Survey of India.

PROFESSIONAL PAPERS.

1905.

SERIAL NO. 8.

EXPERIMENTS MADE TO DETERMINE THE TEMPERATURE CO-EFFICIENTS OF WATSON'S MAGNETOGRAPHS,

BY

CAPTAIN H. A. DENHOLM FRASER, R.E.,

DEPUTY SUPERINTENDENT SURVEY OF INDIA.

PREPARED UNDER THE DIRECTION OF

COLONEL J. R. HOBDAY, I.A.,

OFFG. SURVEYOR GENERAL OF INDIA.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1905.

Price One Rupee or One Shilling Six Pence.

PROFESSIONAL PAPERS.

1905.

SERIAL No. 8.

Agents for the sale of Books published by the Superintendent of Government Printing, India, Calcutta.

IN ENGLAND.

E. A. ARNOLD, 41 & 43, Madox Street, Bond Street, London, W.

CONSTABLE & Co., 16, James Street, Haymarket, London, W.

P. S. KING & SON, 2 & 4, Great Smith Street, Westminster, London.

KEGAN PAUL, TRENCH TRÜBNER & Co., Charing Cross Road, London.

BERNARD QUARITCH, 15, Piccadilly, London.

B. H. BLACKWELL, 50 & 51, Broad Street, Oxford.

DEIGHTON BELL & Co., Cambridge.

H. S. KING & Co., 65, Cornhill, and 9, Pall Mall, London.

ON THE CONTINENT.

R. FRIEDLÄNDER & SOHN, 11, Carlstrasse, Berlin, N.W.

OTTO HARRASSOWITZ, Leipzig.

KARL HIERSEMANN, Leipzig.

ERNEST LEROUX, 28, Rue Bonaparte, Paris.

MARTINUS NIJHOFF, The Hague, Holland.

IN INDIA.

THACKER, SPINK & Co., Calcutta and Simla.

NEWMAN & Co., Calcutta.

S. K. LAHIRI & Co., Calcutta.

R. CAMBRAY & Co., Calcutta.

HIGGINBOTHAM & Co., Madras.

V. KALYANARAMA, AIYER & Co., Madras.

G. A. NATESAN & Co., Madras.

THACKER & Co., LD., Bombay.

A. J. COMBRIDGE & Co., Bombay.

D. B. TARAPOREVALA, SONS & Co., Bombay.

RADHABAI ATMARAM SAGOON, Bombay.

N. B. MATHUR, Superintendent, Nazair Kanun Hind Press, Allahabad.

Rai Sahib M. GULAB SINGH & SONS, Mufid-I-Am Press, Lahore.

SUPERINTENDENT, AMERICAN BAPTIST MISSION PRESS, Rangoon.

Survey of India.

PROFESSIONAL PAPERS.

1905.

SERIAL NO. 8.

PREPARED UNDER THE DIRECTION OF

COLONEL J. R. HOBDAY, I.A.,
OFFG. SURVEYOR-GENERAL OF INDIA.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1905.

CALCUTTA:
GOVERNMENT OF INDIA CENTRAL PRINTING OFFICE,
8, HASTINGS STREET.

THE TEMPERATURE EXPERIMENTS.

By Captain H. A. Denholm Fraser, R.E.,
DEPUTY SUPERINTENDENT, SURVEY OF INDIA.

1. As soon as the first set of Watson's Magnetographs was erected in the underground room at Dehra Dun, arrangements were made to find out the temperature co-efficient for the horizontal force instrument. At this time the two remaining sets of Watson's Magnetographs had been received, and as the magnets and quartz fibres were interchangeable in all three sets, an excellent opportunity was at hand for finding the correction constant for each instrument.

Preliminary arrangements.

In order to correct for changes in the horizontal component during the period occupied by each experiment, magnetograph No. 2 was temporarily erected on wooden trestles in a room in the 12-inch photo-heliograph observatory. This room was moderately well protected from changes of temperature, but being very close to the massive iron dome of the observatory, could only be used for magnetic work on the condition that the dome remained unshifted, and this condition was maintained throughout.

Two small brass stoves for burning charcoal and the necessary connecting pipes having been prepared, the first experiment was commenced on 3rd January 1902. Previously to this date, and at frequent intervals during the whole series of experiments, absolute observations were taken with No. 1 Magnetograph by Cooke for finding and checking the base line values of both magnetographs, and for the determination of the value of the moment of the magnet used in the deflection experiments for finding the scale values of the horizontal force magnetographs.

2. Work commenced as early as possible in the day, by the observer noting the temperature of the H. F. thermometer in No. 2 Magnetograph together with the time. He then did the same in the underground room (No. 1 Magnetograph) and lit the fires. Thereafter temperature readings were taken every 15 minutes in the underground room and every half hour for No. 2 instrument, and the fires were replenished with fuel as often as necessary. After a high temperature had been maintained for some hours, the doors were opened, the fires removed, and the room was allowed to cool down. Usually no readings were taken after 4 P.M.

The routine briefly described.

3. No. 2 set was started on 18th December and records were taken daily till the 3rd January, the date of the first experiment, to make sure that the instruments were in a stable condition.

Diary of the experiments made.

In the first experiment magnet No. 1 with fibre 2 was mounted in No. 1 instrument, and magnet 2 with fibre 12 in No. 2 instrument.

The first experiment failed after a few hours' work owing to No. 2 instrument (which was mounted on trestles), receiving a jar whilst a temperature was being read, which threw it out of adjustment. During this experiment the glass covers had been kept in place over No. 1 instrument in the underground room, but it was found that the lag of temperature under the cover was so great, that it would be necessary to remove them in order to complete an experiment within the limits of a working day. Accordingly the cover of the H. F. instrument was removed, No. 2 instrument was re-adjusted, and after working satisfactorily for two days, the second experiment was started on the 6th January, a little after 7 o'clock in the morning, the doors of the underground room having been left open all the previous night in order to start with as low a temperature as possible.

The next few days were occupied in the temporary reduction of the observations to see whether any change of procedure should be adopted in future experiments, and as the results seemed satisfactory, the following changes were made on the 13th January: Magnet No. 1 and fibre 2 were transferred to No. 2 instrument, and magnet No. 2 with fibre 12 was adjusted in their place in No. 1 instrument. After allowing a short time for settlement, the 2nd experiment was carried through successfully on 15th January. This experiment was repeated on the 20th January, and on the 22nd magnet 2 and fibre 12 were removed and magnet 3 with fibre 6 was mounted in their place in No. 1 instrument. No. 2 instrument was not altered.

The next day another temperature experiment was made with this new arrangement and was repeated on the 28th. During the experiments made previously to the 23rd January, temperatures were read on a Fahrt. thermometer a few feet away from the Cent. thermometer in the horizontal force instrument, but as the temperature changes in the room were often very rapid indeed, it was afterwards thought advisable to read a third (Centigrade) thermometer suspended vertically almost in contact with the torsion tube of the horizontal force instrument. This enabled a record of the differences of the temperatures of the magnet itself and the air immediately surrounding the instrument to be maintained.

On the 29th January, magnet 3 and fibre 6 were removed from No. 1 instrument and magnet 2 and fibre 12 remounted. In removing this magnet on the 22nd, one of the 5 delicate glass hard magnets was accidentally broken. A spare magnet was mounted in its place, but this made it advisable to determine the temperature co-efficient afresh and find out whether the repair had caused any change. After completing satisfactorily this 3rd experiment with No. 2 magnet, the original intention was to close the cycle by repeating the first experiment, thus giving two independent determinations for each magnet and fibre.

However, an examination of the records obtained during the experiments with No. 3 magnet, revealed the fact that it had behaved abnormally. Either owing to a shift of the torsion tube as a whole or to the slipping of the quartz fibre at its points of attachment to the metal clips, certain sudden jumps were observable in the photographic records, which led to a further investigation pointing to the fact that a considerable slow shift in the base line value had been taking place. As it was thought that the peculiarity must be due to slip, the ends of the quartz fibre were resoldered, but on remounting magnet 3 and fibre 6, and observing their behaviour by eye, it became evident that the slip was worse than before, so that No. 5 fibre was then tried in its place.

A series of deflections taken with this fibre in use showed that the magnet was steadily shifting into a position of less strain, the effect being apparently due to the inability of the solder to hold the ends of the quartz fibre rigidly.

This fibre was tried only for a short time, and was then removed and replaced by fibre No. 3. The first set of deflections taken showed evidence of a similar but smaller slip, so the system was left in position for 1½ hours and again tested by deflections which this time gave no evidence of any tendency to drift. On the 5th February a trace was taken and the next day the temperature experiment was proceeded with.

The trace taken on the 5th when developed showed unmistakable evidence of the instability of the system, so no further trial was made with this fibre. On the afternoon of the 7th February, fibre No. 4 was substituted for No. 3 and traces taken on the 8th and 9th. Though considerable drift had occurred at first, the system seemed to have settled down on the 9th and a temperature experiment was therefore made on the 10th February. On the 11th the fibre appeared to be still giving results free from drift, so the 2nd experiment was made on the 12th. From that date till the 20th records were continuously taken with magnet 3 and fibre 4, in order to test the behaviour of the system, and on the 21st, magnet 1 and fibre 2 were removed from No. 2 instrument (in which they had been giving records since the 13th January), and were suspended again in No. 1 instrument.

Fibre 4 and magnet 3 were then erected in No. 2 instrument and satisfactory records were taken on both till the 24th February on which date the second temperature experiment with magnet 1 and fibre 2 was carried out, thus closing the series.

From this date onwards No. 1 instrument has been used for the routine work of the observatory, but No. 2 instrument was dismantled after further records for about one month had been taken in order to test the behaviour of fibre No. 4.

The reduction of the results was postponed till some months later owing to urgent work at the time, and there was no further opportunity of repeating any of the experiments which proved doubtful.

The reduction of the results.

4. The first thing was to obtain an approximate value for the temperature co-efficient, in order to correct the records of No. 2 Magnetograph during the experiments made with No. 1, and to evaluate the base lines of both instruments.

As a first approximation it was assumed that the temperature co-efficient was the same for both instruments. Several experiments were then worked out on Form C, the figures in column 10 and 14 being omitted and those in column 4 corrected by subtracting from them the corresponding figures in column 9.

Column 15 was then column 7—column 13, and the approximate results in column 16 were obtained by dividing the figures in column 15 as thus altered by those in column 4 corrected as explained.

In this manner it was found that $+1^\circ$ Centigrade was approximately equivalent to $-12{\cdot}0\gamma$* of ordinate, and this value was used in both experiments made with magnet 1 and fibre 2, for reducing the values given by No. 2 Magnetograph (*vide* forms C 1 and C 10).

(When subsequently working out the first of these experiments it was found that the temperature co-efficient of magnet 1 and fibre 2 was very nearly $12{\cdot}7\gamma$ and as this system was suspended in No. 2 Magnetograph during the whole of the experiments with the other magnets, it was used throughout the reductions entered in forms C 2 to C 9 inclusive. In view of the small range of temperature of No. 2 instrument it is clear that the errors introduced in reductions C 1 and C 10 due to taking the temperature co-efficient as $12{\cdot}0$ instead of about $12{\cdot}5\gamma$ can only change the results very slightly and it has not been thought necessary to recompute these two experiments using the latter more correct value.)

The absolute observations were then reduced and a mean value obtained for m_0 (the moment of magnet 1A at zero Centigrade). This magnet was used throughout the experiments when taking deflections for finding the scale values of the different systems in the manner now to be explained.

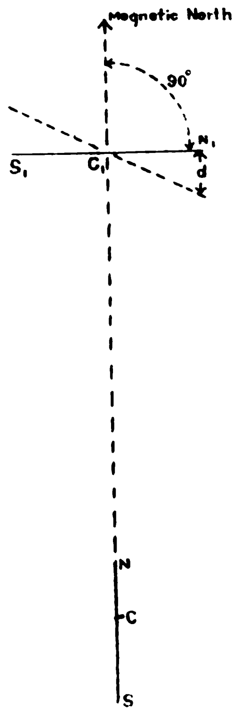
Method of finding the scale value of the H. F. Magnetograph.

5. In Watson's Magnetograph the scale value of the H. F. instrument is found by noting the deflections produced at a known distance by a magnet of known moment placed in the "end on" position due south of the suspended magnet.

---

* γ is the symbol generally used to denote $0{\cdot}00001$ C. G. S. units, where C. G. S. stand for centimetre, gramme, second respectively. In the English system the corresponding units are the foot, the grain, and the second.

$\gamma = 0{\cdot}000217$ English units approximately.



In the figure, $S_1 N_1$ is the H. F. magnet constrained into a position of 90° from the magnetic meridian by the torsion of the suspending quartz fibre. Calling T the torsion co-efficient of the fibre and A the total twist in degrees imparted to its upper end in order to carry the magnet from the magnetic meridian into the position shown, then the torsion couple is represented by T (A − 90°).

Then if m_1 be the moment of the suspended magnet and H the horizontal intensity, we have—

$$T(\mathrm{A}-90^\circ)=m_1 H \sin 90^\circ = m_1 H \ldots\ldots\ldots\ldots (1)$$

Suppose H to become $H-\Delta H$, the magnet will be deflected in the manner shown through a small angle α, and we get—

$$T\ \{\mathrm{A}-(90^\circ+\alpha)\} = m_1\ (H-\Delta H) \sin (90^\circ+\alpha)$$
$$= m_1\ (H-\Delta H) \cos.\ \alpha \ldots\ldots\ldots\ldots (2)$$

Now let us suppose that H does not change, but that the magnet is brought into the position of equilibrium represented in equation (2) by means of another magnet of known moment m placed as shown in the figure at a distance $r=CC_1$.

Then, provided α is small so that cos. α is sensibly equal to unity, the couple acting on the suspended magnet $=\frac{2\ m\ m_1}{r^3}\ (1+\frac{P}{r^2})$ where P is the distribution co-efficient of the magnets.

This couple has by supposition caused a deflection α so that—

$$T\alpha=\frac{2\ m\ m_1}{r^3}\ (1+\frac{P}{r^2}).$$

whence from equation (1)—

$$T\ \{\mathrm{A}-(90^\circ+\alpha)\} = m_1\ \mathrm{H} - \frac{2\ m\ m_1}{r^3}(1+\frac{P}{r^2}).$$

Substituting in equation (2) we have—

$$m_1\ H\ \ \frac{2mm_1}{r^3}\ (1+\frac{P}{r^2}) = m_1\ (H-\Delta H)\ \cos.\ \alpha$$

$$\text{or } \Delta H = H\ (1-\sec\alpha) + \sec\alpha \frac{2m}{r^3}\ (1+\frac{P}{r^2})$$

Putting sec $\alpha=1$, this reduces to

$$\Delta\ H=\frac{2m}{r^3}(1+\frac{P}{r^2})$$

In practice r is about 1 metre, so that $\frac{P}{r^2}$ is negligible and we obtain

$$\Delta H=\frac{2m}{r^3}$$

Then if x be the scale value in C. G. S. units corresponding to 1 *mm* of ordinate on the paper, and if n be the measure in millimetres of the deflection produced by the magnet whose moment is m, acting at the distance r from the suspended magnet, we have

$$xn = \Delta H = \frac{2m}{r^3} \text{ or } x = \frac{2m}{nr^3} \qquad \text{(3)}$$

In this expression m is the actual moment of the magnet as used for taking deflections and should be written m_t where t is the temperature of the magnet. Calling m_0 the moment of the magnet at zero Cent., we have

$$m_t = m_0 \{1 - qt - q_1 t^2\} \text{ or } m_0 \{1 - Qt\}$$

where Q is taken from the table of temperature corrections for the magnet.

Hence equation (3) should be written

$$x = \frac{2m_0 \{1 - Qt\}}{nr^3} \qquad \text{(4)}$$

But as the measuring scale used is divided into twenty-fifths of an inch, whereas x in formula (4) is in terms of 1 millimetre, the factor 1·016 must be inserted, and we get finally

$$x_1 = 1{\cdot}019 \times \frac{2m_0 \{1 - Qt\}}{nr^3},$$ where x_1 is the scale value corresponding to 1-25th inch.

The distance r was measured with beam compasses from the centre of the suspended magnet to the centre of the deflecting magnet and the accordance of independent measures taken by different observers was greater than might have been expected, the greatest difference being less than 1-50th inch. As a matter of fact r is not required with any very great accuracy, for in practice the average length of ordinate is about 60 *mm*, and it will suffice to measure this correctly within ·00001 C. G. S., *i.e.* 1γ. Taking $x = 5\gamma$ (its approximate actual value), we see that it will suffice to find x within $\frac{x}{5} \div 60 = \frac{1}{300}$ of its true value.

Then by giving approximate values as follows: $m = 920$ C. G. S., $r = 100$ cms., $x = 5\gamma$, and substituting in equation (3), we find $n = 36{\cdot}8$ *mm*. If we now change x into $x + \frac{x}{300}$ and using the value just found for n again solve equation (3), we obtain $r = 99{\cdot}89$ cms.

Thus it will suffice to measure r correctly to 0·1 cm., or say 1-25th inch, and the method actually adopted of measuring the distance by beam compasses is therefore quite good enough for practical purposes.

In Watson's Magnetographs there is a simple arrangement for taking visual deflection readings, and the time taken for recording a complete set of five readings, the magnet being reversed every time, is only about two minutes.

In No. 1 magnetograph two deflection distances were used at about 100 and 120 cms.; in No. 2 instrument the nearer distance only is available.

The following tables show the values of the scale co-efficients determined during the various experiments and used in the reduction of the results:—

Table A 1.

Abstract of scale values found for No. 2 H. F. Magnetograph during the temperature experiments.

Formula $x_1 = 1{\cdot}016\frac{2m_0(1-Qt)}{nr^3}$ where x_1 is the scale co-efficient for 1-25th inch.

The mean moment m_0 of the deflecting magnet 1A=1004·23 (Table B).

Period. From	Period. To	Suspended Magnet.	Quartz fibre.	Mean observed temperature=t.	Mean observed deflection =n.	Distance between magnets=r	Resulting scale co-efficient =x_1.	Remarks.
		No.	No.	Cent.	mm.	cms.	γ.	
1902.	1902.							
3rd January	12th January	2	12	14	35·74	100·209	5·64	
13th January	22nd January	1	2	15	54·26	100·361	3·70	The mean value 3·70 has been used throughout this period.
22nd January	3rd February	1	2	15	54·25	100·361	3·70	
4th February	20th February	1	2	16	54·08	100·361	3·71	
21st February	4th March .	3	4	19	44·26	100·361	4·53	

Table A 2.

Abstract of scale values found for No. 1 H. F. Magnetograph during the temperature experiments.

Formula $x_1 = 1{\cdot}016\frac{2mm_0(1-Qt)}{nr^3}$ where x_1 is the scale co-efficient for 1-25th inch.

The mean moment m_0 of the deflecting magnet 1A=1004·23 (Table B).

Period. From	Period. To	Suspended magnet.	Quartz fibre.	Mean observed temperature=t.	I. Mean observed deflection=n.	I. Distance between Magnets=r.	I. Resulting scale co-efficient=x_1.	II. Mean observed deflection=n.	II. Distance between Magnets=r.	II. Resulting scale co-efficient=x_1.	Mean scale co-efficient from I and II.	Remarks.
		No.	No.	cent.	mm.	cms.	γ.	mm.	cms.	γ.	γ.	
1902.	1902.											
3rd January	12th January	1	2	20	53·60	96·028	4·27	27·52	119·954	4·26	4·27	
13th January	22nd January	2	12	21	41·82	96·079	5·46	21·41	120·005	5·47	5·46	
22nd January	28th January	3	6	21	47·43	96·028	4·82	24·31	119·954	4·82	4·82	
29th Junuary	3rd February	2	12	21	35·18	96·079	6·49	17·98	120·005	6·51	6·50	
4th February	7th February	3	3	21	47·57	96·053	4·80	24·24	119·980	4·83	4·81	
8th February	20th February	3	4	22	45·74	95·901	5·01	23·40	119·827	5·03	5·02	
21st February	28th February	1	2	22	57·02	96·028	4·01	29·14	119·954	4·01	4·01	

The agreement between the two values of the scale co-efficient for No. 1 instrument as shown in this last table is satisfactory and justifies the omission from the formula of the term involving P.

It should be noted that the distance r was measured once only for each instrument and subsequently corrections were applied to this distance by noting the distance of the centre of the magnet under trial from the centre of the box in which it was suspended.

Reduction of results resumed.

6. Using the values found above, tables B 1 and B 2 were then completed, which give the base line values obtained by using an assumed temperature co-efficient of $12 \cdot 5\gamma$ per degree Cent. throughout. The greatest differences of temperature from the selected mean amounted in the case of No. 1 instrument to $+1^{\circ}\cdot 3$ and $-1^{\circ}\cdot 2$ on the 24th and 4th January, respectively, and in the case of No. 2 instrument to $+3^{\circ}\cdot 2$ and $+1^{\circ}\cdot 9$ on the 19th February and 30th January, respectively. Consequently the errors due to taking an assumed value for the temperature co-efficient in place of the actual values subsequently determined does not appreciably affect the results.

The reduction of the ten temperature experiments was then completed, the results of which are exhibited in tables C 1 to C 10.

The charts reproduced at the end of this paper were then plotted and tables D 1 to D 10 drawn up with a view to studying the behaviour of the instruments during each experiment. The conclusions arrived at are printed at the foot of each table and dealt with in the Appendix, and show that in most cases there is good reason to suppose that the magnet and fibre under experiment underwent changes during the course of experiment, and the only results that can be accepted with perfect confidence are those given by experiments Nos. 1 and 2 with magnet 1 and fibre 2.

General considerations.

7. The effect of a rise of temperature on a system consisting of a magnet suspended perpendicular to the meridian by a quartz fibre is (1) to increase the torsional resistance of the fibre,* and (2) to reduce the magnetic moment of the magnet, so that on both accounts the value of the horizontal force will appear to diminish. But if the temperatures of the fibre and magnet are not the same, the resulting value of the temperature co-efficient will necessarily be incorrect.

Thus, supposing the temperature of the magnet (and therefore its moment) to remain constant whilst the quartz fibre is heated, we should expect to find an apparent decrease of H. F., and *vice versâ* if the fibre were cooled. Consequently, if during any period of the temperature experiment the fibre is $\frac{\text{hotter}}{\text{cooler}}$ than the magnet, the resulting temperature co-efficient will be too $\frac{\text{large}}{\text{small}}$ by an amount probably bearing a certain ratio to the difference of temperature between the magnet and its fibre.

On the other hand, for a $\frac{\text{rising}}{\text{falling}}$ temperature, the effect of any lag of temperature of the magnet behind that of the attached thermometer would make the temperature co-efficient too $\frac{\text{small}}{\text{large}}$, because the apparent change of force as measured from the curve would be divided by too $\frac{\text{large}}{\text{small}}$ a quantity.

Disturbances produced by air currents would not be expected in an instrument of this class because (1) the volume of air immediately surrounding the magnet is very small, and (2) the period of the magnet is very short and the copper damper acts rapidly.

---

* Threlfall (Phil. Mag., July 1890).

As a matter of fact there is no sign of fuzziness about any of the traces during the temperature experiments, and it is clear that this source of error did not exist.

A study of the diagrams shows that in every case the temperature co-efficient commences almost at once with an abnormally high value, which falls very rapidly whilst the temperature of the room is still rising considerably. This, as above shown, is conclusive evidence that there was no appreciable lag of temperature of the magnet, so that the readings of the thermometer in the damping box of the instrument may be accepted as giving the true temperature of the magnet very closely.

The quartz fibre is carried in a small brass tube, whereas the magnet itself is surrounded closely by a considerable mass of copper, and as both were equally exposed to the air during the experiments one would expect the tube and its contents to pick up the changes of temperature more quickly than the magnet and its damping box. Consequently, though the temperatures recorded by the thermometer may, and probably do, give the temperatures of the magnet throughout the experiment without appreciable error, there is *primâ facie* reason to expect that the temperature of the quartz fibre must have been $\frac{\text{ahead of}}{\text{behind}}$ that of the magnet according as the temperature of the room was $\frac{\text{rising}}{\text{falling}}$.

Now an examination of the charts shows that in every case the air temperature considerably exceeded that of the magnet till the process of cooling off commenced by opening the doors of the room and removing the fires. Thereafter the temperature of the magnet read higher than that of the air, the difference between the two becoming less and less, but being generally quite appreciable at the close of the experiment.

From previous considerations one would therefore expect to find the values of the temperature co-efficient too great during the first or heating up stage, then dropping rather suddenly, though slightly, as soon as the doors were opened, and finally rising again to its real value as the difference between the temperature of the air and the magnet gradually disappeared.*

Tables C 1 to C 10 and the diagrams show that there has been a general tendency throughout the whole series of experiments for the value of the scale co-efficient to behave in this way, except that in the majority of cases the scale value has shown no tendency to increase again towards the close of the experiment.

If any displacement of the instrument as a whole occurred as a result of the rapid temperature changes, such shift would be shown by a displacement of the base line formed by the light reflected from the small mirror attached to the base of the instrument. A careful examination of the curves shows that the amount of shift from this cause was very gradual and small in amount, in fact too small to be taken into account as its maximum amount never exceeded 0·2 scale division, *i.e.*, ·008 of an inch.

Correction for slip of fibre.

8. As above noted, tables C 1 to C 10 show that there is a general tendency for the computed values of the temperature co-efficient to decrease somewhat largely towards the close of each experiment. During this period the system was cooling, so that, as explained in paragraph 7, an effect of this kind was to be expected. But the diagrams show that whereas the differences of the temperatures of the fibre and magnet were small, the drop in the temperature co-efficient was generally large and could hardly be fully accounted for in this manner.

* Throughout the reductions the temperature used in computing the temperature co-efficient was that recorded by the thermometer embedded in the damping box of the H. F. magnet.

As however the drop in the temperature co-efficient could be explained by supposing that the system under trial had given way or slipped under the strains induced by the rapid changes of temperature, it became necessary to investigate this point by comparing the records given by the two sets of magnetographs before and after each experiment.

Consequently Tables D 1 to D 10 were drawn up and they show conclusively that, except in some few cases, slip must have occurred.

The curves taken during the actual experiments when examined showed unmistakable evidence of slip only in two cases, *viz.*, on the 20th and on the 24th January. In the first case (Fig. 3 of Plate II) the experiment has been rejected but in the second case (Fig. 1 of Plate III) as the shift occurred only at the end of the experiment an attempt has been made to correct for it. In all other cases it has been assumed that where slip did occur, it occurred gradually and uniformly and might be allowed for by distributing the amount noted uniformly according to the elapsed interval.

It may be noted that the evidence at disposal shows that in these cases (1) a certain slip has actually occurred and (2) that this slip did not manifest itself by sudden breaks in the curve: there is no evidence that the slip occurred uniformly throughout the course of an experiment, but the assumption that this was the case is not contrary to facts and seems the most reasonable one that can be made under the circumstances.

Tables C 4, 6, 8, 9, were then corrected on this assumption and the new curves so obtained plotted alongside of the old ones.

9. The next point for consideration is what portions of the experiments are to be selected as the most trustworthy for the purposes of finding the true mean values of the temperature correction?

As regards the reading of the thermometers, small errors in reading are of consequence only in the case of the Cent. thermometers embedded in the damping boxes of the two instruments, and as the changes of temperature of these thermometers were always negligible in the space of the few seconds occupied in taking the reading, the liability to errors in the recorded temperatures may be considered equal at all stages of the experiment. Consequently the "Increment in temperature after start" as recorded in column 4 of form C 1 has a much greater probable percentage of error at the commencement and end of each experiment than during the intermediate period.

Errors in scaling off ordinates from the curve are greatest where the inclination of the curve to the base line is greatest, and consequently the first few measures are in each case more doubtful than the rest and the percentage of error in the figures in column 6 of form C 1 obviously decreases in proportion to the increase in the figures.

On both accounts it is plain that, apart from differences of temperature between the magnet and quartz fibre which were always greatest during the first part of each experiment, this and the last portion of each experiment have much less weight than that part in which the figures in columns 4 and 6 of form C are greatest, and the curves showing the values of the derived temperature co-efficient may therefore be expected to show marked irregularities at the beginning and end of each experiment.

