XII. THE BAKERIAN LECTURE.—*On a Method of Meteorological Registration of the Chemical Action of Total Daylight**. *By* HENRY ENFIELD ROSCOE, *B.A., F.R.S., Professor of Chemistry in Owens College, Manchester.*

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IN the last memoir on Photochemical Measurements, presented to the Royal Society†, Professor BUNSEN and I described a method for determining, by simple observations, the varying amount of chemical action effected by the direct and diffuse sunlight on photographic paper, founded upon a law discovered by us, viz. that equal products of the intensity of the light into the times of insolation correspond within very wide limits to equal shades of tints produced on chloride-of-silver paper of uniform sensitiveness—so that light of the intensity 50, acting for the time 1, produces the same blackening effect as light of the intensity 1 acting for the time 50. For the purpose of exposing this paper to light for a known but very short length of time, a pendulum photometer was constructed; and by means of this instrument a strip of paper is so exposed that the different times of insolation for all points along the length of the strip can be calculated to within small fractions of a second, when the duration and amplitude of vibration of the pendulum are known. The strip of sensitive paper insolated during the oscillation of the pendulum exhibits throughout its length a regularly diminishing shade from dark to white; and by reference to a Table, the time needed to produce any one of these shades can be ascertained. The unit of photo-chemical intensity is assumed to be that of the light which produces upon the standard paper in the unit of time (one second) a given but arbitrary degree of shade termed the normal tint. The reciprocals of the times during which the points on the strip have to be exposed in order to attain the normal tint, give the intensities of the acting light expressed in terms of the above unit.

According to this method the chemical action of the total daylight (*i. e.* the direct sunlight and the reflected light from the whole heavens) has been determined, by means of observations made at frequent intervals throughout the day, and curves representing the variation of daily chemical intensity at Manchester have been drawn‡. The labour of obtaining a regular series of such daily measurements of the chemical action of daylight according to this method is, however, very considerable; the apparatus required

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* It is to be carefully borne in mind that no absolute measurement of the more refrangible solar rays falling on the earth's surface is possible, except by the expression of their heat-producing effect; and that all methods of measuring the intensity of these rays depending upon the action which they produce on any single chemical compound, give results which are only true for the particular rays affecting the compound selected as the standard of comparison.

† Philosophical Transactions, 1863, p. 139.

‡ Ibid. 1863, p. 160.

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is bulky, the observations can only be made in calm weather, and the quantity of sensitive paper needed for a day's observations is large.

The aim of the following communication is to describe a very simple mode of determining at any moment the chemical action of the whole direct and diffuse sunlight (as measured by chloride-of-silver paper) adapted to the purpose of regular meteorological registration, and founded upon the principles laid down in the memoir above alluded to. According to this method a regular series of daily observations can without difficulty be kept up at frequent intervals. The whole apparatus needed for exposure can be packed into very small space; the observations can be carried on without regard to wind or weather; and no less than forty-five separate determinations can be made upon 36 square centimetres of sensitive paper.

Strips of the standard chloride-of-silver paper tinted in the pendulum photometer remain as the basis of the more simple mode of measurement now to be described. Two strips of this paper are exposed as usual in the pendulum photometer; one of these strips is fixed in hyposulphite-of-sodium solution, washed, dried, and pasted upon a board furnished with a millimetre-scale. This fixed strip is now graduated in terms of the unfixed pendulum strip by reading off, with the light of a soda-flame, the position of those points on each strip which possess equal degrees of tint, the position of the normal tint upon the unfixed strip being ascertained for the purpose of the graduation. The fixed strip thus becomes in every respect equivalent to the unfixed strip. Upon this comparison with the unfixed pendulum strip depends the subsequent use of the fixed strip. In order to understand how the chemical action of daylight can be measured by help of this fixed and graduated strip, let us suppose, in the first place, that we have ascertained the position of those points upon the fixed strip which possess an equal degree of tint to points on the unfixed strip situated at regular intervals, say 10 millims. from each other. By reference to Table I. of the above-mentioned memoir, given below, we then find the relation between the times of exposure necessary to effect the tints in question when the intensity of the light remains constant.

Let us suppose, in the second place, that the position on the unfixed strip of which the shade corresponds to that of the normal tint has been found; and that the time of exposure, placed opposite to this position in Table I., has been noticed. If, now, the various tints on the strip had been produced in one and the same time by lights of different intensities, instead of being effected by light of the same intensity acting for different times, the law above alluded to shows that the numbers found in the Table would represent the relation of these different intensities; so that in order to express this relation in terms of the unit of intensity employed, it is only necessary to multiply the numbers thus obtained by a constant, viz. the reciprocal of the number found in column II. of the Table, opposite to the position in column I., giving the point on the unfixed strip equal in shade to the normal tint. An example may serve to make this calculation plain: (1) The position on the unfixed strip equal in shade to the normal tint was found to be 112 millims.; (2) the positions on the fixed strip equal in

TABLE I.

I. Millims.	II. Seconds.	I. Millims.	II. Seconds.	I. Millims.	II. Seconds.	I. Millims.	II. Seconds.	I. Millims.	II. Seconds.	I. Millims.	II. Seconds.
0	1·200	32	1·003	64	0·846	96	0·700	128	0·549	160	0·369
1	1·193	33	0·998	65	0·841	97	0·695	129	0·544	161	0·363
2	1·186	34	0·993	66	0·837	98	0·691	130	0·539	162	0·357
3	1·179	35	0·988	67	0·832	99	0·686	131	0·534	163	0·350
4	1·172	36	0·983	68	0·828	100	0·682	132	0·528	164	0·343
5	1·165	37	0·977	69	0·823	101	0·677	133	0·523	165	0·336
6	1·158	38	0·972	70	0·819	102	0·672	134	0·518	166	0·329
7	1·151	39	0·967	71	0·814	103	0·668	135	0·513	167	0·321
8	1·144	40	0·962	72	0·809	104	0·663	136	0·508	168	0·314
9	1·137	41	0·957	73	0·805	105	0·659	137	0·502	169	0·309
10	1·131	42	0·952	74	0·800	106	0·654	138	0·497	170	0·300
11	1·125	43	0·947	75	0·796	107	0·650	139	0·492	171	0·291
12	1·119	44	0·942	76	0·791	108	0·645	140	0·487	172	0·283
13	1·113	45	0·937	77	0·786	109	0·640	141	0·482	173	0·274
14	1·106	46	0·932	78	0·782	110	0·635	142	0·476	174	0·266
15	1·100	47	0·927	79	0·777	111	0·631	143	0·470	175	0·257
16	1·094	48	0·922	80	0·773	112	0·626	144	0·465	176	0·249
17	1·087	49	0·917	81	0·768	113	0·621	145	0·459	177	0·240
18	1·081	50	0·912	82	0·764	114	0·617	146	0·453	178	0·229
19	1·076	51	0·907	83	0·759	115	0·612	147	0·448	179	0·219
20	1·070	52	0·903	84	0·755	116	0·607	148	0·442	180	0·208
21	1·064	53	0·898	85	0·750	117	0·603	149	0·436	181	0·198
22	1·058	54	0·893	86	0·745	118	0·598	150	0·431	182	0·187
23	1·053	55	0·888	87	0·741	119	0·593	151	0·425	183	0·176
24	1·047	56	0·884	88	0·736	120	0·588	152	0·419	184	0·161
25	1·041	57	0·879	89	0·732	121	0·583	153	0·413	185	0·146
26	1·036	58	0·874	90	0·727	122	0·578	154	0·407	186	0·131
27	1·030	59	0·870	91	0·723	123	0·573	155	0·401	187	0·116
28	1·025	60	0·865	92	0·718	124	0·568	156	0·394		
29	1·019	61	0·860	93	0·714	125	0·563	157	0·388		
30	1·014	62	0·856	94	0·709	126	0·558	158	0·382		
31	1·009	63	0·851	95	0·704	127	0·553	159	0·376		

tint to two points on the unfixed strip situated 10 millims. on each side of this, were found to be 100 millims. and 123 millims; (3) by reference to the Table, the relation between the intensities on these two positions is found to be as 0·672 to 0·578; (4) these numbers, multiplied by $\frac{1}{0\cdot626}$, the reciprocal of the intensity corresponding to 112 millims., give the intensities expressed in terms of the unit formerly employed, which acting for one second produce the tints in question.

The method of observation thus becomes very simple. To each of the fixed and graduated strips an Intensity Table is attached, giving the value of the tints upon each millimetre of its length in terms of the described unit; a piece of standard sensitive paper is exposed for a known number of seconds to the light which it is required to measure, until a tint is attained equal to some one of the tints upon the strip; the exact position upon the strip of equality of tint to the exposed paper is next read off by the light of the soda-flame; the number found in the Intensity Table opposite to this position, divided by the time of exposure in seconds, gives the intensity of the acting light in terms of the required unit.

A detailed description of the apparatus employed, and of the methods of preparing and graduating the strips, will be given under separate headings.

The following conditions must be fulfilled in order that this method can be adopted as a reliable measurement of the chemical action of light:—

1st. The tint of the standard strips fixed in hyposulphite must remain perfectly unalterable during a considerable length of time.

2nd. The tints upon these fixed strips must shade regularly into each other, so as to render possible an accurate comparison with, and graduation in terms of, the unfixed pendulum strips.

3rd. Simultaneous measurements made with different strips thus graduated must show close agreement amongst themselves, and they must give the same results as determinations made by means of the pendulum photometer, according to the method described on pages 158, 159 of the last memoir.

I. *Preparation of the Standard fixed Strips.*

For the purpose of preparing the fixed strips, sheets of good white photographic paper are salted in a solution containing 3 per cent. of chloride of sodium, exactly according to the directions given in the last memoir (p. 155) for the preparation of the standard paper. The salted paper after drying is cut into pieces, 16 centimetres in length by 15 centimetres in breadth, and silvered on a bath containing 12 parts of nitrate of silver to 100 parts of water. After drying, one of these papers is fixed at the corners upon a board covered by a well-fitting lid of sheet zinc, so made that it does not touch the paper; the paper is then blackened by exposure to the action of light in the pendulum apparatus. For this purpose, the thin elastic sheet of the blackened mica usually employed, is replaced by a piece of thin sheet zinc 16 centimetres broad. The frame carrying the paper is clamped on to the horizontal plate of pendulum photometer, and the sheet of blackened zinc placed over it; the cover is then withdrawn, and the paper exposed by allowing the pendulum, with the sheet of zinc attached to it, to vibrate until the required tint has been attained. The cover is then replaced, the frame opened in the dark room, the paper washed to remove excess of nitrate of silver, fixed in a saturated solution of hyposulphite of sodium, and well washed for three days. As the tints of the foxy-red colour which the paper possesses after fixing can be accurately compared with the bluish-grey tint of the freshly-exposed paper by means of the monochromatic light of the soda-flame, the use of a toning-bath was specially avoided as likely to render the paper liable to fade. Each sheet thus prepared is cut into four strips, 160 millims. long and 30 millims. broad, which are then preserved for graduation.

In order to ascertain whether these fixed strips undergo any alteration in tint by exposure to light, or when preserved in the dark, two consecutive strips were cut off from several different sheets, and the point on each at which the shade was equal to that of the standard tint (see last memoir, p. 157) was determined by reading off with the light of the soda-flame, by means of the arrangements fully described on p. 143 of the above-cited memoir. One-half of these strips were carefully preserved in the dark, the other half exposed to direct and diffuse sunlight for periods varying from fourteen days to six months, and the position of equality of tint with the standard tint from time to time determined. It appears, from a large number of such comparisons, a few of which only are given below, that in almost all cases an irregular, and in some instances a rapid fading takes place immediately after the strips have been prepared, and that this fading continues for about six to eight weeks from the date of the preparation. It is, however, seen that, after this length of time has elapsed, neither exposure to sunlight nor preservation in the dark produces the slightest change of tint, and that, for many months from this time forward, the tint of the strips may be considered as perfectly unalterable.

(1) *Experiments showing the alteration of tint ensuing immediately after preparation.*

Each number given below represents the intensity (see Table II., p. 159 of the last memoir) corresponding to the mean of ten independent readings on each strip upon the under-mentioned days.

Sheet No. 1, prepared December 9, 1863.			
	Intensity. 1st Reading, Dec. 16, 1863.	Intensity. 2nd Reading, Jan. 7, 1864.	Diminution in three weeks.
Strip A, exposed to sunlight...	2·49	2·05	0·44
Strip B, preserved in the dark	2·49	2·01	0·48
Sheet No. 2, prepared December 9, 1863.			
Strip A, exposed to sunlight...	2·21	1·86	0·35
Strip B, kept in the dark	2·21	2·03	0·18

From these numbers it is seen that the fading which occurs immediately after preparation is not dependent upon exposure, a change of the same kind being observed in those strips which were protected from the action of light.

