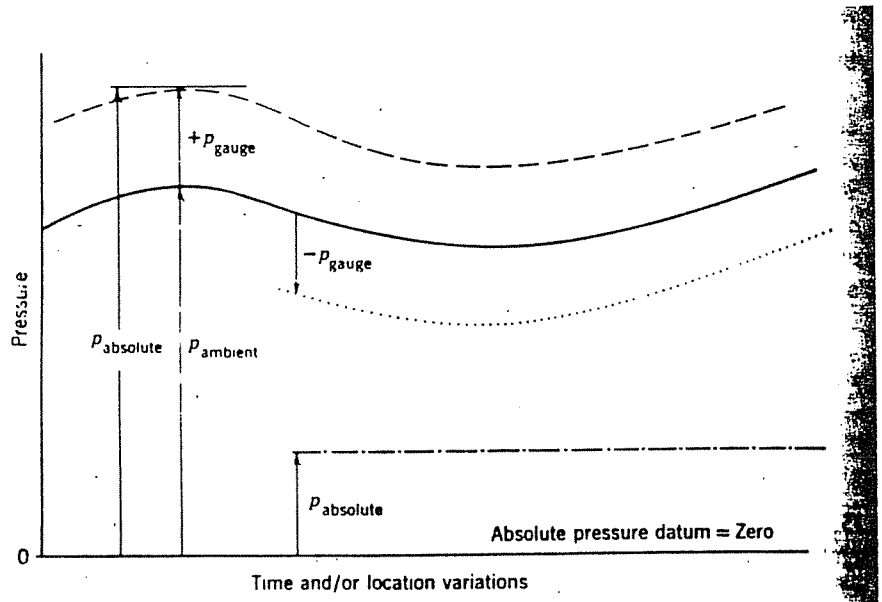


FIGURE 15.10 Relations among terms used in pressure measurements: --- locus of constant positive gauge pressure; —— gauge pressure datum = ambient; . . . . locus of constant negative gauge pressure; —.—. locus of constant absolute pressure.

TABLE 15.5 Pressure Unit Conversion Factors

Pressure Unit	psi	in H_2O	in Hg	atm	μbar	mm Hg	μm
1 psi	1.000	27.730	2.0360	6.8046×10^{-2}	68947.6	51.715	51715.0
1 in H_2O (68°F)	0.036063	1.000	0.073424	2.4539×10^{-3}	2486.4	1.8650	1865.0
1 in Hg (32°F)	0.49115	13.619	1.000	3.3421×10^{-2}	33864.0	25.400	25400.0
1 atm	14.69595	407.513	29.9213	1.0000	1.01325×10^{6}	760.000	7.6000×10^{5}
1 μbar (dyn/cm^2)	1.4504×10^{-5}	4.0218×10^{-4}	2.9530×10^{-5}	9.8692×10^{-7}	1.000	7.5006×10^{-4}	0.75006
1 mm Hg (32°F)	0.019337	0.53620	0.03937	1.3158×10^{-3}	1333.2	1.0000	1000.0
1 μm (32°F)	1.9337×10^{-5}	5.3620×10^{-4}	3.9370×10^{-5}	1.3158×10^{-6}	1.3332	0.0010	1.000

Source: Adopted from NBS Monograph 8 [10].