What is desirable is to have a long period of uniformly high temperature during which the recorded temperatures of the thermometers within and without the H. F. instrument are in very close agreement.

In practice such conditions could not be attained, for the constant stoking of the stoves necessary to maintain a high temperature produced considerable fluctuations in the recorded temperatures and until the fires were allowed to die down the temperature of the air was always in advance of that of the magnet.

Moreover, the copper damping box in which the magnet and its thermometer are contained is close to the base of the instrument, which is rigidly attached to the supporting pillar by means of three stout brass footscrews leaded into recesses cut in the stone cap of the pillar. Consequently a considerable amount of heat must have been continuously conducted away and lost in the pillar which would be slow to attain the temperature of the air.

In all the curves there is a well defined critical point at which the temperature of the air coincides with that of the magnet, and it is in the neighbourhood of this point that all the desirable conditions are most nearly fulfilled.

This point is indicated in the curves by a continuous ordinate, which gives the time of its occurrence on the time scale.

That value of the temperature co-efficient found from the observations taken nearest to this critical point seems therefore the best individual value of the series, but in order to get rid of the errors to which any single observation is liable, it has been considered advisable to derive the temperature co-efficient in each case from a series of 9 values situated symmetrically about this point. In the first four of these values the air temperature was above that of the magnet and in the last four these conditions were reversed, so that the errors arising from this cause should to a large extent cancel out in the mean.

10. Working in this way certain mean values have been obtained in each case which are grouped together in the following table for convenience of reference :—

1902. Date.	No. of Fibre.	No. of Magnet.	Mean values of temperature co-efficient.	Final value of temperature co-efficient.	Remarks.
6th January . . .	2	1	12·60	} 12·6	
24th February . .	„	„	12·67		
15th January . . .	12	2	11·90	...	
20th January . . .	„	„	11·69	...	
31st January . . .	„	„	12·60	12·6	After repairing magnet, corrected for slip (10 γ).
23rd January . . .	6	3	12·07	...	Corrected for slip (15 γ).
28th January . . .	„	„	12·17	...	
6th February . .	3	„	12·90	...	
10th February . .	4	3	12·49	} 12·5	„ „ (19 γ).
12th February . .	„	„	12·49		„ „ (11 γ).

There is very little doubt that the results for magnet 1 and fibre 2 may be confidently accepted. These are now in use in No. 1 Magnetograph at the Dehra Dun Observatory, where the results of the temperature readings during the first complete year of work show that the annual range in the underground room is not likely to exceed 6° or 6°·5 Cent.* Thus the largest multiplier that will be used in this case may be taken as 3·3, and as one cannot hope to read the curves with greater accuracy than 1 γ, the error permissible in finding the temperature co-efficient is $\frac{1\gamma}{3\cdot 3} = 0\cdot 3\ \gamma$. The accordance of the two results makes it highly probable that in this case the temperature co-efficient has been found with all desirable accuracy.

Magnet 2 and fibre 12 have been in use in No. 2 Magnetograph since September 1902 at Kodaikanal. It seems clear that the temperature co-efficient of the magnet itself altered considerably after it was repaired in January, and it is unfortunate that only one determination of the temperature co-efficient of the system was made after that date. At Kodaikanal the annual range of temperature in the underground room is not yet known, but the data available indicate that it will be less than 2° Cent. If this is the case, the greatest multiplier will be 1 and the error permissible in the temperature co-efficient will be 1γ. So that although the single experiment made on the 31st January with the system as now in use at Kodaikanal is not perfectly satisfactory, it seems likely that it is sufficiently good for the very favourable temperature conditions appertaining to the observatory where it is being used.

With regard to the various experiments made with magnet 3 and fibres 3, 4 and 6, the agreement in the case of the two experiments with No. 6 fibre is good, and in the case of No. 4 fibre it is remarkable. But three out of four of these experiments have been corrected for slip and it is hardly possible therefore to trust them implicitly.

Moreover, it is disconcerting to find that the value of the temperature co-efficient *when using the same magnet* should vary from 12·1 to 12·9 when the quartz suspension is changed, for from the nature of a quartz fibre, one would expect different fibres to behave in a uniform manner under similar conditions of changing temperatures.

Whilst therefore it is likely that the results in each case with No. 3 magnet are near the truth, the mere agreement of the results derived from pairs of experiments is not sufficient to justify their acceptance as being exceedingly accurate.

An inspection of the base line values of No. 2 Magnetograph (Table B 2) from the 22nd to 25th February inclusive, shows that magnet 3, with fibre 4, behaved fairly well when transferred to No. 2 Magnetograph during the last experiment with magnet No. 1.

However, in order to see whether fibre No. 4 was really in a stable condition and fit for use at the Barrackpore Observatory, a further prolonged comparison was made throughout March. The result is exhibited in Table D 9 and is not entirely satisfactory, for although there is no evidence of a sudden slip having occurred and the discrepancies noted may very probably be largely due to the fact that No. 2 instrument was supported merely on trestles of wood, which proved by its behaviour to be only partially seasoned, still the fact remains that the results given by the two instruments were not in close accord throughout the period.

---

* Highest temperature = 28·44 on 20th September 1902.
Lowest " = 22·00 on 28th March 1903.

Change in scale value due to change in temperature.

11. In most of the experiments a deflection reading was taken to determine the scale value when the temperature of the room was approximately at its maximum. The resulting values are tabulated below :—

1		2	3	4	5	6	7	8	9	10	11	
PERIOD.		ORDINARY DEFLECTIONS.					SPECIAL DEFLECTIONS DURING TEMPERATURE EXPERIMENTS.					
		at 96 cms.		at 120 cms.								
1902 From	1902 To	Mean deflection.	No. of observations.	Mean deflection.	No. of observations.	Approximate temperature of room.	at 96 cms.	at 120 cms.	Temperature of Instrument.	Col. 2—Col. 7.	Col. 4—Col. 8.	
13th January	20th January	41·82	5	21·41	5	21°	42·30	21·65	31°·3	—0·48	—0·24	
...	...	...	...	...	...	...	42·15	...	31·8	—0·33	...	
22nd January	29th January	47·43	5	24·31	4	21°	47·94	24·54	33·3	—0·51	—0·23	
...	...	...	...	...	...	...	47·68	24·43	33·8	—0·25	—0·12	
29th January	1st February	35·18	3	17·98	3	21°	35·13	18·04	35·7	+0·05	—0·06	
4th February	7th February	47·57	4	24·24	3	21°	47·88	24·47	35·4	—0·31	—0·23	
7th February	18th February	45·74	8	23·40	8	22°	46·39	23·74	34·9	—0·65	—0·34	
...	...	...	...	...	...	...	46·27	23·74	36·6	—0·53	—0·34	
21st February	28th February	57·02	8	29·14	8	22°	57·53	29·46	29·9	—0·51	—0·32	
										—0·41	—0·24	Means.

The accordance of the signs in the last two columns renders it unlikely that the difference in the deflection values obtained during the experiments is the result of chance. Also it will be noted that the deflection at 120 cms. is approximately one-half of the deflection at 96 cms. and that the mean difference in the last column bears approximately the same proportion to that derived from the column before it.

Thus there are strong grounds for supposing that the deflections do actually increase with the temperature, that is to say, the scales value diminishes or the system becomes more sensitive.

Any rise in temperature ought (1) to increase the stiffness of the fibre, (2) to decrease the moment of the suspended magnet and (3) to decrease the moment of the deflecting magnet. On all three counts one would expect to find the deflection decrease slightly for a rise in temperature, and the fact that this is not the case indicates that some important factor has been left out of consideration.

The greatest difference in the deflections occurs during the first temperature experiment with magnet 3 and fibre 4 on the 10th February. The scale values from the special deflections taken at a temperature of 34°·9 Cent. are 4·92 and 4·93 from the near and far distances respectively as compared with 5·01 and 5·02 from the mean values under ordinary conditions, so that the change in the scale value amounts to $0{\cdot}1\gamma$. This is sufficiently large to slightly alter the results of the temperature experiment, as the range of ordinate amounts to almost 40 scale divisions and the resulting change in force would be therefore less by about 4γ than that derived from the scale value adopted.*

There are not sufficient data to justify any attempt at correcting the results for the change in the scale value, and the above figures are chiefly of interest as showing that there appears to have been some unknown factor at work tending to make the resulting values for the temperature co-efficient slightly higher than they should be.

Statement of results accepted.

12. The following results derived from thes experiments have been accepted :—

(*a*) The temperature co-efficient for the system, magnet	1	and fibre	2	$=12{\cdot}6\gamma$
(*b*) " " " "	2	"	12	$=12{\cdot}6\gamma$
(*c*) " " " "	3	"	4	$=12{\cdot}5\gamma$

The experiments would lead one to accept these values as approximately correct and good enough for the desired standard of accuracy in reading the H. F. curves, but it must be said that they differ very widely from the results anticipated.

In the Kew certificate accompanying No. 1 set of Watson's Magnetographs it is stated that the temperature co-efficient per degree Cent. was found to be approximately $5{\cdot}8\gamma$ (using magnet No. 1 and an unknown fibre), whilst Eschenhagen gives for his somewhat similar instrument an approximate value of 7γ per degree Cent.†

---

* Suppose the temperature of the room to be 30° and that of the deflecting magnet 20° (on the average) whilst a set of deflections was being taken.

Then putting $m = 1004{\cdot}23$ at 0° Cent.

We obtain from the temperature corrections for the magnet used

$$m = 996{\cdot}44 \text{ at } 20^\circ \text{ Cent.}$$
$$m = 992{\cdot}28 \text{ at } 30^\circ \text{ Cent.}$$

Hence, since the value of the scale co-efficient varies directly as *m*., the error introduced by assuming the temperature of the deflecting magnet to be the same as that of the room would in this case be roughly 0·4 per cent. only, whereas the average charge actually found exceeded one per cent.

When the deflections at high temperatures were taken, the deflecting magnet was warmed up for some time by exposing it to the sun before bringing it into the room and it is therefore most unlikely that its temperature even at the time of taking the first deflection, was ever as much as 10° from the truth.

Consequently the change in the scale values noted at high temperatures cannot be explained by assuming a large error in the temperature of the deflecting magnet.

† Dr. Chree, F.R.S., has offered the following explanation of the discrepancy here noted.

Let us call C_o the torsion couple at temperature 0° Cent. for unit angle of twist and suppose this to increase to C at some definite temperature *t*.

Treating for the time being the magnet's own moment as unaffected by temperature, call *A H* the couple exerted on it when perpendicular to the magnetic meridian at a place where *H* is the horizontal force.

Suppose θ_o the total twist of the fibre when the temperature is 0° Cent.

and θ " " " " is *t* "

Then $C_o\,\theta_o = C\,\theta = A\,H$ or $\theta - \theta_o = \dfrac{A\,H\,(C_o - C)}{CC_o}$

For a given value of *t*, $\dfrac{(A\,C_o - C)}{CC_o} = B$, a constant

and so $\theta - \theta_o = B\,H$

Thus the twisting accompanying a given change of temperature varies as the force at the place and since $\theta - \theta_o$ means a given change of ordinate, *the effect of a given change of temperature on the ordinate varies directly as* H.

At Dehra Dun, $H = 0{\cdot}335$ C. G. S. approximately, whilst, at Kew $H = 0{\cdot}185$ approximately, so that neglecting the temperature co efficient of the magnet, the temperature co-efficient of the system at Dehra Dun should be $\frac{335}{185} \times 5{\cdot}8 = 10{\cdot}5\gamma$.

If therefore the effect of temperature on the moment of the magnet is small, the results at Dehra are not incompatible with those obtained at Kew.

Facts inferred from the experiments.

13. The following conclusions based on these experiments are worthy of consideration :—

(1) It is the exception to find a quartz suspension as used in these instruments which does not exhibit signs of slip even after having been in use for a considerable number of days.

(2) The increase in sensitiveness of each system for a rise in temperature is contrary to anticipation and cannot at present be explained.

(3) The method of finding the scale values by deflections at a known distance with a magnet of known moment is quite satisfactory.

H. A. DENHOLM FRASER, CAPTAIN, R.E.

B 1.

Abstract of absolute observations for H. F. and computation of the value of the Base line of the H. F. Magnetograph No. 1 for the months of January and February 1902.

{ Selected mean temperature = 21°.0 cent.
{ Temperature co-efficient for 1° cent. = 12.5 γ throughout.

Magnet No. 1A. Magnetometer No. 1 By T. Cooke & Sons.

MAGNET 1, FIBRE 2.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date.	Time of observation.	Vibration of Deflection.	Moment of Magnet at zero = m_0.	P. from 22.5 and 30 cms.	P. from 30 and 40 cms.	Measures of ordinate at the times given in col. 2.	Ordinate converted into Force.	Interpolated Temperature of H. F. thermometer at the times given in col. 2.	Difference of each temperature from the selected mean.	Correction for temperature.	Ordinate corrected to mean temperature = (8) + (11).	Means of corresponding pairs.	Observed value of H.	Value of Base line = (14) − (13).	REMARKS. [The base line is evaluated from the observations taken with magnet 1A in Magnetometer No. 1 by Cooke & Sons.]
Civil.	L. M. T.		C. G. S.			Sc. div.	γ	C.	C.	γ	γ	γ	C. G. S.	C.G.S.	
	h. m.														
4 Jan. 1902	2 30	V	1004.18	...	...	68.2	291.2	19.80	−1.2	−15.0	276.2	277.9	0.33497	.33219	Scale coefficient =4.27 γ.
"	2 58	D	...	7.479	7.201	69.0	294.6	19.80	−1.2	−15.0	279.6	...	...	...	
"	3 32	V	1004.13	...	...	69.2	295.5	19.80	−1.2	−15.0	280.5	280.1	0.33496	216	
7 "	12 22	V	1004.50	...	...	68.3	291.6	20.16	−0.8	−10.0	281.6	281.6	0.33514	232	First experiment on 6th Jan. 1902.
"	12 47	D	...	7.349	7.155	68.3	291.6	20.21	−0.8	−10.0	281.6	...	...	...	
"	1 18	V	1004.29	...	...	69.0	294.6	20.29	−0.7	−8.8	285.8	283.7	0.33507	223	
MAGNET 2, FIBRE 12.															
13 "	2 49	V	1004.20	...	...	56.9	310.7	20.36	−0.6	−7.5	303.2	303.5	0.33498	.33194	Scale co-efficient =5.46 γ.
"	3 18	D	...	7.427	7.716	57.0	311.2	20.36	−0.6	−7.5	303.7	...	...	...	
"	3 46	V	1004.22	...	...	57.5	314.0	20.36	−0.6	−7.5	306.5	305.1	0.33499	194	
14 "	12 9	V	1004.29	...	...	58.4	318.9	20.40	−0.6	−7.5	311.4	310.3	0.33519	209	
"	12 35	D	...	7.427	6.967	58.0	316.7	20.40	−0.6	−7.5	309.2	...	...	...	
"	1 3	V	1004.29	...	...	57.3	312.9	20.40	−0.6	−7.5	305.4	307.3	0.33519	212	
"	1 20	V	...	...	...	57.3	312.9	20.40	−0.6	−7.5	305.4	305.4	0.33517	212	From mean "m."
18 "	12 38	V	1004.38	...	...	52.1	284.5	20.40	−0.6	−7.5	277.0	276.7	0.33493	216	1st experiment on 15th Jan. 1902.
"	1 6	D	...	7.400	7.295	52.0	283.9	20.40	−0.6	−7.5	276.4	...	...	...	
"	1 32	V	1004.32	...	...	52.1	284.5	20.40	−0.6	−7.5	277.0	276.7	0.33491	214	
"	2 30	V	1004.25	...	...	52.8	288.3	20.40	−0.6	−7.5	280.8	281.6	0.33493	211	
"	2 54	D	...	7.505	7.110	53.1	289.9	20.40	−0.6	−7.5	282.4	...	...	...	
"	3 19	V	1004.27	...	...	53.6	292.7	20.40	−0.6	−7.5	285.2	283.8	0.33493	209	
"	3 43	D	1004.22	7.427	8.043	54.0	294.8	20.40	−0.6	−7.5	287.3	286.3	0.33495	209	
"	4 7	V	1004.20	...	...	54.4	297.0	20.40	−0.6	−7.5	289.5	288.4	0.33494	206	

B 1—*contd.*

Abstract of absolute observations for H. F. and computation of the value of the Base line of the H. F. Magnetograph No. 1 for the months of January and February 1902.

Magnet No. 1A. Magnetometer No. 1 By T. Cooke & Sons.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date.	Time of observation.	Vibration or Deflection.	Moment of magnet at zero $=m_0$.	P. from 22.5 and 30 cms.	P. From 30 and 40 cms.	Measures of ordinate at the times given in col. 2.	Ordinate converted into force.	Interpolated Temperature of H. F. thermometer at the times given in col. 2.	Difference of each temperature from the selected mean.	Correction for temperature.	Ordinate corrected to mean temperature=(8)+(11).	Means of corresponding pairs.	Observed values of H.	Value of Base line=(14)−(13).	Remarks.
Civil.	L.M.T.		C.G.S.			Sc. div.	γ	C.	G.	γ	γ	γ	C.G.S.	G.G.S.	
						MAGNET 2, FIBRE 12.									
	h. m.														
19 Jan. 1902 .	11 10	V	1004·22	...	...	51·3	280·1	20·69	−0·3	−3.8	276·3	276·3	0·33486	210	
„ .	11 34	D	...	7·582	7·201	51·3	280·1	20·69	−0·3	−3·8	276·3	...	...	...	
„ .	11 58	V	1004·27	...	...	51·6	281·7	20·69	−0·3	−3·8	277·9	277·1	0·33487	210	
„ .	11 58 / 12 23	D	1004·20	7·504	7·716	52·1	284·5	20·69	−0·3	−3·8	277·9 / 280·7	279·3	·33489	·33210	
„ .	12 46	V	1004·18	...	...	53·0	289·4	20·69	−0·3	−3·8	285·6	283·2	·33488	205	2nd experiment on 20th January.
						MAGNET 3, FIBRE 6.									
22 „ .	2 42	V	1004·06	...	...	57·4	276·7	20·60	−0·4	−5·0	271·7	273·9	·33500	·33226	Scale coefficient =4·82γ.
„ .	3 10	D	...	7·660	7·110	58·3	281·0	20·60	−0·4	−5·0	276·0				
„ .	3 36	V	1004·25	...	...	59·6	287·3	20·60	−0·4	−5·0	282·3	279·2	·33507	·33228	
24 „ .	12 1	V	1004·34	...	...	65·0	313·3	22·3	+1·3	+16·3	329·6	330·6	·33518	187	1st experiment on 23rd January 1902.
„ .	12 25	D	...	7·479	7·529	65·4	315·2	22·3	+1·3	+16·3	331·5				
„ .	12 53	V	1004·38	...	...	66·1	318·6	22·3	+1·3	+16·3	334·9	333·2	·33520	187	
„ .	1 14	D	1004·22	7·374	7·576	66·5	320·5	22·3	+1·3	+16·3	336·8	335·9	·33525	189	Mean value of Base line =0·33186.
„ .	1 36	V	1004·25	...	...	66·1	318·6	22·3	+1·3	+16·3	334·9	335·9	·33526	190	
[illegible] „ .	12 5	D	...	7·452	7·903	73·2	352·8	21·18	+0·2	+2·5	355·3				
„ .	12 31	V	1004·43	...	...	75·0	361·5	21·18	+0·2	+2·5	364·0	359·7	·33541	181	
„ .	12 55	D	1004·36	7·479	7·249	75·0	361·5	21·18	+0·2	+2·5	364·0	364·0	·33544	180	2nd experiment on 28th January 1902.
						MAGNET 2, FIBRE 12.									
30 „ .	12 1	V	...	...	...	58·0	377·0	21·60	+0·6	+7·5	384·5	384·5	·33530	·33145	From mean "m."
„ .	12 24	V	1004·13	...	...	58·0	377·0	21·60	+0·6	+7·5	384·5	384·5	·33520	135	Scale coefficient =6·50γ.
„ .	12 47	D	...	7·192	7·483	58·0	377·0	21·60	+0·6	+7·5	384·5				Mean value of Base line =0·33137.
„ .	1 10	V	1003·99	...	...	57·7	375·1	21·60	+0·6	+7·5	382·6	383·6	·33515	131	3rd experiment on 31st January 1902.

B 1—*contd.*

Abstract of absolute observations for H. F. and Computation of the value of the Base line of the H. F. Magnetograph No. 1 for the months of January and February 1902.

Magnet No. 1 A. Magnetometer No. 1 By T. Cooke & Sons.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date.	Time of observation.	Vibration or Deflection.	Moment of Magnet at zero $=m_0$.	P. from 22·5 and 30 cms.	P. from 30 and 40 cms.	Measures of ordinate at the times given in col. 2.	Ordinate converted into Force.	Interpolated Temperatures of H. F. thermometer at three times given in col. 2.	Difference of each temperature from the selected mean.	Correction for temperature.	Ordinate corrected to mean temperature=(8)+(11).	Means of corresponding pairs.	Observed values of H.	Value of Base line=(14)−(13).	REMARKS.
Civil.	L.M.T.		C.G.S.			Sc. div.	γ	C	C	λ	γ	γ	C.G.S.	C.G.S.	
	MAGNET 3, FIBRE 3.														
	h. m.														
5 Feb. 1902	11 26	V	1004·38	...	...	60·8	292·4	21·39	+0·4	+5·0	297·4	296·7	·33520	·33223	Scale coefficient =4·81 γ
„	11 49	D	...	7·374	7·529	60·5	291·0	21·39	+0·4	+5·0	296·0				Mean value of Base line =0·33223.
„	12 14	V	1004·36	...	...	60·7	292·0	21·39	+0·4	+5·0	297·0	296·5	·33519	222	
„	12 37	D	1004·29	7·400	7·435	61·0	293·4	21·39	+0·4	+5·0	298·4	297·7	·33522	224	Experiment on 6th February 1902.
„	1 1	V	1004·45	...	...	64·0	...	21·39	+0·4	+5·0	...	...	·33527	...	Commenced slipping at 12·50.
	MAGNET 3, FIBRE 4.														
8 Feb. 1902	11 30	V	1004·36	...	...	51·1	256·5	20·5	−0·5	−6·3	250·2	251·2	·33495	·33244	Scale coefficient 5·02γ.
„	11 56	D	...	7·349	7·483	51·0	256·0	20·7	−0·3	−3·8	252·2				
„	12 21	V	1004·34	...	...	50·3	252·5	20·7	−0·3	−3·8	248·7	250·5	·33494	243	
„	12 46	D	1004·38	7·244	7·483	50·0	251·0	20·8	−0·2	−2·5	248·5	248·6	·33492	243	
„	1 11	V	1004·18	...	...	47·0	235·9	20·8	−0·2	−2·5	233·4	241·0	·33485	244	
11 „	11 38	V	1004·36	...	...	69·0	346·4	20·8	−0·2	−2·5	343·9	344·4	·33520	176	1st Experiment on 10th February 1902.
„	12 2	D	...	7·322	7·483	69·2	347·4	20·8	−0·2	−2·5	344·9				
„	12 27 12 27	V	1004·36	...	...	69·0	346·4	20·8	−0·2	−2·5	343·9	344·4	·33520	176	
„	12 51	D	1004·41	7·322	7·483	68·4	343·4	20·8	−0·2	−2·5	341·9	342·9	·33518	·33175	
„	1 15	V	1004·20	...	...	68·1	341·9	20·8	−0·2	−2·5	338·4	340·2	·33511	171	2nd Experiment on 12th February 1902.
19 „	2 59	V	1004·20	...	...	72·4	363·4	21·6	+0·6	+7·5	370·9	370·4	·33498	128	
„	3 19	D	...	7·400	7·856	72·2	362·4	21·6	+0·6	+7·5	369·9				
	MAGNET 1, FIBRE 2.														
22 „	11 39	V	1004·29	...	...	55·3	221·8	21·4	+0·4	+5·0	226·8	227·4	·33511	·33284	Scale coefficient =4·01γ.
„	12 5	D	...	7·374	8·043	55·6	223·0	21·4	+0·4	+5·0	228·0				
„	12 31	V	1004·22	...	...	55·7	223·4	21·5	+0·5	+6·3	229·7	228·9	·33509	280	
„	12 55	D	1004·18	7·244	7·669	55·9	224·2	21·5	+0·5	+6·3	230·5	230·1	·33510	280	
„	1 19	V	1004·02	...	...	55·6	223·0	21·5	+0·5	+6·3	229·3	229·9	·33505	275	

B I—*concld.*

Abstract of absolute observations for H. F. and Computation of the value of the Base line of the H. F. Magnetograph No. 1 for the months of January and February 1902.

Magnet No. 1 A. Magnetometer No. 1 by T. Cooke & Sons.

MAGNET 1, FIBRE 2.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date.	Time of observation.	Vibration of Deflection.	Moment of Magnet at zero = m_0.	P. from 22·5 and 30 cms.	P. from 30 and 40 cms.	Measures of ordinate at the times given in col. 2.	Ordinate converted into Force.	Interpolated Temperature of H. F. thermometer at the times given in col. 2.	Difference of each temperature from the selected mean.	Correction for temperature.	Ordinate corrected to mean temperature = (8) + (11).	Mean of corresponding pairs.	Observed value of H.	Value of Base line = (14) − (13).	REMARKS.
Civil.	L. M. T.		C. G. S.			Sc. div.	γ	C.	C.	γ	γ	γ	C. G. S.	C.G.S.	
	h. m.														
23 Feb. 1902 .	11 40	V	1004·13	...	...	59·1	237·0	21·6	+0·6	+7·5	244·5	244·3	·33524	280	
" .	12 4	D	...	7·530	7·295	59·0	236·6	21·6	+0·6	+7·5	244·1				
" .	12 29	V	1004·06	...	...	58·3	233·8	21·6	+0·6	+7·5	241·3	242·7	·33522	279	
" .	12 54	D	1004·11	7·349	7·623	58·0	232·6	21·6	+0·6	+7·5	240·1	240·7	·33520	279	
" .	1 20	V	1004·04	...	...	57·1	229·0	21·6	+0·6	+7·5	236·5	238·3	·33518	280	
25 " .	11 51	V	1004·36	...	...	55·0	220·6	21·8	+0·8	+10·0	230·6	230·2	·33516	286	2nd Experiment on 24th February 1902.
" .	12 16	D	...	7·427	7·856	54·8	219·7	21·8	+0·8	+10·0	229·7				
" .	12 39	V	1003·88	...	...	55·3	221·8	21·9	+0·9	+11·3	233·1	231·4	·33500	269	
" .	1 2	D	1003·76	7·374	7·342	56·0	224·6	22·0	+1·0	+12·5	237·1	235·1	·33504	269	
" .	1 24	V	1003·92	...	...	55·2	221·4	22·0	+1·0	+12·5	233·9	235·5	·33510	274	
Means .	...	...	1004·23	7·403	7·510										

B-2.

Computation of the value of the Base Line of the H. F. Magnetograph No. 2 for the months of January and February 1902.

MAGNET 2, FIBRE 12. Temperature Coefft. for 1° C.=12·5γ throughout.