(2) *Experiments showing the permanency of tint after lapse of some time from date of preparation.*

Sheet No. 3, prepared September 21, 1863.				
	Intensity. 1st Reading, Dec. 10, 1863.	Intensity. 2nd Reading, Dec. 18, 1863.	Intensity. 3rd Reading, Jan. 11, 1864.	Intensity. 4th Reading, Feb. 4, 1864.
Strip A, exposed to sunlight...	1·40	1·40	1·38	1·36
Strip B, kept in the dark	1·38	1·37	1·39	1·35
Sheet No. 4, prepared September 21, 1863.				
Strip A, exposed to sunlight...	1·45	1·39	1·39	1·38
Strip B, kept in the dark	1·43	1·43	1·45	1·46

(3) *Experiments showing alteration and subsequent permanency of Tint.*

Sheet No. 5, prepared March 10, 1864.						
	Intensity. 1st Reading, Mar. 12, 1864.	Intensity. 2nd Reading, Mar. 21, 1864.	Intensity. 3rd Reading, Apr. 27, 1864.	Intensity. 4th Reading, May 11, 1864.	Intensity. 5th Reading, June 3, 1864.	Intensity. 6th Reading, July 18, 1864.
Strip A, exposed to sunlight...	2·08	2·13	1·93	1·99	2·03	1·89
Strip B, in the dark	2·10	2·13	1·93	1·93	1·89	1·89
Sheet No. 6, prepared March 10, 1864.						
Strip A, exposed to sunlight...	2·23	2·23	2·13	2·15	2·15	2·10
Strip B, kept in the dark	2·23	2·23	1·99	2·01	2·08	1·97
Sheet No. 7, prepared March 10, 1864.						
Strip A, exposed to sunlight...	2·35	2·42	2·08	2·18	2·13	2·01
Strip B, kept in the dark	2·35	2·54	2·01	2·03	2·08	2·03

The above numbers show that, after the standard fixed strips have been prepared for about two months, the tints remain constant both when the paper is exposed to light and when it is kept in the dark. The small differences seen in some instances arise from unavoidable experimental errors of various kinds.

II. *Graduation of the fixed Strips in terms of the Standard Pendulum Strips.*

The value of the proposed method of measurement entirely depends upon the possibility of accurately determining the intensities of the various shades of the fixed strips in terms of the known intensities of the standard strips prepared in the pendulum photometer.

Two modes of effecting this graduation, and of comparing the accuracy of the graduation of one strip with that of another, were employed.

The first of these methods consists in determining by direct comparison the points on the fixed strip having equal intensities to points on the pendulum strip. For this purpose the position of the standard tint upon the pendulum strip was first observed; circular pieces of this strip, situated 20 millims. apart, were then stamped out with a punch 5 millims. in diameter, and half of each circle pasted on to the wooden reading block (fig. 4 of the last memoir), so that the centre of the paper circle came into the centre of the hole. The readings were conducted in the way described on p. 159 of the last memoir, every comparison being made independently ten times by each of two observers, and the mean reading taken as the result, whilst several pendulum strips were used for the graduation of one fixed strip. The following may serve as an example of the first method of graduation. Four pendulum strips were employed for the graduation of the fixed strip A.

Graduation of fixed strip A.

Position of standard tint upon pendulum strip No. 1=85 millims., from which the constant $\frac{1}{0{\cdot}750}$ is found in Table I. p. 607.

The position	20 mm.	on pendulum strip=	1·427	intensity, and corresponds to	67·4	mm. on fixed strip.
„	40	„	1·283	„	79·8	„
„	60	„	1·154	„	83·0	„
„	80	„	1·031	„	91·6	„
„	100	„	0·910	„	94·5	„
„	120	„	0·784	„	119·8	„
„	140	„	0·650	„	121·6	„

In like manner the constants for three other pendulum strips were determined.

$$\text{Constant for pendulum strip No. } 2=\frac{1}{0{\cdot}431}.$$

$$\text{Constant for pendulum strip No. } 3=\frac{1}{0{\cdot}607}.$$

$$\text{Constant for pendulum strip No. } 4=\frac{1}{0{\cdot}508}.$$

By comparison of each of these three pendulum strips with the fixed strip the following numbers were obtained. Column I. gives the readings on the millimetre-scale of the fixed strip; Column II. the corresponding intensities calculated as in the foregoing example.

No. 2.		No. 3.		No. 4.	
I.	II.	I.	II.	I.	II.
26·0	2·12	49·9	1·76	34·6	2·10
35·3	1·90	60·0	1·59	40·4	1·89
55·5	1·69	70·5	1·43	53·4	1·70
72·6	1·47	81·5	1·27	64·8	1·52
80·1	1·25	92·4	1·12	82·5	1·16
90·5	1·00	103·0	0·97	93·0	0·96
		121·4	0·80	123·6	0·72
		131·5	0·61		

In order to obtain the mean result of these numbers, the curve for each of the four graduations was drawn, the abscissæ giving the positions on the fixed strip in millimetres, and the ordinates the intensities corresponding to these positions. A curve was then interpolated, lying as nearly as possible between the points determining the single observations, and from this mean curve the intensity for each millimetre on the scale was calculated. The following are these tabular values for every 10 millims. Column I. gives the position in millims. on the fixed strip, Column II. the corresponding intensity, and Column III. the mean tabular error.

I.	II.	III.	I.	II.	III.
20	2·30	0·10	70	1·47	0·022
30	2·10	0·09	80	1·28	0·010
40	1·90	0·02	90	1·07	0·045
50	1·76	0·016	100	0·916	0·053
60	1·62	0·013	110	0·830	0·056
			120	0·755	0·050

A comparison of the several curves of the graduation of strip A found in Plate XXVIII. fig. 1 shows that the determinations agree as well as can be expected from such photometric experiments; the mean tabular error between the positions 40 and 80 millims. on the strip not exceeding one per cent. of the measured intensity.

For the second method of graduation sheets of paper tinted by lithography of a brownish colour and of different shades are employed, and a portion of each sheet is cut out, so that the several tints differ considerably from each other, and correspond to the tints taken at definite intervals along the fixed strip. These are then gummed over half the reading block, and the value of each read off on several pendulum strips, the intensity of which had previously been determined by the normal tint. Having thus obtained the intensity of each of the fixed tints, the fixed strip is graduated in terms of the pendulum strip by determining the points on the former equal in intensity to the fixed tints. This method possesses several advantages over that just described, and is to be preferred to it, although the comparison is an indirect one, as the intensity of the fixed tints can be found with a great degree of accuracy by repeated measurements; and when their intensities are once determined they can be preserved for a length of time, as they do not undergo any change of shade, and therefore can serve for the graduation of a large number of fixed strips; the preparation of which is accordingly not dependent, as is the case in the first method, upon the state of the weather.

The following numbers may serve as an example of this method:

(1) Determination of the intensity of fixed tints upon pendulum strips.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
Reading of normal tint on pendulum strip	153·2	82·0	131·1	136·6	105·7	17·5	121·6	19·2	51·9	131·6	119·4	98·0
Reading on pendulum strip of fixed tint ... No. I.	40·3	...	5·0	...	...	...	...	...	...	15·7	24·5	...
„ No. II.	90·4	...	50·2	67·2	25·4	...	...	...	...	50·1	52·3	22·6
„ No. III.	115·7	29·7	91·0	100·7	66·1	...	99·0	...	...	98·4	89·3	51·7
„ No. IV.	...	108·7	159·5	...	...	50·5	...	51·2	93·0	...	145·5	134·0
„ No. V.	...	...	...	...	...	125·8	...	120·6	150·0	...	...	...

The intensities for each determination of a fixed tint are obtained from the above numbers by dividing the numbers found in Column II. of Table I. (p. 607) opposite the millimetre readings of each fixed tint by those found in the same Table opposite to the readings of the normal tint.

Intensity of Fixed Tints.

Fixed Tint.	Expt. 1.	Expt. 2.	Expt. 3.	Expt. 4.	Expt. 5.	Expt. 6.	Expt. 7.	Expt. 8.	Expt. 9.	Expt. 10.	Expt. 11.	Expt. 12.
I.	2·336	......	2·185	......	......	......	......	......	......	2·067	1·768	......
II.	1·767	......	1·709	1·647	1·585	......	......	......	......	1·689	1·524	1·548
III.	1·480	1·328	1·356	1·346	1·276	......	1·182	......	......	1·289	1·235	1·317
IV.	......	0·840	0·698	......	......	0·891	......	0·838	0·794	......	0·773	0·755
V.	......	......	......	......	......	0·515	......	0·544	0·473			

Mean Intensity.

Fixed Tint No. I....... 2·089 Fixed Tint No. IV....... 0·798
„ II....... 1·637 „ V....... 0·512
„ III....... 1·312

(2) Graduation of fixed strips B and C, by means of the fixed tints. The graduation of the fixed strips by means of the fixed tints is now made in the way described in the first method.

	Readings on fixed strip B.	Readings on fixed strip C.	Corresponding intensity.
	millims.	millims.	millims.
Fixed tint I.......	20·2	27·7	2·089
„ II.......	3·88	42·8	1·637
„ III.......	67·3	71·7	1·312
„ IV.......	105·1	100·6	0·798
„ V.......	129·0	122·6	0·512
Standard tint	96·0	97·5	1·000

The Intensity Tables for these two strips are obtained by careful graphical interpolation from the above numbers; the curves are given (in black) on Plate XXVIII. fig. 2, the abscissæ representing the position on the millimetre-scale of the strips, and the ordinates the corresponding intensities. In every case the normal tint (intensity=1·00) is read off on the fixed strip, serving as a control of the accuracy of the graduation.

A second series of intensity determinations of the same fixed tints with pendulum strips is appended for the purpose of controlling the accuracy of the first series. The intensities of the fixed tints thus obtained are given in the 3rd column of the following Table. A new fixed tint, No. III. A, was introduced of a shade between Nos. III. and IV. This new tint was found to coincide with the positions 82·1 millims. and 82·3 millims. on the strips B and C respectively. The readings of the remaining tints are the same as in the first series.

(3) Second graduation of Strips B and C.

	I.	II.	III.
	Readings on strip B.	Readings on strip C.	Corresponding intensity.
Fixed tint I.......	20·2	27·7	1·955
„ II.......	38·8	42·8	1·597
„ III.......	67·3	71·7	1·291
„ III A....	82·1	82·3	1·123
„ IV.......	105·1	100·6	0·807
„ V.......	129·0	122·6	0·547
Standard tint	96·0	97·5	1·000

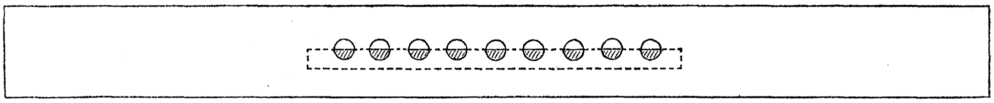
The Intensity Tables for strips B and C obtained by graphical interpolation from both the above determinations, are those used in most of the observations of daily chemical intensity about to be described. The curves of these two last graduations are given (dotted lines) on Plate XXVIII. fig. 2; and from these curves the close agreement of the graduations is seen.

The fixed strip graduated according to the above method is gummed upon the brass drum (M) of the reading-apparatus, fig. 6, care being taken to place a thick sheet of white paper between the metal and the fixed strip. In this position it is ready for use.

III. *Method of Exposure and Reading.*

For the purpose of making the observations, standard sensitive paper is prepared, according to the directions given on p. 155 of the last memoir, by salting photographic paper in a 3 per cent. solution of chloride of sodium, and subsequently silvering on a bath containing 12 parts of nitrate of silver to 100 of water. After drying in the dark, the paper is cut into pieces 100 millims. long by 10 millims. wide, and each piece gummed upon the back of an *insolation-band* (fig. 4) in the position denoted by the dotted lines, so that the lower half of each of the nine holes (5 millims. in diameter) stamped out of the paper 10 millims. apart, is filled up with the sensitive preparation. These insolation-bands may be easily cut out of white cartridge paper by means of an iron ruler 400 millims. long and 35 millims. broad, the holes in the paper being stamped out by a punch fitting into nine corresponding holes in the ruler. The holes in the paper are numbered, and the numbers are repeated upon the band at a distance of 87 millims. from each hole for the purpose of subsequent adjustment.

Fig. 4.



