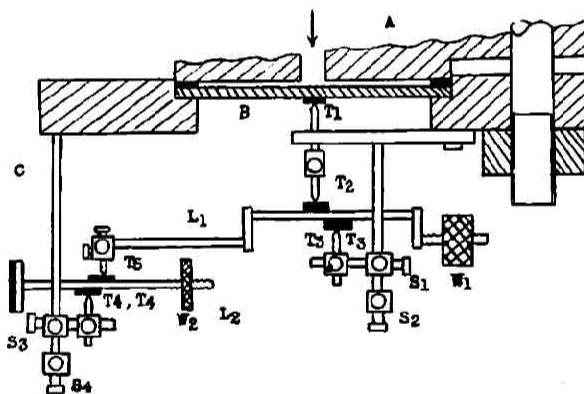


ON A MEMBRANE PRESSURE GAUGE.

By RYO KIYAMA and KEIZO SUZUKI.

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. $T_1, \dots, T_5$ are fulcras 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. $S_1, \dots, S_4$ are the screws to move slightly the fulcras, 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,

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

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 membrane¹⁾. 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)

$$\sigma = \frac{3}{4} \frac{Pr^2}{t^2}, \quad (2)$$

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

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/cm ²) *	σ (kg/cm ²)
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: Tensile strength, 14,000 kg/cm²~.

(quenching) 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/cm ²	
					calc.	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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