1 Date.	2 Time of observation.	3 Vibration or Deflection.	4 Moment of Magnet at zero = m_0.	5 P. from 22·5 and 30 cms.	6 P. from 30 and 40 cms.	7 Measures of ordinates at times given in col. 2.	8 Ordinate converted into Force.	9 Interpolated temperatures of the H. F. thermometer at times given in col. 2.	10 Difference of each temperature from the selected mean.	11 Correction for temperature.	12 Ordinate corrected to mean temperature = (8) + (11).	13 Means of corresponding pairs.	14 Observed value of H.	15 Value of Base line = (14) − (13).	16 REMARKS. (The base line is evaluated from the observations taken with Magnet 1A in Magnetometer No. 1 by Cook & Sons.—The figures in columns 4, 5 and 6 are therefore omitted being given in Table B 1.)
Civil.	L.M.T.		C.G.S.			Sc. div.	γ	C	C	γ	γ	γ	C.G.S.	C.G.S.	
	h. m.														
4 Jan. 1902 .	2 30	V	...	...	...	54·6	307·9	13·5	0·0	0·0	307·9	309·7	·33497	·33187	Selected mean temperature =13°·5C.
„ .	2 58	D	...	...	...	55·0	310·2	13·6	+0·1	+ 1·3	311·5				Scale Coefft. = 5·64γ.
„ .	3 32	V	...	...	...	54·9	309·6	13·7	+0·2	+ 2·5	312·1	311·8	·33496	184	
7 „ .	12 22	V	...	...	...	55·0	310·2	13·2	−0·3	− 3·8	306·4	307·1	·33514	207	Mean value of Base line = ·33194.
„ .	12 47	D	...	...	...	55·0	310·2	13·3	−0·2	− 2·5	307·7				
„ .	1 18	V	...	...	...	55·7	314·1	13·3	−0·2	− 2·5	311·6	309·7	·33507	197	

MAGNET 1, FIBRE 2.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
13 Jan. 1902 .	2 49	V	...	...	...	56·2	207·9	14·7	−0·3	− 3·8	204·1	205·6	·33498	·33292	
„ .	3 18	D	...	...	...	57·0	210·9	14·7	−0·3	− 3·8	207·1				·33291.
„ .	3 46	V	...	...	...	57·8	213·9	14·7	−0·3	− 3·8	210·1	208·6	·33499	290	Selected mean temperature =15°·0C.
14 „ .	12 9	V	...	...	...	61·0	225·7	14·3	−0·7	− 8·8	216·9	214·9	·33519	304	Scale Coefft. =3·70.
„ .	12 35	D	...	...	...	59·9	221·6	14·3	−0·7	− 8·8	212·8				
„ .	1 3	V	...	...	...	58·9	217·9	14·4	−0·6	− 7·5	210·4	211·6	·33519	307	
„ .	1 20	V	...	...	...	58·6	216·8	14·5	−0·5	− 6·3	210·5	210·5	·33517	306	
18 „ .	12 38	V	...	...	...	54·9	203·1	13·9	−1·1	−13·8	189·3	188·7	·33493	304	
„ .	1 6	D	...	...	...	54·2	200·5	14·0	−1·0	−12·5	188·0				
„ .	1 32	V	...	...	...	54·3	200·9	14·1	−0·9	−11·3	189·6	188·8	·33491	302	
„ .	2 30	V	...	...	...	55·0	203·5	14·3	−0·7	− 8·8	194·7	195·5	·33493	297	
„ .	2 54	D	...	...	...	55·4	205·0	14·3	−0·7	− 8·8	196·2				
„ .	3 19	V	...	...	...	55·8	206·5	14·4	−0·6	− 7·5	199·0	197·6	·33493	295	
„ .	3 43	D	...	...	...	56·3	208·3	14·4	−0·6	− 7·5	200·8	199·9	·33495	295	
„ .	4 7	V	...	...	...	57·0	210·9	14·5	−0·5	− 6·3	204·6	202·7	·33494	291	
19 „ .	11 10	V	...	...	...	55·1	203·9	13·9	−1·1	−13·8	190·1	189·9	·33486	·33296	
„ .	11 34	D	...	...	...	55·0	203·5	13·9	−1·1	−13·8	189·7				Mean Base line
„ .	11 58	V	...	...	...	55·0	203·5	13·9	−1·1	−13·8	189·7	189·7	·33487	297	value to 19-1-02
„ .	12 23	D	...	...	...	56·0	207·2	14·0	−1·0	−12·5	194·7	192·2	·33489	297	incl.=·33297.
„ .	12 46	V	...	...	...	56·5	209·1	14·0	−1·0	−12·5	196·6	195·7	·33488	292	
22 „ .	2 42	V	...	...	...	57·9	214·2	14·9	−0·1	− 1·3	212·9	214·5	·33500	285	
„ .	3 10	D	...	...	...	58·4	216·1	15·0	0·0	0·0	216·1				
„ .	3 36	V	...	...	...	59·9	221·6	15·1	+0·1	+ 1·3	222·9	219·5	·33507	287	
24 „ .	12 1	V	...	...	...	62·0	229·4	15·3	+0·3	+ 3·8	233·2	233·6	·33518	284	
„ .	12 25	D	...	...	...	62·2	230·1	15·3	+0·3	+ 3·8	233·9				Mean value of
„ .	12 53	V	...	...	...	63·1	233·5	15·3	+0·3	+ 3·8	237·3	235·6	·33520	284	Base line =
„ .	1 14	D	...	...	...	63·4	234·6	15·4	+0·4	+ 5·0	239·6	238·5	·33525	286	·33283.
„ .	1 36	V	...	...	...	62·6	231·6	15·4	+0·4	+ 5·0	236·6	238·1	·33526	288	
26 „ .	12 5	D	...	...	...	69·4	256·8	15·4	+0·4	+ 5·0	261·8				
„ .	12 31	V	...	...	...	70·8	262·0	15·4	+0·4	+ 5·0	267·0	264·4	·33541	277	
„ .	12 55	D	...	...	...	71·2	263·4	15·5	+0·5	+ 6·3	269·7	268·4	·33544	276	

B 2.—*contd.*

Computation of the value of the Base Line of the H. F. Magnetograph No. 2 for the months of January and February 1902.

Magnet 1, Fibre 2. Temperature Coefft. for 1° C.=12·5γ throughout.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date.	Time of observation.	Vibration or Deflection.	Moment of Magnet at zero = m_0	P. from 22·5 and 30 cms.	P. from 30 and 40 cms.	Measures of ordinates at times given in col. 2.	Ordinate converted into Force.	Interpolated temperatures of the H. F. thermometer at times given in col. 2.	Difference of each temperature from the selected mean.	Correction for temperature.	Ordinate corrected to mean temperature = (8) + (11).	Means of corresponding pairs.	Observed value of H.	Value of Base line = (14) − (13).	**Remarks.** (The base line is evaluated from the observations taken with Magnet 1A in Magnetometer No. 1 by Cook & Sons.—The figures in columns 4, 5 and 6 are therefore omitted being given in Table B 1).
Civil.	L.M.T.		C.G.S.			Sc. div.	γ	C	C	γ	γ	γ	C.G.S.	C.G.S.	

Date	h. m.														
30 Jan. 1902	12 1	V	...	...	...	57·9	214·2	16·9	+1·9	+23·8	238·0	238·0	·33530	292	
”	12 24	V	...	...	...	57·7	213·5	16·9	+1·9	+23·8	237·3	236·4	·33520	284	Mean value of Base line = ·33286.
”	12 47	D	...	...	...	57·2	211·6	16·9	+1·9	+23·8	235·4				
”	1 10	V	...	...	...	56·4	208·7	16·9	+1·9	+23·8	232·5	234·0	·33515	281	
5 Feb. 1902	11 26	V	...	...	...	64·3	237·9	15·0	0·0	0·0	237·9	237·5	·33520	282	
”	11 49	D	...	...	...	64·1	237·2	15·0	0·0	0·0	237·2				
”	12 14	V	...	...	...	64·1	237·2	15·0	0·0	0·0	237·2	237·2	·33519	282	Mean value of Base line = ·33284.
”	12 37	D	...	...	...	64·3	237·9	15·1	+0·1	+ 1·3	239·2	238·2	·33522	284	
”	1 1	V	...	...	...	64·0	236·8	15·2	+0·2	+ 2·5	239·3	239·3	·33527	288	
8 ”	11 30	V	...	...	...	60·8	225·0	14·6	−0·4	− 5·0	220·0	220·4	·32495	275	
”	11 56	D	...	...	...	61·0	225·7	14·6	−0·4	− 5·0	220·7				
”	12 21	V	...	...	...	60·1	222·4	14·6	−0·4	− 5·0	217·4	219·1	·33494	275	
”	12 46	D	...	...	...	58·7	217·2	14·7	−0·3	− 3·8	213·4	215·4	·33492	277	
”	1 11	V	...	...	...	55·0	203·5	14·8	−0·2	− 2·5	201·0	207·2	·33485	278	
11 ”	11 38	V	...	...	...	65·3	241·6	14·9	−0·1	− 1·3	240·3	241·7	·33520	278	
”	12 2	D	...	...	...	65·7	243·1	15·0	0·0	0·0	243·1				
”	12 27	V	...	...	...	65·0	240·5	15·0	0·0	0·0	240·5	241·8	·33520	278	
”	12 51	D	...	...	...	64·4	238·3	15·1	+0·1	+ 1·3	239·6	240·1	·33518	278	
”	1 15	V	...	...	...	63·9	236·4	15·1	+0·1	+ 1·3	237·7	238·7	·33511	272	
19 ”	2 59	V	...	...	...	51·0	188·7	18·1	+3·1	+38·8	227·5	227·8	·33498	270	
”	3 19	D	...	...	...	50·8	188·0	18·2	+3·2	+40·0	228·0				

Magnet 3, Fibre 4.

Date	h. m.														
22 Feb. 1902	11 39	V	...	...	...	66·6	301·7	18·0	−0·4	− 5·0	296·7	297·6	·33511	·33213	Selected mean temperature =18·4. Scale Coefft. =4·53.
”	12 5	D	...	...	...	66·7	302·2	18·1	−0·3	− 3·8	298·4				
”	12 31	V	...	...	...	66·9	303·1	18·1	−0·3	− 3·8	299·3	298·9	·33509	210	·33210.
”	12 55	D	...	...	...	66·9	303·1	18·2	−0·2	− 2·5	300·6	300·0	·33510	210	
”	1 19	V	...	...	...	66·6	301·7	18·2	−0·2	− 2·5	299·2	299·9	·33505	205	
23 ”	11 40	V	...	...	...	70·2	318·0	18·2	−0·2	− 2·5	315·5	315·7	·33524	208	
”	12 4	D	...	...	...	70·0	317·1	18·3	−0·1	− 1·3	315·8				
”	12 29	V	...	...	...	69·4	314·4	18·3	−0·1	− 1·3	313·1	314·5	·33522	207	·33207.
”	12 54	D	...	...	...	69·0	312·6	18·4	0·0	0·0	312·6	312·9	·33520	207	
”	1 20	V	...	...	...	68·1	308·5	18·4	0·0	0·0	308·5	310·6	·33518	207	
25 ”	11 51	V	...	...	...	66·8	302·6	18·5	+0·1	+ 1·3	303·9	303·8	·33516	212	
”	12 16	D	...	...	...	66·5	301·2	18·6	+0·2	+ 2·5	303·7				
”	12 39	V	...	...	...	67·2	304·4	18·6	+0·2	+ 2·5	306·9	305·3	·33500	195	·33201.
”	1 2	D	...	...	...	67·7	306·7	18·7	+0·3	+ 3·8	310·5	308·7	·33504	195	
”	1 24	V	...	...	...	66·9	303·1	18·7	+0·3	+ 3·8	306·9	308·7	·33510	201	

C 1.

Reduction of temperature coefficients of H. F. Magnetographs (Watson's)
First experiment with Magnet 1 and Fibre 2.

		Magnet 1, Fibre 2. Inst. 1.					Magnet 2. Fibre 12. Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	**Remarks.**
Date.	Time.	Temperature Thermometer No. 909.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into Force.	Temperature Thermometer No. 910.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into Force.	Difference in ordinate corrected for temperature *i.e.*, (13) + (10).	Actual change in ordinate due to change in temperature (7) − (14).	Temperature co-efficient for + 1°C, *i. e.* (15) ÷ (4).	γ = ·00001. C. G. S units. Temperature co-efficient for No. 2 Inst. assumed at 1°C = −12 γ. Sc. value of No. 1 Inst. = 4·27 γ. Sc. value of No. 2 Inst. = 5·6 γ.
		Cent.	Cent.	Sc. divns.	Sc. divns.	γ	Cent.	Cent.	γ	Sc. divns.	Sc. divns.	γ	γ	γ	γ	
	h. m.															
6th Jan. 1902.	7 25	20·15	0·00	73·1	0·0	0·0	·00	0·00	0·00	58·5	0·0	0.0	0·0	0·0	...	Stoves lighted at
"	7 45	20·45	+0·30	72·6	−0·5	−2·1	13·00	·00	0.00	58·9	+ 0·4	+2·3	+2·3	−4·4	...	7-30.
"	8 0	21·30	1·15	70·0	3·1	13·2	12·99	− ·01	−0·1	59·1	+ 0·6	+3·4	+3·3	16·5	...	
"	15	22·75	2·60	64·7	8·4	35·9	·98	− ·02	−0·2	59·4	+ 0·9	+5·1	+4·9	40·8	−15·7	
"	30	23·81	3·66	62·7	10·4	44·4	12·96	− ·04	−0·5	59·7	+ 1·2	+6·8	+6·3	50·7	13·9	
"	45	24·56	4·41	60·8	12·3	52·5	·96	−0·04	−0·5	59·7	+ 1·2	+6·8	+6·3	58·8	13·3	
"	9 0	24·90	4·75	60·0	13·1	55·9	·96	−0·04	−0·5	59·8	+ 1·3	+7·3	+6·8	62·7	13·2	
"	15	25·20	5·05	58·7	14·4	61·5	·96	−0·04	−0·5	59·5	+ 1·0	+5·6	+5·1	66·6	13·2	
"	30	26·00	5·85	56·0	17·1	73·0	12·96	−0·04	−0·5	59·4	+ 0·9	+5·1	+4·6	77·6	13·3	
"	45	26·80	6·65	53·6	19·5	83·3	·97	−0·03	−0·4	59·2	+ 0·7	+3·9	+3·5	86·8	13·1	
"	10 0	27·10	6·95	52·7	20·4	87·1	12·98	−0·02	−0·2	59·0	+ 0·5	+2·8	+2·6	89·7	12·9	
"	15	27·15	7·00	52·3	20·8	88·8	·98	−0·02	−0·2	59·0	+ 0·5	+2·8	+2·6	91·4	13·1	
"	30	27·60	7·45	51·0	22·1	94·4	12·98	−0·02	−0·2	59·0	+ 0·5	+2·8	+2·6	97·0	13·0	
"	45	28·00	7·85	50·0	23·1	98·6	·99	−0·01	−0·1	59·0	+ 0·5	+2·8	+2·7	101·3	12·9	
"	11 0	28·30	8·15	49·2	23·9	102·1	13·00	0·00	0·0	59·0	+ 0·5	−2·8	+2·8	104·9	12·9	
"	15	28·70	8·55	48·3	24·8	105·9	·00	0·00	0·0	59·1	+ 0·6	+3·4	+3·4	109·3	12·8	
"	30	28·95	8·80	48·0	25·1	107·2	13·00	0·00	0·0	59·4	+ 0·9	+5·1	+5·1	112·3	12·8	
"	45	28·95	8·80	48·7	24·4	104·2	·04	+0·04	+ 0·5	59·8	+ 1·3	+7·3	+7·8	112·0	12·7	
"	12 0	29·05	8·90	48·8	24·3	103·8	13·08	+0·08	+ 1·0	60·0	+ 1·5	+8·5	+9·5	113·3	12·7	
"	15	29·20	9·05	48·5	24·6	105·0	·10	+0·10	+ 1·2	60·0	+ 1·5	+8·5	+9·7	114·7	12.7	
"	30	29·35	9·20	48·0	25·1	107·2	13·12	+0·12	+ 1·4	59·9	+ 1·4	+7·9	+9·3	116·5	12·7	
"	45	29·60	9·45	47·0	26·1	111·4	·16	+0·16	+ 1·9	59·5	+ 1·0	+5·6	+7·5	118·9	12·6	Mean = 12·60 γ.
"	13 0	29·55	9·40	46·4	26·7	114·0	13·20	+0·20	+ 2·4	59·0	+ 0·5	+2·8	+5·2	119·2	12·7	Both doors slightly
"	15	29·30	9·15	46·8	26·3	112·3	·25	+0·25	+ 3·0	58·5	0·0	0·0	+3·0	115·3	12·6	opened at 1-35.
"	30	28·99	8·84	47·0	26·1	111·4	13·30	+0·30	+ 3·6	58·0	− 0·5	−2·8	+0·8	112·2	12·7	Inside door opened
"	45	28·50	8·35	48·1	25·0	106·8	·31	+0·31	+ 3·7	57·8	− 0·7	−3·9	−0·2	106·6	12·8	1 foot at 1-47.
"	14 0	28·30	8·15	49·0	24·1	102·9	·31	+0·31	+ 3·7	57·3	− 1·2	−6·8	−3·1	99·8	12·2	Inside door opened
"	15	27·50	7·35	50·0	23·1	98·6	13·32	+0·32	+ 3·8	57·0	− 1·5	−8·5	−4·7	93·9	12·8	wide at 2-2.
"	30	27·10	6·95	51·2	21·9	93·5	13·40	+0·40	+ 4·8	56·6	− 1·9	−10·7	−5·9	87·6	12·6	Removed fires.
"	45	26·45	6·30	52·9	20·2	86·3	·43	+0·43	+ 5·2	56·1	− 2·4	−13·5	−8·3	78·0	12·4	
"	15 0	25·50	5·35	55·3	17·8	76·0	·47	+0·47	+ 5·6	56·0	− 2·5	−14·1	−8·5	67·5	12·6	
"	15	24·60	4·45	57·9	15·2	64·9	13·51	+0·51	+ 6·1	55·9	− 2·6	−14·7	−8·6	56·3	12·7	
"	30	23·95	3·80	60·0	13·1	55·9	13·60	+0·60	+ 7·2	56·1	− 2·4	−13·5	−6·3	49·6	13·1	
"	45	23·45	3·30	61·8	11·3	48·3	·65	+0·65	+ 7·8	56·1	− 2·4	−13·5	−5·7	42·6	12·9	
"	16 0	23·15	3·00	63·0	10·1	43·1	13·70	+0·70	+ 8·4	56·4	− 2·1	−11·8	−3·4	39·7	13·2	
"	15	22·80	2·65	64·4	8·7	37·1	·74	+0·74	+ 8·9	56·5	− 2·0	−11·3	−2·4	34·7	13·1	
"	30	22·60	2·45	65·3	7·8	33·3	·77	+0·77	+ 9·2	56·8	− 1·7	−9·6	−0·4	32·9	13·4	
"	40	...	...	...	...	...	13·80	...	...	56·8	− 1·7	−9·6	...	...	...	

C 2.

Reduction of temperature coefficients of H. F. Magnetographs (Watson's)
First experiment with Magnet 2 and Fibre 12.

		Magnet 2. Fibre 12. Inst. 1.					Magnet 1. Fibre 2. Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks.
Date.	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into Force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into Force.	Difference in ordinate corrected for temperature *i.e.* (13) + (10).	Actual change in ordinate due to change in temperature (7) − (14).	Temperature coefficient for + 1°C *i.e.*, (15) ÷ (4).	γ = .00001 C. G. S. Units. Sc. value of No. 1 Inst. = 5.46 γ. Sc. value of No. 2 Inst. = 3.70 γ. Temperature coefficient of Magnet 1 and fibre 2 in No. 2 Inst. is taken from experiment on 6th January 1902, *viz.*, 1°C. = −12.7 γ
		Cent.	Cent.	Sc. divns.	Sc. divns.	γ	Cent.	Cent.	γ	Sc. divns.	Sc. divns.	γ	γ	γ	γ	
	h. m.															
15th Jan. 1902	7 30	20.50	0.00	59.3	0.0	0.0	14.36	0.00	0.0	62.5	0.0	0.0	0.0	0.0	0.0	Stoves lighted at 7-32.
"	45	20.74	+0.24	58.7	−0.6	−3.3	.33	−0.03	−0.4	62.5	0.0	0.0	−0.4	−2.9	12.1	
"	8 0	22.44	1.94	54.2	5.1	27.8	14.30	−0.06	−0.8	62.5	0.0	0.0	−0.8	27.0	13.9	
"	15	24.80	4.30	48.9	10.4	56.8	.28	−0.08	−1.0	62.1	−0.4	−1.5	−2.5	54.3	12.6	
"	30	27.00	6.50	43.9	15.4	84.1	14.26	−0.10	−1.3	62.0	−0.5	−1.9	−3.2	80.9	12.4	
"	45	27.70	7.20	42.1	17.2	93.9	.28	−0.08	−1.0	61.6	−0.9	−3.3	−4.3	89.6	12.4	
"	9 0	28.20	7.70	40.8	18.5	101.0	14.30	−0.06	−0.8	61.1	−1.4	−5.2	−6.0	95.0	12.3	
"	15	28.10	7.60	40.6	18.7	102.1	.32	−0.04	−0.5	60.0	−2.5	−9.3	−9.8	92.3	12.1	
"	30	27.96	7.46	40.3	19.0	103.7	14.33	−0.03	−0.4	59.1	−3.4	−12.6	−13.0	90.7	12.2	
"	45	28.20	7.70	39.0	20.3	110.8	.34	−0.02	−0.3	58.2	−4.3	−15.9	−16.2	94.6	12.3	
"	10 0	29.05	8.55	36.8	22.5	122.9	14.35	−0.01	−0.1	57.7	−4.8	−17.8	−17.9	105.0	12.3	
"	15	29.25	8.75	36.2	23.1	126.1	.37	+0.01	+0.1	57.7	−4.8	−17.8	−17.7	108.4	12.4	
"	30	29.85	9.35	35.3	24.0	131.0	14.38	+0.02	+0.3	58.1	−4.4	−16.3	−16.0	115.0	12.3	
"	45	30.15	9.65	35.0	24.3	132.7	.38	+0.02	+0.3	58.4	−4.1	−15.2	−14.9	117.8	12.2	
"	11 0	30.10	9.60	35.8	23.5	128.3	14.38	+0.02	+0.3	59.1	−3.4	−12.6	−12.3	116.0	12.1	
"	15	30.45	9.95	35.1	24.2	132.1	.38	+0.02	+0.3	59.7	−2.8	−10.4	−10.1	122.0	12.3	
"	30	31.10	10.60	33.8	25.5	139.2	14.38	+0.02	+0.3	60.0	−2.5	−9.3	−9.0	130.2	12.3	
"	45	31.25	10.75	33.6	25.7	140.3	.39	+0.03	+0.4	59.8	−2.7	−10.0	−9.6	130.7	12.2	Deflections taken.
"	12 0	31.30	10.80	33.4	25.9	141.4	14.40	+0.04	+0.5	59.5	−3.0	−11.1	−10.6	130.8	12.1	Mean = 11.90 γ.
"	15	30.98	10.48	34.3	25.0	136.5	.45	+0.09	+1.1	59.5	−3.0	−11.1	−10.0	126.5	12.1	
"	30	30.45	9.95	35.9	23.4	127.8	14.50	+0.14	+1.8	59.9	−2.6	−9.6	−7.8	120.0	12.1	Both doors slightly opened.
"	45	30.00	9.50	36.7	22.6	123.4	.52	+0.16	+2.0	59.4	−3.1	−11.5	−9.5	113.9	12.0	
"	13 0	29.56	9.06	37.7	21.6	117.9	14.53	+0.17	+2.2	59.3	−3.2	−11.8	−9.6	108.3	12.0	Inner door opened wide.
"	15	29.04	8.54	39.3	20.0	109.2	.55	+0.19	+2.4	59.7	−2.8	−10.4	−8.0	101.2	11.8	
"	30	28.20	7.70	41.1	18.2	99.4	14.58	+0.22	+2.8	59.3	−3.2	−11.8	−9.0	90.4	11.7	Outer door opened wide.
"	45	27.21	6.71	43.1	16.2	88.5	.60	+0.24	+3.0	59.0	−3.5	−13.0	−10.0	78.5	11.7	
"	14 0	26.50	6.00	44.8	14.5	79.2	14.63	+0.27	+3.4	59.0	−3.5	−13.0	−9.6	69.6	11.6	
"	15	26.00	5.50	45.8	13.5	73.7	.68	+0.32	+4.1	58.4	−4.1	−15.2	−11.1	62.6	11.4	Removed fires.
"	30	25.78	5.28	46.1	13.2	72.1	14.72	+0.36	+4.6	58.2	−4.3	−15.9	−11.3	60.8	11.5	
"	45	25.15	4.65	48.0	11.3	61.7	.76	+0.40	+5.1	58.6	−3.9	−14.4	−9.3	52.4	11.3	
"	15 0	24.50	4.00	49.9	9.4	51.3	14.80	+0.44	+5.6	59.0	−3.5	−13.0	−7.4	43.9	11.0	
"	15	24.00	3.50	51.2	8.1	44.2	.86	+0.50	+6.4	59.3	−3.2	−11.8	−5.4	38.8	11.1	
"	30	23.60	3.10	52.0	7.3	39.9	14.92	+0.56	+7.1	59.5	−3.0	−11.1	−4.0	35.9	11.6	
"	45	23.30	2.80	52.9	6.4	34.9	.96	+0.60	+7.6	59.4	−3.1	−11.5	−3.9	31.0	11.1	
"	16 0	23.00	2.50	53.5	5.8	31.7	15.00	+0.64	+8.1	59.5	−3.0	−11.1	−3.0	28.7	11.5	

C 3.

Reduction of temperature coefficient of H. F. Magnetographs (Watson's)
Second experiment with Magnet 2 and Fibre 12.

