ON A MEMBRANE PRESSURE GAUGE.

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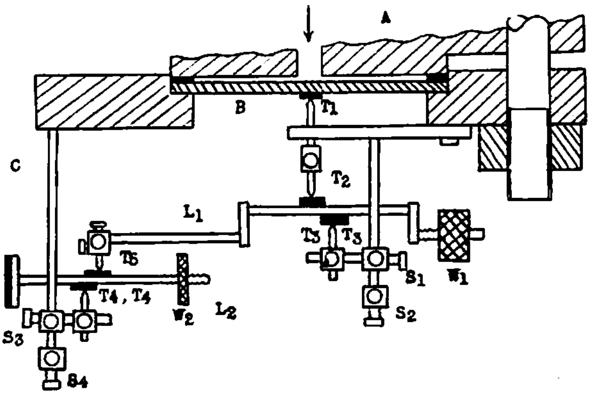
The apparatus consists of flange A by which the membrane B is fixed and the part of optical lever C with two step levers, L_1 and L_2. The first step lever L_1 is designed, as shown in the figure, to raise the strength of the structure and stability. T_1, ..., T_5 are fulcra respectively, at which the steel needle contacts with the surface of glass plate. L_1 and L_2 are held with two steel needles at T_3 and T_4 respectively. In order to increase the stability, the assurance for sliding is done at the point where the surface of glass plate contacts with the needle. S_1, ..., S_4 are the screws to move slightly the fulcra, T_3 and T_4. The procedure to ensure the contact of each fulcrum is the adjustment to make the balance weight W_1 slightly heavy and W_2 slightly light on the side of the weight.



Assuming the distance between the mirror and the scale to be l, the displacement of the readings of scale, x, is given in the following relation,

$$x = l \tan 2\left(\tan^{-1}\frac{bf}{ac}\right), \tag{1}$$

where a, b and c are the distance between T_3T_2, T_3T_5 and T_4T_5 respectively, and f is the displacement of membrane at the center. The design is based on the following two equations concerning membrane[1]. The former gives the radial stress of the circumference, σ and the latter shows the displacement at the center of membrane, f.

1) A. Morley, "*Strength of Materials*," P. 430, 431 (1926)

$$\sigma=\frac{3}{4}\frac{Pr^2}{t^2}, \tag{2}$$

$$f=\frac{3}{16}\frac{Pr^4}{Em^2t^3}(m^2-1). \tag{3}$$

Where P, pressure ; m, reciprocal Poisson's ratio ; r, the radius of membrane ; t, the thickness of membrane ; E, coefficient of elasticity.

The maximum pressure satisfying the linearity between the displacement of membrane and pressure is obtained from the experiment. Substituting the results in P of Equation (2), σ is obtained as shown in Table 1.

Table 1

Substance	t (cm)	Max. press. (kg/cm²)	σ (kg/cm²)
Mild steel	0.310	19～21	1247～1378
"	0.311	19～21	1239～1369
Spring steel*	0.195	50	8293

Membrane radius, 2.9 cm.

* Composition percent : C(0.63), Mn(0.79), Si(1.52), P(0.015), S(0.018), Cu(0.21), Ni(0.22), Cr(0.36).
Heat treatment : Quenching, heat to 820～850°C for 30 min. and quench in oil.
Annealing, heat to 450～470°C for 2 hours and cool in oil.
Mechanical properties (quenching) : Tensile strength, 14,000 kg/cm²～.
Yield point, 12,000 kg/cm²～.

The comparison of the displacement of a scale per 1 kg/cm² calculated from Equations (1) and (3), where $m=3$, $E=2{,}115{,}000$ kg/cm² (mild steel), 2,000,000 kg/cm² (spring steel), with that of the observed are shown in Table 2.

Table 2

Substance	t	a	b	c	Displacement per 1 kg/cm² calc.	Displacement per 1 kg/cm² obs.
Mild steel	0.300	1.0	6.0	0.5	0.5	0.5
"	0.320	0.4	5.4	0.3	1.5	1.6
"	0.420	1.9	6.0	0.5	0.2	0.2
"	"	0.4	5.4	0.3	0.6	0.7
Spring steel	0.175	"	"	"	9.9	8.0
"	0.195	"	"	"	7.2	7.2

Membrane radius, 2.9 cm ; distance between mirror and scale, 100 cm ; figures in the Table, in cm unit.

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