The insolation-apparatus (fig. 3) consists of a thin metal slide (A) 174 millims. in length and 40 millims. wide, with space enough between the sides to allow the paper band (B) to pass through easily. A circular opening (C) 10 millims. in diameter is cut in the middle of the upper side of the slide, and the marks on the bands are so arranged that the line marked No. 1 coincides with one end of the slide when the centre of the hole No. 1 in the band coincides with the centre of the opening (C) in the slide. A thin slip of brass (E) moves easily over the slide, and when brought into the position shown by the dotted lines, effectually protects the sensitive paper from the action of the light. If the slide (A) be used alone, the cover (E) can be moved by means of a button placed at the back of the slide; it is, however, more convenient to place the slide upon the stand (G), to which a lever handle (F) is attached, fitting into the button for the purpose of enabling the observer to cover and uncover the opening with greater ease and exactitude than is practicable when the hand alone is used. When the intensity of the light is such that the time of insolation does not exceed 2 or 3 seconds, the error introduced by this opening and closing may become considerable; for the purpose of diminishing this error by increasing the duration of exposure, the intensity of the acting light is decreased by

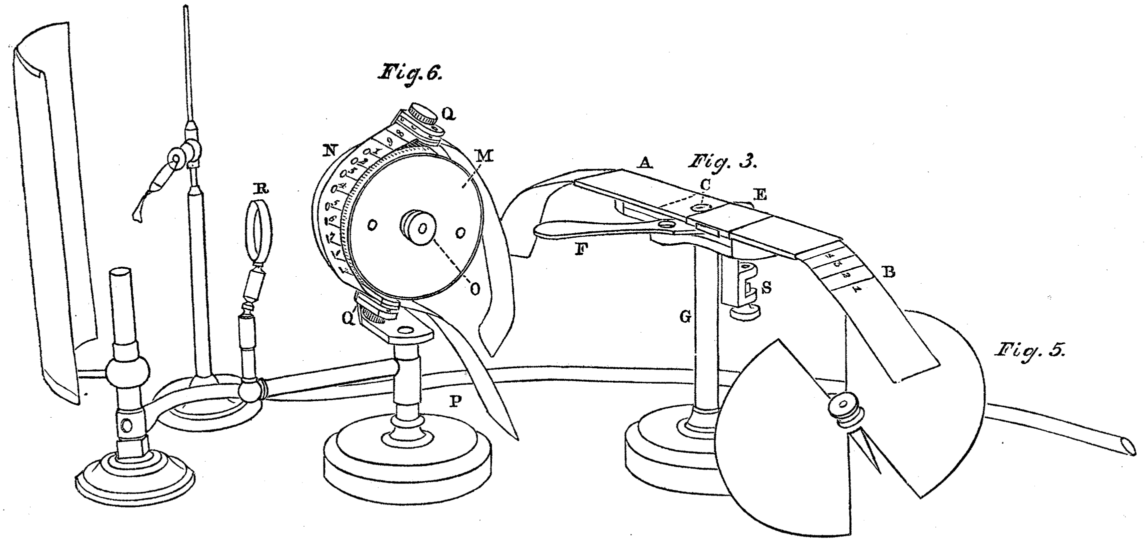


Fig. 6.

Fig. 3.

Fig. 5.

a known amount by allowing the circular disk of blackened metal (fig. 5), out of which two segments, each of $\frac{1}{12}$th of the whole area, have been cut, to revolve rapidly close above the upper surface of the slide (A); the spindle of the disk, for this purpose, fitting into the socket (S, fig. 3) on the stand. As the rate of rotation of the disk does not affect the accuracy of the result, it is made to revolve by turning the spindle with the hand. In order that the insolation-band carrying the sensitive paper may be made to press close against the lower edge of the opening (C), a piece of cartridge paper is placed underneath it, having several thicknesses of paper pasted at the part underlying the opening, whilst the ends of the same are made fast at the back of the slide. To enable the operator to observe when the paper has been sufficiently exposed, a small piece of photographically-tinted fixed paper of the requisite degree of shade is gummed upon the surface of the permanent paper band so as to lie directly under the opening (C).

When one observation has been made and the time and duration of the insolation noted, the remaining papers can be similarly exposed at any required time, by successively bringing them under the central opening (C), the right adjustment being ensured by making the corresponding mark coincide with the end of the slide. When all the nine papers upon the band have thus been exposed, it can be withdrawn and a second band prepared, as the first can be substituted without the necessity of bringing the apparatus into a dark room. This is done by means of a small black silk bag or sleeve, open at both ends; one end can be closed round the end of the brass slide by an elastic band, and the other is left open to admit the hand. When it is required to withdraw an insolation-band from the slide, the end of the paper is drawn out into the bag and the band rolled up into a small coil, and thus preserved until it can be read off, whilst the new band is introduced into the bag in the form of a coil, then unwound and pushed into the slide.

The reading-instrument is represented by fig. 6. It consists essentially of a metallic drum 80 millims. in diameter and 37 millims. broad, upon which a piece of thick white cartridge paper, and over it the graduated strip, is fastened. The edge of the drum is furnished with a millimetre-scale, and the dark end of the strip is made to coincide with the commencement of the scale. The drum turns upon a horizontal fixed axis against a vertical circular plate (N), being held in position by the screw (O). The drum and vertical plate are fixed upon a pillar and foot (P). The insolation-band is held against the graduated strip by means of two spring clamps (QQ′), placed apart at a distance of 130 millims. and fixed to the vertical plate (N). By moving the drum on its horizontal axis, the various shades of the fixed strip can be made to pass and repass each of the holes on the insolation-band, and the points of coincidence in tint on the strip and each of the insolated papers can be easily ascertained by reading off by the light of a soda-flame in a dark room. The lens (R) fixed upon the brass pillar of the instrument serves to concentrate the light from the flame upon the small surface under examination. If a coal-gas flame can be procured at the Observatory, the best mode of obtaining the monochromatic light is to place two beads of sodic carbonate upon fine platinum loops into the colourless flame of a Bunsen burner; if a coal-gas flame cannot be obtained, the flame of a lamp fed with spirit saturated with common salt can be used, and beads of the more volatile sodic chloride held into the flame. The reading of each observation is made ten times, and the mean of these readings taken as the result.

The following observations of the intensity of the chemical action of light on July 8, 1864, may serve as an example of the detail of the determinations.

Solar time. T.	Duration of exposure, n.	Mean reading, R.	Tabulated intensity of strip, I.	Calculated intensity, $\frac{I}{n}$.	Condition of solar disk.	Amount of cloud.	Barom.	Temperature.	
								Dry bulb.	Wet bulb.
h m	″	millims.							
7 10 A.M.	18	96	1·00	0·055	Clouded over	8			
7 50	15	93	1·03	0·068	Clouds	7			
8 25	12	90	1·06	0·089	„	9			
9 0	10	76	1·20	0·12	„	„			
9 30	10	75	1·21	0·12	„	„	millims.		
10 30	10	64	1·33	0·13	„	„	765·1	18·6° C.	13·9° C.
11 0	10	76	1·20	0·12	Clouded over	10			
11 30	10	67	1·30	0·13	„	„			
12 0	10	86	1·10	0·11	„	„		18·7	13·3
12 30 P.M.	6	107	0·78	0·13	Light clouds	9		19·3	13·5
1 10	8	73	1·24	0·15	„	7			
1 40	5	105	0·80	0·16	„	„		19·3	13·7
2 15	4	93	1·03	0·26	Unclouded ...	4		19·7	13·9
3 0	4	80	1·16	0·29	„	3		20·0	14·4
3 30	21 (with disk)	99	0·93	0·26	„	„			
4 0	5	86	1·10	0·22	„	„		21·1	14·4
4 30	8	76	1·20	0·15	„	1			
5 0	11	66	1·31	0·12	„	„			
6 10	60	116	0·66	0·011	„	„			

IV. *Concerning the accuracy and trustworthiness of the method.*

The most satisfactory mode of testing the reliability and accuracy of the method of measurement just described, is to compare the results of two series of independent determinations of the chemical action of daylight, made simultaneously at the same spot with the present arrangement and with the pendulum photometer, according to the method described in the last memoir, upon which the present mode of measurement is founded. For the purpose of making these comparisons, the strips of standard photographic paper placed in the pendulum apparatus (see fig. 1 of last memoir) and the pieces of the same material placed on the insolation-band in the exposing slide (fig. 3, A) were simultaneously insolated, each for a known length of time, both instruments being placed near one another in a position (on the roof of the laboratory of Owens College, Manchester) having a tolerably free horizon. If the varying daily intensities thus measured by the two methods are found to agree, we may conclude that the unavoidable experimental errors arising from graduation, exposure, and reading are not of sufficient magnitude materially to affect the accuracy of the measurement. The intensity with the pendulum photometer was determined exactly as described on pp. 158 & 159 of the above-cited memoir; the time of exposure and the number of vibrations were noted, the position at which the strip possessed a shade equal to that of the normal tint was then read off, and the corresponding intensity obtained by dividing the number found in Table II. of the above memoir by the number of the vibrations. The intensity, according to the new method, was obtained by insolating the standard paper in the exposing slide (fig. 3, A) for a known number of seconds, and then reading off, by means of the arrangement shown in fig. 6, the position in millimetres on the calibrated strip equal in shade to the exposed paper. The number found in the second column of the Intensity Table, of the strip opposite to this position, when divided by the time of exposure in seconds, gives the required intensity. In this way comparisons of the working of the two modes of measurement have been made during four different days. On each of these days a large number of simultaneous observations were made, and on some of them two or more determinations were made with each instrument immediately succeeding each other. An examination of the following Tables, giving the results of these observations, shows that the agreement between the intensities as obtained by the two methods is as close as can be expected.

Simultaneous Measurements with Pendulum Instrument and New Photometer.

April 29th, 1864.			
Time.	Intensity.		Difference.
	Pendulum instrument.	New photometer.	
h m			
9 30 A.M.	0·210	0·180	−0·03
10 0	0·160	0·160	0·00
11 0	0·073	0·083	+0·010
11 5	0·064	0·078	+0·014
12 30 P.M.	0·200	0·210	−0·01
12 32	0·210	0·220	+0·01
1 30	0·068	{ 0·072 0·056 } 0·064	−0·04
2 0	0·105	0·105	0·00
2 30	0·124	{ 0·133 0·133 }	+0·009
3 0	0·136	0·144	+0·008
3 0	0·117	0·114	−0·003
3 30	0·157	0·182	+0·025

May 10th, 1864.			
Time.	Intensity.		Difference.
	Pendulum instrument.	New photometer.	
h m			
9 0 A.M.	0·093	{ 0·079 0·085 } 0·082	−0·011
10 0	0·100	0·110	+0·010
11 15	0·130	0·150	+0·020
12 30 P.M.	0·220	0·250	+0·030
1 0	0·100	{ 0·099 0·102 } 0·100	0·000
2 30	0·105	{ 0·109 0·096 } 0·102	−0·003
2 33	0·115	0·116	+0·001
4 30	0·0125	0·0106	−0·002

Simultaneous Measurements (continued).

June 8, 1864.			
Time.	Intensity.		Difference.
	Pendulum photometer.	New instrument.	
h m			
10 40 A.M.	0·229	0·203	−0·026
10 42	0·232	{ 0·226 0·238 } 0·233	+0·001
11 25	0·218	0·207	−0·011
11 27	0·225	0·217	−0·008
1 33 P.M.	0·205	0·231	+0·026
2 15	0·218	0·230	+0·012
2 17	0·224	0·233	+0·009
3 20	0·072	0·064	−0·010
3 22	0·077	0·068	−0·009
4 0	0·039	0·048	+0·009
4 3	0·031	0·036	+0·005

July 16, 1864.			
Time.	Intensity.		Difference.
	Pendulum photometer.	New instrument.	
h m			
9 50 A.M.	....	0·24	
10 25	....	0·16	
10 40	{ 0·19 0·19 } 0·19	{ 0·18 0·20 0·17 0·21 } 0·19	0·00
11 45	{ 0·21 0·17 } 0·19	0·17	−0·02
12 15 P.M.	{ 0·19 0·17 } 0·18	{ 0·24 0·20 0·18 0·20 } 0·205	+0·02
12 45	{ 0·14 0·13 } 0·135	{ 0·17 0·14 0·11 0·17 } 0·147	+0·012
1 30	{ 0·15 0·14 } 0·145	{ 0·12 0·12 0·12 } 0·12	−0·025
2 21	0·14	{ 0·17 0·15 } 0·16	+0·02
2 46	{ 0·13 0·13 0·12 0·13 } 0·127	{ 0·12 0·14 0·14 0·14 } 0·135	+0·008

The curves on figs. 7, 8, & 9, Plate XXVIII. exhibit these results graphically for the first three days, and a glance at these curves show how closely the measurements made by the two methods agree. The black line represents the intensity as determined by the pendulum instrument, the dotted line that obtained by the new photometer, the abscissæ giving the times of observation, and the ordinates the chemical intensity in the terms of the unit above described. The mean chemical intensities, as observed on the above days by the two methods, are represented by the following numbers, for the definition of which the reader is referred to page 621.

