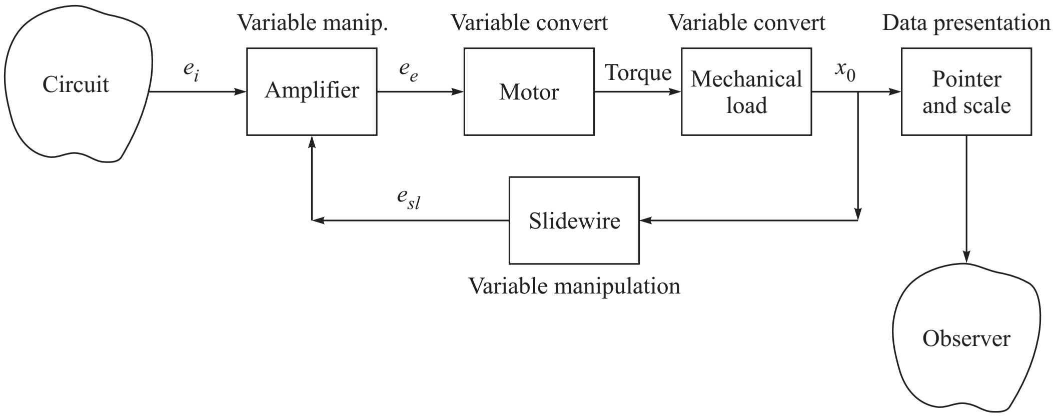
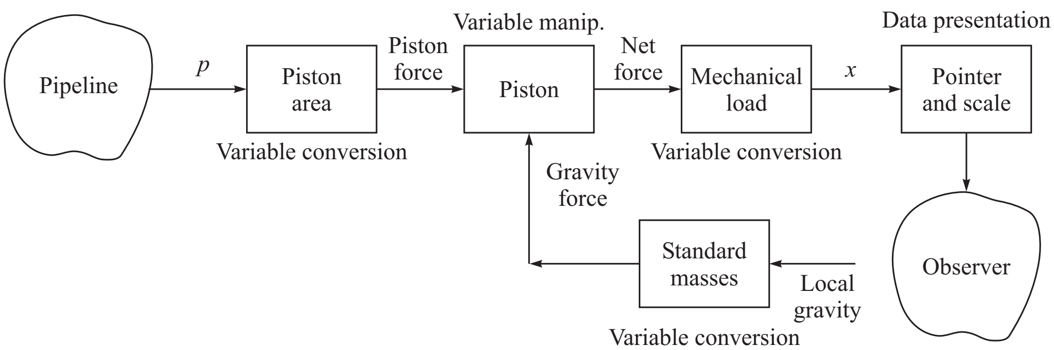
Chapter 2

Solutions

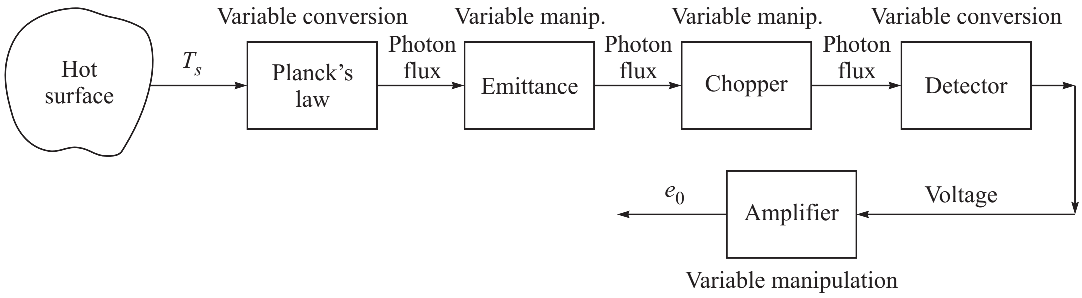
2.1 a. As noted in the text, such diagrams are somewhat a matter of opinion, so other versions may also be correct.



b.



c.



2.2 a. No active transducers.

b. No active transducers.

c. The bridge circuit battery provides power without taking it from the strain gage, so it is an active transducer.

d. No active transducers.

e. No active transducers.

2.3 a. The incoming light waves have only minuscule power while it takes significant energy to push the pedal through some distance, so the driver is functioning as an active transducer.

b. The car's motion is driven by the full power of the engine, whereas the energy taken from the human foot is small in comparison, so the engine is clearly an active transducer with a very large power amplification.

2.4 A laboratory beam balance is usually used to determine masses, but it can be used to measure forces by balancing the unknown force against the gravity force of known masses in the opposite pan of the balance.

2.5 The potentiometric method of voltage measurement is a null method. The unknown voltage is connected in series opposition with a known voltage picked off a slide-wire resistance. A galvanometer (current detector) is connected in the loop so formed. This current detector will read zero only when the slide-wire has been adjusted to the same voltage as the unknown. The slide-wire has a calibrated scale which gives its voltage, and thus the unknown.

2.6 One solution is to use 10-to-1 gearing between the measured shaft and the shaft shown in Fig. 2.4. Another way is to put 10 "bumps" on shaft. Students should provide neat sketches of these designs.

2.7 a. Modifying and interfering inputs must in general be divided into those felt to be significant and those which probably are not important. This classification is somewhat subjective and sensitive to the particular application and the accuracy required. Thus the lists now provided should not be considered definitive or exhaustive. In Fig. 2.2, some interfering inputs would include: temperature (thermal expansion and/or spring creep cause a zero shift), vertical acceleration (zero shift and/or dynamic error), vibration (causes jitter in pointer). Modifying effects include: temperature (changes the spring stiffness, changes the piston area, changes the frictional effects, changes lever ratio on pointer), pressure (changes the cylinder area), vibration (changes frictional effects).

b. Interfering inputs include: temperature (thermal expansion in optical system causes shift in the light spot position, expansion of paper chart), acceleration (inertia forces on mirror cause light spot deflection), imperfect tracking of the paper chart, humidity (causes expansion/contraction of paper chart). Modifying inputs: temperature (changes spring stiffness, magnet field strength, coil resistance), time (aging effects, magnet strength, spring stiffness, lamp brightness).

2.10 To compensate for the reduced spring constant, we need to decrease the moment of inertia. A method actually used in mechanical watches employs bimetallic strips which deflect in the desired direction when temperature changes. Various geometrical arrangements are possible; students should neatly sketch their concept. One possible solution is shown below.

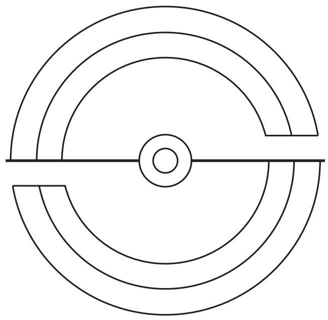


Fig. 1 Bimetallic strip to compensate for temperature changes