The purpose of this communication is to give a preliminary description of a new method for establishing the calibrations of pressure balances which has recently been developed at the National Physical Laboratory. In measuring the change of effective area of a balance as the pressure is raised, the method makes use of a quite simple principle of similarity as applied to pressure balances of the same dimensions but constructed of different materials. If we consider two piston–cylinder assemblies of the same nominal dimensions but of materials the elastic constants of which differ in a known ratio, then in certain circumstances, considered in more detail below, the distortions, under applied pressure, of the two assemblies will remain proportional to one another throughout the range of pressure concerned. Under these conditions, and neglecting small quantities of the second order, we may represent the effective areas A and B of the two assemblies at a given pressure in the form

$$A = A_0\{1 + \alpha.\mathrm{f}(P)\}\ ;\ B = B_0\{1 + \beta.\mathrm{f}(P)\}.$$

In these expressions A_0 and B_0 are the (nominally equal) effective areas at zero pressure, α and β are constants inversely proportional to the elastic moduli of the two materials, and $\mathrm{f}(P)$ is an unknown function of the pressure, P. The ratio of the two effective areas will be given, to the same order, by the expression

$$A/B = A_0/B_0\{1 + (\alpha - \beta).\mathrm{f}(P)\}.$$

This ratio is easily determined by balancing the two assemblies directly against one another, and this procedure determines the quantity $(\alpha - \beta).\mathrm{f}(P)$. The quantity α/β may be obtained from direct measurements of the elastic constants of the two materials. These two procedures thus enable the absolute value of the change of effective area of each of the piston–cylinder assemblies to be determined.

For the theory outlined above to be valid, a number of conditions must be satisfied, both as regards the materials and the construction of the assemblies. Since two independent elastic moduli will be involved in a somewhat complicated manner in the distortion of each assembly, true proportionality can only be achieved if both moduli are in the same ratio—in other words, the values of Poisson's ratio for the two materials should be closely similar. As regards construction, the forms of the internal bores of the cylinders, and of the pistons, must be closely similar in contour, since otherwise the distributions of pressure in the gap between piston and cylinder will not be the same in the two assemblies. The similarity principle also requires that the gap-