		MAGNET 2. FIBRE 12. INST. 1.					MAGNET 1. FIBRE 2. INST. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	REMARKS.
Date.	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into Force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in Ordinate after start.	Difference in ordinate converted into Force.	Difference in ordinate corrected for temperature, *i.e.*, (13) + (10).	Actual change in ordinate due to change in temperature (7)—(14).	Temperature coefficient for + 1°C., *i.e.* (15) ÷ (4).	γ = ·00001 C.G.S. Units. Sc. value of No. 1 Inst. = 5·46 γ. Sc. value of No. 2 Inst. = 3·70 γ. Temp. coeft. for No. 2 Inst. taken = 12·7 γ.
		Cent.	Cent.	Sc. divns.	Sc. divns.		Cent.	Cent.	γ	Sc. divns.	Sc. divns.	γ	γ	γ	γ	
	h.m.															
20 Jan. 1902 .	7-30	20·63	0·00	56·1	0·0	0·0	13·99	0·00	0·0	61·6	0·0	0·0	0·0	0·0		Fires lighted at 7-30.
„ .	45	21·10	+0·47	55·1	—1·0	—5·5	·99	0·00	0·0	61·9	+0·3	+1·1	+1·1	— 6·6	14·0	
„ .	8-0	23·95	3·32	48·2	7·9	43·1	13·99	0·00	0·0	62·0	+0·4	+1·5	+1·5	44·6	13·4	
„ .	15	26·80	6·17	42·0	14·1	77·0	·98	—0·01	—0·1	62·0	+0·4	+1·5	+1·4	78·4	12·7	
„ .	30	28·16	7·53	38·9	17·2	93·9	13·97	—0·02	—0·3	62·0	+0·4	+1·5	+1·2	95·1	12·6	
„ .	45	28·32	7·69	39·0	17·1	93·4	·97	—0·02	—0·3	62·0	+0·4	+1·5	+1·2	94·6	12·3	
„ .	9-0	28·00	7·37	39·2	16·9	92·3	13·97	—0·02	—0·3	61·9	+0·3	+1·1	+0·8	93·1	12·6	
„ .	15	28·43	7·80	37·7	18·4	100·5	·98	—0·01	—0·1	61·2	—0·4	—1·5	—1·6	98·9	12·7	
„ .	30	28·98	8·35	36·5	19·6	107·0	14·00	+0·01	+0·1	61·0	—0·6	—2·2	—2·1	104·9	12·6	
„ .	45	29·03	8·40	36·3	19·8	108·1	·00	+0·01	+0·1	60·2	—1·4	—5·2	—5·1	103·0	12·3	
„ .	10-0	29·60	8·97	33·9	22·2	121·2	14·00	+0·01	+0·1	59·6	—2·0	—7·4	—7·3	113·9	12·7	
„ .	15	30·42	9·79	31·6	24·5	131·8	·00	+0·01	+0·1	58·8	—2·8	—10·4	—10·3	123·5	12·6	
„ .	30	30·72	10·09	30·8	25·3	138·1	14·00	+0·01	+0·1	58·0	—3·6	—13·3	—13·2	124·9	12·4	
„ .	45	30·45	9·82	31·1	25·0	136·5	·00	+0·01	+0·1	57·1	—4·5	—16·7	—16·6	119·9	12·2	
„ .	11-0	30·58	9·95	30·6	25·5	139·2	14·00	+0·01	+0·1	56·7	—4·9	—18·1	—18·0	121·2	12·2	
„ .	15	30·78	10·15	30·0	26·1	142·5	·01	+0·02	+0·3	56·3	—5·3	—19·6	—19·3	123·2	12·1	No fuel added after 11-30.
„ .	30	31·22	10·59	28·9	27·2	148·5	14·03	+0·04	+0·5	56·3	—5·3	—19·6	—19·1	129·4	12·2	Deflections taken.
„ .	45	31·65	11·02	28·3	27·8	151·8	·06	+0·07	+0·9	56·1	—5·5	—20·4	—19·5	132·3	12·0	Mean = 11·69 γ
„ .	12-0	31·95	11·32	28·0	28·1	153·4	14·10	+0·11	+1·4	56·0	—5·6	—20·7	—19·3	134·1	11·8	
„ .	15	31·94	11·31	28·0	28·1	153·4	·13	+0·14	+1·8	55·9	—5·7	—21·1	—19·3	134·1	11·9	Both doors slightly opened.
„ .	30	31·60	10·97	29·1	27·0	147·4	·16	+0·17	+2·2	56·0	—5·6	—20·7	—18·5	128·9	11·8	
„ .	45	31·60	10·97	30·7	25·4	138·7	14·20	+0·21	+2·7	56·3	—5·3	—19·6	—16·9	121·8	11·1	Inner door opened wide.
„ .	13-0	30·37	9·74	32·4	23·7	129·4	14·22	+0·23	+2·9	56·3	—5·3	—19·6	—16·7	112·7	11·6	Outer door opened wide.
„ .	15	29·20	8·57	34·9	21·2	115·8	·26	+0·27	+3·4	56·0	—5·6	—20·7	—17·3	98·5	11·5	
„ .	30	28·08	7·45	37·6	18·5	101·0	14·30	+0·31	+3·9	56·1	—5·5	—20·4	—16·5	84·5	11·3	
„ .	45	27·20	6·57	39·7	16·4	89·5	·34	+0·35	+4·4	56·1	—5·5	—20·4	—16·0	73·5	11·2	
„ .	14-0	26·55	5·92	41·1	15·0	81·9	14·38	+0·39	+5·0	56·7	—4·9	—18·1	—13·1	68·8	11·6	Fires removed.
„ .	15	26·20	5·57	41·9	14·2	77·5	·39	+0·40	+5·1	56·0	—5·6	—20·7	—15·6	61·9	11·1	
„ .	30	25·45	4·82	43·8	12·3	67·2	14·40	+0·41	+5·2	56·0	—5·6	—20·7	—15·5	51·7	10·7	
„ .	45	24·72	4·09	45·6	10·5	57·3	·45	+0·46	+5·8	56·0	—5·6	—20·7	—14·9	42·4	10·4	
„ .	15-0	24·15	3·52	47·0	9·1	49·7	14·50	+0·51	+6·5	56·6	—5·0	—18·5	—12·0	37·7	10·7	
„ .	15	23·70	3·07	48·3	7·8	42·6	·54	+0·55	+7·0	56·7	—4·9	—18·1	—11·1	31·5	10·3	
„ .	30	23·40	2·77	49·3	6·8	37·1	14·57	+0·58	+7·4	57·0	—4·6	—17·0	—9·6	27·5	9·9	
„ .	45	23·13	2·50	50·2	5·9	32·2	·61	+0·62	+7·9	57·2	—4·4	—16·3	—8·4	23·8	9·5	
„ .	16-0	22·93	2·30	51·1	5·0	27·3	14·66	+0·67	+8·5	57·7	—3·9	—14·4	—5·9	21·4	9·3	

C 4.

Reduction of temperature coefficient of H. F. Magnetographs (Watson's)
First experiment with Magnet 3 and Fibre 6.

		Magnet 3. Fibre 6. Inst. 1.					Magnet 1. Fibre 2. Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks.
Date.	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into Force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into Force.	Difference in ordinate corrected for temperature, *i.e.* (13) + (10).	Actual change in ordinate due to change in temperature (7) − (14).	Temperature coefficient for + 1°C., *i.e.* (15) ÷ (4).	γ = ·0000 1 C. Units. Sc. value of No. 1 Inst. = 4·82 γ. Sc. value of No. 2 Inst. = 3·70 γ. Temp. coefft. for No. 2 Inst. taken = 12·70 γ.
		Cent.	Cent.	Sc. divns.	Sc. divns.		Cent.	Cent.	γ	Sc. divns.	Sc. divns.	γ	γ	γ	γ	
	h.m.															
23 Jan. 1902 .	7-30	...	...	...	...	...	14·90	0·00	0·0	61·5	...	...	...	...	...	
" .	45	20·80	0·00	64·4	0·0	0·0	·90	0·00	0·0	61·7	0·0	0·0	0·0	0·0	...	Fires started 7-47.
" .	8-0	21·16	+0·36	63·6	−0·8	−3·9	14·90	0·00	0·0	62·0	+0·3	+1·1	+1·1	−5·0	13·9	
" .	16	24·12	3·32	54·0	−10·4	50·1	·90	0·00	0·0	61·8	+0·1	+0·4	+0·4	50·5	15·2	
" .	30	26·83	6·03	48.2	−16·2	78·1	14·90	0·00	0·0	61·8	+0·1	+0·4	+0·4	78·5	13·0	
" .	45	29·10	8·30	42·7	21·7	104·6	·90	0·00	0·0	61·5	−0·2	−0·7	−0·7	103·9	12·5	
" .	9-0	30·17	9·37	40·3	24·1	116·2	14·90	0·00	0·0	61·0	−0·7	−2·6	−2·6	113·6	12·1	
" .	15	30·38	9·58	39·1	25·3	121·9	·91	+0·01	+0·1	60·1	−1·6	−5·9	−5·8	116·1	12·1	
" .	30	30·66	9·86	37·9	26·5	127·7	14·92	+0·02	+0·3	59·2	−2·5	−9·3	−9·0	118·7	12·0	
" .	45	31·03	10·23	36·5	27·9	134·5	·93	+0·03	+0·4	58·2	−3·5	−13·0	−12·6	121·9	11·9	
" .	10-0	31·10	10·30	35·9	28·5	137·4	14·94	+0·04	+0·5	57·4	−4·3	−15·9	−15·4	122·0	11·8	
" .	15	31·00	10·20	35·7	28·7	138·3	·95	+0·05	+0·6	56·7	−5·0	−18·5	−17·9	120·4	11·8	
" .	30	31·38	10·58	34·6	29·8	143·6	14·95	+0·05	+0·6	56·0	−5·7	−21·1	−20·5	123·1	11·6	
" .	45	31·55	10·78	32·8	31·6	152·3	·96	+0·06	+0·8	55·4	−6·3	−23·3	−22·5	129·8	12·0	
" .	11·0	32·60	11·80	30·6	33·8	162·9	14·97	+0.07	+0·9	55·3	−6·4	−23·7	−22·8	140·1	11·9	No fuel added after 11-0.
.	15	33·10	12·30	29·4	35·0	168·7	·96	+0·06	+0·8	55·0	−6·7	−24·8	−24·0	144·7	11·8	Deflections taken.
" .	30	33·48	12·68	28·4	36·0	173·5	14·96	+0·06	+0·8	55·0	−6·7	−24·8	−24·0	149.5	11·8	
" .	45	33·40	12·60	29·0	35·4	170·6	·98	+0·08	+1·0	55·0	−6·7	−24·8	−23·8	146·8	11·7	
" .	12-0	32·90	12·10	30·8	33·6	162·0	15·00	+0·10	+1·3	55·0	−6·7	−24·8	−23·5	138·5	11·4	Both doors opened slightly.
" .	15	32·20	11·40	32·9	31·5	151·8	·02	+0·12	+1·5	55·0	−6·7	−24·8	−23·3	128·5	11·3	Inner doors opened wide.
" .	30	31·39	10·59	35·6	28·8	138·8	·05	+0·15	+1·9	55·0	−6·7	−24·8	−22·9	115·9	10·9	Outer doors opened wide.
" .	45	30·10	9·30	39·0	25·4	122·4	·07	+0·17	+2·2	55·1	−6·6	−24·4	−22·2	100·2	10·8	
" .	13-0	29·00	8·20	41·7	22·7	109·4	15·10	+0·20	+2·5	55·2	−6·5	−24·1	−21·6	87·8	10·7	Fires removed.
" .	15	28·20	7·40	44·0	20·4	98·3	·13	+0·23	+2·9	55·0	−6·7	−24·8	−21·9	76·4	10·3	
" .	30	27·30	6·50	46·2	18·2	87·7	15·16	+0·26	+3·3	55·0	−6·7	−24·8	−21·5	66·2	10·2	
" .	45	26·36	5·56	48·9	15·5	74·7	·20	+0·30	+3·8	55·0	−6·7	−24·8	−21·0	53·7	9·7	
" .	14-0	25·60	4·80	50·3	14·1	68·0	15·24	+0·34	+4·3	54·8	−6·9	−25·5	−21·2	46·8	9·8	
" .	16	25·00	4·20	51·8	12·6	60·7	·26	+0·36	+4·6	54·1	−7·6	−28·1	−23·5	37·2	8·9	
" .	30	24·60	3·80	52·7	11·7	56·4	15·29	+0·39	+5·0	54·1	−7·6	−28·1	−23·1	33·3	8·8	
" .	45	24·20	3·40	53·8	10·6	51·1	·33	+0·43	+5·5	54·2	−7·5	−27·8	−22·3	28·8	8·5	
" .	15-0	23·93	3·13	55·0	9·4	45·3	15·36	+0·46	+5·8	54·8	−6·9	−25·5	−19·7	25·6	8·2	
" .	15	23·78	2·98	56·3	8·1	39·0	·39	+0·49	+6·2	55·0	−6·7	−24·8	−18·6	20·4	6·9	Sharp rise of 0·7 divn. at 3 P.M. in trace of No. 1 Inst.
" .	30	23·60	2·80	57·0	7·4	35·7	15·41	+0·51	+6·5	55·4	−6·3	−23·3	−16·8	18·9	6·3	
" .	45	23·42	2·62	57·9	6·5	31·3	·45	+0·55	+7·0	55·9	−5·8	−21·5	−14·5	16.8	6·4	
" .	16-0	23·30	2·50	58·3	6·1	29·4	15·50	+0·60	+7·6	56·0	−5·7	−21·1	−13·5	15·9	6·4	

C 4a.

Table showing results of Temperature Experiment No. 1 with Magnet 3 and Fibre 6 corrected for slip.

1	2	3	4	5	6	7	
Date.	Time.	Increment in temperature after start.	Actual change in ordinate due to change in temperature.	Correction for slip.	True change in ordinate due to change in temperature =4+5.	Temperature coefficient for 1° Cent=6÷3.	REMARKS.
Civil.	L. M. T.	C.	γ	γ	γ	γ	
23-1-1902	7·45	0·00	0·0	0·0	0·0	...	Columns 1, 2, 3 and 4 are copied from columns 1, 2, 4 and 15 of the Temperature Experiment. The total slip measured from 7·45 to 16·0 is 15 γ. The curve shows a sudden jump of 0·7 Scale divns.=3·4 γ at 15·0. Consequently, a slip amounting to 11·6 γ has been applied uniformly up till 15·0, nd after that hour a slip of 15 γ has been assumed.
,,	8·0	+0·36	−5·0	−0·4	−5·4	−15·0	
,,	·16	3·32	50·5	0·8	51·3	15·5	
,,	·30	6·03	78·5	1·2	79·7	13·2	
,,	·45	8·30	103·9	1·6	105·5	12·7	
,,	9·0	9·37	113·6	2·0	115·6	12·3	
,,	·15	9·58	116·1	2·4	118·5	12·4	
,,	·30	9·86	118·7	2·8	121·5	12·3	
,,	·45	10·23	121·9	3·2	125·1	12·2	
,,	10·0	10·30	122·0	3·6	125·6	12·2	
,,	·15	10·20	120·4	4·0	124·4	12·2	
,,	·30	10·58	123·1	4·4	127·5	12·1	
,,	·45	10·78	129·8	4·8	134·6	12·4	
,,	11·0	11·80	140·1	5·2	145·3	12·3	
,,	·15	12·30	144·7	5·6	150·3	12·2	
,,	·30	12·68	149·5	6·0	155·5	12·3	
,,	·45	12·60	146·8	6·4	153·2	12·2	Mean 12·07 γ
,,	12·0	12·10	138·5	6·8	145·3	12·0	
,,	·15	11·40	128·5	7·2	135·7	11·9	
,,	·30	10·59	115·9	7·6	123·5	11·7	
,,	·45	9·30	100·2	8·0	108·2	11·6	
,,	13·0	8·20	87·8	8·4	96·2	11·7	
,,	·15	7·40	76·4	8·8	85·2	11·5	
,,	·30	6·50	66·2	9·2	75·4	11·6	
,,	·45	5·56	53·7	9·6	63·3	11·4	
,,	14·0	4·80	46·8	10·0	56·8	11·8	
,,	·16	4·20	37·2	10·4	47·6	11·3	
,,	·30	3·80	33·3	10·8	44·1	11·6	
,,	·45	3·40	28·8	11·2	40·0	11·8	
,,	15·0	3·13	25·6	11·6	37·2	11·9	
,,	·15	2·98	20·4	15·0	35·4	11·9	
,,	·30	2·80	18·9	15·0	33·9	12·1	
,,	·45	2·62	16·8	15·0	31·8	12·1	
,,	16·0	2·50	15·9	15·0	30·9	12·4	

C 5

Reduction of temperature coefficient of H. F. Magnetograph (Watson's) Second Experiment with Magnet 3 and Fibre 6.

		Magnet 3, Fibre 6, Inst. 1.					Magnet 1, Fibre 2, Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks.
Date.	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Difference in ordinate corrected for temperature, *i.e.* (13)+(10).	Actual change in ordinate due to change in temperature (7)—(14).	Temperature coefficient for +1°C, *i.e.*, (15)÷(4).	γ ·00001 C. G. S. Units. Scale coefficient of No. 1 Inst.=4·82γ. Scale coefficient of No. 2 Instrument =3·70γ. Temperature coefficient for No. 2 instrument taken −12·7γ.
	h.m.	Cent.	Cent.	Sc. divns.	Sc. divns.	γ	Cent.	Cent.	γ	Sc. divns.	Sc. divns.	γ	γ	γ	γ	
28th Jan. 1902	7-45	21·38	0·00	75·0	0·0	0·0	15·60	0·00	0·0	62·0	0·0	0·0	0·0			Fires started at 7·50
"	8-0	21·42	+ 04	74·3	−0·7	−3·4	15·62	+0·02	+0·3	62·6	+0·6	+2·2	+2·5	−5·9		
"	15	21·67	0·29	73·0	2·0	9·6	·61	0·01	0·1	62·9	+0·9	+3·3	+3·4	13·0		
"	30	23·83	2·45	68·0	7·0	33·7	15·60	0·00	0·0	63·6	+1·6	+5·9	+5·9	39·6	−16·2	
"	45	26·84	5·46	60·0	15·0	72·3	·61	0.01	0·1	63·9	+1·9	+7·0	+7·1	79·4	14·5	
"	9-0	29·18	7·80	55·5	19·5	94·0	15·62	0·02	0·3	64·1	+2·1	+7·8	+8·1	102·1	13·1	
"	15	29·92	8·54	53·9	21·1	101·7	·66	0·06	0·8	64·3	+2·3	+8·5	+9·3	111·0	13·0	
"	30	31·09	9·71	51·3	23·7	114·2	15·70	0·10	1·3	64·2	+2·2	+8·1	+9·4	123·6	12·7	
"	45	31·67	10·29	49·0	26·0	125·3	·71	0·11	1·4	63·5	+1·5	+5·6	+7·0	132·3	12·9	
"	10-0	32·24	10·86	46·9	28·1	135·4	15·72	0·12	1·5	62·6	+0·6	+2·2	+3·7	139·1	12·8	
"	15	32·60	11·22	44·8	30·2	145·6	·73	0·13	1·7	60·8	−1·2	−4·4	−2·7	142·9	12·7	No fuel added after 10-15.
"	30	33·20	11·82	42·8	32·2	155·2	15·74	0·14	1·8	59·9	−2·1	−7·8	−6·0	149·2	12·6	Deflections taken.
"	45	33·75	12·37	41·1	33·9	163·4	·75	0·15	1·9	59·0	−3·0	−11·1	−9·2	154·2	12·5	
"	11-0	33·60	12·22	41·8	33·2	160·0	15·76	0·16	2·0	58·9	−3·1	−11·5	−9·5	150·5	12·3	
"	15	33·16	11·78	43·8	31·2	150·4	·77	0·17	2·2	59·1	−2·9	−10·7	−8·5	141·9	12·0	
"	30	32·58	11·20	45·2	29·8	143·6	15·78	0·18	2·3	59·2	−2·8	−10·4	−8·1	135·5	12·1	Mean 12·17γ.
"	45	31·92	10·54	47·5	27·5	132·6	·79	0·19	2·4	59·5	−2·5	−9·3	−6·9	125·7	11·9	Opened both doors wide.
"	12-0	30·62	9·24	51·2	23·8	114·7	15·80	0·20	2·5	60·0	−2·0	−7·4	−4·9	109·8	11·9	
"	15	29·38	8·00	55·0	20·0	96·4	·81	0·21	2·7	60·1	−1·9	−7·0	−4·3	92·1	11·5	
"	30	27·88	6·50	58·8	16·2	78·1	15·83	0·23	2·9	60·1	−1·9	−7·0	−4·1	74·0	11·4	
"	45	26·58	5·20	62·0	13·0	62·7	·86	0·26	3·3	60·0	−2·0	−7·4	−4·1	58·6	11·3	
"	13-0	25·66	4·28	64·0	11·0	53·0	15·90	0·30	3·8	59·8	−2·2	−8·1	−4·3	48·7	11·4	
"	15	25·08	3·70	65·2	9·8	47·2	·93	0·33	4·2	59·0	−3·0	−11·1	−6·9	40·3	10·9	
"	30	24·44	3·06	66·0	9·0	43·4	·97	0·37	4·7	58·6	−3·4	−12·6	−7·9	35·5	11·6	
"	45	24·14	2·76	67·2	7·8	37·6	16·00	0·40	5·1	58·7	−3·3	−12·2	−7·1	30·5	11·1	
"	14-0	23·84	2·46	68·0	7·0	33·7	16·03	0·43	5·5	58·8	−3·2	−11·8	−6·3	27·4	11·1	
"	15	23·68	2·30	68·7	6·3	30·4	·08	0·48	6·1	59·0	−3·0	−11·1	−5·0	25·4	11·0	
"	30	23·56	2·18	68·8	6·2	29·9	16·13	0·53	6·7	58·8	−3·2	−11·8	−5·1	24·8	11·4	
"	45	23·38	2·00	69·4	5·6	27·0	·17	0·57	7·2	58·5	−3·5	−13·0	−5·8	21·2	10·6	
"	15-0	23·23	1·85	69·7	5·3	25·5	16·20	0·60	7·6	58·5	−3·5	−13·0	−5·4	20·1	10·9	
"	15	23·13	1·75	69·9	5·1	24·6	·24	0·64	8·1	58·1	−3·9	−14·4	−6·3	18·3	10·5	
"	30	23·00	1·62	70·0	5·0	24·1	16·28	0·68	8·6	57·9	−4·1	−15·2	−6·6	17·5	10·8	
"	45	22·88	1·50	70·2	4·8	23·1	·32	0·72	9·1	57·5	−4·5	−16·7	−7·6	15·5	10·3	
"	16-0	22·80	1·42	70·2	4·8	23·1	16·35	0·75	9·5	57·4	−4·6	−17·0	−7·5	15·6	11·0	

C 6.

Reduction of temperature coefficient of H. F. Magnetograph (Watson's). Third experiment with Magnet 2 ana Fibre 12.

		Magnet 2. Fibre 12. Inst. 1.					Magnet 1. Fibre 2. Inst. 2.								
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks.
Date.	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Difference corrected for temperature, *i.e.*, (13) + (10).	Actual change in ordinate due to change in temperature, *i.e.*, (7)—(14).	Temperature coefficient for + 1°C., *i.e.* (15) ÷ (4).	γ = ·00001 C. G.S. Units. Sc. Coefft. of No. 1 Inst. = 6·50 γ. Sc. Coefft. of No. 2 Inst. = 3·70 γ. Temp. Coefft. of No. 2 Inst. taken = —12·7 γ.
	h.m.	Cent.	Cent.	Sc. Divn.	Sc. Divn.	γ	Cent.	Cent.	γ.	Sc. Divn.	Sc. Divn.	γ.	γ.	γ.	γ.	
31st Jan. 1902	7·52	19·64	0·00	62·0	0·0	0·0	16·42	0·00	0·0	59·8	0·0	0·0	0·0	0·0		
„	8·0	19·81	+0·17	61·7	− 0·3	−2·0	16·40	−0·02	−0·3	60·0	+0·2	+ 0·7	+ 0·4	− 2·4	− 14·1	Fire started 7·55.
„	15	20·86	1·21	59·0	3·0	19·5	·40	−0·02	−0·3	60·0	+0·2	+ 0·7	+ 0·4	19·9	16·3	Deflections taken.
„	30	25·00	5·36	51·3	10·7	69·6	16·40	−0·02	−0·3	60·0	+0·2	+ 0·7	+ 0·4	70·0	13·1	Both doors slightly
„	45	28·50	8·86	44·8	17·2	111·8	·40	−0·02	−0·3	60·0	+0·2	+ 0·7	+ 0·4	112·2	12·7	opened.
„	9·0	30·64	11·00	40·2	21·8	141·7	16·40	−0·02	−0·3	59·7	−0·1	− 0·4	− 0·7	141·0	12·8	Both doors opened
„	15	31·63	11·99	38·1	23·9	155·4	·40	−0·02	−0·3	59·8	0·0	0·0	− 0·3	155·1	13·0	wide.
„	30	32·68	13·04	36·0	26·0	169·0	16·40	−0·02	−0·3	59·0	−0·8	− 3·0	− 3·3	165·7	12·7	Fire removed.
„	45	33·40	13·76	34·7	27·3	177·5	·41	−0·01	−0·1	59·0	−0·8	− 3·0	− 3·1	174·4	12·7	
„	10·0	33·40	14·76	32·6	29·4	191·1	16·43	+0·01	+0·1	58·7	−1·1	− 4·1	− 4·0	187·1	12·7	
„	15	34·75	15·11	31·8	30·2	196·3	·44	+0·02	+0·3	58·0	−1·8	− 6·7	− 6·4	189·9	12·6	
„	30	34·80	15·16	31·1	30·9	200·9	16·45	+0·03	+0·4	57·2	−2·6	− 9·6	− 9·2	191·7	12·6	
„	45	35·70	16·06	29·2	32·8	213·2	·47	+0·05	+0·6	56·9	−2·9	−10·7	−10·1	203·1	12·6	
„	11·0	35·40	15·76	29·8	32·2	209·3	16·48	+0·06	+0·8	56·0	−3·8	−14·1	−13·3	196·0	12·4	
„	19	34·70	15·06	31·1	30·9	200·9	·49	+0·07	+0·9	55·3	−4·5	−16·7	−15·8	185·1	12·3	
„	30	34·70	15·06	31·0	31·0	201·5	16·50	+0·08	+1·0	55·2	−4·6	−17·0	−16·0	185·5	12·3	
„	45	34·42	14·78	31·5	30·5	198·3	·52	+0·10	+1·3	55·0	−4·8	−17·8	−16·5	181·8	12·3	
„	12·00	33·80	14·16	33·0	29·0	188·5	16·54	+0·12	+1·5	55·4	−4·4	−16·3	−14·8	173·7	12·3	
„	15	32·28	12·64	36·0	26·0	169·0	·57	+0·15	+1·9	55·0	−4·8	−17·8	−15·9	153·1	12·1	
„	30	30·88	11·24	38·7	23·3	151·5	16·60	+0·18	+2·3	54·1	−5·7	−21·1	−18·8	132·7	11·8	
„	45	29·72	10·08	41·0	21·0	136·5	·61	+0·19	+2·4	54·6	−5·2	−19·2	−16·8	119·7	11·9	
„	13·0	28·26	8·62	44·7	17·3	112·5	16·62	+0·20	+2·5	55·3	−4·5	−16·7	−14·2	98·3	11·4	
„	15	27·08	7·44	47·1	14·9	96·9	·63	+0·21	+2·7	56·0	−3·8	−14·1	−11·4	85·5	11·5	
„	30	26·12	6·48	48·5	13·5	87·8	16·64	+0·22	+2·8	55·2	−4·6	−17·0	−14·2	73·6	11·4	
„	45	25·46	5·82	49·8	12·2	79·3	·67	+0·25	+3·2	55·1	−4·7	−17·4	−14·2	65·1	11·2	
„	14·0	25·14	5·50	50·9	11·1	72·2	16·70	+0·28	+3·6	55·4	−4·4	−16·3	−12·7	59·5	10·8	
„	15	24·72	5·08	51·7	10·3	67·0	·73	+0·31	+3·9	55·5	−4·3	−15·9	−12·0	55·0	10·8	
„	30	24·42	4·78	51·9	10·1	65·7	16·76	+0·34	+4·3	55·1	−4·7	−17·4	−13·1	52·6	11·0	
„	45	24·18	4·54	52·4	9·6	62·4	·79	+0·37	+4·7	55·1	−4·7	−17·4	−12·7	49·7	10·9	
„	15·0	23·06	4·32	52·9	9·1	59·2	16·82	+0·40	+5·1	55·2	−4·6	−17·0	−11·9	47·3	10·9	At 14·56 the curve of No. 2 has been displaced sharply by 1·0 Sc. divns. All measures after 15 have been cleared from this irregularity which is evidently accidental, as there is no sign of it in the curve of No. 1 Inst.
„	15	23·80	4·16	53·1	8·9	57·9	·84	+0·42	+5·3	55·1	−4·7	−17·4	−12·1	45·8	11·0	
„	30	23·74	4·10	53·4	8·6	55·9	·86	+0·44	+5·6	55·1	−4·7	−17·4	−11·8	44·1	10·8	
„	45	23·60	3·96	53·9	8·1	52·7	·88	+0·46	+5·8	55·3	−4·5	−16·7	−10·9	41·8	10·6	
„	16·0	23·48	3·84	54·1	7·9	51·4	16·90	+0·48	+6·1	55·8	−4·0	−14·8	− 8·7	42·7	11·1	

C 6a.

Table showing results of Temperature Experiment No. 3 with Magnet 2 and Fibre 12 corrected for slip.