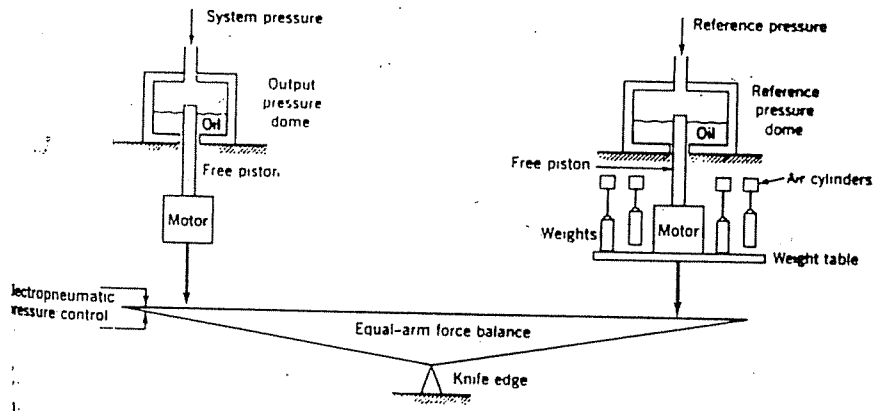
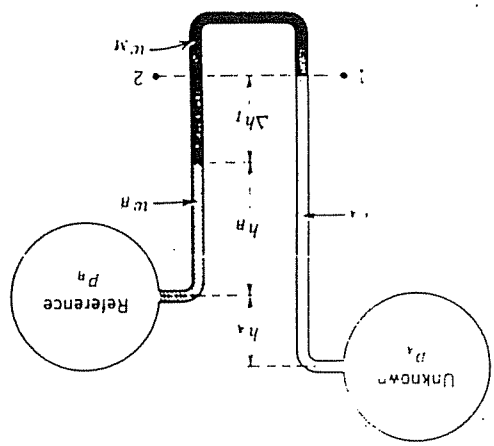


FIGURE 15.4 Equal-arm force balance piston gauge. (*Source:* After [7].)

TABLE 15.1 Specific Weights of Mercury and Water[a]

Temperature (°F)	Specific Weight ($w_{,,}$) Mercury (lbf/in^3)	Water (lbf/in^3)
32	0.491154	0.036122
36	0.490956	0.036126
40	0.490757	0.036126
44	0.490559	0.036124
48	0.490362	0.036120
52	0.490164	0.036113
56	0.489966	0.036104
60	0.489769	0.036092
64	0.489572	0.036078
68	0.489375	0.036062
72	0.489178	0.036045
76	0.488981	0.036026
80	0.488784	0.036005
84	0.488588	0.035983
88	0.488392	0.035958
92	0.488196	0.035932
96	0.488000	0.035905
100	0.487804	0.035877

[a]At standard gravity value of 32.1740 ft/s^2.



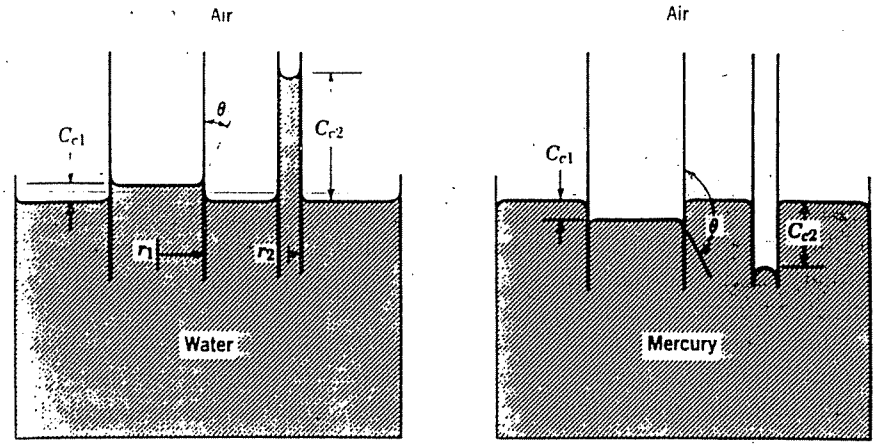


FIGURE 15.6 Capillary effects in water and mercury. Pressure difference inside and outside tubes is zero so that variations in liquid heights because of capillarity must be accounted for in pressure measurements. The single-tube correction factor is $C_c = 2\sigma \cos \theta / w_{,,} r$.

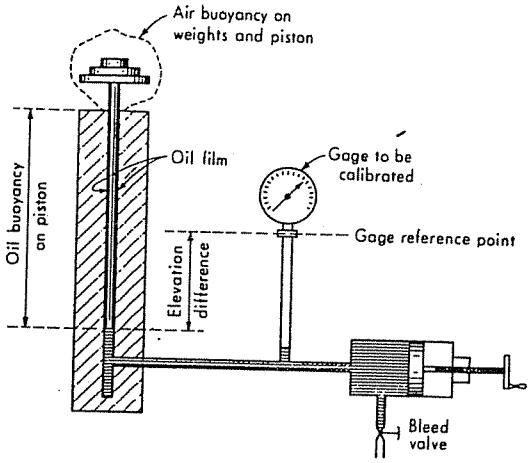


Figure 6.2 Deadweight gage calibrator.

