The masses of the loading weights have been determined and have been reported in tabular form as shown in columns 1 and 2 of table 1. The value given in column 2 is the apparent mass and therefore the density, ρ_m, is assumed to be 8.4 g/cm^3.

All of the quantities thus determined can be listed as illustrated in table 2 and from these values the factors and terms of the numerator of eq (24) and the reference level, Δh, can be computed as shown in table 2.

The importance of the various factors and terms of the numerator can now be evaluated. In the first term $\frac{M_m}{A_0}$ is the dominant factor, while the factor kg_L accounts for about 0.06 percent and the factor $\left(1-\frac{\rho_a}{\rho_m}\right)$ accounts for about 0.014 percent. The contribution of the second term is -0.295 psi with the factor $\left(1-\frac{\rho_a}{\rho_{fa}}\right)$ having an effect amounting to about 0.0004 psi. In this case the third term amounts to 0.0027 psi. The importance of each factor and term depends upon the design of the instrument, the environment, and the application, and none should be neglected without first evaluating it to determine its significance.

8.2. Machine Computation

The temperature and pressure factors, $1+a(t-t_s)$ and $(1+bp_p)$, in the denominator of eq (24) can be combined in a double entry table to give values of

$$\frac{1}{[1+a(t-t_s)](1+bp_p)}$$

for values of t and p_p as illustrated in table 3.

To further facilitate computations the weight table, table 1, has been extended to give values of M_m times the factor 7.6726 (from table 2) for each weight as shown in column (3) and the value of

$$M_{fa}\left(1-\frac{\rho_a}{\rho_{fa}}\right)\frac{kg_L}{A_0}+\frac{\gamma C}{A_0}=-0.292$$

is added to the value of 7.6726 M_m for the piston. Accumulative totals, for frequently used combinations of weights, are given in column (4). Computation of pressure p_p is now simplified to the process of multiplying the sum of values from column (3) or a value from column (4) by the appropriate value from table 3. Greater simplification to suit the requirements of specific applications will be left to the ingenuity of the user.

8.3. Slide Rule Computation

The method just described can be modified slightly for use with a slide rule. Using the same values as were used in the preceding illustration, eq (24) for p_p may be written in the form

$$p_p=(M_m 7.6726-0.292)+(M_m 7.6726-0.292)\times\left(\frac{1}{[1+a(t-t_s)](1+bp_p)}-1\right). \quad (25)$$

TABLE 1. *List of weights and appropriate values for weight set and piston gage No. 1357 used at Washington, D.C., with aviation instrument oil*

Piston gage No. 1357 with weight set No. 1357

Location—NBS, Washington, D.C.

Fluid—Aviation instrument oil

(1) Weight No.	(2) Mass (M_m)	(3) $M_m\times 7.6726$	(4) Accumulative Total
	lb	*psi*	*psi*
piston	1.3024	9.993−0.292* = 9.701	9.701
1	2.6042	19.981	29.682
2	2.6045	19.983	49.665
3	6.5123	49.966	99.631
4	26.0473	199.85	299.48
5	26.0454	199.84	499.32
6	65.1095	499.56	998.88
7	65.1190	499.63	1498.51
8	65.1065	499.54	1998.0
9	65.1165	499.61	2497.7

*Fluid buoyancy and surface tension correction,

$$M_{fa}\left(1-\frac{\rho_a}{\rho_{fa}}\right)\frac{kg_L}{A_0}+\frac{\gamma C}{A_0}=-0.292 \text{ psi.}$$

TABLE 2. *Tabulated values of parameters for piston gage No. 1357 used at Washington, D.C., with aviation instrument oil*

Values for Piston Gage No. 1357

$A_0=0.13024$ in^2.
$y_{fa}=2.5$ in.
$V_{fa}=1.525$ in^3.
$C=1.964$ in.
$a=\alpha_k+\alpha_c=(12+18.4)\times10^{-6}=30.4\times10^{-6}$ in^2./in^2. °C
$t_s=25$ °C
$b=1.48\times10^{-7}$ in^2./in^2.psi
$y_{fp}=1.625$ in.
$V_{fp}=0.2778$ in^3.

Values for Weight Set No. 1357

$\rho_m=8.4$ g/cm^3

Values for Room 131, MTL Bldg., NBS, Washington, D.C.

$\rho_a=0.00117$ g/cm^3 or 0.0000423 lb/in^3.
$g_L=980.10$ cm/sec^2

Values for Aviation Instrument Oil

$\rho_{fa}=0.0321$ lb/in^3.
$\gamma=0.00018$ lbf/in.

Computations

$kg_L=0.99942$

$\frac{kg_L}{A_0}=7.6737$/in^2.

