Force Observations, 1902 (C.M.G.).

Date.	H.F.	V.F. (H.F. tan dip.)	T.F. (H.F. sec dip.)
January	0·17822	0·45056	0. 48453
February	0·17840	0·45043	0·48465
March	0·17822	0·45050	0·48445
April	0·17817	0·45047	0·48442
May	0·17850	0·45115	0·48518
June	0·17838	0·45068	0·48470
July	0·17831	0·45020	0·48423
August	0·17825	0·45002	0·48399
September	0·17825	0·44986	0·48389
October	0·17824	0·44977	0·48379
November	0·17843	0·45032	0·48438
December	0·17853	0·45022	0·48433
Means	0·17833	0·45035	0·48438

[These annual reports will in future be published, along with the other British magnetic observations, in the Reports of the National Physical Laboratory. The Falmouth magnetic observations are published in the Annual Reports of the Royal Cornwall Polytechnic Society, and will also be reprinted in the Reports of the National Physical Laboratory.—Sec.]

"On the Measurement of the Diffusion of Salts in Solution." By J. C. Graham. Communicated by Professor W. E. Ayrton, F.R.S. Received May 14,—Read June 11,—Received in revised form June 25, 1903.

In order to get the solution of the salt below the pure water which is above it, without any intermixing at their common surface, the apparatus was used which is shown in fig. 1. A is a cylindrical glass vessel containing a solution of the salt to be investigated, in the lower half, and containing pure water in the upper half. The internal diameter of the vessel was about 125 mm., and the depth of the cylindrical part about 300 mm. B is a tube which passes up through the bottom of the vessel, and is continued outside in the manner shown. C is a tube which opens into the lowest part of the vessel and is connected with a funnel C_1. D is a small tube which passes up the centre of the vessel to the point D_1.

The vessel is first completely filled with pure water through the funnel C_1, until it has risen to the point marked D_1; the cocks X_3 and X_4 being closed, and the cocks X_1 and X_2 open.

The vessel is then ready for the introduction of the salt solution, which is allowed to drop into the funnel C_1 from which it passes through the pipe C into the vessel A, where it gradually floats the water upwards and continually forces it out through the pipe B.

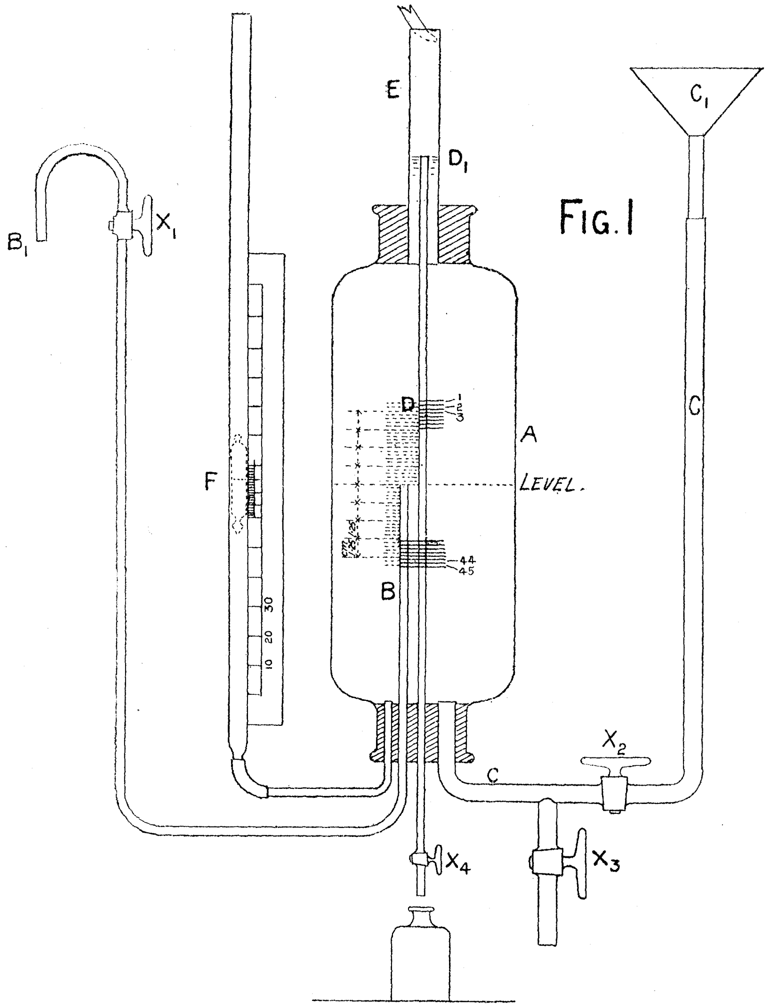

FIG. I

It will be noticed that the water which is thus forced out is that which lay below the point marked "level"; after say an hour the first portions of the salt solution reach the point marked "level" and are then forced out, and ultimately the salt solution of the normal density, *i.e.*, the density used, occupies the lower half of the vessel, and pure water occupies the upper half, and there is no mixing at the common surface.