1	2	3	4	5	6	7	
Date.	Time.	Increment in temperature after start.	Actual change in ordinate due to change in temperature.	Correction for slip.	True change in ordinate due to change in temperature.	Temperature coefficient for 1° Cent = 6 ÷ 3.	Remarks.
Civil.	L. M. T.	C	γ	γ	γ	γ	
31st Jan. 1902	7·52	0·0	0·0	0·0	0·0	...	Columns 1, 2, 3 and 4 are copied from columns 1, 2, 4 and 15 of the temperature experiment. The total slip measured from 7·50 to 16·0 is 10γ and this has been distributed uniformly throughout.
"	8·0	+0·17	−2·4	−0·3	−2·7	−15·9	
"	15	1·22	19·9	0·6	20·5	16·8	
"	30	5·36	70·0	0·9	70·9	13·2	
"	45	8·86	112·2	1·2	113·4	12·8	
"	9·0	11·00	141·0	1·5	142·5	13·0	
"	15	11·99	155·1	1·8	156·9	13·1	
"	30	13·04	165·7	2·1	167·8	12·9	
"	45	13·76	174·4	2·4	176·8	12·9	
"	10·0	14·76	187·1	2·7	189·8	12·9	
"	15	15·11	189·9	3·0	192·0	12·8	
"	30	15·16	191·7	3·3	195·0	12·9	
"	45	16·06	203·1	3·7	206·7	12·9	Mean 12·60γ (rows 10·45 to 12·45)
"	11·0	15·76	196·0	4·0	200·0	12·7	
"	19	15·06	185·1	4·3	189·4	12·6	
"	30	15·06	185·5	4·6	190·1	12·6	
"	45	14·78	181·8	4·9	186·7	12·7	
"	12·0	14·16	173·7	5·2	178·9	12·6	
"	15	12·64	153·1	5·5	158·6	12·5	
"	30	11·24	132·7	5·8	138·5	12·3	
"	45	10·08	119·7	6·1	125·8	12.5	
"	13·0	8·62	98·3	6·4	104·7	12·1	
"	15	7·44	85·5	6·7	92·2	12·4	
"	30	6·48	73·6	7·0	80·6	12·4	
"	45	5·82	65·1	7·3	72·4	12·5	
"	14·0	5·50	59·5	7·6	67·1	12·2	
"	15	5·08	55·0	7·9	62·9	12·4	
"	30	4·78	52·6	8·2	60·8	12·7	
"	45	4·54	49·7	8·5	58·2	12·8	
"	15·0	4·32	47·3	8·8	56·1	13·0	
"	15	4·16	45·8	9·1	54·9	13·2	
"	30	4·10	44·1	9·4	53·5	13·0	
"	45	3·96	41·8	9·7	51·5	13·0	
"	16·0	3·84	42·7	10·0	52·7	13·7	

C. 7.

Reduction of temperature coefficient of Horizontal Force Magnetograph (Watson's).
First Experiment with Magnet 3 and Fibre 3.

		Magnet 3. Fibre 3. Inst. 1.					Magnet 1. Fibre 2. Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks.
Date.	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Differences in ordinate converted into force.	Difference in ordinate corrected for temperature, *i.e.*, (13)+(10).	Actual change in ordinate due to change in temperature (7)−(14).	Temperature coefficient for +1°C, *i.e.*, (15)÷(4).	γ = ·00001 C. G. S. Units. Scale coefficient of No. 1 Instrument = 4·81 γ. Scale coefficient of No. 2 Instrument = 3·71 γ. Temperature coefficient of No. 2 instrument taken = −12·7 γ.
	h. m.	Cent.	Cent.	Sc. Divn.	Sc. divn.	γ	Cent.	Cent.	γ	S. C. divn.	S. C. divn.	γ	γ	γ	γ	
6th Feby. 1902	7-4	21·05	0·00	75·0	0·0	0·0	14·75	0·00	0·0	64·3	0·0	0·0	0·0	0·0	...	Fires lighted.
	8-0	21·29	+0·24	74·3	−0·7	−3·4	14·74	−0·01	−0·1	64·4	+0·1	+0·4	+0·3	−3·7	−15·4	
„	15	22·80	1·75	70·0	5·0	24·1	·73	−0·02	−0·3	65·1	+0·8	+3·0	+2·7	26·8	15·3	
„	30	26·60	5·55	59·5	15·5	74·6	14·72	−0·03	−0·4	65·0	+0·7	+2·6	+2·2	76·8	13·8	
„	45	29·50	8·45	52·3	22·7	109·2	·73	−0·02	−0·3	64·7	+0·4	+1·5	+1·2	110·4	13·1	
„	9-0	30·63	9·58	49·0	26·0	125·1	14·74	−0·01	−0·1	64·3	0·0	0·0	−0·1	125·0	13·0	
„	15	31·80	10·75	45·9	29·1	140·0	·75	0·00	0·0	64·1	−0·2	−0·7	−0·7	139·3	13·0	
„	30	33·50	12·45	42·1	32·9	158·2	14·76	+0·01	+0·1	63·9	−0·4	−1·5	−1·4	156·8	12·6	
„	45	33·80	12·75	39·8	35·2	169·3	·76	+0·01	+0·1	63·0	−1·3	−4·8	−4·7	164·6	12·9	
„	10-0	34·10	13·05	38·9	36·1	173·6	14·76	+0·01	+0·1	62·9	−1·4	−5·2	−5·1	168·5	12·9	Last fuel added. Deflection taken.
„	15	34·25	13·20	38·0	37·0	178·0	·76	+0·01	+0·1	62·4	−1·9	−7·0	−6·9	171·1	13·0	
„	30	34·56	13·51	37·5	37·5	180·4	14·76	+0·01	+0·1	62·8	−1·5	−5·6	−5·5	174·9	12·9	
„	45	35·18	14·13	35·8	39·2	188·6	·77	+0·02	+0·3	62·7	−1·6	−5·9	−5·6	183·0	13·0	
„	11-0	35·40	14·35	35·1	39·9	191·9	14·78	+0·03	+0·4	62·8	−1·5	−5·6	−5·2	186·7	13·0	
„	15	34·78	13·73	37·1	37·9	182·3	·78	+0·03	+0·4	62·8	−1·5	−5·6	−5·2	177·1	12·9	Mean 12·90 γ.
„	30	33·84	12·79	39·8	35·2	169·3	14·78	+0·03	+0·4	62·8	−1·5	−5·6	−5·2	164·1	12·8	Both doors half opened.
„	45	32·86	11·81	42·5	32·5	156·3	·79	+0·04	+0·5	62·8	−1·5	−5·6	−5·1	151·2	12·8	Both doors opened wide.
„	12-0	31·76	10·71	46·2	28·8	138·5	·80	+0·05	+0·6	63·8	−0·5	−1·9	−1·3	137·2	12·8	
„	15	Omitted.	...	50·6	24·4	117·4	14·82	+0·07	+0·9	64·1	−0·2	−0·7	+0·2	117·6	...	Fires removed.
„	30	28·90	7·85	53·4	21·6	103·9	·87	+0·12	+1·5	63·8	−0·5	−1·9	−0·4	113·5	14·5	
„	45	26·60	5·55	57·4	17·6	84·7	14·92	+0·17	+2·2	63·9	−0·4	−1·5	+0·7	85·4	15·4	
„	13-0	26·45	5·40	60·0	15·0	72·2	14·94	+0·19	+2·4	63·8	−0·5	−1·9	+0·5	72·7	13·5	
„	15	25·70	4·65	62·3	12·7	61·1	·97	+0·22	+2·8	63·7	−0·6	−2·2	+0·6	61·7	13·3	
„	30	25·10	4·05	63·5	11·5	55·3	15·00	+0·25	+3·2	63·3	−1·0	−3·7	−0·5	54·8	13·5	
„	45	24·50	3·45	64·8	10·2	49·1	·04	+0·29	+3·7	63·1	−1·2	−4·5	−0·8	48·3	14·0	
„	14-0	24·25	3·20	66·0	9·0	43·3	·08	+0·33	+4·2	63·6	−0·7	−2·6	+1·6	44·9	14·0	
„	15	23·85	2·80	66·9	8·1	39·0	15·12	+0·37	+4·7	63·4	−0·9	−3·3	+1·4	40·4	14·4	
„	30	23·55	2·50	67·5	7·5	36·1	·16	+0·41	+5·2	63·4	−0·9	−3·3	+1·9	38·0	15·2	
„	45	23·35	2·30	68·1	6·9	33·2	·20	+0·45	+5·7	63·4	−0·9	−3·3	+2·4	35·6	15·5	
„	15-0	23·20	2·15	68·4	6·6	31·7	·24	+0·49	+6·2	63·3	−1·0	−3·7	+2·5	34·2	15·9	
„	15	23·10	2·05	69·0	6·0	28·9	15·28	+0·53	+6·7	63·6	−0·7	−2·6	+4·1	33·0	16·1	
„	30	22·95	1·90	69·5	5·5	26·5	·32	+0·57	+7·2	63·7	−0·6	−2·2	+5·0	31·5	16·6	
„	45	22·90	1·85	69·7	5·3	25·5	15·36	+0·61	+7·7	63·7	−0·6	−2·2	+5·5	31·0	16·8	
„	16-0	22·75	1·70	70·4	4·6	22·1	15·40	+0·65	+8·3	64·2	−0·1	−0·4	+7·9	30·0	17·6	

C 8

Reduction of temperature coefficient of Horizontal Force Magnetograph (Watson's).
First experiment with Magnet 3 and Fibre 4.

		Magnet 3. Fibre 4. Inst. 1.					Magnet 1. Fibre 2. Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks
Date	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Difference in ordinate corrected for temperature, *i.e.*, (13) + (10).	Actual change in ordinate due to change in temperature (7) − (14).	Temperature coefficient for + 1°C, *i.e.*, (15) ÷ (4).	γ = ·00001 C. G. S. Units. Scale value of No. 1 instrument = 5·02γ. Scale value of No. 2 instrument = 3·71γ. Temperature coefficient for No. 2 instrument taken = −12·7γ.
	h. m.	Cent.	Cent.	Sc. divns.	Sc. divns.	γ	Cent.	Cent.	γ	Sc. divns.	Sc. divns.	γ	γ	γ	γ	
10th Feb. 1902.	7-32	19·90	0·00	65·0	0·0	0·0	14·70	0·00	0·0	63·1	0·0	0·0	0·0	0·0	...	Fires lighted 7·32.
,,	47	20·35	+0·45	63·9	−1·1	−5·5	·70	0·00	0·0	63·0	−0·1	−0·4	−0·4	−5·1	−11·3	
,,	8-2	22·20	2·30	57·8	7·2	36·1	14·70	0·00	0·0	63·6	+0·5	+1·9	+1·9	38·0	16·5	
,,	17	26·80	6·90	45·0	20·0	100·4	·70	0·00	0·0	64·3	+1·2	+4·5	+4·5	104·9	15·2	
,,	32	29·20	9·30	39·9	25·1	126·0	14·70	0·00	0·0	64·4	+1·3	+4·8	+4·8	130·8	14·1	
,,	47	31·40	11·50	35·9	29·1	146·1	·70	0·00	0·0	64·4	+1·3	+4·8	+4·8	150·9	13·1	
,,	9-2	32·20	12·30	33·9	31·1	156·1	14·70	0·00	0·0	64·2	+1·1	+4·1	+4·1	160·2	13·0	
,,	17	33·60	13·70	30·0	35·0	175·7	·70	0·00	0·0	64·0	+0·9	+3·3	+3·3	179·0	13·1	
,,	32	34·60	14·70	27·4	37·6	188·8	14·70	0·00	0·0	63·4	+0·3	+1·1	+1·1	189·9	12·9	
,,	47	35·20	15·30	26·3	38·7	194·3	·69	−0·01	−0·1	63·1	0·0	0·0	−0·1	194·2	12·7	
,,	10-2	35·80	15·90	25·0	40·0	200·8	14·68	−0·02	−0·3	63·0	−0·1	−0·4	−0·7	200·1	12·6	
,,	16	35·44	15·54	26·8	38·2	191·8	·68	−0·02	−0·3	63·1	0·0	0·0	−0·3	191·5	12·3	
,,	30	34·70	14·80	28·9	36·1	181·2	·68	−0·02	−0·3	63·0	−0·1	−0·4	−0·7	180·5	12·2	Last fuel added.
,,	44	34·50	14·60	29·0	36·0	180·7	·68	−0·02	−0·3	62·4	−0·7	−2·6	−2·9	177·8	12·2	Deflections taken.
,,	11-0	35·38	15·48	26·0	39·0	195·8	14·68	−0·02	−0·3	62·0	−1·1	−4·1	−4·4	191·4	12·4	
,,	15	35·70	15·80	25·3	39·7	199·3	·69	−0·01	−0·1	61·7	−1·4	−5·2	−5·3	194·0	12·3	
,,	30	35·24	15·34	27·3	37·7	189·3	·70	0·00	0·0	61·9	−1·2	−4·5	−4·5	184·8	12·0	
,,	45	34·42	14·52	30·0	35·0	175·7	·71	+0·01	+0·1	61·8	−1·3	−4·8	−4·7	171·0	11·8	Both doors opened slightly.
,,	12-0	33·50	13·60	32·8	32·2	161·6	14·72	+0·02	+0·3	61·6	−1·5	−5·6	−5·3	156·3	11·5	Both doors opened wide.
,,	15	31·70	11·80	37·8	27·2	136·5	·75	+0·05	+0·6	61·9	−1·2	−4·5	−3·9	132·6	11·2	Fires removed.
,,	30	30·25	10·35	42·0	23·0	115·5	·78	+0·08	+1·0	62·1	−1·0	−3·7	−2·7	112·8	10·9	
,,	45	28·70	8·80	46·2	18·8	94·4	·82	+0·12	+1·5	62·0	−1·1	−4·1	−2·6	91·8	10·4	
,,	13-0	27·50	7·60	49·6	15·4	77·3	14·86	+0·16	+2·0	61·5	−1·6	−5·9	−3·9	73·4	9·7	
,,	15	26·40	6·50	51·9	13·1	65·8	·92	+0·22	+2·8	61·0	−2·1	−7·8	−5·0	60·8	9·4	
,,	30	25·70	5·80	53·6	11·4	57·2	14·98	+0·28	+3·6	60·6	−2·5	−9·3	−5·7	51·5	8·9	
,,	45	25·20	5·30	54·5	10·5	52·7	15·00	+0·30	+3·8	60·1	−3·0	−11·1	−7·3	45·4	8·6	
,,	14-0	24·80	4·90	55·2	9·8	49·2	·02	+0·32	+4·1	59·9	−3·2	−11·9	−7·8	41·4	8·5	
,,	15	24·50	4·60	55·6	9·4	47·2	·05	+0·35	+4·4	59·2	−3·9	−14·5	−10·1	37·1	8·1	
,,	30	24·25	4·35	56·2	8·8	44·2	15·08	+0·38	+4·8	59·0	−4·1	−15·2	−10·4	33·8	7·8	
,,	45	24·10	4·20	56·3	8·7	43·7	·12	+0·42	+5·3	58·3	−4·8	−17·8	−12·5	31·2	7·4	
,,	15-0	23·90	4·00	56·8	8·2	41·2	15·17	+0·47	+6·0	58·3	−4·8	−17·8	−11·8	29·4	7·4	
,,	15	23·70	3·80	57·2	7·8	39·2	·21	+0·51	+6·5	58·1	−5·0	−18·6	−12·1	27·1	7·1	
,,	30	23·60	3·70	57·7	7·3	36·6	·25	+0·55	+7·0	58·3	−4·8	−17·8	−10·8	25·8	7·0	
,,	45	23·50	3·80	58·0	7·0	35·1	·29	+0·59	+7·5	58·0	−5·1	−18·9	−11·4	23·7	6·6	
,,	16-0	23·35	3·45	58·1	6·9	34·6	15·33	+0·63	+8·0	58·1	−5·0	−18·6	−10·6	24·0	7·0	

C 8a.

Table showing results of Temperature Experiment No. 1 with Magnet 3 and Fibre 4 corrected for slip.

1	2	3	4	5	6	7	
Date.	Time.	Increment in temperature after start.	Actual change in ordinate due to change in temperature.	Correction for slip.	True change in ordinate due to change in temperature.	Temperature coefficient for 1° Cent. = 6 ÷ 3.	REMARKS.
Civil.	L. M. T.	Cent.	γ	γ	γ	γ	
10th Feb. 1902 .	7·32	0·0	0·0	0·0	...	...	Columns 1, 2, 3 and 4 are copied from columns 1, 2, 4 and 15 of the Temperature Experiment.
,, . .	47	+0·45	−5·1	−0·5	−5·6	−12·4	The total slip measured from 7-30 to 16·0 is 19γ and this has been distributed uniformly throughout.
,, . .	8·2	2·30	38·0	1·1	39·1	17·0	
,, . .	17	6·90	104·9	1·7	106·6	15·4	
,, . .	32	9·30	130·8	2·3	133·1	14·3	
,, . .	47	11·50	150·9	2·9	153·8	13·4	
,, . .	9·2	12·30	160·2	3·5	163·7	13·3	
,, . .	17	13·70	179·0	4·1	183·1	13·4	
,, . .	32	14·70	189·9	4·7	194·6	13·2	
,, . .	47	15·30	194·2	5·2	199·4	13·0	
,, . .	10·2	15·90	200·1	5·8	205·9	12·9	
,, . .	16	15·54	191·5	6·3	197·8	12·7	
,, . .	30	14·80	180·5	6·9	187·4	12·7	
,, . .	44	14·60	177·8	7·4	185·2	12·7	
,, . .	11·0	15·48	191·4	8·0	199·4	12·9	
,, . .	15	15·80	194·0	8·5	202·5	12·8	
,, . .	30	15·34	184·8	9·1	193·9	12·6	Mean 12·49γ.
,, . .	45	14·52	171·0	9·6	180·6	12·4	
,, . .	12·0	13·60	156·3	10·2	166·5	12·2	
,, . .	15	11·80	132·6	10·7	143·3	12·1	
,, . .	30	10·35	112·8	11·3	124·1	12·0	
,, . .	45	8·80	91·8	11·8	103·6	11·8	
,, . .	13·0	7·60	73·4	12·4	85·8	11·3	
,, . .	15	6·50	60·8	12·9	73·7	11·4	
,, . .	30	5·80	51·5	13·5	65·0	11·3	
,, . .	45	5·30	45·4	14·0	59·4	11·2	
,, . .	14·0	4·90	41·4	14·6	56·0	11·4	
,, . .	15	4·60	37·1	15·1	52·2	11·3	
,, . .	30	4·35	33·8	15·7	49·5	11·4	
,, . .	45	4·20	31·2	16·2	47·4	11·3	
,, . .	15·0	4·00	29·4	16·8	46·2	11·6	
,, . .	15	3·80	27·1	17·3	44·4	11·7	
,, . .	30	3·70	25·8	17·9	43·7	11·8	
,, . .	45	3·60	23·7	18·4	42·1	11·7	
,, . .	16·0	3·45	24·0	19·0	43·0	12·5	

C. 9.

Reduction of temperature coefficient of Horizontal Force Magnetograph (Watson's).
Second experiment with Magnet 3 and Fibre 4.

	Magnet 3. Fibre 4. Inst. 1.						Magnet 1. Fibre 2. Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks.
Date.	Time	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Difference in ordinate corrected for temperature i.e. (13)+(10).	Actual change in ordinate due to change in temperature (7)−(14).	Temperature coefficient for +1°C, i.e. (15)÷(4).	γ =.00001 C. G. S. Units. Scale value of No. 1 instrument=5.02γ. Scale value of No. 2 instrument=3.71γ. Temperature coefficient of No. 2 instrument taken =−12.7γ.
	h. m.	Cent.	Cent.	Sc. divns.	Sc. divns.	γ	Cent.	Cent.	γ	Sc. divns.	Sc. divns.	γ	γ	γ	γ	
12th Feb. 1902	7-28	20.05	0.00	70.7	0.0	0.0	15.37	0.00	0.0	63.5	0.0	0.0	0.0	0.0		Fires lighted at 7-30.
"	45	20.70	+0.65	69.4	− 1.3	− 6.5	.37	0.00	0.0	64.6	+1.1	+ 4.1	+ 4.1	−10.6	−16.3	
"	8-0	24.50	4.45	57.0	13.7	68.8	15.38	+0.01	+ 0.1	65.2	+1.7	+ 6.3	+ 6.4	75.2	16.9	
"	15	28.40	8.35	47.5	23.2	116.5	.34	−0.03	− 0.4	65.7	+2.2	+ 8.2	+ 7.8	124.3	14.9	
"	30	30.70	10.65	43.7	27.0	135.5	15.30	−0.07	− 0.9	65.5	+2.0	+ 7.4	+ 6.5	142.0	13.3	
"	45	32.20	12.15	39.7	31.0	155.6	.30	−0.07	− 0.9	65.0	+1.5	+ 5.6	+ 4.7	160.3	13.2	
"	9-0	33.60	13.55	35.3	35.4	177.7	15.30	−0.07	− 0.9	64.9	+1.4	+ 5.2	+ 4.3	182.0	13.4	
"	15	35.00	14.95	32.9	37.8	189.8	.33	−0.04	− 0.5	64.5	+1.0	+ 3.7	+ 3.2	193.0	12.9	
"	30	35.10	15.05	33.1	37.6	188.8	15.36	−0.01	− 0.1	64.3	+0.8	+ 3.0	+ 2.9	191.7	12.7	
"	45	35.20	15.15	32.4	38.3	192.3	.35	−0.02	− 0.3	64.2	+0.7	+ 2.6	+ 2.3	194.6	12.8	
"	10-0	35.30	15.25	31.9	38.8	194.8	15.35	−0.02	− 0.3	63.6	+0.1	+ 0.4	+ 0.1	194.9	12.8	
"	15	35.40	15.35	31.8	38.9	195.3	.36	−0.01	− 0.1	63.7	+0.2	+ 0.7	+ 0.6	195.9	12.8	
"	30	36.00	15.95	30.1	40.6	203.8	.37	0.00	0.0	63.8	+0.3	+ 1.1	+ 1.1	204.9	12.8	
"	45	36.60	16.55	28.4	42.3	212.3	15.38	+0.01	+ 0.1	63.2	−0.3	− 1.1	− 1.0	211.3	12.8	
"	11-0	36.85	16.80	28.8	41.9	210.3	.39	+0.02	+ 0.3	64.0	+0.5	+ 1.9	+ 2.2	212.5	12.6	Deflection taken.
"	17	36.16	16.11	31.0	39.7	199.3	.40	+0.03	+ 0.4	64.0	+0.5	+ 1.9	+ 2.3	201.6	12.5	Last fuel added.
"	30	35.60	15.55	32.4	38.3	192.3	15.42	+0.05	+ 0.6	64.0	+0.5	+ 1.9	+ 2.5	194.8	12.5	
"	45	35.78	15.73	32.1	38.6	193.8	.45	+0.08	+ 1.0	64.3	+0.8	+ 3.0	+ 4.0	197.8	12.6	
"	12-0	35.50	15.45	33.9	36.8	184.7	15.48	+0.11	+ 1.4	65.1	+1.6	+ 5.9	+ 7.3	192.0	12.4	Both doors opened slightly.
"	15	34.40	14.35	37.6	33.1	166.2	.50	+0.13	+ 1.7	65.1	+1.6	+ 5.9	+ 7.6	173.8	12.1	Both doors opened wide.
"	30	32.70	12.65	42.1	28.6	143.6	.52	+0.15	+ 1.9	65.1	+1.6	+ 5.9	+ 7.8	151.4	12.0	Fires removed.
"	45	31.60	11.55	45.1	25.6	128.5	.55	+0.18	+ 2.3	64.0	+0.5	+ 1.9	+ 4.2	132.7	11.5	
"	13-0	29.80	9.75	49.2	21.5	107.9	15.58	+0.21	+ 2.7	63.1	−0.4	− 1.5	+ 1.2	109.1	11.2	
"	15	28.40	8.35	52.7	18.0	90.4	.62	+0.25	+ 3.2	63.3	−0.2	− 0.7	+ 2.5	92.9	11.1	
"	30	27.50	7.45	54.7	16.0	80.3	15.67	+0.30	+ 3.8	63.0	−0.5	− 1.9	+ 1.9	82.2	11.0	
"	45	26.70	6.65	56.0	14.7	73.8	.71	+0.34	+ 4.3	62.1	−1.4	− 5.2	− 0.9	72.9	11.0	
"	14-0	26.25	6.20	57.0	13.7	68.8	.75	+0.38	+ 4.8	61.9	−1.6	− 5.9	− 1.1	67.7	10.9	
"	15	25.30	5.25	57.5	13.2	66.3	15.80	+0.43	+ 5.5	61.0	−2.5	− 9.3	− 3.8	62.5	11.9	
"	30	25.30	5.25	57.6	13.1	65.8	15.84	+0.47	+ 6.0	60.0	−3.5	−13.3	− 7.0	58.8	11.2	
"	45	25.26	5.21	58.3	12.4	62.2	.88	+0.51	+ 6.5	60.0	−3.5	−13.3	− 6.5	55.7	10.7	
"	15-0	25.05	5.00	59.0	11.7	58.7	15.93	+0.56	+ 7.1	60.1	−3.4	−12.2	− 5.5	53.2	10.6	
"	15	24.95	4.90	59.4	11.3	56.7	.98	+0.61	+ 7.7	59.9	−3.6	−13.3	− 5.7	51.0	10.4	
"	30	24.70	4.65	59.7	11.0	55.2	16.03	+0.66	+ 8.4	59.3	−4.2	−15.6	− 7.2	48.0	10.3	
"	45	24.50	4.45	59.3	11.4	57.2	.10	+0.73	+ 9.3	58.4	−5.1	−18.9	− 9.6	47.6	10.7	
"	16-0	Omitted					16.17	+0.80	+10.2	58.0	−5.5	−20.4	−10.2			
"	15	24.40	4.35	59.0	11.7	58.7										

C 9a.

Table showing results of Temperature Experiment No. 2 with Magnet 3 and Fibre 4 corrected for slip.

1	2	3	4	5	6	7	
Date.	Time.	Increment in temperature after start.	Actual change in ordinate due to change in temperature.	Correction for temperature.	True change in ordinate due to change in temperature.	Temperature coefficient for 1° Cent. = 6 + 3.	Remarks.
Civil.	L. M. T.	Cent.	γ	γ	γ	γ	
12th Feb. 1902 .	7·28	0·00	0·0	0·0	0·0	...	Columns 1, 2, 3 and 4 are copied from columns 1, 2, 4 and 5 of the Temperature Experiment.
" .	45	+0·65	−10·6	−0·3	−10·9	−16·8	
" .	8·0	4·45	75·2	0·6	75·8	17·0	
" .	15	8·35	124·3	1·0	125·3	15·0	
" .	30	10·65	142·0	1·3	143·3	13·5	The total slip measured from 7·20 to 15·45 is 11 γ, and this has been distributed uniformly throughout.
" .	45	12·15	160·3	1·6	161·9	13·3	
" .	9·0	13·55	182·0	2·0	184·0	13·6	
" .	15	14·95	193·0	2·4	195·4	13·1	
" .	30	15·05	191·7	2·7	194·4	12·9	
" .	45	15·15	194·6	3·0	197·6	13·0	
" .	10·0	15·25	194·9	3·4	198·3	13·0	
" .	15	15·35	195·9	3·7	199·6	13·0	
" .	30	15·95	204·9	4·0	208·9	13·1	
" .	45	16·55	211·3	4·4	215·7	13·0	
" .	11·0	16·80	212·5	4·7	217·2	12·9	
" .	17	16·11	201·6	5·0	206·6	12·8	
" .	30	15·55	194·8	5·4	200·2	12·9	
" .	45	15·73	197·8	5·7	203·5	12·9	
" .	12·0	15·45	192·0	6·0	198·0	12·8	} Mean 12·49 γ (11·0 to 13·0)
" .	15	14·35	173·8	6·4	180·2	12·6	
" .	30	12·65	151·4	6·7	158·1	12·5	
" .	45	11·55	132·7	7·0	139·7	12·1	
" .	13·0	9·75	109·1	7·4	116·5	11·9	
" .	15	8·35	92·9	7·7	100·6	12·0	
" .	30	7·45	82·2	8·0	90·2	12·1	
" .	45	6·65	72·9	8·4	81·3	12·2	
" .	14·0	6·20	67·7	8·7	76·4	12·3	
" .	15	5·25?	62·5	9·0	71·5	...	
" .	30	5·25?	58·8	9·4	68·2	...	
" .	45	5·21	55·7	9·7	65·4	12·6	
" .	15·0	5·00	53·2	10·0	63·2	12·6	
" .	15	4·90	51·0	10·4	61·4	12·5	
" .	30	4·65	48·0	10·7	58·7	12·6	
" .	45	4·45	47·6	11·0	58·6	13·1	
" .	16·0	...	...	...	...	...	

C 10.

Reduction of Temperature coefficient of H. F. Magnetograph (Watson's). Second experiment with Magnet 1 and Fibre 2.