Daily Mean Chemical Intensity.

Plate XXVIII.	1. Pendulum photometer.	2. New instrument.
Fig. 7, April 29, 1864 . . .	62·0	62·3
Fig. 8, May 10, 1864 . . .	41·3	43·3
Fig. 9, June 8, 1864 . . .	64·7	65·3

From these results the agreement of the two methods is well seen.

As a second test of the trustworthiness and availability of the method for actual measurement, I give the following results of determinations, made at the same time and on the same spot, by two observers with two of the new instruments. These determinations, made with the two graduated fixed strips B and C (page 613), were conducted in every way independently, so that the results serve as a fair sample of the accuracy with which the measurements can be practically carried out.

Simultaneous Determinations made independently with two Instruments by two observers.

July 11, 1864.			July 15, 1864.		
Time.	Chemical Intensity.		Time.	Chemical Intensity.	
	Instrument 1. Strip B.	Instrument 2. Strip C.		Instrument 1. Strip B.	Instrument 2. Strip C.
h m			h m		
10 30 A.M.	0·16	0·14	10 0 A.M.	0·16	0·17
"	0·14	0·14	10 1	0·19	0·19
10 31	0·14	0·15	11 0	0·049	0·046
"	0·12	0·13	11 1	0·049	0·046
10 32	0·13	0·11	11 35	0·12	0·12
"	0·15	0·12	"	0·12	0·12
10 33	0·14	0·12	11 36	0·12	0·13
11 0	0·13	0·12	"	0·11	0·11
12 0	0·31	0·27	12 30 P.M.	0·13	0·10
12 30 P.M.	0·31	0·29	"	0·13	0·12
12 31	0·38	0·37	"	0·14	0·13
12 32	0·33	0·31	"	0·14	0·12
12 33	0·35	0·32	1 0	0·17	0·17
1 5	0·13	0·13	"	0·18	0·18
2 0	0·27	0·25	2 30	0·057	0·060
"	0·27	0·25	"	0·068	0·070
3 10	0·24	0·23	3 30	0·059	0·057
3 11	0·21	0·24	"	0·067	0·062
3 12	0·18	0·23	3 31	0·063	0·045
3 13	0·17	0·18	"	0·054	0·045
3 40	0·24	0·23	4 20	0·028	0·025
3 41	0·14	0·15	"	0·028	0·025
4 0	0·21	0·20	"	0·032	0·028
4 30	0·11	0·13			
"	0·14	0·14			
4 31	0·14	0·15			
"	0·15	0·14			
4 32	0·16	0·14			

Figs. 10 & 11, Plate XXVIII. exhibit the daily curve of chemical intensity thus determined; the close agreement of the two curves for each day shows that the errors of graduation, exposure, and reading do not materially affect the accuracy of the measurements; whilst the values of the Daily Mean chemical intensities obtained from each curve, viz. 42·0 and 41·7 for fig. 11, July 15, 1864; and 74·3 and 70·0 for fig. 10, July 11, 1864, confirm this conclusion.

V. *Application of the Method to actual Registration.*

A series of determinations of the varying intensity of the chemical action of total daylight, made at Manchester on more than forty days, at the most widely differing seasons of the year, extending from August 1863 to September 1864, serves to show, in the first place, that the daily determination of the varying chemical intensity can without difficulty be carried on; whilst, secondly, they reveal a few of the many interesting results to which an extended series of such measurements must lead. The whole of the observations, with a few exceptions, were carried on in Manchester, upon the roof of the laboratory of Owens College. As a rule, one observation was made every half-hour; frequently, however, when the object was either to control the measurements, or to record the great changes which suddenly occur when the sun is obscured or appears from behind a cloud, the determinations were made at intervals of a few minutes or even seconds. Sometimes, when the sky was overclouded, or when no great changes in the light occurred, the observations were made once every hour. On most of the days employed for observation, the temperature, atmospheric moisture, barometric pressure, varying amount of cloud, and the condition of the sun's disk were noted.

The curves given on Plate XXIX. serve to exhibit these same results graphically, the abscissæ representing the hours of the day (solar time), and the ordinates giving corresponding chemical intensity expressed in terms of the unit above described.

Consecutive observations were carried on each day for nearly a month, from June 16 to July 9, 1864; the labour thus incurred was found to be comparatively light, so that, when all the preliminary arrangements are made, the daily measurements take up but a small portion of the attention and time of one observer. From the results of these measurements the great difference becomes perceptible which often exists between the chemical intensity of neighbouring days; examples of this variation are seen on Plate XXIX. figs. 12 & 13, for June 27th and 28th, and on figs. 14 & 15, for June 29th and 30th. The tabular results show that the amount of chemical action generally corresponds to the degree of cloud or sunshine, as noted in the observation. Irregular changes in the chemical action are, however, observed on some days (as on March 19, 1864, fig. 16), on which the sun shone continuously, and these are to be mainly attributed to the variation in the amount of cloud passing at the time of observation. In several cases, when no apparent change in the amount of light as affecting the eye could be noticed, a considerable and sudden alteration in the chemical intensity occurred. This was clearly seen on September 26, 1864, when the whole sky was apparently unclouded throughout the day; at $9^{h}\,25'$ A.M. the chemical intensity was found to be 0·13; at 10^{h}, without any visible change in the light, the chemical action sank to 0·07, and continued at this point for more than half an hour, rising again to 0·11 at 11 o'clock. That this diminution of the chemical activity arises from the presence of mist, or of suspended particles of water imperceptible to the eye, is rendered probable by the very powerful absorptive action which a light haze or mist exerts upon the chemical rays. Thus on March 18, 1864, the action at 8^{h} A.M., when a light mist obscured the sun, amounted to 0·0026, whereas the normal action for that day and hour, with an unclouded sky, is twenty-five times as large. It is scarcely necessary to remark that on this occasion the ratio of decrease of visible luminosity was not nearly so great. The same absorptive action of mist is well seen in the following measurements on September 27 and 28, 1864.

September 27, clear sun.			September 28, sun obscured by haze.		
Time.	Intensity.	Weather.	Time.	Intensity.	Weather.
h m			h m		
10 0 A.M.	0·13	Clear sky and direct sun.	10 0 A.M.	0·016	Hazy.
10 30	0·17	,,	10 30	0·039	,,
11 0	0·18	,,	11 0	0·053	,,
11 30	0·13	,,	11 30	0·075	,, [pearing.
12 40 P.M.	0·16	,,	12 0	0·042	Sunshine, haze gradually disap-
1 10	0·13	,,	12 45 P.M.	0·056	,,
1 40	0·17	,,	1 0	0·053	,,
2 10	0·14	,,	1 30	0·10	Haze gone.
			2 15	0·12	,,

For the purpose of expressing the relation of the sums of all these various hourly intensities, giving the *daily mean chemical intensity* of the place, a rough, but sufficiently accurate method of integration may be resorted to. This consists simply in cutting the curves out in strong homogeneous paper or cardboard, and in determining in each case the weights of the paper enclosed between the base-line and the curve. A portion of the paper of given size is cut out between every four or five curves, and the small variations in weight caused by irregularity in the thickness of the paper thus allowed for.

In the following Table the numbers are compared with the action, taken as 1000, which would be produced by light of the intensity 1 acting uniformly throughout the twenty-four hours.

Daily Mean Chemical Intensities at Manchester, 1863–64.

(Intensity 1·0 acting for 24 hours = 1000.)

Date.	Intensity.	Date.	Intensity.	Date.	Intensity.
1863.		1864.		1864.	
August 26.........	40·5	March 19	36·8	June 28...........	26·6
27.........	29·8	April 19	78·6	29...........	26·7
Sept. 4.........	41·8	20	85·3	30...........	64·4
16.........	30·8	June 16	100·7	July 1...........	61·5
23.........	12·4	17	47·2	2...........	19·1
24.........	18·7	18	118·7	4...........	51·2
25.........	18·1	20	50·9	5...........	76·2
28.........	29·1	21	99·0	6...........	78·9
Dec. 21.........	3·3	22	119·0	7...........	39·1
22.........	4·7	23	81·4	8...........	72·2
		25	83·0	9...........	83·6
		27	83·0	Sept. 26...........	48·8

The remarkable differences observed in the chemical intensity on two neighbouring days is shown on fig. 17, in which the curves for the 20th and 22nd June 1864 are represented. The integrals for these days are 50·9 and 119; or the total chemical action on the 20th and 22nd June is in the ratio of 1 to 2·34.

The chemical action of daylight at Manchester at the winter and summer solstice, and the vernal and autumnal equinoxes, is clearly seen by reference to the curves on fig. 18, in which the actions on September 28, 1863, December 22, 1863, March 19, 1864, and June 22, 1864, are represented graphically. These days were chosen out from amongst the observations made near the required periods, as being days upon which the sun shone most brightly, and as therefore giving the nearest approach to the maximum actions for the several periods in question. The integral for the winter solstice is 4·7, that of the vernal equinox 36·8, that of the summer solstice is 119, and that of the autumnal equinox 29·1. Hence if the total chemical action on the shortest day be taken as the unit, that upon the equinox will be represented by 7, and that upon the longest day by 25. From these numbers, as well as from the curves (fig. 18), it is seen that the increase of chemical action from December to March is not nearly so great as that from March to June. With the small amount of experimental data which we as yet possess upon this subject, it is useless to attempt to give an explanation of the probable cause of this difference; suffice it to say that it does not appear to be mainly produced by the absorptive action exerted by the direct sunlight in passing through the different lengths of the columns of air which the rays have to traverse on the days in question.

In carrying out a regular series of meteorological observations upon the variation of mean daily chemical intensity at any spot, a fair average result may be obtained by a much smaller number of observations than is necessary when the object is to indicate the rapid changes occurring in the intensity. Thus, for instance, if determinations had been made on the following days once every two hours, viz. at 8^h, 10^h A.M., 12^h, 2^h, 4^h, and 6h P.M., instead of about every fifteen minutes, the numbers for mean chemical intensity would have been—

Date.	Mean Chemical Intensity.	
	From 26 observations.	From 6 observations.
1863, August 26	40·5	43·0
„ Sept. 4	41·8	42·7
1864, April 20	85·3	96·3

As examples of simultaneous determinations made in different localities, I give the results of observations made by myself in Heidelberg, lat. 49° 24′ N., on July 4, 1864, and near Dingwall in Rossshire, lat. 57° 35′ N, on September 27, 1864, compared with the results of observations made in Manchester, 53° 20′ N. latitude, by my assistant. The curves for Heidelberg and Manchester are given in fig. 19, those of Dingwall and Manchester on fig. 20. The integral giving the mean action at Heidelberg on July 4 is 160, that at Manchester on the same day being 51·2; so that the chemical action at Manchester and Heidelberg was on July 4 in the ratio of 1 to 3·12. The integral for Dingwall on September 27 is 66·4, whilst that of Manchester is 49·5; or the ratio of chemical action at Manchester and Dingwall on the day in question was 1 to 1·34. From these observations it would appear that the chemical action at Manchester is smaller than accords with the latitude of the place. This is easily accounted for by the absorptive action exerted by the atmosphere of coal smoke in which the whole of South Lancashire is constantly immersed. Indeed, from the frequent occurrence in Manchester of dull or rainy days, and of fogs or mists, it would be difficult to choose a spot more unsuited to the prosecution of experiments on the chemical action of light.

From the integrals of daily intensity giving the mean chemical action for each day, the mean monthly or yearly chemical intensity of the place of observation can, in like manner, be ascertained; so that, should this method of measurement prove capable of general adoption, we may look forward to obtaining in this way a knowledge of the distribution of the chemically active rays over the surface of our planet analogous to that which we already possess respecting the heating rays.

Tables giving the Results of the Measurement of Daily Chemical Intensity in 1863–64, at Manchester, Heidelberg, and Dingwall.

Daily Chemical Intensity, Manchester, 1863.

August 26, 1863.