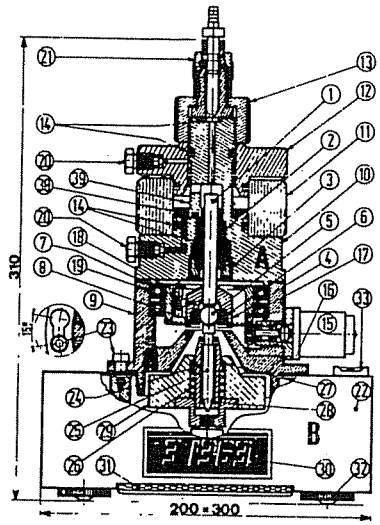


Figure 6.3 Pressure standard using electromagnetic balance. The digital standard is made up of piston-cylinder measuring element (A + a) and an electronic dynamometer (B) *manufactured Mettl. Instrument.*

Measuring element (A + a):

1. Piston in tungsten carbide
2. Cylinder in tungsten carbide
3. Cylinder retaining nut
4. Piston head
5. Ball in tungsten carbide
6. Ball bearing to center the ball (5)
7. Drive bearing
8. Retaining ring for ball (5)
9. Rotation mechanism housing
10. Piston-cylinder housing
11. Acrylic sight glass
12. Cover
13. Retaining nut
14. O-ring seals
15. Electric drive motor
16. Drive pinion
17. Toothed drive wheel
18. Drive bearing pin
19. Toothed wheel bearings
20. Purge screws
21. Quick-connect system (standard threads available)

Electronic dynamometer B:

22. Housing
23. 3 pins giving a quick release facility for th measuring assembly (A + a). *(After 15° rotation on the pins a locking me chanism secures the measuring element to th dynamometer.)*
24. Force limiting guide
25. Coupling rod
26. Force limiting spring

27-28. 2 vibration dampers

29. Force receiving plate
30. 40000 points 5 digits display
31. Auto-zero bar
32. 2 leveling screws
33. Bubble level

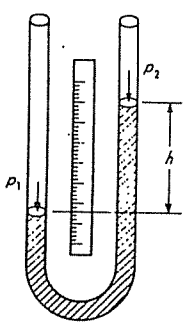


Figure 6.4 U-tube manometer.

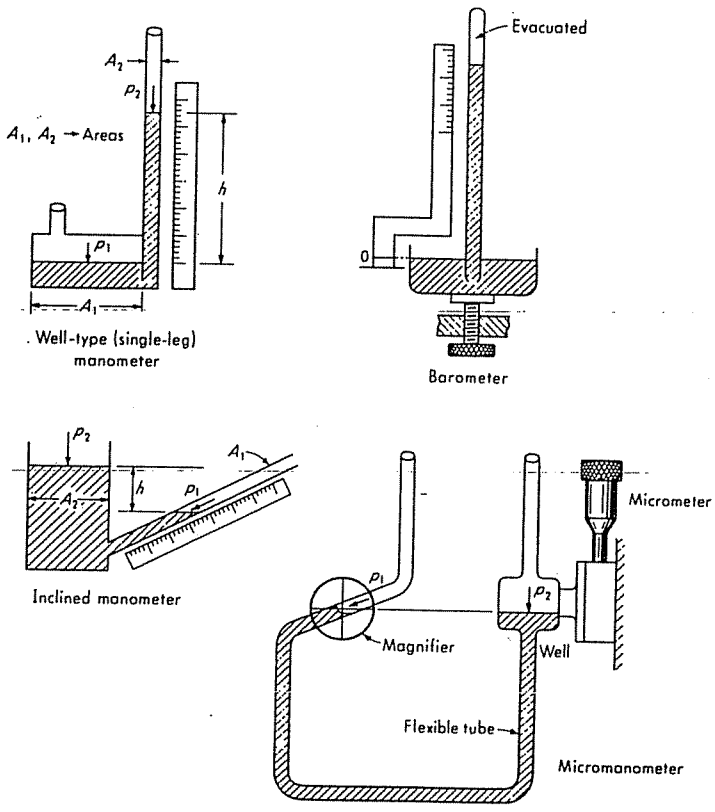


Figure 6.5 Various forms of manometers.