$\left(1-\frac{\rho_a}{\rho_m}\right)=0.99986$

$M_m\left(1-\frac{\rho_a}{\rho_m}\right)\frac{kg_L}{A_0}=M_m\times7.6726$ psi

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$M_{fa}=(A_e y_{fa}-V_{fa})\rho_{fa}=-0.0385$ lb (17)

$\left(1-\frac{\rho_a}{\rho_{fa}}\right)=-0.9987$

$M_{fa}\left(1-\frac{\rho_a}{\rho_{fa}}\right)\frac{kg_L}{A_0}=-0.295$ psi

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$\frac{\gamma C}{A_0}=0.0027$ psi

$p_p=(M_m\times7.6726-0.292)\frac{1}{[1+a(t-t_s)](1+bp_p)}$ (25)

$\Delta h=y_{fp}-\frac{V_{fp}}{A_e}=-0.508$ in. (19)

TABLE 3. *Temperature and pressure correction factors for piston gage No. 1357, for calculation of pressure, in psi*

Pressure, p_p	Values of $\frac{1}{[1+a(t-t_s)](1+bp_p)}$ for piston gage No. 1357				
	Temperature, t, °C				
	23	24	25	26	27
psi					
2500	0.99969	0.99966	0.99963	0.99960	0.99957
2000	.99976	.99973	.99970	.99967	.99964
1500	.99984	.99981	.99978	.99975	.99972
1000	.99991	.99988	.99985	.99982	.99979
500	.99999	.99996	.99993	.99990	.99987
0	1.00006	1.00003	1.00000	.99997	.99994

TABLE 4. *Temperature and pressure correction factors for piston gage No. 1357, for calculation of corrections, in psi*

Pressure, p_p	Values of $\frac{1}{[1+a(t-t_s)](1+bp_p)}-1$ for piston gage No. 1357				
	Temperature, t, °C				
	23	24	25	26	27
psi					
2500	−0.00031	−0.00034	−0.00037	−0.00040	−0.00043
2000	−.00024	−.00027	−.00030	−.00033	−.00036
1500	−.00016	−.00019	−.00022	−.00025	−.00028
1000	−.00009	−.00012	−.00015	−.00018	−.00021
500	−.00001	−.00004	−.00007	−.00010	−.00013
0	+.00006	+.00003	.00000	−.00003	−.00006

A double entry table for values of

$$\frac{1}{[1+a(t-t_s)](1+bp_p)}-1$$

for various values of t and p_p can be prepared as illustrated in table 4. A slide rule can be used to multiply the appropriate value from this table by the sum of values from column (3) or a value from column (4) of table 1 to obtain a correction to be added to the value from table 1 to give pressure p_p.

TABLE 5. *Temperature and pressure corrections in psi, for piston gage No. 1357*

Pressure, p_p	Values of $p_p\left[\frac{1}{[1+a(t-t_s)](1+bp_p)}-1\right]$ for piston gage No. 1357				
	Temperature, t, ° c				
	23	24	25	26	27
	Corrections, psi				
psi					
2500	−0.8	−0.8	−0.9	−1.0	−1.1
2000	−.5	−.5	−.6	−.7	−.7
1500	−.24	−.28	−.33	−.38	−.42
1000	−.09	−.12	−.15	−.18	−.21
500	.00	−.02	−.04	−.05	−.06
0	.00	.00	.00	.00	.00

8.4. Correction Table Computation

A correction table may be preferred in many instances. Again using the same values as before to illustrate, a double entry table of values of

$$p_p\left(\frac{1}{[1+a(t-t_s)](1+bp_p)}-1\right)$$

for various values of p_p and t is prepared as illustrated by table 5. Appropriate corrections from the table are added to values of M_m 7.6726−0.292 obtained from table 1 to obtain pressure p_p.

8.5. Conclusions

By construction of tables a procedure similar to one of those illustrated can be established to suit the particular needs and application of the user. The computation of pressure from piston gage data is thereby reduced to a simple, fast operation.

9. Appendix B. Working Equations

The equations that may be required for the computation of the absolute or the gage pressure in a system, from measurements made with a piston gage, are listed below:

$$P=p_p+H_{fp}+P_a \quad (3)$$

$$p_g=p_p+H_{fp}-H_a \quad (4)$$

$$H_{fp}=-\rho_{fp}h_{fp}kg_L \quad (11)$$

$$H_a=-\rho_a h_a kg_L \quad (12)$$

$$A_0=\frac{A_k+A_c}{2}[1+a(t_s-t_m)] \quad (22)$$

$$a=\alpha_k+\alpha_c \quad (21)$$

$$b=\frac{3\mu-1}{Y} \quad (23)$$

$$M_{fa}=(A_e y_{fa}-V_{fa})\rho_{fa} \quad (17)$$

$$\Delta h=y_{fp}-\frac{V_{fp}}{A_e} \quad (19)$$

$$p_p=\frac{\frac{M_m}{A_0}\left(1-\frac{\rho_a}{\rho_m}\right)kg_L+\frac{M_{fa}}{A_0}\left(1-\frac{\rho_a}{\rho_{fa}}\right)kg_L+\frac{\gamma C}{A_0}}{[1+a(t-t_s)](1+bp_p)[1+d(p_z-p_j)]} \quad (24)$$