Barom. = 746 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
h m		
7 3 A.M.	0·060	Unclouded.
7 33	0·038	Cloudy.
7 45	0·092	Unclouded.
8 15	0·077	"
8 45	0·070	Unclouded, hazy.
9 15	0·086	Unclouded, haze.
9 45	0·97	"
10 30	0·133	"
10 50	0·187	"
11 10	0·148	"
11 13	0·191	"
11 30	0·229	"
11 50	0·203	Light clouds.
12 0	0·160	"
12 20 P.M.	0·210	Unclouded.
12 40	0·075	Cloudy.
1 0	0·062	"
1 22	0·062	"
1 40	0·094	Light clouds.
2 20	0·069	Clouds.
3 0	0·021	"
3 30	0·016	Clouded over.
4 0	0·016	"
4 30	0·018	"
5 0	0·009	"
5 30	0·004	"
6 0	0·010	"

September 4, 1863.

Barom. = 756 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
h m		
7 45 A.M.	0·062	Unclouded.
8 15	0·075	"
8 45	0·083	Ditto, hazy.
9 20	0·098	Unclouded.
9 40	0·097	"
10 0	0·166	"
10 30	0·115	"
10 45	0·173	"
11 0	0·165	"
11 30	0·135	Cloud.
11 42	0·079	"
11 50	0·128	Unclouded.
11 57	0·137	"
12 10 P.M.	0·072	Clouded.
12 26	0·159	Unclouded.
12 29	0·143	"
12 45	0·165	"
1 20	0·099	Light clouds.
1 21	0·105	"
2 25	0·149	Unclouded.
2 45	0·038	Cloudy.
3 0	0·024	"
3 30	0·035	"
4 0	0·040	Cloudy, rain.
5 0	0·035	Clouds.
5 30	0·016	"

August 27, 1863.

Barom. = 745 millims.

8 5 A.M.	0·026	Cloudy.
8 33	0·068	Clouds.
9 0	0·041	"
9 45	0·039	"
10 30	0·098	Light clouds.
11 0	0·146	"
11 4	0·132	Unclouded.
11 30	0·115	Light clouds.
12 0	0·059	Cloudy.
12 30 P.M.	0·122	Unclouded.
1 0	0·057	Clouds.
1 30	0·078	Clouded over.
2 0	0·159	Sunshine.
2 20	0·155	"
3 0	0·027	Clouded over.
3 20	0·051	Light clouds.
3 50	0·066	Unclouded.
4 10	0·004	Overclouded.
4 30	0·002	Thunder-storm.

September 16, 1863.

Barom. = 767 millims.

9 0 A.M.	0·059	Cloudy.
9 35	0·120	Light clouds.
10 15	0·078	Overclouded.
10 45	0·077	"
11 15	0·041	"
11 45	0·104	"
12 0	0·103	"
12 35 P.M.	0·080	"
1 0	0·086	"
2 0	0·091	"
2 40	0·093	"
3 20	0·037	"
4 0	0·027	Rain.
4 45	0·034	Clouds.
6 0	0·007	"

Daily Chemical Intensity, Manchester, 1863 (continued).

September 23, 1863.

Barom. = 738 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
h m		
9 0 A.M.	0·026	Overclouded.
9 30	0·054	Light clouds.
10 0	0·063	Overclouded.
10 30	0·042	"
11 0	0·065	Light clouds.
11 30	0·077	Sun, clouds.
12 0	0·013	Overclouded.
12 20 P.M.	0·031	"
12 45	0·041	"
1 0	0·056	"
1 50	0·062	"
2 10	0·038	"
2 30	......	Rain.
......	......	Heavy rain.
4 0	0·01	

September 24, 1863.

Barom. = 744 millims.

9 0 A.M.	0·068	Light clouds.
9 30	0·069	"
10 10	0·105	Sunshine.
10 40	0·016	Overclouded.
11 20	0·038	Light clouds.
11 40	0·015	Overclouded.
12 0	0·033	Light clouds.
12 30 P.M.	0·046	"
12 45	0·087	Unclouded.
12 46	0·099	"
1 0	0·110	"
1 55	0·088	Light clouds.
2 10	0·068	Unclouded.
2 40	0·042	Overclouded.
3 0	0·021	"
3 30	0·014	"
......	......	Rain.
5 0	0·014	Overclouded.

September 25, 1863.

Barom. = 753 millims.

9 0 A.M.	0·042	Overclouded.
9 40	0·077	Unclouded, hazy.
10 20	0·035	Light clouds.
11 0	0·042	"
11 30	0·037	"
1 50 P.M.	0·031	Overclouded.
2 20	0·055	Light clouds.
2 21	0·075	Unclouded.
2 22	0·081	"

September 25, 1863 (continued).

Barom. = 753 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
h m		
2 50 P.M.	0·065	Unclouded.
3 15	0·050	Light clouds.
3 20	0·064	Unclouded.
3 50	0·063	"
3 50	0·063	"
5 0	0·012	Overclouded.

September 28, 1863.

Barom. = 755 millims.

9 20 A.M.	0·045	Light clouds.
10 20	0·108	Unclouded.
10 21	0·108	"
10 55	0·101	"
10 56	0·106	"
11 20	0·125	"
11 48	0·133	"
12 20 P.M.	0·047	Overclouded.
1 0	0·052	"
1 40	0·055	Light clouds.
2 30	0·099	Unclouded.
2 31	0·094	"
3 0	0·080	"
3 1	0·079	"
3 40	0·072	"
3 50	0·059	"
4 0	0·044	"
4 10	0·043	"
4 30	0·037	Light clouds.
5 0	0·019	"
5 30	0·004	"

December 21, 1863.

Barom. = 760 millims.

11 0 A.M.	0·013	Clouds.
11 10	0·011	"
11 20	0·012	Hazy.
11 30	0·014	"
11 43	0·019	Unclouded.
12 0	0·003	Rain.
12 15 P.M.	0·018	Clouds.
12 30	0·010	Overclouded.
1 0	0·017	Light clouds.
1 30	0·013	Overclouded.
2 0	0·066	"
2 30	0·0066	"
3 0	0·0084	"
3 30	0·0017	"

Daily Chemical Intensity, Manchester, 1863–64.

December 22, 1863.
Barom. = 761 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
h m		
9 10 A.M.	0·0077	Hazy.
9 40	0·0057	Cloudy.
10 20	0·011	„
11 20	0·020	„
11 40	0·025	„
11 50	0·026	Unclouded.
11 55	0·028	„
12 0	0·023	Light clouds.
12 30 P.M.	0·020	Hazy.
12 35	0·032	Unclouded.
1 0	0·029	Hazy.
1 30	0·017	Unclouded.
2 0	0·017	„
2 30	0·0066	„

March 19, 1864.
Barom. = 753 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
8 0 A.M.	0·0026	Misty.
9 0	0·070	Unclouded.
9 40	0·120	„
10 25	0·080	„
10 45	0·13	„
11 0	0·13	„
11 15	0·080	„
11 35	0·10	„
11 45	0·11	„
11 55	0·10	„
12 0	0·12	„
12 5 P.M.	0·12	„
12 10	0·12	„
12 33	0·14	„
1 0	0·12	„
1 35	0·045	„
2 20	0·11	„
3 30	0·069	„
4 40	0·039	Light clouds.
6 0	0·007	„

April 19, 1864.
Barom. = 758 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
7 50 A.M.	0·10	Unclouded.
9 25	0·22	„

April 19, 1864 (continued).
Barom. = 758 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
h m		
10 0 A.M.	0·29	Unclouded.
10 46	0·20	„
11 0	0·33	„
12 0	0·25	„
1 0 P.M.	0·26	„
2 14	0·15	„
2 45	0·20	„
3 15	0·13	„
3 45	0·11	„
4 20	0·10	„
4 50	0·081	„

April 20, 1864.
Barom. = 759 millims.

Solar time.	Chemical intensity of light.	Sun's disk.
6 50 A.M.	0·067	Hazy.
7 45	0·17	Unclouded.
8 15	0·22	Hazy.
8 45	0·22	„
9 20	0·35	„
10 0	0·26	Unclouded.
10 50	0·30	„
11 15	0·16	„
11 30	0·17	„
11 40	0·19	„
11 50	0·17	„
12 0	0·16	„
12 30 P.M.	0·16	„
12 45	0·14	„
1 1	0·18	„
1 30	0·14	„
2 5	0·23	„
2 46	0·12	Cloudy.
3 13	0·11	„
3 30	0·10	„
4 15	0·091	„
5 5	0·094	„
5 30	0·060	„
6 5	0·041	„
6 50	0·014	„
7 30	0·0037	„

Daily Chemical Intensity, Manchester 1864.

June 16th, 1864. Mean Temp. Dry bulb 17°·9.
Barom.=758·3 millims. „ Wet bulb 12°·9C.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
6 25 A.M.	0·039	......	Clouded over.
7 0	0·019	......	„
7 30	0·10	......	Clouds breaking.
8 0	0·13	......	„
8 30	0·15	......	Light clouds.
9 0	0·13	......	Clouded over.
9 30	0·24	......	Unclouded.
10 0	0·38	......	„
10 30	0·29	......	„
11 0	0·38	......	„
11 30	0·35	......	„
12 0	0·22	......	Light cloud.
12 30 P.M.	0·37	......	Unclouded.
1 0	0·31	......	„
1 30	0·26	......	„
2 0	0·24 0·23	......	„
2 30	0·17	......	Clouds.
3 0	0·13	......	Unclouded.
3 30	0·15	......	Light clouds.
4 0	0·10	......	„
4 30	0·052	......	Clouded over.
5 0	0·045	......	„
5 30	0·087	......	Light clouds.
7 15	0·030	......	„
8 15	0·010	......	„
8 40	0·0027	......	„

June 17th, 1864. Mean Temp. Dry bulb 20°·5.
Barom.=760·9 millims. „ Wet bulb 17°·1 C.

6 40 A.M.	0·053	......	Clouded over.
7 10	0·086	......	„
7 50	0·18	......	„
8 30	0·11	......	Light clouds.
9 0	0·11	......	„
9 30	0·28	......	„
9 55	0·13	......	Clouded over.
10 25	0·045	......	„
11 10	0·15	......	„
11 40	0·12	......	„
12 10 P.M.	0·14	......	„
12 30	0·14	......	„
1 0	0·35	......	„
1 35	0·18	......	„
2 0	0·12	......	„
2 40	0·059	......	„
3 10	0·062	......	„
3 40	0·027	......	„
4 20	......	......	Rain.

June 18th, 1864.
Barom.=761 millims.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
7 50 A.M.	0·19	......	Unclouded.
8 40	0·30	......	„
9 10	0·19	......	Clouds.
9 55	0·19	......	„
10 45	0·13	......	„
11 30	0·19	......	„
12 35 P.M.	0·33	......	Light clouds.
1 30	0·38	......	„
3 0	0·21	......	„
4 0	0·22	......	Unclouded.
6 30	0·033	......	Clouds.
8 0	0·0079	......	„

June 20th, 1864. Mean Temp. Dry bulb 19°·5.
Barom.=763·8 millims. „ Wet bulb 15°·9 C.

8 0 A.M.	0·14	......	Light clouds.
8 45	0·14	......	Clouds.
9 15	0·099	......	„
9 55	0·094	......	„
10 30	0·16	......	„
11 0	0·12	......	„
11 30	0·15	......	„
12 0	0·13	......	„
12 15 P.M.	0·13	......	„
12 45	0·16	......	„
1 0	0·15	......	„
1 30	0·11	......	„
2 10	0·074	......	„
2 45	0·075	......	„
3 15	0·044	......	„
3 50	0·053	......	Clouded over.
4 30	0·031		
5 30	0·030	......	Rain.
7 0	0·010	......	„

June 21st, 1864. Mean Temp. Dry bulb 16°·1.
„ Wet bulb 11°·1 C.

6 40 A.M.	0·12		
7 15	0·13	......	Light clouds.
7 45	0·074	......	„
8 30	0·080	......	„
9 30	0·21	......	Unclouded.
10 0	0·27	......	Light clouds.
10 30	0·27		
11 10	0·33	5	
11 30	0·29	......	Sun shining.
12 0	0·072	8	Clouds.
12 30 P.M.	0·22	8	Unclouded.

Daily Chemical Intensity, Manchester, 1864 (continued).