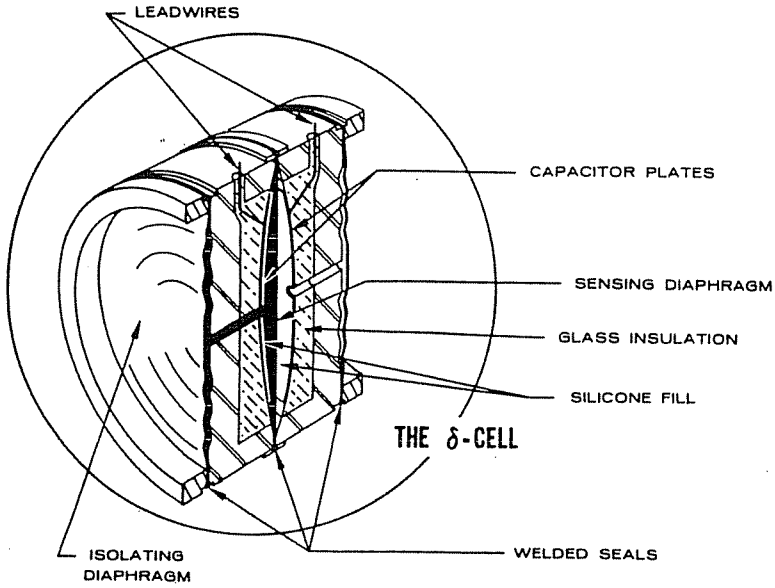


Figure 6.16 Capacitive differential-pressure transmitter. (*Courtesy Rosemount Inc., Minneapolis, Minn.*)

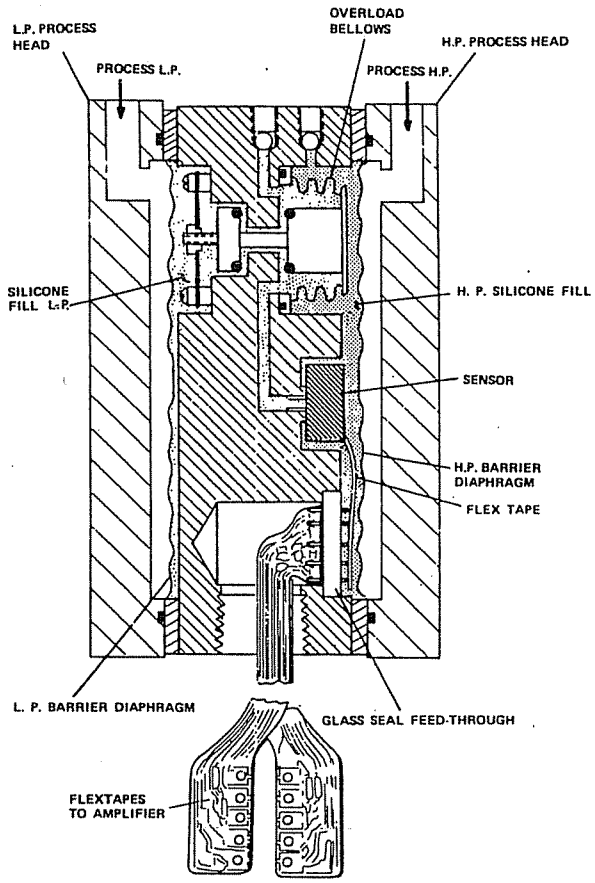


Figure 6.17 Diffused strain-gage differential-pressure transmitter. (*Courtesy Honeywell Inc., Ft. Washington, Pa.*)