		Magnet 1. Fibre 2. Inst. 1.					Magnet 3. Fibre 4. Inst. 2.									
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Remarks.
Date.	Time.	Temperature.	Increment in temperature after start.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Temperature.	Increment in temperature after start.	Correction for temperature.	Ordinate.	Difference in ordinate after start.	Difference in ordinate converted into force.	Difference in ordinate corrected for temperature, *i.e.*, (13) + (10).	Actual change in ordinate due to change in temperature (7) − (14).	Temperature coefficient for +1°C. *i.e.*, (15) ÷ (4).	γ = ·00001 C. G. S. Units. Sc. value of No. 1 Inst. = 4·01 γ. Sc. value of No. 2 Inst = 4·53 γ. Temperature coefficient for No. 2 Inst. taken. = −12 γ.
	h.m.	Cent.	Cent.	Sc. divns.	Sc. divns.	γ	Cent.	Cent.	γ	Sec. divns.	Sec. divns.	γ	γ	γ	γ	
24th Feb. 1902	7 36	20·65	0·00	58·1	0·0	0·0	18·40	0·00	...	65·8	0·0	0·0	...	...	...	Stoves lighted.
,,	46	20·80	+0·15	57·7	−0·4	−1·6	40	0·00	...	65·8	0·0	0·0	...	−1·6	...	
,,	8 0	22·50	+1·85	51·0	7·1	28·5	18·40	0·00	...	65·9	+0·1	+0·5	+0·5	29·0	15·7	
,,	15	26·20	5·55	33·8	24·3	97·4	·40	0·00	...	66·0	+0·2	+0·9	+0·9	98·3	17·7	
,,	30	30·40	9·75	25·9	32·2	129·1	18·40	0·00	...	66·2	+0·4	+1·8	+1·8	130·9	13·4	
,,	45	32·18	11·53	20·7	37·4	150·0	·40	0·00	...	66·6	+0·8	+3·6	+3·6	153·6	13·3	
,,	9 0	32·70	12·05	20·1	38·0	152·4	18·40	0·00	...	66·9	+1·1	+5·0	+5·0	157·4	13·1	
,,	15	32·80	12·15	19·8	38·3	153·6	·40	0·00	...	67·1	+1·3	+5·9	+5·9	159·5	13·1	
,,	30	33·50	12·85	18·1	40·0	160·4	·41	+0·01	+0·1	67·4	+1·6	+7·2	+7·3	167·7	13·1	
,,	45	33·70	13·05	18·1	40·0	160·4	18·42	+0·02	+0·2	67·8	+2·0	+9·1	+9·3	169·7	13·0	
,,	10 0	34·00	13·35	18·0	40·1	160·8	18·44	+0·04	+0·5	68·1	+2·3	+10·4	+10·9	171·7	12·9	
,,	15	33·64	12·99	19·8	38·3	153·6	·45	+0·05	+0·6	68·5	+2·7	+12·2	+12·8	166·4	12·8	
,,	30	33·80	13·15	19·8	38·3	153·6	·46	+0·06	+0·7	69·1	+3·3	+14·9	+15·6	169·2	12·9	
,,	45	33·80	13·15	20·2	37·9	152·0	·47	+0·07	+0·8	69·4	+3·6	+16·3	+17·1	169·1	12·9	
,,	11 0	34·20	13·55	19·5	38·6	154·8	18·49	+0·09	+1·1	70·0	+4·2	+19·0	+20·1	174·9	12·9	Last fuel added.
,,	20	34·98	14·33	17·1	41·0	164·4	·53	+0·13	+1·6	70·0	+4·2	+19·0	+20·6	185·0	12·9	
,,	30	34·98	14·33	17·5	40·6	162·8	·57	+0·17	+2·0	70·0	+4·2	+19·0	+21·0	183·8	12·8	
,,	45	34·52	13·87	19·4	38·7	155·2	18·62	+0·22	+2·6	70·0	+4·2	+19·0	+21·6	176·8	12·7	Both doors opened slightly. Mean 12·67γ
,,	12 0	33·60	12·95	22·5	35·6	142·8	·62	+0·22	+2·6	69·9	+4·1	+18·6	+21·2	164·0	12·7	Both doors opened wide.
,,	15	32·00	11·35	28·0	30·1	120·7	·62	+0·22	+2·6	69·7	+3·9	+17·7	+20·3	141·0	12·4	Fires removed.
,,	30	30·80	10·15	31·6	26·5	106·3	·62	+0·22	+2·6	69·5	+3·7	+16·8	+19·4	125·7	12·4	Deflections taken.
,,	45	29·50	8·85	35·0	23·1	92·6	18·62	+0·22	+2·6	68·9	+3·1	+14·0	+16·6	109·2	12·3	
,,	13 0	28·40	7·75	38·4	19·7	79·0	·64	+0·24	+2·9	68·9	+3·1	+14·0	+16·9	95·9	12·4	
,,	15	27·60	6·95	40·9	17·2	69·0	·66	+0·26	+3·1	68·6	+2·8	+12·7	+15·8	84·8	12·2	
,,	30	26·70	6·05	42·2	15·9	63·8	18·69	+0·29	+3·5	68·2	+2·4	+10·9	+14·4	78·2	12·9	
,,	45	26·40	5·75	43·8	14·3	57·3	·73	+0·33	+4·0	68·0	+2·2	+10·0	+14·0	71·3	12·4	
,,	14 0	25·90	5·25	44·5	13·6	54·5	18·78	+0·38	+4·6	67·5	+1·7	+7·7	+12·3	66·8	12·7	
,,	15	...	...	...	...	...	·80	+0·40	+4·8	67·1	+1·3	+5·9	+10·7	...	...	
,,	30	25·25	4·60	46·0	12·1	48·5	18·82	+0·42	+5·0	67·0	+1·2	+5·4	+10·4	58·9	12·8	
,,	45	25·05	4·40	46·1	12·0	48·1	·86	+0·46	+5·5	66·3	+0·5	+2·3	+7·8	55·9	12·7	
,,	15 0	24·80	4·15	47·0	11·1	44·5	18·90	+0·50	+6·0	66·3	+0·5	+2·3	+8·3	52·8	12·7	
,,	15	24·60	3·95	46·9	11·2	44·9	·93	+0·53	+6·4	65·5	−0·3	−1·4	+5·0	49·9	12·6	
,,	30	24·50	3·85	46·9	11·2	44·9	·96	+0·56	+6·7	65·1	−0·7	−3·2	+3·5	48·4	12·6	
,,	45	24·40	3·75	47·0	11·1	44·5	19·00	+0·60	+7·2	65·0	−0·8	−3·6	+3·6	48·1	12·8	
,,	16 0	...	...	...	...	...	·04	+0·64	+7·7	64·5	−1·3	−5·9	+1·8	...	...	
,,	12	24·30	3·65	47·3	10·8	43·3	19·08	+0·68	+8·2	64·2	−1·6	−7·2	+1·0	44·3	12·1	

APPENDIX.

Abstract of deductions made from the Tables of comparisons of the two Magnetographs, and the base line values found for each.

The H. F. Magnet is constrained by the torsion in the fibre to lie with its North end East and the recording arrangement is such that an increase of H. F. corresponds to an increase of ordinate.

If the fibre slips or gives way under the strain, the ordinates will increase; consequently a sudden increase of ordinate not common to both instruments presumably denotes a slip in that one in which the increase occurred. Hence also as the last column of the tables of comparisons gives the quantity Instrument 1 – Instrument 2, an increase in the values in this column shows that a slip has occurred in No. 1 instrument, whereas a decrease would show that a slip had occurred in No. 2 instrument.

Now an examination of the base line values of No. 2 instrument and of the comparative tables shows that no great slip occurred at any time in No. 2 instrument. Between the 13th January and 19th February there is a decrease in the base line value from ·33291 to ·33270, and this probably represents pretty closely the slip or settlement that occurred in fibre No. 2 during that period. The deflections obtained during the above period show that there has been no marked change in the moment of the suspended magnet and any decrease in the moment would make the ordinates also decrease and thus increase the base line value. An examination of the curves shows a sudden decrease of ordinates at 15·30 on the 27th January amounting to 15γ and a sudden increase at 15·0 on 31st January amounting to about 4γ. No certain explanation can be given of these changes the first of which, it may be noted, is in a contrary direction to that of a slip, but it is probable that they were due to an actual deflection caused by the approach of some magnetic substance thereafter left in position. The base lines at these points are unchanged and no general shift of the instrument can therefore have occurred. Consequently there is strong evidence for accepting the changes given by No. 2 instrument as showing the real changes that occurred during any short period such as that occupied by an entire temperature experiment.

All the temperature experiments were made with No. 1 instrument.

The two experiments with magnet 1 and fibre 2 were made on the 6th January and 24th February and an examination of comparative tables Nos. D1 and D8 shows that on both occasions not only were both instruments in accord before and after the experiments but also that there is no evidence of slip during the experiment itself.

These two experiments seem therefore quite satisfactory, and the results are in close accord.

Magnet 2 and fibre 12 were tried on the 15th and 20th January and the first experiment seems satisfactory but the second must be rejected as there is unmistakable evidence of sudden shifting having occurred during its progress. Shortly afterwards it was broken and after repairs, was again tested on the 31st January and the experiment on that date is moderately satisfactory. Such slip as occurred in the course of it was probably gradual as the curve is smooth throughout and a correction has therefore been applied on the assumption that this was the case.

Magnet 3 was tried with three different fibres, *viz.*, Nos. 6, 3 and 4. The first trial with fibre 3 on the 23rd January is unsatisfactory as slip undoubtedly occurred, but as the curve is smooth except where a well marked jump occurred towards the end of the experiment, an attempt has been made to correct the results by distributing the slip on the assumption that it was uniform up to this jump.

The second experiment on the 28th seems quite satisfactory.

Fibre 3 behaved very badly at first but seems to have steadied down before the experiment was made on the 6th February and there seems no reason why the result should be rejected.

The pair of experiments with fibre 4 were made on the 10th and 12th February and by correcting the results on the assumption of uniformity of slip, a close approximation to the truth has probably been obtained. The curves are smooth throughout and table 7 shows that the fibre was slipping steadily with a small but fairly uniform rate throughout the whole period during which it was suspended in No. 1 instrument. Subsequently when tried in No. 2 instrument the fibre seems to have behaved fairly well.

F 2

D 1.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiments.

		Magnetograph No. 1. Scale co-efficient=4·27γ. Mean value of Base line=·33223. Selected mean temperature=21°C. Temperature coefficient=12·5γ.							Magnetograph No. 2. Scale coefficient=5·64γ. Mean value of Base line=·33194. Selected mean temperature=13°·5 C. Temperature co-efficient=12·5γ.							1st experiment with Magnet 1 and Fibre 2.	
Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1—Inst. 2.	Remarks.
Civil.	L.M. T.	C.	C.	γ.	Sc. divn.	γ.	γ.	C.G.S.	C.	C.	γ.	Sc. divn.	γ.	γ.	C.G.S.	γ.	
4th Jan. 1902	14-0	19·8	−1·2	−15·0	67·6	288·7	273·7	·33497	13·4	−0·1	−1·3	54·2	305·7	304·4	·33498	−1	The temperatures given were observed.
5th "	11-0	19·3	−1·7	−21·3	74·5	318·1	296·8	520	13·0	−0·5	−6·3	59·0	332·8	326·5	521	−1	
"	16-10	19·3	−1·7	−21·3	72·1	307·9	286·6	510	13·5	0·0	0·0	55·3	311·9	311·9	506	+4	
6th "	7-25	20·2	−0·8	−10·0	72·9	311·3	301·3	524	13·0	−0·5	−6·3	58·2	328·2	321·9	516	+8	} Temperature Experiment.
"	16-30	22·6	+1·6	+20·0	65·0	277·6	297·6	521	13·8	+0·3	+3·8	56·3	317·5	321·3	515	+6	
7th "	10-20	19·4	−1·6	−20·0	71·1	303·6	283·6	507	13·1	−0·4	−5·0	56·1	316·4	311·4	505	+2	
"	12-0	20·1	−0·9	−11·3	69·0	294·6	283·3	506	13·2	−0·3	−3·8	55·5	313·0	309·2	503	+3	
"	14-42	20·5	−0·5	−6·3	70·0	298·9	292·6	516	13·5	0·0	0·0	56·0	315·8	315·8	510	+6	
9th "	15-35	20·9	−0·1	−1·3	69·0	294·6	293·3	516	14·1	+0·6	+7·5	55·0	310·2	317·7	512	+4	
10th "	16-20	20·9	−0·1	−1·3	70·5	301·0	299·7	523	14·4	+0·9	+11·3	55·2	311·3	322·6	517	+6	
11th "	13-10	20·8	−0·2	−2·5	66·8	285·2	282·7	506	14·1	+0·6	+7·5	52·9	298·4	305·9	500	+6	

During the above comparison the arrangement was—

No. 1 Inst. Magnet 1. Fibre 2.

" 2 " " 2. " 12.

It appears that the instruments gave fairly accordant results throughout and that there was no change in No. 1 instrument after the temperature experiment on 6th January.

D 2.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiments.

		Magnetograph No. 1. Scale coefficient = 5·46γ. Mean value of Base line = ·33208. Selected mean temperature = 21°0 Cent. Temperature coefficient = 12·5γ.							Magnetograph No. 2. Scale coefficient = 3·70γ. Mean value of Base line = ·33297. Selected mean temperature = 15°·0 Cent. Temperature co-efficient = 12·5γ.							1st and 2nd Experiments with Magnet 2 and Fibre 12.	
Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1—Inst. 2.	Remarks.
Civil.	L.M.T.	C.	C.	γ.	Sc. divn.	γ.	γ.	C.G.S.	C.	C.	γ.	Sc. divn.	γ.	γ.	C.G.S.	γ.	
13th Jan. 1902	16-0	20·4	−0·6	−7·5	57·5	314·0	306·5	·33515	14·7	−0·3	−3·8	57·8	213·9	210·1	·33507	+8	The temperatures given were observed.
14th „	11-10	20·4	−0·6	−7·5	59·8	326·5	319·0	527	14·2	−0·8	−10·0	63·1	233·5	223·5	521	+6	
„	15-0	20·4	−0·6	−7·5	58·3	318·3	310·8	519	14·7	−0·3	−3·8	59·2	219·0	215·2	512	+7	
15th „	7-30	20·5	−0·5	−6·3	59·0	322·1	315·8	524	14·4	−0·6	−7·5	62·1	229·8	222·3	519	+5	} 1st temperature Experiment.
„	16-0	23·0	+2·0	+25·0	53·1	289·9	314·9	523	15·0	0·0	−0·0	59·2	219·0	219·0	516	+7	
16th „	10-30	21·1	−0·1	−1·3	49·0	267·5	266·2	474	14·2	−0·8	−10·0	50·0	185·0	175·0	472	+2	
18th „	11-20	20·4	−0·6	−7·5	53·1	289·9	282·4	490	13·7	−1·3	−16·3	57·2	211·6	195·3	492	−2	
„	13-45	20·4	−0·6	−7·5	52·3	285·6	278·1	486	14·1	−0·9	−11·3	54·7	202·4	191·1	488	−2	
19th „	10-20	20·7	−0·3	−3·8	51·9	283·4	279·6	488	13·9	−1·1	−13·8	56·2	207·9	194·1	491	−3	
„	13-0	20·7	−0·3	−3·8	53·1	289·9	286·1	494	14·0	−1·0	−12·5	56·7	209·8	197·3	494	0	
20th „	7-30	20·6	−0·4	−5·0	55·8	304·7	299·7	508	14·0	−1·0	−12·5	61·2	226·4	213·9	511	−3	} 2nd temperature experiment.
„	16-0	22·9	+1·9	+23·8	51·0	278·5	302·3	510	14·7	−0·3	−3·8	57·3	212·0	208·2	505	+5	

During the above comparison the arrangement was—

No. 1 Inst. Magnet 2. Fibre 12.

„ 2 „ „ 1. „ 2.

There is nothing in the above figures to show that any serious shift occurred in either instrument during the first experiment with Magnet 2 and Fibre 12. In the 2nd experiment the Fibre seems to have slipped to the extent of 8 C.G.S. units and an inspection of the curve shows several sharp jumps. The 2nd experiment must therefore be rejected.

D 3.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiments.

Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1, Inst. 2.	REMARKS.
		Magnetograph No. 1. Scale co-efficient=4·82γ. Mean value of Base line=·33186. Selected mean temp.=21°·0 Cent. Temp. co-efficient=12·5γ.							Magnetograph No. 2. Scale co-efficient=3·70γ. Mean value of Base line=·33283. Selected mean temp.=15°·0 Cent. Temp. co-efficient=12·5γ.							1st and 2nd Experiments with Magnet 3 and Fibre 6.	
Civil.	L. M. T.	C.	C.	γ.	Sc. divn.	γ.	γ.	C. G. S.	C.	C.	γ.	Sc. divn.	γ.	γ.	C. G. S.	γ.	
	H. M.																
22nd Jan. 1903	15 50	20·6	−0·4	−5·0	60·0	289·2	284·2	·33470	15·1	+0·1	+1·3	60·0	222·0	223·3	·33506	−36	The temperatures recorded were observed.
23rd "	7 45	20·8	−0·2	−2·5	64·1	309·0	306·5	493	14·9	−0·1	−1·3	61·3	226·8	225·5	509	−16	Temperature experiment on 23rd, slip of 15 C. G. S. units.
"	16 0	23·3	+2·3	+28·8	58·0	279·6	308·4	494	15·5	+0·5	+6·3	55·7	206·1	212·4	495	−1	
24th "	11 0	22·4	+1·4	+17·5	64·9	312·8	330·3	516	15·2	+0·2	+2·5	62·0	229·4	231·9	515	+1	
"	15 0	22·3	+1·3	+16·3	64·2	309·4	325·7	512	15·6	+0·6	+7·5	59·0	218·3	225·8	509	+3	
26th "	11 20	21·2	+0·2	+2·5	71·3	343·7	346·2	532	15·4	+0·4	+5·0	67·5	249·8	254·8	538	−6	
"	13 15	21·2	+0·2	+2·5	75·2	362·5	365·0	551	15·6	+0·6	+7·5	71·0	262·7	270·2	553	−2	
28th "	7 40	21·4	+0·4	+5·0	74·7	360·1	365·1	551	15·6	+0·6	+7·5	61·8	228·7	236·2	519	+32	Temperature experiment on 28th: +17
"	16 0	22·8	+1·8	+22·5	70·0	337·4	359·9	546	16·3	+1·3	+16.3	57·1	211·2	227·5	511	+35	+20
29th "	10 50	20·8	−0·2	−2·5	70·4	339·3	336·8	523	16·4	+1·4	+17·5	51·0	188·7	206·2	489	+34	+19 (These are the amended figures, *vide* Table D4.)

During the above comparison the arrangement was—
No. 1 Inst. Magnet 3 Fibre 6.
No. 2 " 1 " 2.

There is evidence that Fibre 6 began slipping as soon as erected on 22nd January and seems to have slipped uniformly up till the conclusion of the 1st experiment on 23rd. From 4 P.M. on that date it seems to have remained steady till about 8 A.M. on 27th. During the next 12 hours, *i.e.*, till 8 P.M. on 27th a gradual slip, amounting to about 15 C. G. S. units took place. But during the 28th and up till the time of removal on 29th there is no evidence of any further appreciable slip having occurred. Consequently it would seem that the second temperature experiment may be accepted with confidence. The gradual slip from 8 A.M. to 8 P.M. on 27th is investigated on the next sheet from which the above deduction is drawn.

D 4.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiments.

Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1—Inst. 2.		Remarks.
		Magnetograph No. 1. Scale co-efficient = 4·82γ. Mean value of Base line = ·33186. Selected mean temp. = 21°·0 Cent. Temp. co-efficient = 12·5γ.							Magnetograph No. 2. Scale co-efficient = 3·70γ. Mean value of Base line = ·33283. Selected mean temp. = 15°·0 Cent. Temp. co-efficient = 12·5γ.								2nd Expt. with Magnet 3 and Fibre 6.		
Civil.	L. M. T.	C.	C.	γ.	Sc. divn.	γ.	γ.	C. G. S.	C.	C.	γ.	Sc. divn.	γ.	γ.	C. G. S.	γ.		
26th Jan. 1902	14	21·2	+0·2	+2·5	73·1	352·3	354·8	·33541	15·8	+0·8	+10·0	67·9	251·2	261·2	·33544	− 3		The temperatures on this sheet have been interpolated from certain observed temperatures with the aid of the thermograph sheets. The maximum error is probably not greater than 0·1 or 0·2 Cent.
,,	16	21·2	0·2	2·5	65·0	313·3	315·8	502	16·0	1·0	12·5	57·1	211·3	223·8	507	− 5		
,,	18	21·2	0·2	2·5	63·4	305·6	308·1	494	16·1	1·1	13·8	54·8	202·8	215·6	499	− 5		
,,	20	21·3	0·3	3·8	66·4	320·0	323·8	510	,,	1·1	,,	57·8	213·9	227·7	511	− 1		
,,	22	21·3	0·3	3·8	66·7	321·5	325·3	511	,,	1·1	,,	58·0	214·6	228·4	511	0		
,,	Mid	21·4	0·4	5·0	66·3	319·6	324·6	511	,,	1.1	,,	58·0	214·6	228·4	511	0		
27th ,,	2	,,	,,	,,	67·7	326·3	331·3	517	,,	1·1	,,	60·0	222·0	235·8	519	− 2		
,,	4	,,	,,	,,	66·7	321·5	326·5	513	15·9	0·9	11·3	59·1	218·7	230·0	513	0		The paper was changed on No. 2 inst. between 3-27 and 3-39 P.M. Comparison of the ordinates at these hours shows a shift of 4 Sc. divns. occurred in the interval $\{=15\gamma\}$. But the trace of No. 1 Inst. shows that there was no change in the force during this interval. Hence the ordinates of the curves on 27th to 29th have been corrected accordingly.
,,	6	,,	,,	,,	67·1	323·4	328·4	514	15·7	0·7	8·8	60·2	222·7	231·5	515	− 1		
,,	8	,,	,,	,,	68·6	330·7	335·7	522	15·6	0·6	7·5	61·8	228·7	236·2	519	+ 3		
,,	10	,,	,,	,,	66·2	319·1	324·1	510	15·6	0·6	7·5	58·1	215·0	222·5	506	+ 4		
,,	12	,,	,,	,,	68·9	332·1	337·1	523	15·7	0·7	8·8	60·3	223·1	231·9	515	+ 8		
,,	14	,,	,,	,,	69·2	333·5	338·5	525	15·9	0·9	11·3	60·0	222·0	233·3	516	+ 9		
,,	16	,,	,,	,,	69·0	332·6	337·6	524	16·1	1·1	13·8	55·0	203·5	217·3	500	+24	+ 9	
,,	18	,,	,,	,,	69·4	334·5	339·5	526	16·1	1·1	13·8	54·4	201·3	215·1	498	+28	+13	
,,	20	,,	,,	,,	70·7	340·8	345·8	532	16·1	1·1	13·8	55·4	205·0	218·8	502	+30	+15	
,,	22	,,	,,	,,	71·0	342·2	347·2	533	16·0	1·0	12·5	56·2	207·9	220·4	503	+30	+15	
,,	Mid	,,	,,	,,	71·4	344·1	349·1	535	16·0	1·0	,,	56·9	210·5	223·0	506	+29	+14	
28th ,,	2	,,	,,	,,	71·4	344·1	349·1	535	16·0	1·0	,,	57·0	210·9	223·4	506	+29	+14	
,,	4	,,	,,	,,	72·0	347·0	352·0	538	15·8	0·8	10·0	57·9	214·2	224·2	507	+31	+16	
,,	6	,,	,,	,,	72·9	351·4	356·4	542	15·7	0·7	8·8	59·1	218·7	227·5	511	+31	+16	

This tabulation was made to account for and show the nature of the divergence which occurred in the results given by the two instruments between 1-15 P.M. on 26th January 1902 and 7-40 A.M. on 28th January 1902, as shown in Table D3.

The figures indicate that there was no appreciable difference between the instruments up till 8 A.M. on 27th. From that hour till 8 P.M. a gradual shift of one of the instruments relatively to the other seems to have taken place. After 8 P.M. on 27th till the system in No. 1 instrument was changed on 29th, no appreciable change has occurred. The investigation is complicated by the sudden shift which occurred in No. 2 Instrument, when changing papers on 27th; the reason for this shift is not known, but the evidence that it occurred is perfectly clear.

D 5.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiments.

Date.	Hour.	Magnetograph No. 1. Scale co-efficient = 6·50 γ. Mean value of Base line = ·33137. Selected mean temperature = 21°·0 Cent. Temperature co-efficient = 12·5 γ.							Magnetograph No. 2. Scale co-efficient = 3·70 γ. Mean value of Base line = ·33286. Selected mean temp. = 15°·0 Cent. Temp. co-efficient = 12·5 γ.							3rd Expt. with Magnet 2 and Fibre 12.	
		Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1—Inst. 2.	REMARKS.
29th Jan. 1902	13 10	21·4	+0·4	+ 5·0	56·8	369·2	374·2	·33511	16·6	+ 1·6	+ 20·0	57·0	210·9	230·9	·33517	−6	The temperatures given were observed.
30th "	11 30	21·6	+0·6	+ 7·5	57·5	373·8	381·3	518	16·8	+ 1·8	+ 22·5	57·0	210·9	233·4	519	−1	
31st "	7 50	19·6	−1·4	−17·5	61·3	398·5	381·0	518	16·4	+ 1·4	+ 17·5	59·3	219·4	236·9	523	−5	
"	16 0	23·5	+2·5	+31·3	54·0	351·0	382·3	519	16·9	+ 1·9	+ 23·8	55·3*	204·6	228·4	514	+5	*There is a sudden break or rise of 1 Sec. divn. in the curve of No. 2 Instrument at 3 P.M., which has been allowed for in this and the next measure taken on 2nd February.
2nd Feb. 1902	13 20	21·7	+0·7	+ 8·8	56·1	364·7	373·5	511	15·2	+ 0·2	+ 2·5	59·3	219·4	221·9	508	+3	

During the above comparison the arrangement was—
N o. 1 Inst. Magnet 2 and Fibre 12.
" 2 " " 1 " , 2.

The agreement between the instruments is not good before the temperature experiment during which a slip of 10 γ seems to have occurred but as there is no evidence from the curve of No. 1 Inst. of any sudden movement, the slip probably occurred gradually and may be allowed for in the computations.

D 6.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiments.

		Magnetograph No. 1. Scale co-efficient=4·81γ. Mean value of Base line=·33223. Selected mean temperature=21°·0C. Temperature co-efficient=12·5γ.							Magnetograph No. 2. Scale co-efficient=3·70γ. Mean value of Base line=·33284. Selected mean temperature=15°·0C. Temperature co-efficient= 12·5γ.							First experiment with Magnet 3 and Fibre 3.	
Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1 — Inst. 2.	Remarks.
Civil.	L. M. T.	C	C	γ.	Sc. divn.	γ.	γ.	C.G.S.	C	C	γ.	Sc. divn.	γ.	γ.	C.G.S.	γ.	
5th Feb. 1902.	10·0	21·4	+0·4	+5·0	62·3	299·7	304·7	·33528	14·9	—0·1	—1·3	66·8	247·2	245·9	·33530	—2	The temperatures recorded were observed.
„ .	11·0	„	„	„	61·0	293·4	298·4	521	15·0	0·0	0·0	65·0	240·5	240·5	525	—4	
„ .	12·0	„	„	„	60·5	291·0	296·0	519	15·0	0·0	0·0	64·4	236·8	236·8	521	—2	
„ .	13·0	„	„	„	63·1	303·5	308·5	532	15·2	+0·2	+2·5	64·0	236·8	239·3	523	+9	
„ .	14·0	„	„	„	71·9	345·8	350·8	574	15·2	+0·2	+2·5	63·1	233·5	236·0	520	+54	
„ .	15·0	21·5	0·5	6·3	70·9	341·0	347·3	570	15·4	+0·4	+5·0	61·3	226·8	231·8	516	+54	
„ .	16·0	21·4	0·4	5·0	70·9	341·0	346·0	569	15·6	+0·6	+7·5	60·9	225·3	232·8	517	+52	
6th „ .	7·45	21·1	0·1	1·3	74·4	357·9	359·2	582	14·8	—0·2	—2·5	63·9	236·4	233·9	518	+64	Temperature experiment.
„ .	16·0	22·8	1·8	22·5	70·1	337·2	359·7	583	15·4	+0·4	+5·0	63·7	235·7	240·7	525	+58	
7th „ .	14·0	22·2	1·2	15·0	69·9	336·2	351·2	574	15·0	0·0	0·0	61·9	229·0	229·0	513	+61	

During the above comparison the arrangement was—
No. 1 Instrument, Magnet 3 and Fibre 3
2 „ „ 1 „ „ 2.