June 21st, 1864 (continued).			Mean Temp. Dry bulb 16°·1. „ Wet bulb 11°·1.
Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
1 0 P.M.	0·29	6	Unclouded.
1 35	0·28	6	Clouds.
2 45	0·21	4	Unclouded.
3 15	0·24	3	Hazy sunshine.
4 15	0·13	......	Unclouded.
5 30	0·038	......	Clouds.
6 10	0·031	......	„
7 40	0·012	......	„
June 22nd, 1864. Barom.=761 millims.			Mean Temp. Dry bulb 17°·6. „ Wet bulb 13°·5 C.
8 0 A.M.	0·15	......	Clouded over.
......	......	......	Rain.
8 45	0·017	10	Clouded over.
9 15	0·22	6	Clouds.
10 0	0·22	9	„
10 30	0·21	8	„
11 0	0·19	8	„
11 30	0·45	6	Unclouded.
12 15 P.M.	0·49	5	„
1 30	0·28	3	„
1 50	0·27	......	„
2 0	0·26	2	„
2 30	0·38	......	„
3 0	0·17	5	Light clouds.
3 30	0·17	2	„
4 0	0·16	3	Unclouded.
5 0	0·15	1	„
6 0	0·068	......	Clouds.
June 23rd, 1864. Barom.=757·6 millims.			Mean Temp. Dry bulb 15°·1. „ Wet bulb 11°·6 C.
7 0 A.M.	0·090	10	Heavy rain.
9 20	0·18	10	Clouded over.
10 10	0·18	9	„
11 30	0·18	9	Rain.
12 0	0·21	10	Clouds.
1 0 P.M.	0·22	7	Rain.
3 0	0·16		
3 40	0·17	6	Unclouded.
4 35	0·12	8	Clouded.
5 0	0·093	9	„
June 25th, 1864. Barom.=761·2 millims.			Mean Temp. Dry bulb 16°·7. „ Wet bulb 13°·4.
7 45 A.M.	0·055	10	Clouded over.
8 30	0·14	10	„
10 10	0·27	10	„
11 0	0·18	10	„
12 0	0·27	10	„
12 30 P.M.	0·22	......	„
June 25th, 1864 (continued). Barom.=761·2 millims.			Mean Temp. Dry bulb 16°·7. „ Wet bulb 13·4.
Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
1 0 P.M.	0·16	......	Clouds.
1 45	0·33	......	Clouded over.
2 30	0·23	8	Unclouded.
3 10	0·13	10	Clouded over.
5 15	0·10	......	„
6 30	0·037	......	„
June 27th, 1864. Barom.=765·2 millims.			Mean Temp. Dry bulb 16°·4. „ Wet bulb 12°·0 C.
7 45 A.M.	0·15	4	Light clouds.
8 30	0·22	4	Unclouded.
9 10	0·11	8	Clouds.
9 30	0·25	7	Unclouded.
10 0	0·12	6	Clouds.
10 40	0·34	4	Unclouded.
11 30	0·11	9	Clouded over.
12 0	0·21	7	Unclouded.
1 15 P.M.	0·050	9	Clouded over.
4 30	0·17	1	Unclouded.
5 7	0·15	1	„
5 30	0·092	1	„
6 0	0·020	......	„
June 28th, 1864. Barom.=763·2 millims.			Mean Temp. Dry bulb 15°·0. „ Wet bulb 13°·4 C.
7 30 A.M.	0·031	10	Clouded over.
8 40	0·043	10	„
9 30	0·15	10	„
10 20	0·060	10	„
11 0	0·037	10	Rain.
11 30	0·034	10	„
12 30 P.M.	......	10	„
2 30	0·095	10	„
June 29th, 1864. Barom.=759·2 millims.			Mean Temp. Dry bulb 13°·0. „ Wet bulb 11°·4 C.
7 40 A.M.	0·11	10	Clouds.
8 30	0·13	10	„
9 40	0·042	10	„
10 20	0·044	10	„
11 20	0·047	......	„
11 35	0·026	......	„
12 0	0·022	......	„
12 30 P.M.	0·040	......	„
1 15	0·018	......	„
2 20	0·013	......	„
3 0	......	......	Rain.
4 0	0·028	......	Clouds.
5 0	0·014	......	„

Daily Chemical Intensity, Manchester, 1864 (continued).

June 30th, 1864. Mean Temp. Dry bulb 12°·6.
Barom.=758 millims. „ Wet bulb 12°·1.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
7 15 A.M.	0·021	10	Clouded over.
8 15	0·10	10	”
9 10	0·21	8	Sunshine cloud.
10 0	0·060	9	Clouds.
11 0	0·37	5	Sunshine cloud.
11 30	0·12	6	Clouds.
12 0	0·46	......	Unclouded.
12 30 P.M.	0·077	......	Clouded over.
1 45	0·090	......	”
3 0	0·061	6	”
4 0	0·075	......	”
4 30	......	......	Rain.
5 20	0·054	6	Light clouds.
6 10	0·010	6	Sun shining.

July 1st, 1864. Mean Temp. Dry bulb 14°·6.
Barom.=758·2 millims. „ Wet bulb 11°·1.

8 15 A.M.	0·067	9	Clouded over.
9 5	0·11	4	Light clouds.
9 40	0·12	9	”
10 0	......	8	Rain.
10 30	0·17	......	Light clouds.
11 0	0·19	7	Clouds.
11 45	0·086	......	Clouded over.
12 30 P.M.	0·040	......	”
1 0	0·20	......	Sunshine.
2 15	0·25	5	Unclouded.
3 45	0·085	......	Clouded.
4 30	0·063	......	”
5 30	0·050	......	”

July 2nd, 1864.
Barom.=752 millims.

8 10 A.M.	0·042	10	Rain.
10 0	......	10	Rain.
12 0	0·028	......	”
3 45 P.M.	0·071	......	Fair, clouded.
4 20	0·046	......	”
4 50	0·043	......	Rain.

July 4th, 1864. Mean Temp. Dry bulb 20°·3.
Barom.=759·5 millims. „ Wet bulb 11°·8.

7 30 A.M.	0·076	8	Clouded.
8 0	0·11	6	”
8 30	0·077	9	”
9 0	0·041	10	Rain.
9 30	0·023	10	Clouded over.
10 10	0·055	9	”
10 30	0·056	9	”
11 0	0·038	9	Rain.
11 30	0·034	10	”

July 4th, 1864 (continued). Mean Temp. Dry bulb 20°·3.
Barom.=759·5 millims. „ Wet bulb 11°·8.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
12 0	0·065	9	Rain.
12 30 P.M.	0·070	9	”
1 0	0·097	8	”
1 30	0·090	8	”
2 0	0·14	8	”
2 30	0·14	......	Clouds.
3 0	0·34	......	Unclouded.
3 30	0·25	5	”
4 0	0·11	7	Clouded.
4 30	0·095	7	”
5 0	0·074	6	”
5 30	0·072	6	”
6 0	0·056	6	”
6 30	0·067	2	Sunshine.
7 0	0·043	0	Unclouded.
7 30	0·023	0	”

July 5th, 1864. Mean Temp. Dry bulb 14°·0.
Barom.=761·6 millims. „ Wet bulb 10°·7.

8 10 A.M.	0·12	10	Clouds.
8 30	0·10	10	”
9 0	0·033	10	”
9 30	0·14	10	”
10 0	0·11	10	”
10 30	0·077	10	”
11 0	0·14	10	”
11 30	0·15	10	”
12 0	0·18	10	”
12 30 P.M.	0·12	10	”
1 0	0·10	10	”
1 45	0·32	7	Light clouds.
2 15	0·13	10	Clouded over.
2 45	0·28	6	Unclouded.
3 30	0·25	6	Clouds.
4 0	0·18	6	Light cloud
4 30	0·26	6	”
5 0	0·072	7	”
5 30	0·093	6	”
6 0	0·067	4	Clouds.
7 30	0·035	4	Unclouded.

July 6th, 1864. Mean Temp. Dry bulb 17°·6.
Barom.=765·3 millims. „ Wet bulb 13°·4.

7 30 A.M.	0·058	1	Hazy.
8 0	0·083	1	”
8 30	0·10	3	”
9 0	0·077	7	Clouds.
9 30	0·20	7	Hazy.
10 15	0·13	4	”
10 45	0·078	10	Clouded over.
11 20	0·071	6	Light clouds.
11 50	0·10	7	”

Daily Chemical Intensity, Manchester, 1864 (continued).

July 6th, 1864 (continued). Mean Temp. Dry bulb 17°·6.
Barom.=765·3 millims. „ Wet bulb 13°·4.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
12 30 P.M.	0·22	3	Light clouds.
1 0	0·21	6	„
1 30	0·17	9	„
2 0	0·28	7	„
2 30	0·36	7	„
3 0	0·15	……	„
3 30	0·17	4	„
4 0	0·21	……	Unclouded.
4 30	0·24	4	Light clouds.
5 15	0·092	……	„
6 30	0·063	4	„

July 7th, 1864. Mean Temp. Dry bulb 16°·4.
Barom.=764·7 millims. „ Wet bulb 13°·2.

7 30 A.M.	0·040	10	Clouds above.
8 0	0·058	10	„
8 30	0·10	10	„
9 15	0·079	10	„
9 45	0·073	10	„
10 10	0·069	10	„
10 45	0·056	7	„
11 30	0·020	7	„
12 0	0·055	9	„
12 30 P.M.	0·021	10	„
1 0	0·12	9	„
1 45	0·064	……	„
2 25	0·022	10	„
3 0	0·15	7	Light clouds.
3 30	0·092	……	Clouded over.
4 0	0·070	……	„
4 30	0·11	……	„
5 0	0·10	……	Clouds.
7 20	0·025	……	

July 8th, 1864. Mean Temp. Dry bulb 19°·6.
Barom.=765·1 millims. „ Wet bulb 13°·8.

7 10 A.M.	0·055	8	Clouded over.
7 50	0·068	7	Clouds.
8 25	0·089	9	„
9 0	0·12	……	„
9 30	0·12	……	„
10 30	0·13	……	„
11 0	0·12	10	Clouded over.
11 30	0·13	……	„

July 8th, 1864 (continued). Mean Temp. Dry bulb 19°·6.
Barom.=765·1 millims. „ Wet bulb 13°·8.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
12 0	0·11	…..	Clouded over.
12 30 P.M.	0·13	9	Light clouds.
1 10	0·15	7	„
1 40	0·16	……	„
2 15	0·26	4	Unclouded.
3 0	0·29	3	„
3 30	0·26	……	„
4 0	0·22	……	„
4 30	0·15	1	„
5 0	0·12	1	„
6 10	0·011	……	„

July 9th, 1864. Mean Temp. Dry bulb 15°·5.
Barom.=764·1 millims. „ Wet bulb 11°·7.

8 0 A.M.	0·060	3	Hazy.
9 0	0·15	……	„
10 0	0·14	……	„
11 0	0·18	……	Unclouded.
12 20 P.M.	0·15	……	„
1 30	0·23	……	„
2 30	0·22	……	„
3 30	0·22	……	„
4 30	0·14	……	„
5 30	0·10	……	„

September 26th, 1864.

8 50 A.M.	0·11	……	Cloudless sky.
9 25	0·13	……	„
10 0	0·070	……	„
10 30	0·071	……	„
11 0	0·11	……	„
11 30	0·12	……	„
12 10	0·10	……	„
12 40 P.M.	0·11	……	„
1 5	0·15	……	„
1 55	0·17	……	„
2 30	0·12	……	„
3 0	0·096	……	„
3 40	0·078	……	„
4 10	0·056	……	„
4 45	0·038	……	„
5 15	0·018	……	„

Daily Chemical Intensity, Heidelberg, Dingwall, and Manchester, 1864.

July 4, 1864.—Heidelberg.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
6 56 A.M.	0·072	......	Clouded.
7 1	0·170	......	Unclouded.
8 6	0·208	......	Clouds.
8 21	0·206	......	Unclouded.
8 50	0·244	......	„
9 21	0·290	.. ...	„
9 40	0·394	2	„
9 42	0·470	2	„
10 23	0·475	2	„
10 35	0·590	2	„
11 30	0·620	......	„
11 49	0·60	......	„
12 18 P.M.	0·52	......	„
1 5	0·516	......	„
2 21	0·248	......	Clouded.
3 5	0·300	......	Unclouded.
3 50	0·270	......	„
4 30	0·126	......	Overclouded.
4 50	0·163	.....	Unclouded.
5 25	0·124	0	„

September 27, 1864.—Dingwall, N.B.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
9 16 A.M.	0·18	......	Unclouded.
9 26	0·17	......	„
9 36	0·16	......	„
10 0	0·17	......	„
10 5	0·19	......	„
10 10	0·19	......	„

September 27, 1864.—Dingwall, N.B. (continued).

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
h m			
10 23 A.M.	0·22	......	Unclouded.
10 30	0·18	......	Haze.
10 35	0·16	......	„
10 50	0·13	......	Cloudy.
11 25	0·16	......	Clouds.
11 26	0·15	......	„
12 45 P.M.	0·24	......	Unclouded.
2 37	0·19	......	„
2 45	0·13	......	Clouds.
2 58	0·18	......	Unclouded.
3 57	0·066	......	Clouded.

September 27, 1864.—Manchester.