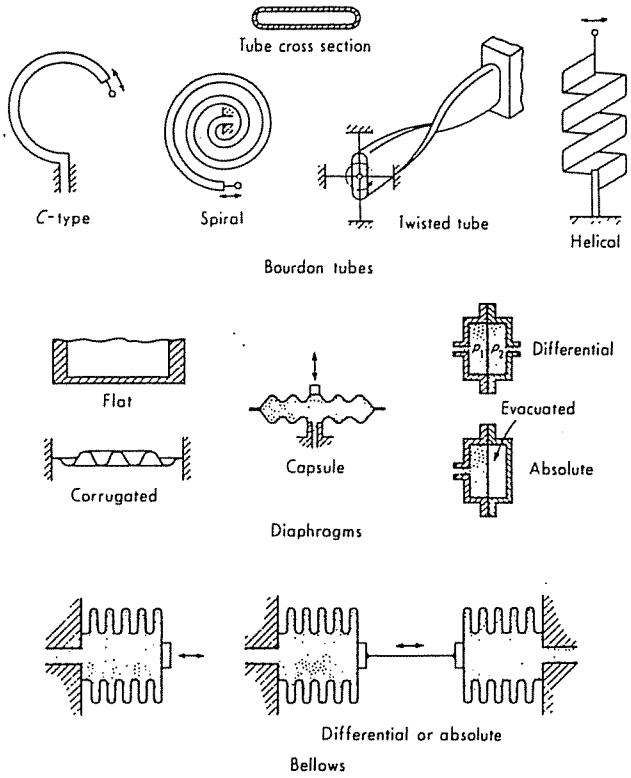
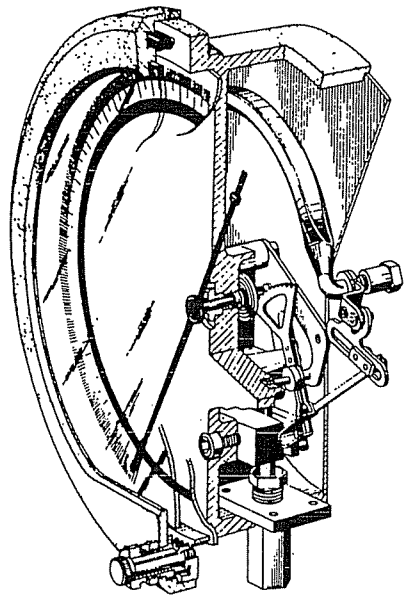


Figure 6.8 Elastic pressure transducers.



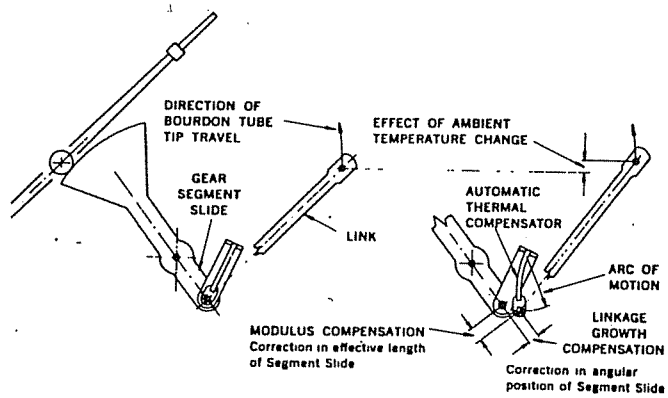


Figure 6.9 Bourdon-tube gage construction. (*Courtesy Heise Gage, Dresser Industries, Newton, Conn.*)

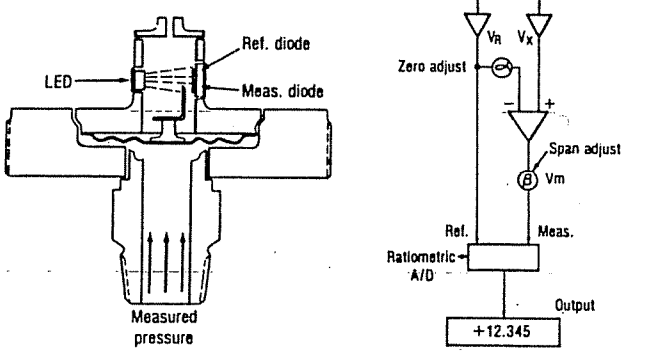


Figure 6.10 Electro-optic pressure transducer. (*Courtesy Heise Gage, Dresser Industries, Newton, Conn.*)