The absolute observations from which the base line values are derived occupied from 11·25 to 13·1 on the 5th February and in the case of No. 1 Instrument the last result had to be rejected owing to the appearance of the large and sudden slip that commenced about 12·50 and ended at 13·30.

From this time onwards till Magnet 3 and Fibre 3 were dismounted the agreement between the instruments is fair and there is certainly no evidence of slip in No. 1 Inst. during the experiment. If anything it would seem that the other instrument was at fault, but the slight discordance of the last three values in the last column is probably accidental. On the whole, it would appear that the temperature experiment with Magnet 3 and Fibre 3 may be accepted and it is regrettable that a further trial was not made with the system. The very obvious shift that occurred just afternoon on the 5th lead to the impression that the fibre was unstable and another one was tried as soon as the trace showed this fault after development on the 7th February (see Plate V, Fig. 1).

D 7.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiment. 1st and 2nd Experiments with Magnet 3 and Fibre 4.

		Magnetograph No. 1. Scale co-efficient = 5·02γ. Mean value of Base line = ·33175. Selected mean temperature = 21°·0C. Temperature co-efficient = 12·5γ.							Magnetograph No. 2. Scale co-efficient = 3·70γ. Mean value of Base line = ·33277. Selected mean temperature = 15°·0C. Temperature co-efficient = 12·5γ.								
Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1—Inst. 2.	Remarks.
Civil.	L.M.T.	C.	C.	γ.	Sc. divn.	γ.	γ.	C.G.S.	C.	C.	γ.	Sc. divn.	γ.	γ.	C.G.S.	γ.	
8th Feb. 1902	11-0	20·5	−0·5	−6·3	51·4	258·0	251·7	·33427	14·6	−0·4	−5·0	60·6	224·2	219·2	·33496	−69	The temperatures given were observed.
„	12-0	20·7	−0·3	−3·8	51·1	256·5	252·7	428	14·6	−0·4	−5·0	61·0	225·7	220·7	498	−70	
„	13-0	20·8	−0·2	−2·5	47·6	239·0	236·5	412	14·8	−0·2	−2·5	55·9	206·8	204·3	481	−69	
„	14-0	20·8	−0·2	−2·5	48·1	241·5	239·0	414	15·0	0·0	0·0	55·9	206·8	205·8	484	−70	68.
„	15-0	21·0	0·0	0·0	49·9	250·5	250·5	426	15·1	+0·1	+1·3	57·7	213·5	214·8	492	−66	
„	16-0	21·1	+0·1	+1·3	49·2	247·0	248·3	423	15·2	+0·2	+2·5	56·2	207·9	210·4	487	−64	
10th „	7-30	19·9	−1·1	−11·8	64·6	324·3	312·5	488	14·7	−0·3	−3·8	62·6	231·6	227·8	505	−17	Slip of 19γ in 1st experiment.
„	16-0	23·4	+2·4	+30·0	58·0	291·2	321·2	496	15·3	+0·3	+3·8	57·6	213·1	216·9	494	+2	
11th „	10-0	20·7	−0·3	−3·8	67·9	340·9	337·1	512	14·8	−0·2	−2·5	64·5	238·7	236·2	513	−1	
„	11-0	20·8	−0·2	−2·5	68·1	341·9	339·4	514	14·8	−0·2	−2·5	64·9	240·1	237·6	515	−1	
„	12-0	„	„	„	69·1	346·9	344·4	519	15·0	0·0	0·0	65·9	243·8	243·8	521	−2	Date of absolute observations —1.
„	13-0	„	„	„	68·7	344·9	342·4	517	15·1	+0·1	+1·3	64·3	237·9	239·2	516	+1	
„	14-0	„	„	„	67·3	337·8	335·3	510	15·2	+0·2	+2·5	62·4	230·9	233·4	510	0	
„	15-0	„	„	„	66·8	335·3	332·8	508	15·4	+0·4	+5·0	61·4	227·2	232·2	509	−1	
„	16-0	„	„	„	66·9	335·8	333·3	508	15·7	+0·7	+8·8	60·0	222·0	230·8	508	0	
12th „	7-20	20·1	−0·9	−11·3	69·3	347·9	336·6	512	15·4	+0·4	+5·0	62·4	230·9	235·9	513	−1	Slip of 11 γ in 2nd experiment.
„	15-45	24·5	+3·5	+43·8	59·0	296·2	340·0	515	16·1	+1·1	+13·8	58·0	214·6	228·4	505	+10	
13th „	10-0	21·2	+0·2	+2·5	73·2	367·5	370·0	545	15·7	+0·7	+8·8	68·4	253·1	261·9	539	+6	
„	13-0	21·2	+0·2	+2·5	71·1	356·9	359·4	534	15·8	+0·8	+10·0	64·6	239·0	249·0	526	+8	7.
„	16-0	21·2	+0·2	+2·5	67·1	336·8	339·3	514	10·3	+1·3	+16·3	58·0	214·6	230·9	508	+6	
14th „	10-0	22·2	+1·2	+15·0	72·8	365·5	380·5	556	15·7	+0·7	+8·8	69·1	255·7	264·5	542	+14	13.
„	14-0	22·0	+1·0	+12·5	68·2	342·4	354·9	530	16·1	+1·1	+13·8	61·5	227·6	241·4	518	+12	
15th „	10-0	22·1	+1·1	+13·8	69·7	349·9	363·7	539	16·1	+1·1	+13·8	61·3	226·8	240·6	518	+21	
„	13-0	22·1	+1·1	+13·8	67·2	337·3	351·1	526	16·3	+1·3	+16·3	57·1	211·3	229·6	507	+19	20.
„	16-0	22·0	+1·0	+12·5	67·5	338·9	351·4	526	16·8	+1·8	+22·5	56·1	207·6	230·1	507	+19	
16th „	10-0	22·0	+1·0	+12·5	74·0	371·5	384·0	559	16·5	+1·5	+18·8	64·2	237·5	256·3	533	+26	26.
„	13-0	22·0	+1·0	+12·5	73·0	366·5	379·0	554	16·7	+1·7	+21·3	62·0	229·4	250·7	528	+26	Temperature of No. 2 at 16 hrs. is abnormal.
„	16-0	22·1	+1·1	+13·8	68·0	341·4	355·2	530	16·6	+1·6	+20·0	53·2	196·8	216·8	494	+36	
17th „	10-0	21·9	+0·9	+11·3	72·1	361·9	373·2	548	16·9	+1·9	+23·8	58·4	216·1	239·9	517	+31	
„	13-0	21·9	+0·9	+11·3	74·0	371·5	382·8	558	17·2	+2·2	+27·5	59·9	221·6	249·1	526	+32	
„	16-0	21·8	+0·8	+10·0	69·7	349·9	359·9	535	17·5	+2·5	+31·3	52·9	195·7	227·0	504	+31	31.
18th „	10-0	21·7	+0·7	+8·8	73·1	367·0	375·8	551	16·9	+1·9	+23·8	58·0	214·6	238·4	515	+36	
„	13-40	21·8	+0·8	+10·0	75·6	379·5	389·5	565	17·3	+2·3	+28·8	60·0	222·0	250·8	528	+7	
„	16-20	21·6	+0·6	+7·5	72·9	366·0	373·5	549	17·8	+2·8	+35·0	54·5	201·7	236·7	514	+35	36.
19th „	10-0	21·4	+0·4	+5·0	73·8	370·5	375·0	550	17·6	+2·6	+32·5	54·4	201·3	233·8	511	+39	
„	13-35	21·4	+0·4	+5·0	72·0	361·4	366·4	541	17·9	+2·9	+36·3	51·0	188·7	225·0	502	+39	
„	16-0	21·8	+0·8	+10·0	72·7	365·0	375·0	550	18·3	+3·3	+41·3	51·0	188·7	230·0	507	+43	41.
20th „	10-0	21·6	+0·6	+7·5	74·0	371·5	379·0	554	17·4	+2·4	+30·0	53·0	196·1	226·1	503	+51	

During the above comparison the arrangement was—
No. 1 Inst., Magnet 3, and Fibre 4.
„ 2 „ „ 1 „ 2.

A large slip occurred between the 8th and 18th. During the first temperature experiment a slip of about 19 γ occurred and during the second experiment a slip of 10 γ. Between the two experiments there was no slip, but after the second a steady slip of about 5 to 7 γ seems to have continued till the system was dismantled.

Obviously these two temperature experiments are unreliable, and as far as the above figuges go Fibre No. 4 seems to have been in an unstable condition.

D 8.

Comparison of Magnetographs Nos. 1 and 2 during the Temperature Experiment.

	Magnetograph No. 1. Scale co-efficient = 4·01γ. Mean value of Base line = ·33280. Selected mean temp. = 21°·0 C. Temp. co-efficient = 12·5γ.								Magnetograph No. 2. Scale co-efficient = 4·53γ. Mean value of Base line = ·33207. Selected mean temp. = 18°·4C. Temp. co-efficient = 12·5γ.							2nd expt. with Magnet and Fibre 2.	
Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Instrument 1 — Instrument 2.	REMARKS.
Civil.	L. M. T.	C.	C.	γ.	Sc. divn.	γ.	γ.	C. G. S.	C.	C.	γ.	Sc. divn.	γ.	γ.	C. G. S.	γ.	
21st Feb. 1902	15·0	21·4	+0·4	+5·0	49·6	198·9	203·9	·33484	19·1	+0·7	+8·8	56·1	254·1	262·9	·33470	+14	+13. Both curves standardized by absolute observations taken on the 23rd February.
„ .	16·0	21·4	+0·4	5·0	48·1	192·9	197·9	478	18·9	+0·5	+6·3	56·0	253·7	260·0	467	+11	
22nd „ .	10·0	21·4	+0·4	5·0	55·1	221·0	226·0	506	18·0	−0·4	−5·0	66·6	301·7	296·7	504	+2	+2. The temperatures given were observed.
„ .	13·0	21·5	+0·5	6·3	55·7	223·4	229·7	510	18·2	−0·2	−2·5	66·8	302·6	300·1	507	+3	
„ .	16·0	21·6	+0·6	7·5	52·2	209·3	216·8	497	18·6	+0·2	+2·5	63·0	285·4	287·9	495	+2	
23rd „ .	10·0	21·6	„	„	57·3	229·8	237·3	517	18·2	−0·2	−2·5	68·9	312·1	309·6	517	0	
„ .	13·0	21·6	„	„	57·9	232·2	239·7	520	18·4	0·0	0·0	68·9	312·1	312·1	519	+1	
„ .	16·0	21·6	„	„	54·5	218·5	226·0	506	18·8	+0·4	+5·0	64·6	292·6	297·6	505	+1	
24th „ .	7·30	20·7	−0·3	−3·8	57·7	231·4	227·6	508	18·4	0·0	0·0	66·0	299·0	299·0	506	+2	+2. Temperature experiment.
„ .	15·45	24·4	+3·4	+42·5	46·8	187·7	230·2	510	19·0	+0·6	+7·5	65·1	294·9	302·4	509	+1	
25th „ .	10·0	21·4	+0·4	+5·0	57·8	231·8	236·8	517	18·4	0·0	0·0	68·2	308·9	308·9	516	+1	+1.
„ .	13·0	22·0	+1·0	12·5	56·1	225·0	237·5	518	18·7	+0·3	+3·8	67·6	306·2	310·0	517	+1	
26th „ .	10·0	21·8	+0·8	10·0	50·0	200·5	210·5	491	18·2	−0·2	−2·5	62·6	283·6	281·1	488	+3	+4.
.	16·0	21·9	+0·9	11·3	52·2	209·3	220·6	501	18·8	+0·4	+5·0	63·0	285·4	290·4	497	+4	
27th „ .	10·0	22·0	+1·0	12·5	54·3	217·7	230·2	510	18·4	0·0	0·0	66·2	299·9	299·9	507	+3	
„ .	16·40	22·0	+1.0	12·5	55·0	220·6	233·1	513	19·2	+0·8	+10·0						
28th „ .	10·10	21·9	+0·9	11·3	58·0	232·6	243·9	524	18·8	+0·4	+5·0						
„ .	15·7	21·7	+0·7	8·8	57·3	229·8	238·6	519	19·4	+1·0	+12·5						

During the above comparison the arrangement was—No. 1 Instrument, Magnet, 1 and Fibre 2.
2 „ „ 3 „ 4.

The magnets were rearranged on the 21st. From 10 A. M. on the 22nd till the 27th February the curves agreed remarkably well and also during the actual temperature experiment no shift seems to have occurred, so that the result may be accepted with confidence.

D 9.

Comparison of Magnetographs Nos. 1 and 2 after the Temperature Experiments.

	Magnetograph No. 1. Scale co-efficient = 4·00γ. Magnet 1, Fibre 2. Mean value of base line = ·33315 C. G. S. Temperature co-efficient = 12·6γ. Selected mean Temperature = 22° Cent.							Magnetograph No. 2. Scale co-efficient = 4·45γ. Magnet 3, Fibre 4. Mean value of base line = ·33300 C. G. S. Temperature co-efficient = 12·5γ. Selected mean Temperature = 22° Cent.								
Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Inst. 1 — Inst. 2.	Remarks.
Civil.	L. M. T.	Cent.	Cent.	γ.	Sc. divns.	γ.	γ.	C. G. S.	Cent.	Cent.	γ.	Sc. divns.	γ.	γ.	C. G. S.	γ.	
28th Feb. 1902	16-0	21·7	−0·3	−4	...	...	...	...	19·6	−2·4	−30	61·8	275	245	...	...	
1st Mar. 1902	10-20	22·0	0·0	0	60·6	242	242	·33557	19·0	−3·0	−38	66·4	295	257	·33557	0	The value of the base line of No. 2 has been arbitrarily fixed to make the instruments agree at 10-20 on 1st March.
„	16-9	22·0	0·0	0	56·9	228	228	543	19·3	−2·7	−34	62·0	276	242	542	+1	
2nd „	13-0	21·8	−0·2	−3	58·0	232	229	544	19·5	−2·5	−31	63·9	284	253	553	−9	
„	16-0	21·8	−0·2	−3	53·2	213	210	525	19·6	−2·4	−30	58·5	260	230	530	−5	The value of the base line of No. 1 is the actual mean value found for the months.
3rd „	13-0	21·9	−0·1	−1	60·5	242	241	556	19·4	−2·6	−33	65·7	292	259	559	−3	
„	16-0	21·9	−0·1	−1	57·0	228	227	542	19·8	−2·2	−28	61·1	272	244	544	−2	
4th „	10-15	21·8	−0·2	−3	60·7	243	240	555	19·4	−2·6	−33	65·8	293	260	560	−5	
5th „	13-0	21·8	−0·2	−3	62·7	251	248	563	20·2	−1·8	−23	58·6	261	238	563	0	*Mean value of base line of No. 2 = ·33325.* No. 2 Instrument was re-adjusted on the 4th after receiving a jar whilst changing the papers at 10·20. Hence a fresh arbitrary value has been given to its base line after the adjustment to make the instruments agree on the 5th March at 13 hours.
„	16-0	21·8	−0·2	−3	58·5	234	231	546	20·6	−1·4	−18	53·0	236	218	43	+3	
6th „	13-0	21·8	−0·2	−3	60·9	244	241	556	21·2	−0·8	−10	54·1	241	231	56	0	
„	16-0	21·8	−0·2	−3	55·9	224	221	536	21·6	−0·4	−5	48·6	216	211	36	0	
7th „	13-0	21·7	−0·3	−4	62·2	249	245	560	21·8	−0·2	−3	53·3	237	234	59	+1	
„	16-0	21·8	−0·2	−3	57·3	229	226	541	22·2	+0·2	−3	48·0	214	217	42	−1	
8th „	13-0	21·8	−0·2	−3	57·5	230	227	542	22·3	+0·3	+4	48·0	214	218	43	−1	
„	16-0	21·8	−0·2	−3	54·1	216	213	528	22·7	+0·7	+9	44·0	196	205	30	−2	
9th „	13-0	22·0	0·0	0	57·9	232	232	547	22·3	+0·3	+4	49·0	218	222	47	0	
„	16-0	22·0	0·0	0	53·7	215	215	530	22·6	+0·6	+8	44·3	197	205	30	0	
10th „	13-0	22·0	0·0	0	56·9	228	228	543	22·2	+0·2	+3	49·5	220	223	48	−5	
„	16-0	22·0	0·0	0	53·7	215	215	530	22·4	+0·4	+5	45·2	201	206	31	−1	
11th „	13-0	22·0	0·0	0	60·2	241	241	556	22·0	0·0	0	52·8	235	235	60	−4	
„	16-0	21·9	−0·1	−1	57·0	228	227	542	22·2	+0·2	+3	49·8	222	225	50	−8	
12th „	13-0	22·0	0·0	0	57·5	230	230	545	21·6	−0·4	−5	51·4	229	224	49	−4	
„	16-0	22·0	0·0	0	53·9	216	216	531	22·0	0·0	0	47·2	210	210	35	−4	
13th „	13-0	22·1	+0·1	+1	56·5	226	227	542	21·5	−0·5	−6	50·9	227	221	46	−4	
„	16-0	21·1	+0·1	+1	55·2	221	222	537	22·0	0·0	0	49·0	218	218	43	−6	
14th „	13-0	22·2	+0·2	+3	56·5	226	229	544	21·8	−0·2	−3	51·0	227	224	49	−5	
„	16-0	22·2	+0·2	+3	53·0	212	215	530	22·2	+0·2	+4	46·5	207	210	35	−5	

D 9—*contd.*

Comparison of Magnetographs Nos. 1 and 2 after the Temperature Experiments—contd.

	Magnetograph No. 1.	Magnetograph No. 2.
Scale co-efficient	= 4·00 γ.	= 4·45 γ.
Magnet / Fibre	Magnet 1, Fibre 2	Magnet 3, Fibre 4
Mean value of base line	= ·33315 C. G. S.	= ·33300 C. G. S.
Temperature co-efficient	= 12·6 γ.	= 12·5 γ.
Selected mean temperature	= 22° Cent.	= 22° Cent.

Date.	Hour.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Temperature.	Difference of temperature from selected mean.	Correction for temperature.	Ordinate.	Ordinate converted into force.	Ordinate corrected to mean temperature.	Value of H. F.	Difference Instrument 1 — Instrument 2.	REMARKS.
Civil.	L. M. T.	Cent.	Cent.	γ.	Sc. divns.	γ.	γ.	C. G. S.	Cent.	Cent.	γ.	Sc. divns.	γ.	γ.	C. G. S.	γ.	
15th Mar. 1902	13-0	22·2	+0·2	+3	58·5	234	237	·33552	22·0	0·0	0	51·0	227	227	·33552	0	
,, .	16-0	22·2	+0·2	+3	54·6	218	221	536	22·1	+0·1	+1	47·0	209	210	35	+1	
16th ,, .	13-0	22.2	+0·2	+3	57·8	231	234	549	22·3	+0·3	+4	49·9	222	226	51	−2	
,, .	16-0	22·2	+0·2	+3	54·1	216	219	534	22·7	+0·7	+9	45·7	203	212	37	−3	
17th ,, .	13-0	22·2	+0·2	+3	55·0	220	223	538	22·3	+0·3	+4	47.6	212	216	41	−3	
,, .	16-0	22·2	+0·2	+3	51·7	207	210	525	22·7	+0·7	+9	43·8	195	204	29	−4	
18th ,, .	13-0	22·2	+0·2	+3	56·0	224	227	542	22·6	+0·6	+8	47·9	213	221	46	−4	
,, .	16-0	22·2	+0·2	+3	53·0	212	215	530	22·8	+0·8	+10	44·7	199	209	34	−4	
19th ,, .	13-0	22·2	+0·2	+3	57·3	229	232	547	22·5	+0·5	+6	49·5	220	226	51	−4	
,, .	16-0	22·2	+0·2	+3	53·0	212	215	530	22·8	+0·8	+10	45·1	201	211	36	−6	
20th ,, .	13-0	22·2	+0·2	+3	61·7	247	250	565	22·4	+0·4	+5	53·1	236	241	66	−1	
,, .	15-0	22·2	+0·2	+3	55·9	224	227	542	22·6	+0·6	+8	47·9	213	221	46	−4	
21st ,, .	13-0	22·2	+0·2	+3	61·1	244	247	562	21·9	−0·1	−1	54·0	240	239	64	−2	
,, .	16-0	22·4	+0·4	+5	54·3	217	222	537	22·0	0·0	0	48·0	214	214	39	−2	
22nd ,, .	13-0	22·2	+0·2	+3	59·7	239	242	557	21·4	−0·6	−8	54·8	244	236	61	−4	
,, .	16-0	22·2	+0·2	+3	54·0	216	219	534	21·8	−0·2	−3	48·8	217	214	39	−5	
23rd ,, .	13-0	22·2	+0·2	+3	58·0	232	235	550	21·9	−0·1	−1	53·0	236	235	60	−10	
,, .	16-0	22·2	+0·2	+3	56·8	227	230	545	22·0	0·0	0	51·6	230	230	55	−10	
24th ,, .	13-0	22·4	+0·4	+5	56·0	224	229	544	21·8	−0·2	−3	52·0	231	228	53	−9	
,, .	16-0	22·4	+0·4	+5	50·9	204	209	524	22·2	+0·2	+3	45·9	204	207	32	−8	
25th ,, .	13-0	22·7	+0·7	+9	56·0	224	233	548	21·8	−0·2	−3	52·9	235	232	57	−9	
,, .	16-0	22·7	+0·7	+9	46·5	186	195	510	22·2	+0·2	+3	42·3	188	191	16	−6	
26th ,, .	13-0	22·6	+0·6	+8	55·2	221	229	544	22·4	+0·4	+5	49·4	220	225	50	−6	
,, .	16-0	22·6	+0·6	+8	49·3	197	205	520	22·8	+0·8	+10	42·9	191	201	26	−6	
27th ,, .	13-0	22·6	+0.6	+8	52·7	211	219	534	23·2	+1·2	+15	44·6	198	213	38	−4	
,, .	16-0	22·6	+0·6	+8	50·3	201	209	524	23·4	+1·4	+18	41·9	186	204	29	−5	
28th ,, .	13-0	22·6	+0·6	+8	56·9	228	236	551	23·0	+1·0	+13	49·6	221	234	59	−8	
,, .	16-0	22·6	+0·6	+8	51·0	204	212	527	23·4	+1·4	+18	44·1	196	214	39	−12	
29th ,, .	13-0	22·7	+0·7	+9	57·0	228	237	552	23·1	+1·1	+14	51·7	230	244	69	−17	
,, .	16-0	22·7	+0·7	+9	52·1	208	217	532	23·5	+1·5	+19	46·5	207	226	51	−19	
30th ,, .	10-15	22·4	+0·4	+5	56·9	228	233	548	23·0	+1·0	+13	51·0	227	240	65	−17	
,, .	13-0	22·5	+0·5	+6	58·6	234	240	555	23·2	+1·2	+15	52·8	235	250	75	−20	
31st ,, .	13-0	22·5	+0·5	+6	59·0	236	242	557	23·6	+1·6	+20	51·5	229	249	74	−17	
,, .	16-0	22·5	+0·5	+6	53·7	215	221	536	24·0	+2·0	+25	45·7	203	228	53	−17	
1st April 1902	13-0	22·6	+0·6	+8	55·8	223	231	546	23·8	+1·8	+23	48·1	214	237	62	−16	
,, .	16-0	22·6	+0·6	+8	50·4	202	210	525	24·2	+2·2	+28	41·7	186	214	39	−14	
2nd ,, .	10-30	22·7	+0·7	+9	54·0	216	225	540	23·8	+1·8	+23	46·6	207	230	55	−15	

The instruments are in fair accordance up to 28th March, though it seems that No. 2 has given way slightly relatively to No. 1. After the 28th March up till the end of the comparison the agreement is again good. The relative displacement of the instruments which occurred about the 28th March may or may not be due to slip of the fibre, for it must be borne in mind that No. 2 Instrument was not rigidly fixed like No. 1 and that the result noted might have been caused by a shift of one of the wooden tripods due to shrinkage of the wood with the increasing heat. **On the whole it may be concluded that Fibre No. 4 behaved satisfactorily.**

G. I. C. P. O.—No. 174 S. G.—25-7-05.—250.—W. D'C.

PLATE I.

The curves are traced from the originals and reduced by photography to $\frac{1}{4}$ scale.

Fig. 1.

Temperature Experiment No. 1.

Magnet 1 and Fibre 2 in Instrument No. 1.

Date 6-1-02.

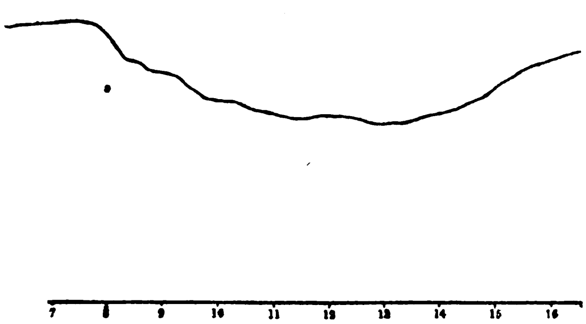


Fig. 3.

Temperature Experiment No. 10.

Magnet 1 and Fibre 2 in Instrument No. 1.

Date 24-2-02.

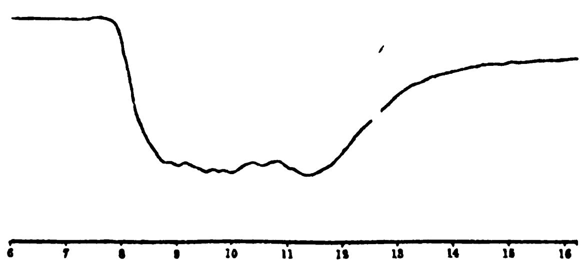


Fig. 2.

Magnet 2 and Fibre 12 in Instrument No. 2.

Date 6-1- 02.

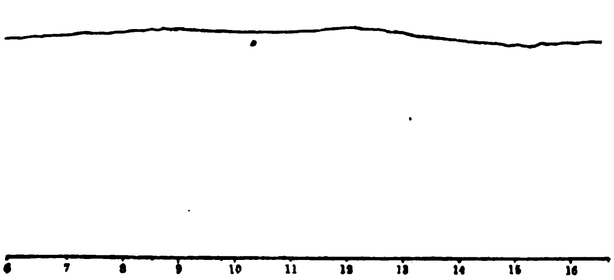


Fig. 4.

Magnet 3 and Fibre 4 in Instrument No. 2.

Date 24-2-02.

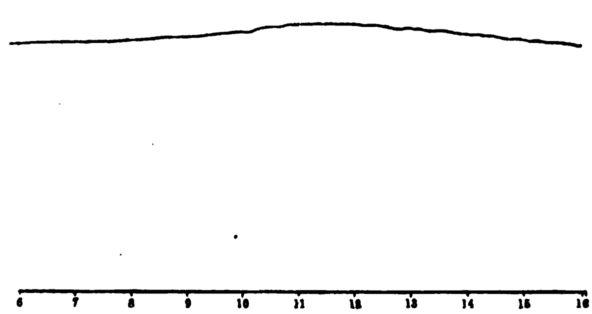


PLATE II.

The curves are traced from the originals and reduced by photography to ½ scale.

Fig. 1.

Temperature Experiment No. 2.

Magnet 2 and Fibre 12 in Instrument No. 1.

Date 15-1-02.