Solar time.	Chemical intensity of light.	Amount of cloud.	Sun's disk.
8 50 A.M.	0·13	......	Unclouded.
9 30	0·16	......	„
10 0	0·13	......	„
10 40	0·18	......	„
10 50	0·18	......	„
11 30	0·13	......	„
12 0	0·098	......	Cloud.
12 40 P.M.	0·16	......	„
1 10	0·13	......	„
1 40	0·17	......	„
2 10	0·14	......	„
2 55	0·12	......	„
3 40	0·081	......	„
4 20	0·052	......	„

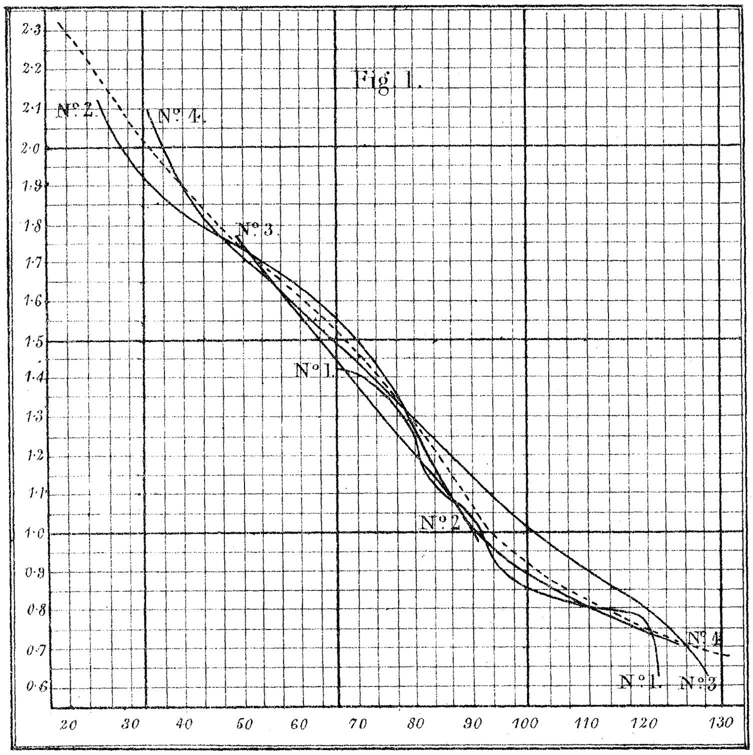
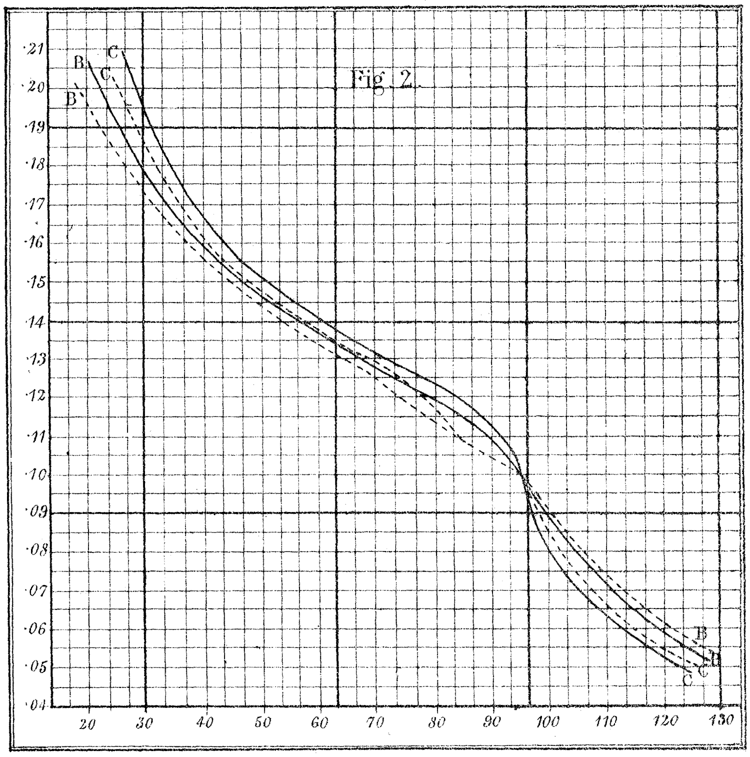


Fig. 1.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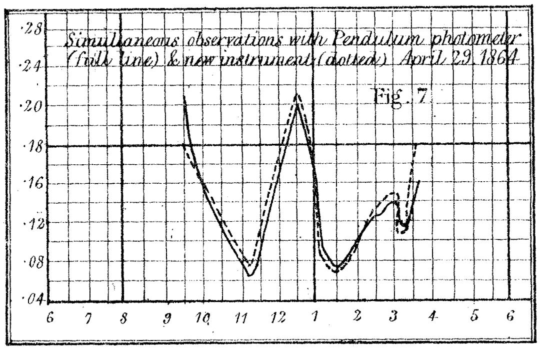

Simultaneous observations with Pendulum photometer (full line) & new instrument (dotted) April 29. 1864

Fig. 7.

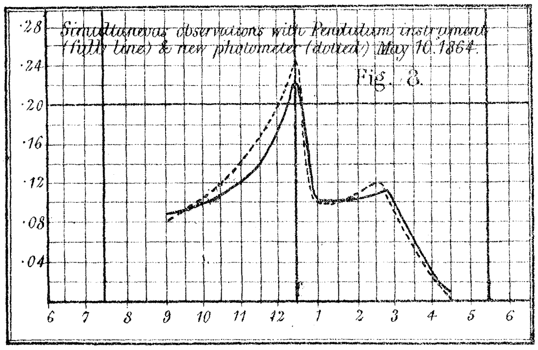
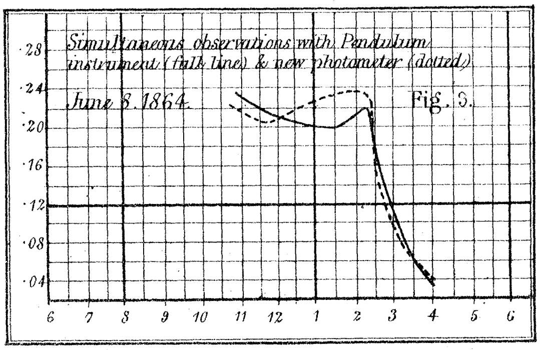
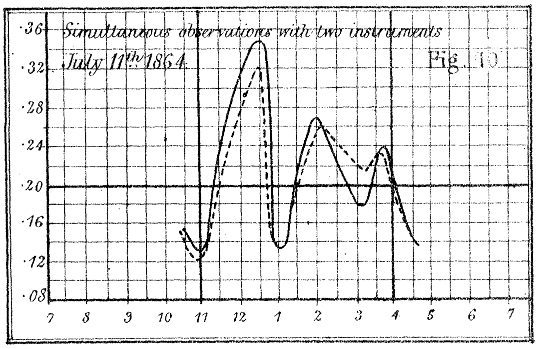

Simultaneous observations with Pendulum instrument (full line) & new photometer (dotted) May 10. 1864.

Fig. 8.


Simultaneous observations with Pendulum instrument (full line) & new photometer (dotted)

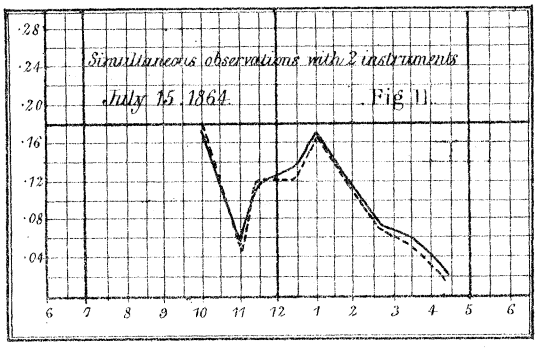
June 8. 1864.

Fig. 9.


Simultaneous observations with two instruments

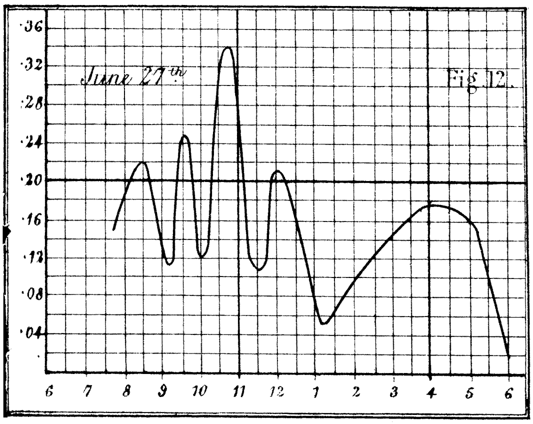
July 11th 1864

Fig. 10


Simultaneous observations with 2 instruments

July 15. 1864.

Fig. 11.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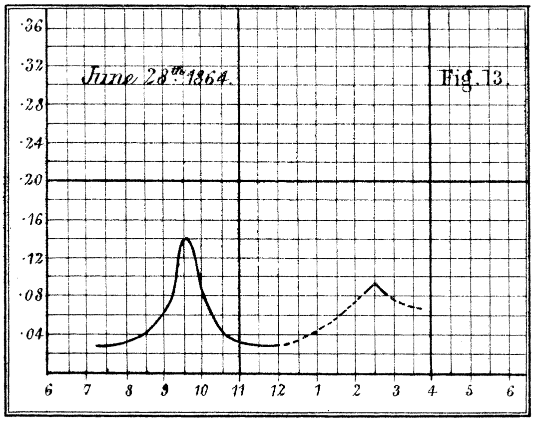
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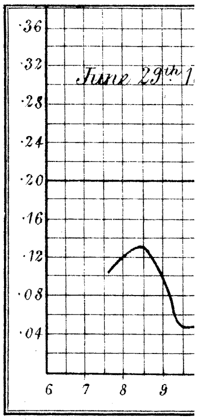

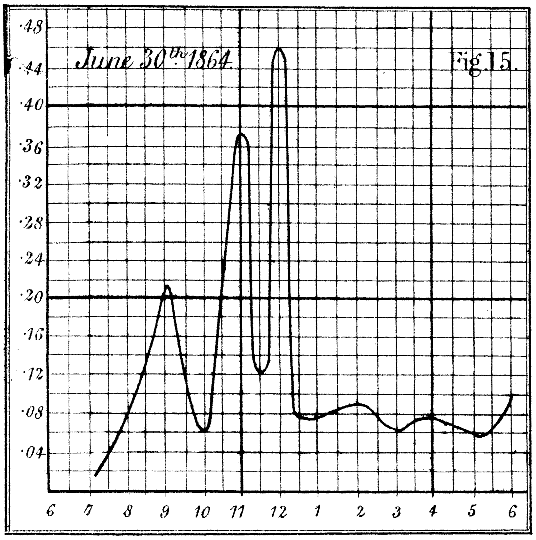
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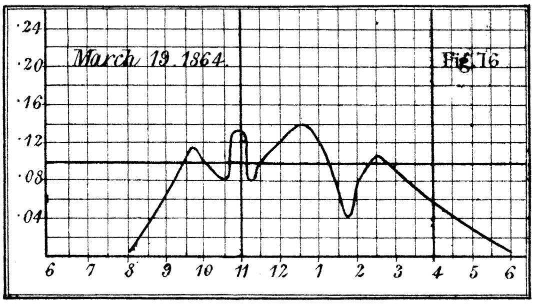
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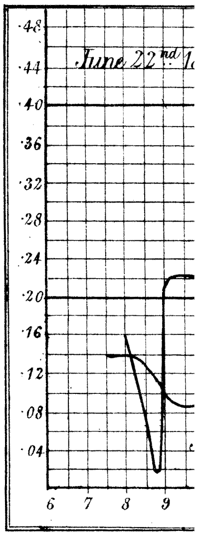