The supply of salt solution is now stopped and the cock X_1 is closed.

When diffusion has gone on for 6 or 8 days the various strata marked 1 to 45 in the drawing are drawn off as follows :—

The volume of the vessel between the stratum 1 and the point D_1 is approximately known. This volume of some solution denser than the salt solution is then run in through the funnel C_1, and thus the top of stratum 1 is brought to D_1; the displaced volume flows down the pipe D, the cock X_4 having been opened.

Each stratum is $2\frac{1}{2}$ mm. thick, and has a volume of 32·6 c.c. If now 32·6 c.c. of the dense solution are slowly dropped into the funnel

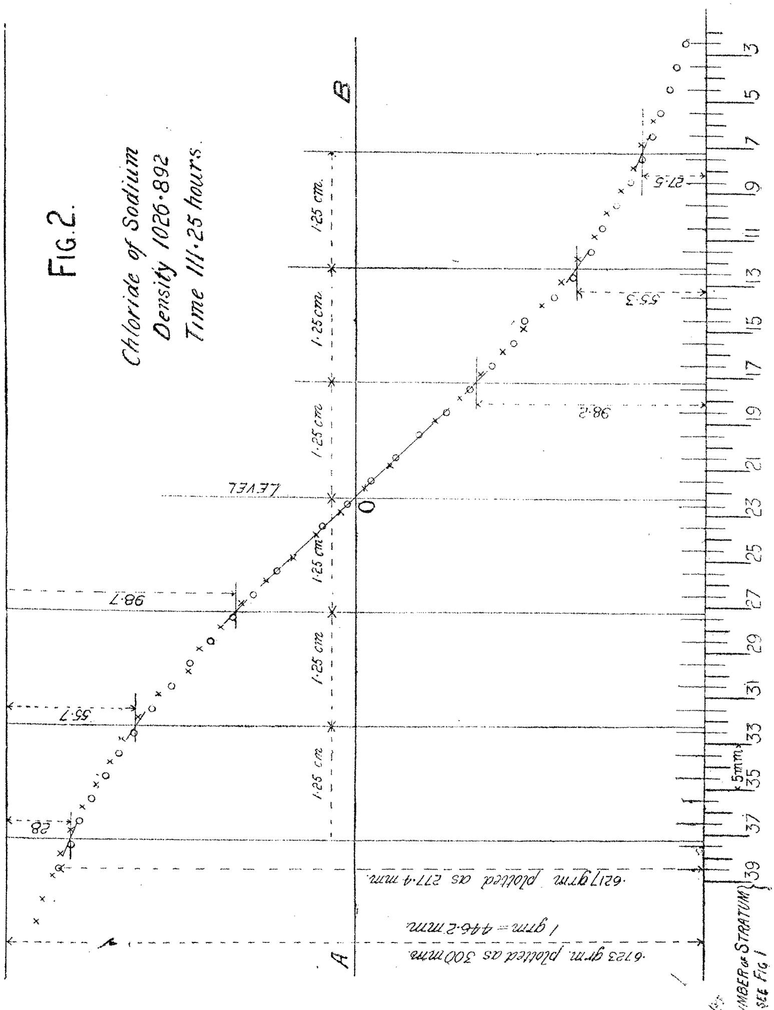

FIG. 2.

(This drawing is to a reduced scale.)

C_1, the top stratum passes down through the tube D and is reserved for weighing. In the same manner all the remaining strata are drawn off.

The specific gravity of each stratum is ascertained.

These specific gravities when plotted give a curve from which κ can be calculated.

Fig. 2 shows how this was done with a solution of chloride of sodium of density 1026·892. The contents of the 25 c.c. sp.g. bottle weighed 25·6723 grammes. I assumed (which is not quite correct) that the weight of salt was 0·6723 gramme, and plotted this as 300 mm.