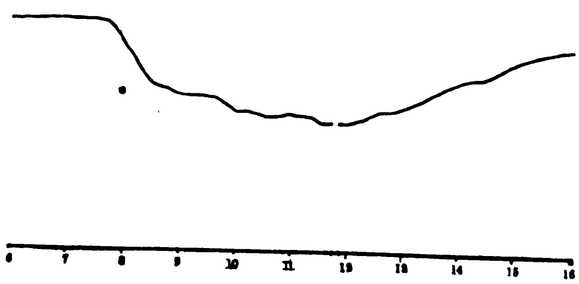


Fig. 2.

Magnet 1 and Fibre 2 in Instrument No. 2.

Date 15-1- 02.

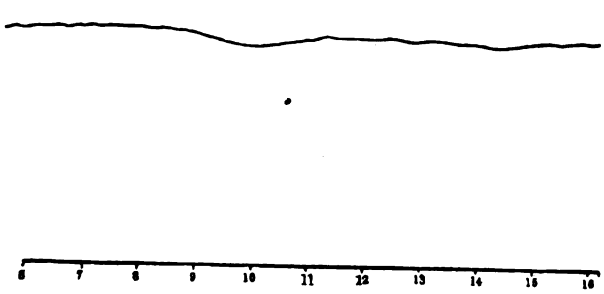


Fig. 3.

Temperature Experiment No. 3.

Magnet 2 and Fibre 12 in Instrument No. 1.

Date 20-1-02.

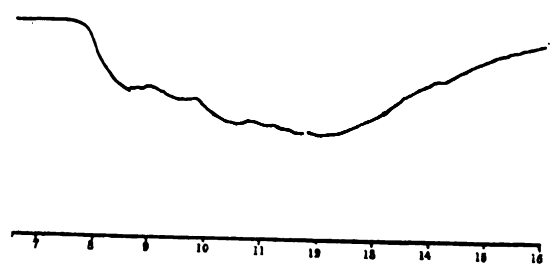


Fig. 4.

Magnet 1 and Fibre 2 in Instrument No. 2.

Date 20-1-02.

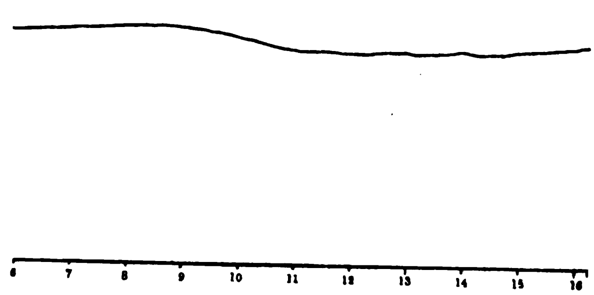


PLATE III.

The curves are traced from the originals and
reduced by photography to ½ scale.

Fig. 1.

Temperature Experiment No. 4.
Magnet 3 and Fibre 6 in Instrument No. 1.
Date 24-1-02.

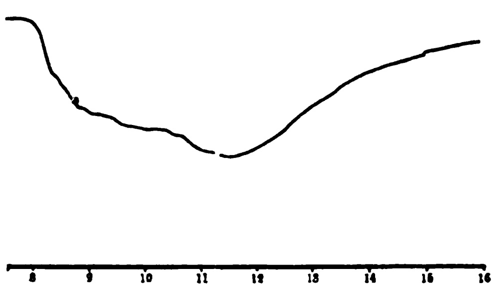


Fig. 3.

Temperature Experiment No. 5.
Magnet 3 and Fibre 6 in Instrument No. 1.
Date 28-1-02.

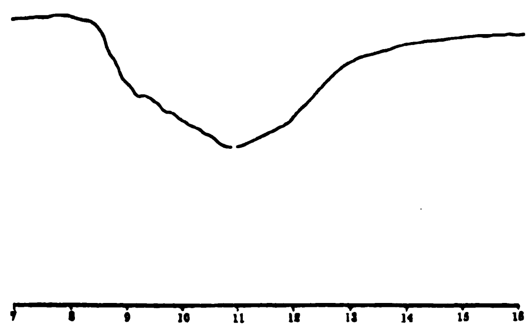


Fig. 2.

Magnet 1 and Fibre 2 in Instrument No. 2.
Date 24-1- 02.

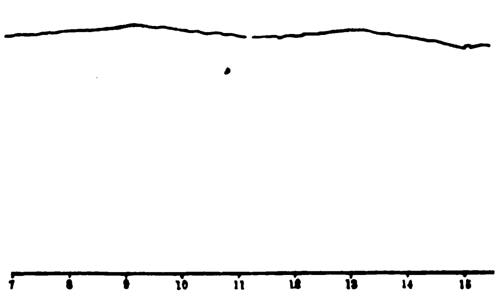


Fig. 4.

Magnet 1 and Fibre 2 in Instrument No. 2.
Date 28-1-02.

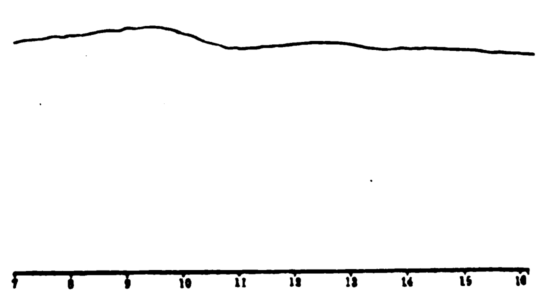


PLATE IV.

The curves are traced from the originals and
reduced by photography to ½ scale.

Fig. 1.

Temperature Experiment No. 6.

Magnet 2 and Fibre 12 in Instrument No. 1.

Date 31-1-02.

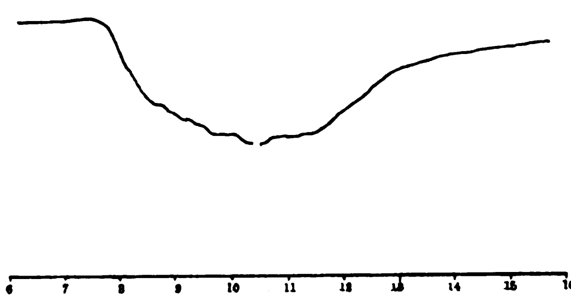


Fig. 2.

Magnet 1 and Fibre 2 in Instrument No. 2.

Date 31-1- 02.

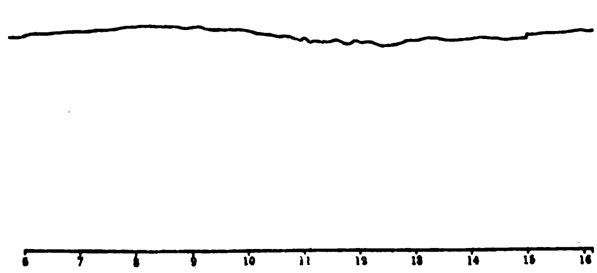


PLATE V.

The curves are traced from the originals and
reduced by photography to ½ scale.

Fig. 1.

Portion of Curve on 5-2-02
Showing the Slip of Fibre No. 3
Mounted in Instrument No. 1.

Fig. 3.

Temperature Experiment No. 7.
Magnet 3 and Fibre 3 in Instrument No. 1.
Date 6-2-02.

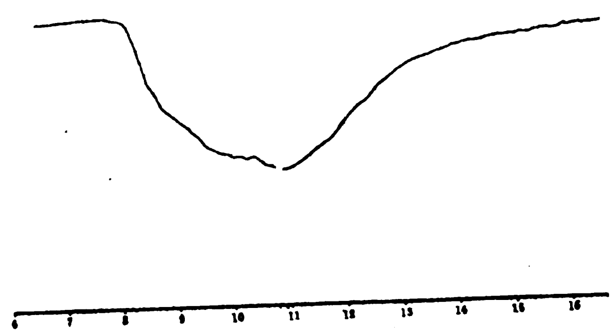


Fig. 2.

Portion of Curve on 5-2-02
Corresponding to that shown in Fig. 1
Magnet 1 and Fibre 2 in Instrument No. 2.

Fig. 4.

Magnet 1 and Fibre 2 in Instrument No. 2.
Date 6-2-02.

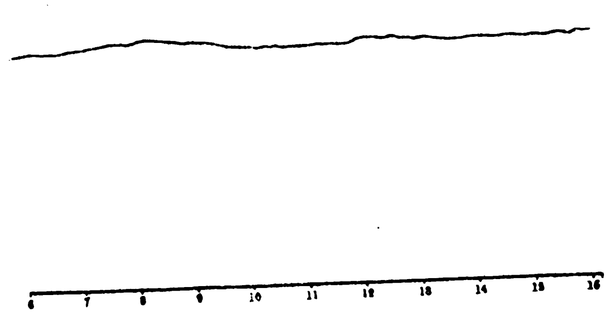


PLATE VI.

The curves are traced from the originals and reduced by photography to ½ scale.

Fig. 1.

Temperature Experiment No. 8.
Magnet 3 and Fibre 4 in Instrument No. 1.
Date 10-2-02.

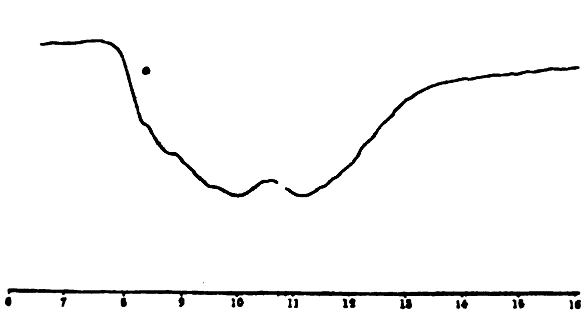


Fig. 3.

Temperature Experiment No. 9.
Magnet 3 and Fibre 4 in Instrument No. 1.
Date 12-2-02.

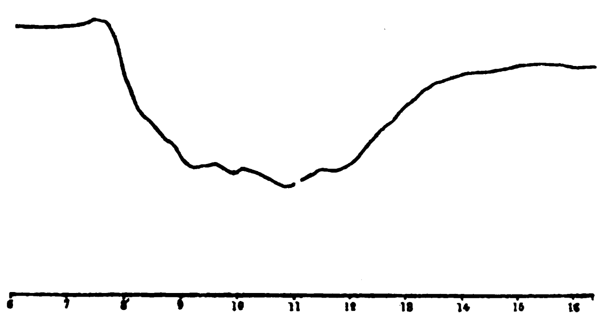


Fig. 2.

Magnet 1 and Fibre 2 in Instrument No. 2.
Date 10-2- 02.

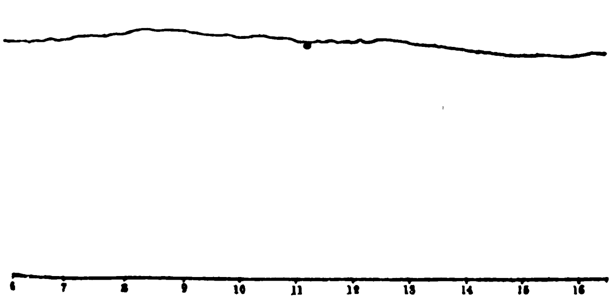
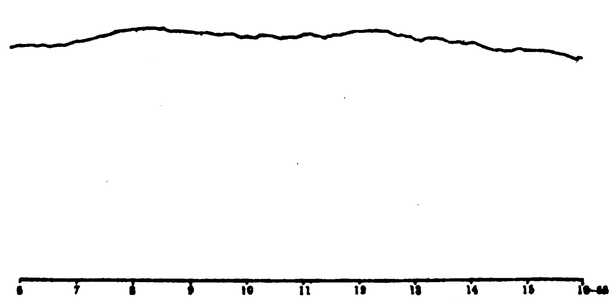
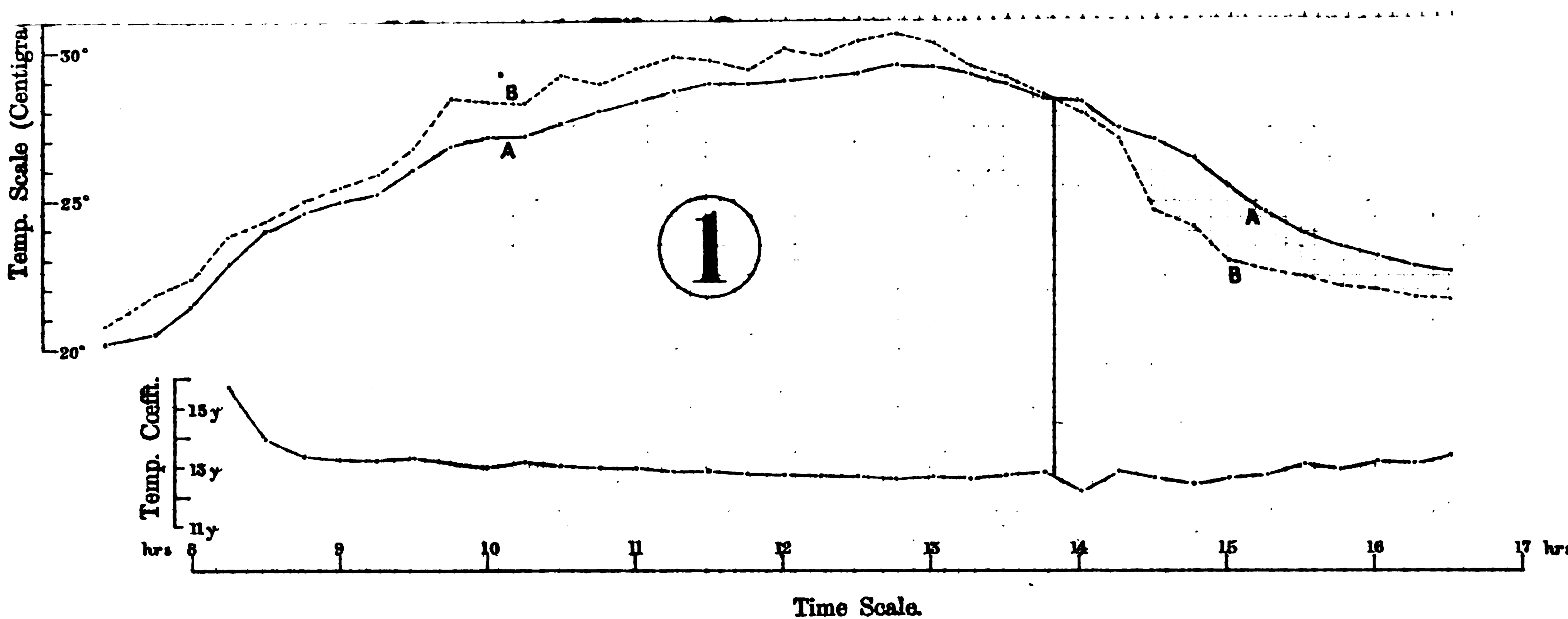


Fig. 4.

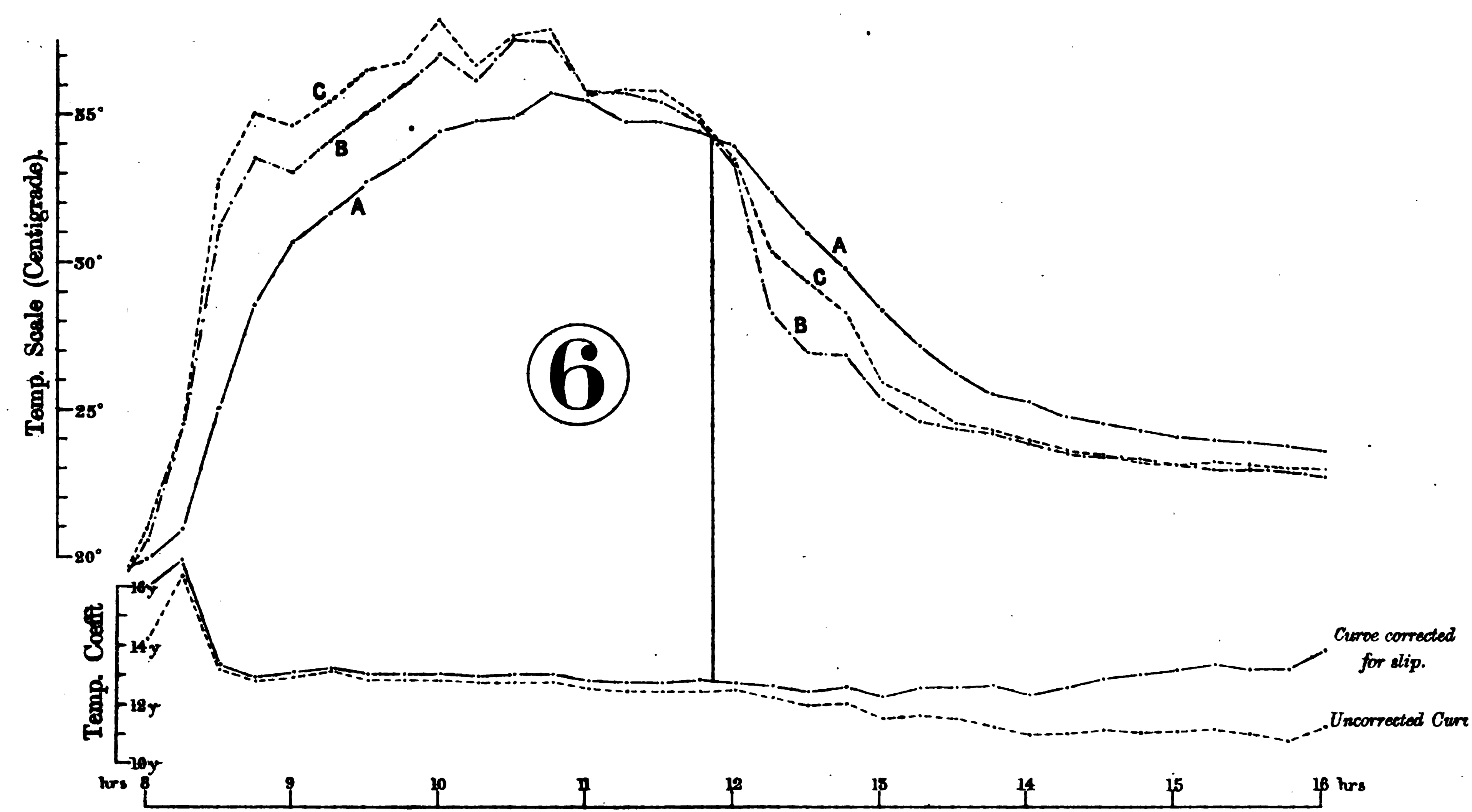
Magnet 1 and Fibre 2 in Instrument No. 2.
Date 12-2-02.



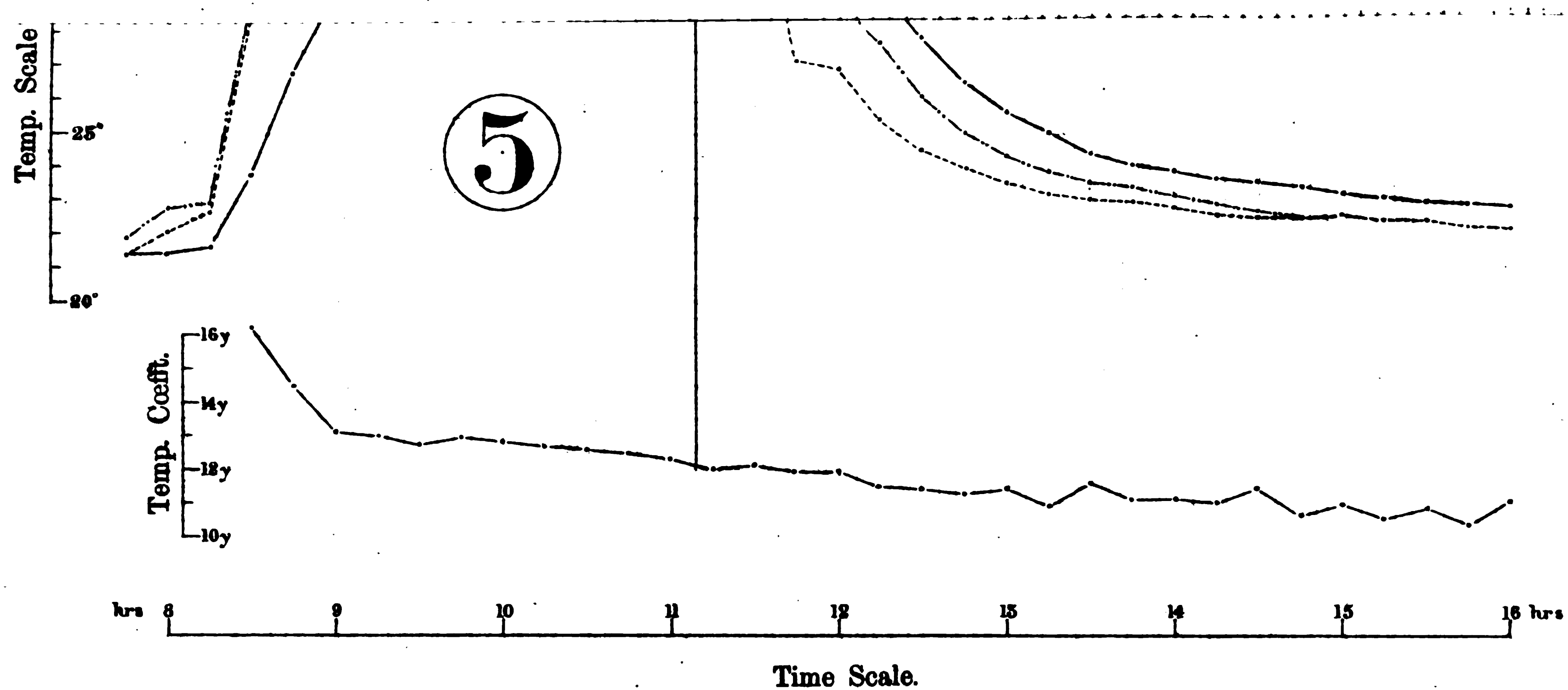


NOTE.—A=H. F. Thermometer
B=Thermometer on table
C=Thermometer near H. F. tube
The numbers enclosed in circles are the Serial Nos. of the experiments.

III. 31st Jan. 02.

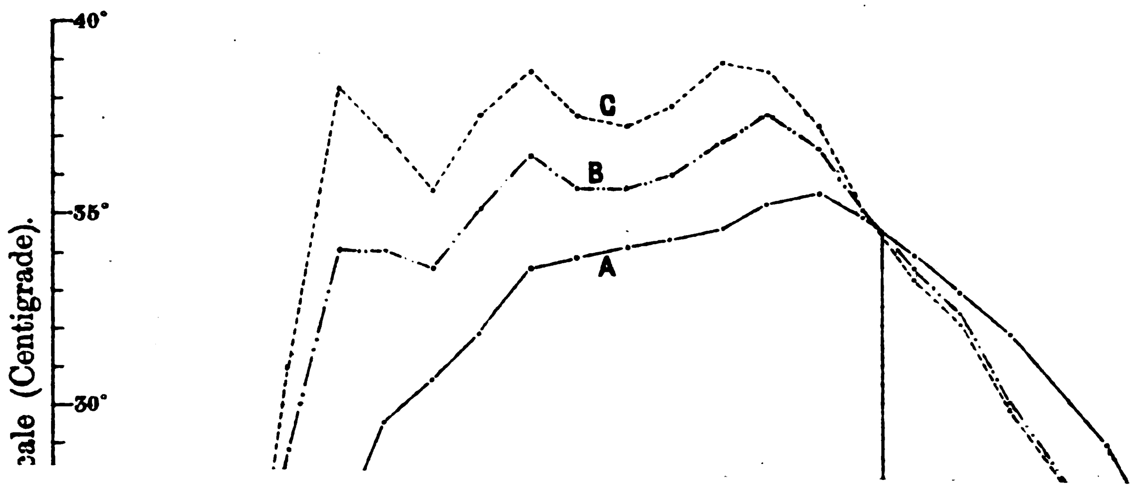


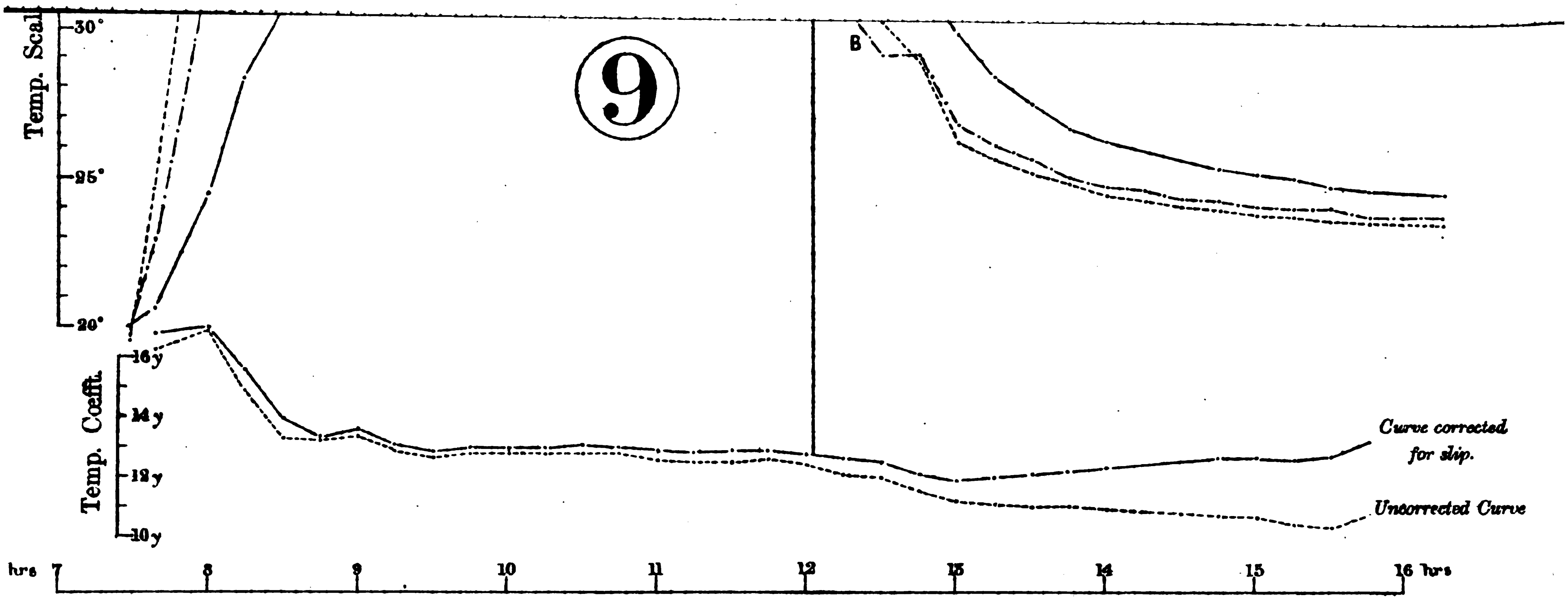
NOTE. A = H. F. Thermometer
B = Thermometer on table
C = Thermometer near H. F. tube
The numbers enclosed in circles are the Serial Nos. of the experiments.



NOTE.—A=H. F. Thermometer
B=Thermometer on table
C=Thermometer near H. F. tube
The numbers enclosed in circles are the Serial Nos. of the experiments.

Magnet 3 Fibre 3
6th Feb. 02.





Time Scale.

NOTE.—A = Horizontal Force Thermometer
B = Thermometer on table
C = Thermometer near H. F. tube
The numbers enclosed in circles are the Serial Nos. of the experiments.

Survey of India.

PROFESSIONAL PAPERS.

1905.

SERIAL NO. 8.

EXPERIMENTS MADE TO DETERMINE THE TEMPERATURE CO-EFFICIENTS OF WATSON'S MAGNETOGRAPHS,

BY

CAPTAIN H. A. DENHOLM FRASER, R.E.,

DEPUTY SUPERINTENDENT SURVEY OF INDIA.

PREPARED UNDER THE DIRECTION OF

COLONEL J. R. HOBDAY, I.A.,

OFFG. SURVEYOR GENERAL OF INDIA.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT OF GOVERNMENT PRINTING, INDIA.
1905.

Price One Rupee or One Shilling Six Pence.