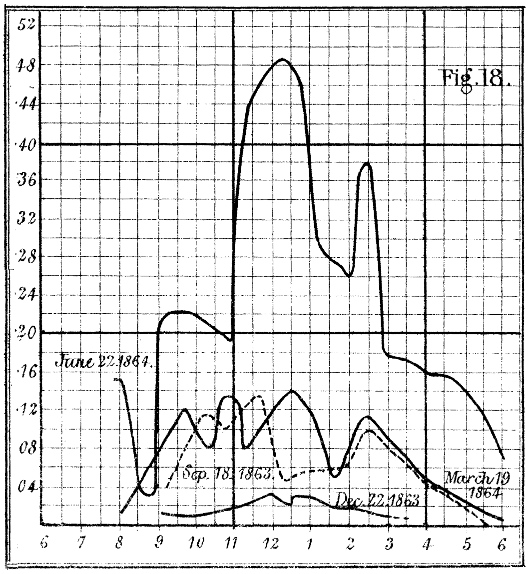
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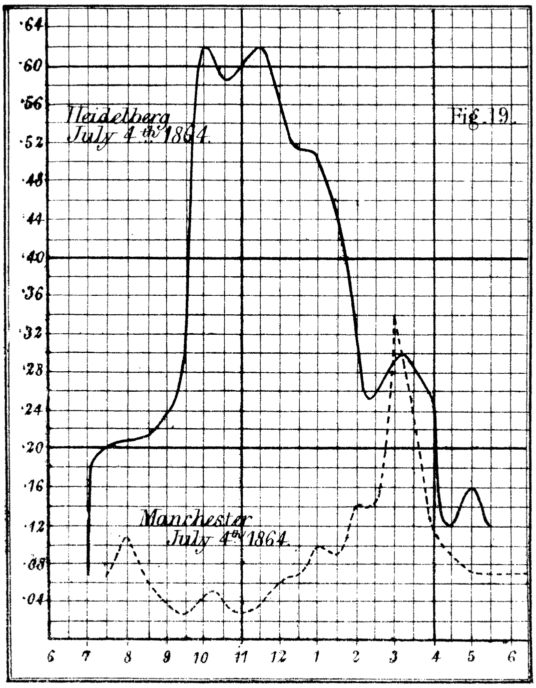
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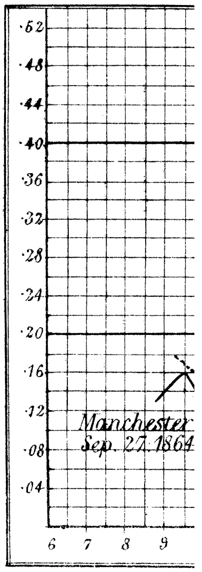

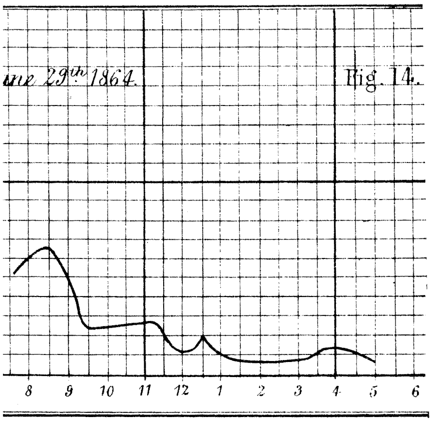
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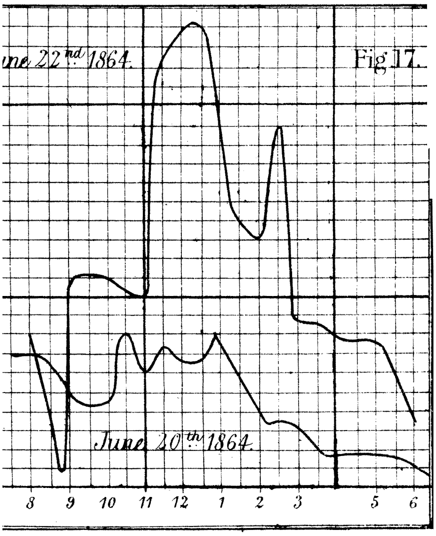
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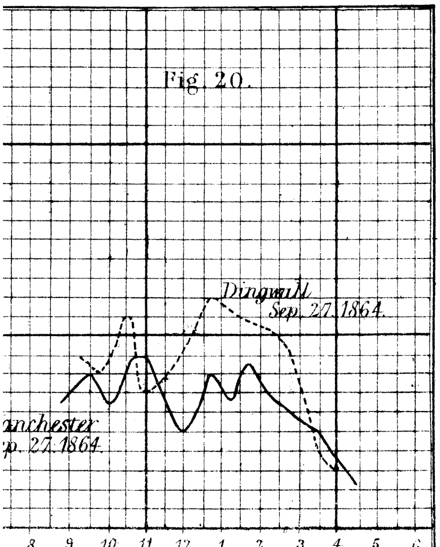
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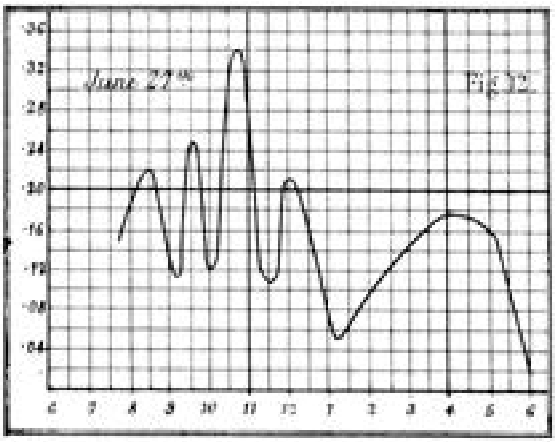
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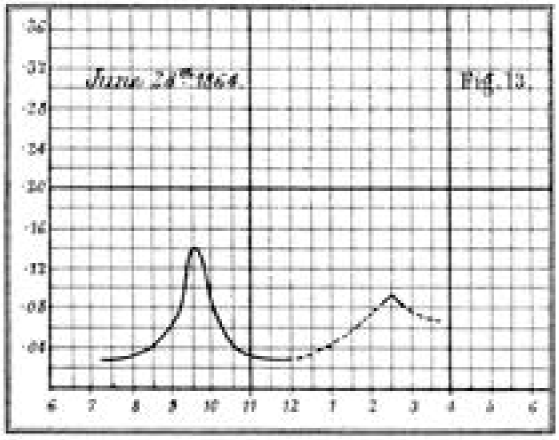
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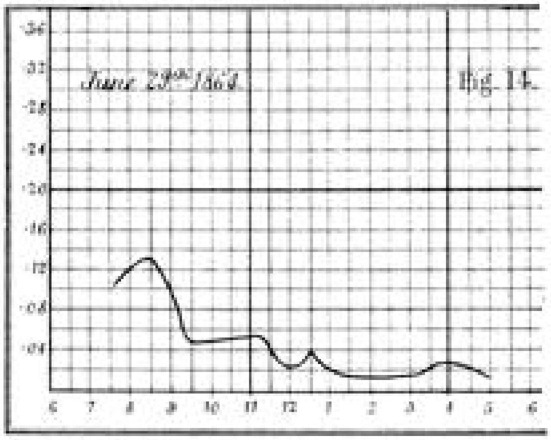
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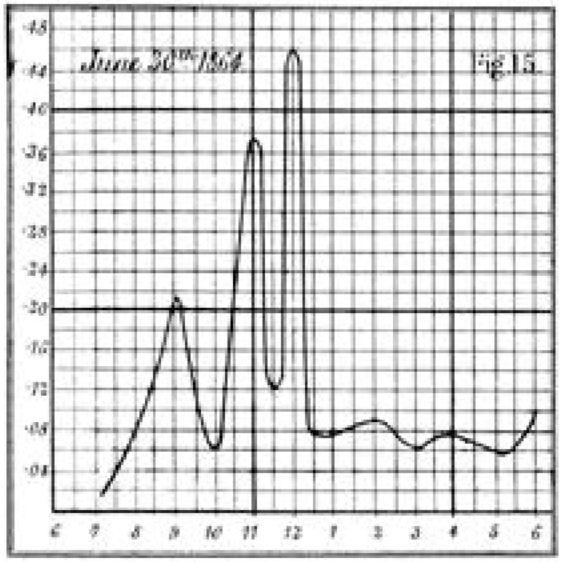
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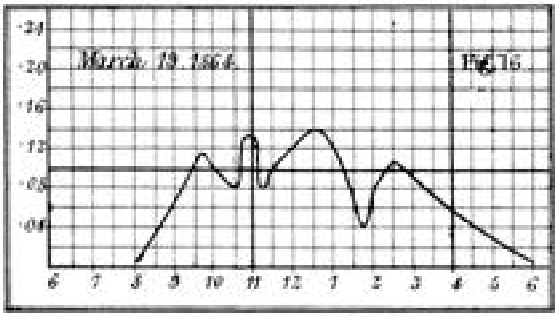
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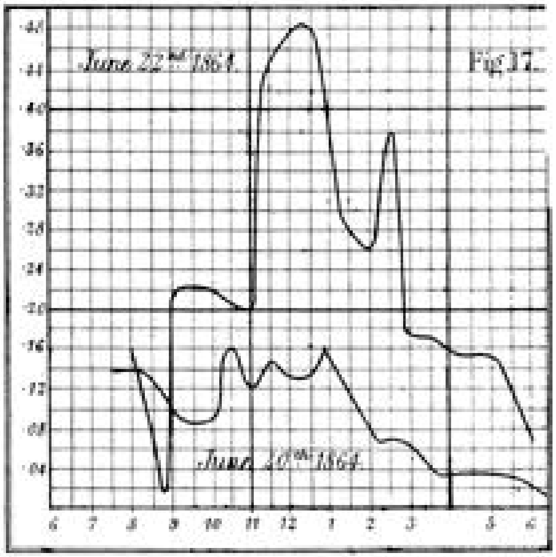
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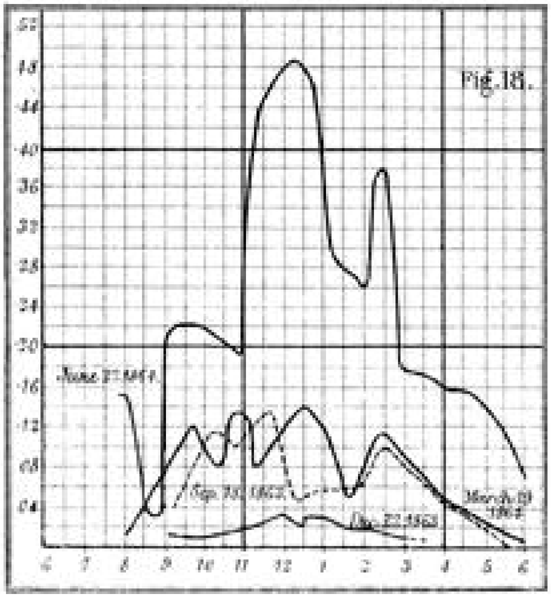
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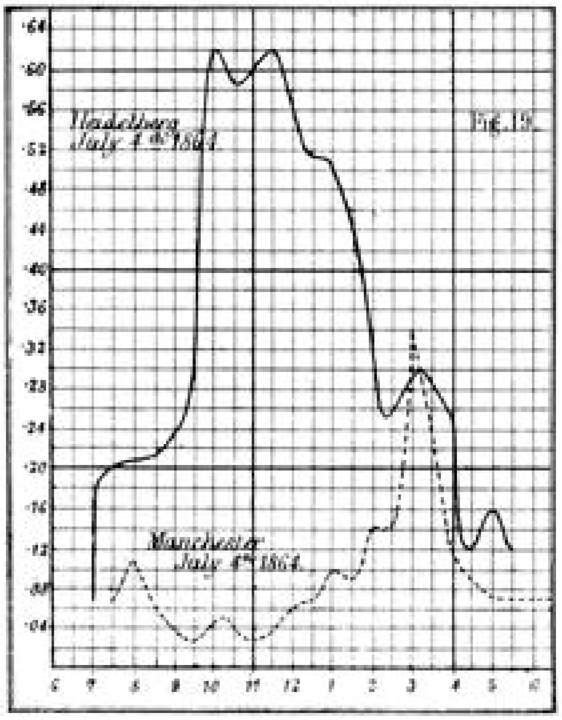
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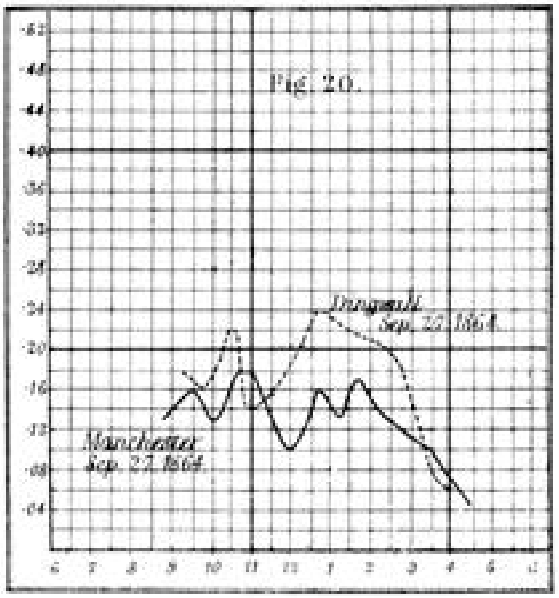
Fig. 20.