In the same way the weights of salt in 25 c.c. of all the other strata were plotted. The small circles show the curve so obtained. And from this curve κ can be calculated by means of Fourier's equation

$$u = \tfrac{1}{2} + \frac{1}{\sqrt{\pi}} \left\{ \frac{x}{2\sqrt{\kappa t}} - \tfrac{1}{3}\left(\frac{x}{2\sqrt{\kappa t}}\right)^3 + \tfrac{1}{5}\cdot\tfrac{1}{2}\left(\frac{x}{2\sqrt{\kappa t}}\right)^5 - \text{etc.} \right\}.$$

In this particular case diffusion went on for $111\frac{1}{4}$ hours and the average value of κt for $111\frac{1}{4}$ hours was 3·95, therefore κ (for one hour) $= 3{\cdot}95/111\frac{1}{4} = 0{\cdot}0355$.

This equation gives a curve which is symmetrical with respect to the line AB. The small crosses were obtained by marking the small circles on tracing paper and turning the tracing paper through 180° round the point O. The near agreement of the two curves is a good test of the accuracy of the observations.

The fluids and the room where the experiment was made were at about 14° C, but it was not possible to keep the temperature of the room constant. The vessel A was very completely enclosed in flannel.

The labour of calculating κt from any observed curve is obviated by means of the curves shown on fig. 3. Here the values of u at the distances 1·25, 2·5, 3·75, and 5 cm. were calculated from the above equation, for successive values of κt from 1 to 10, and plotted to the scale of 300 mm. = unity. For example, the figure 98·45 (the average of 98·2 and 98·7 see fig. 2) where x = 1·25 cm. is seen by the curve to give the value 3·93 for κt. Inasmuch as these calculations of u are very laborious, I have given the values in the following table. Each must be multiplied by 300 if 300 mm. is taken as unity. With such curves the value of κt is obtained by inspection.

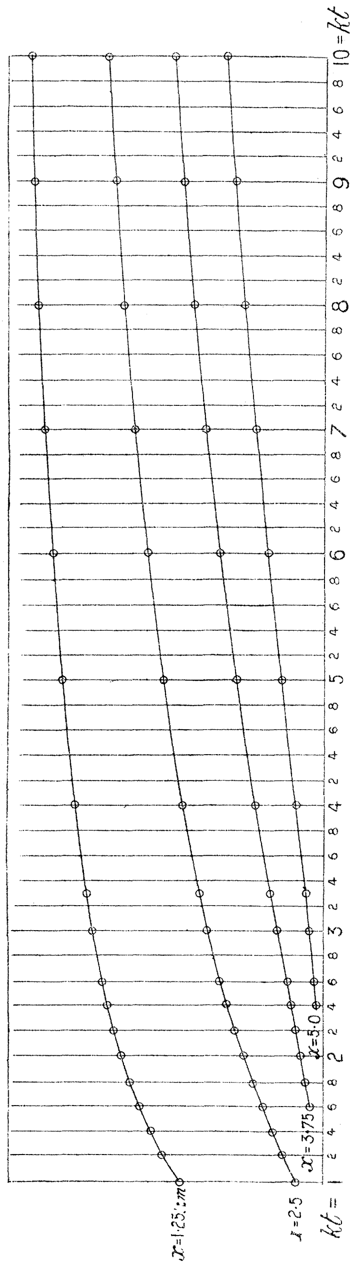

FIG. 3.

(This drawing is to a reduced scale.)

$\kappa t =$	1.	1·2.	1·4.	1·6.	1·8.	2.	2·2.	2·4.	2·6.
x = 1·25 cm.	·1884	·2098	·2276	·2424	·255	·266	·27 56	·2841	·2918
x = 2·5 cm.	·0386	·0532	·0676	·0812	·0939	·1056	·1171	·1268	·1365
x = 3·75 cm.	..	..	..	·018	·0241	·0303	·0369	·0435	·05
x = 5 ·0 cm.	..	..	..	..	..	..	..	·0109	·0143

$\kappa t =$	3.	3·3.	4.	5.	6.	7.	8.	9.	10.
x = 1·25 cm.	·3049	·3133	·3293	·3463	·3591	·3692	·3773	·3842	·3892
x = 2·5 cm.	·1538	·1652	·1879	·2146	·2352	·252	·2659	·2778	·287
x = 3·75 cm.	·0623	·0721	·0923	·1177	·1395	·158	·1743	·1884	·2009
x = 5·0 cm.	·0205	·025	·0395	·0569	·074	·0913	·1056	·1193	·1318