spective of the position of the exciting helices, whether both were on the magnet, both on the cores, or one on the magnet and one on a core.

From the foregoing experiments it appears clear that the more near the approach to a closed magnetic circuit, the stronger is the field of force, and the longer is retained the magnetism of the mass or masses of iron constituting the circuit. The same rule holds good with regard to permanent magnets. In closed circuits the attractive force is at its height, and diminishes in intensity as the magnetic field is more extended. But the parallel goes beyond this, for the more open the magnetic field, the more rapidly is the magnetic force itself dissipated.

These principles have guided us in the construction of a dynamo-electric machine of whose magnetic circuits we here present a sketch, and which we hope to describe more fully in a future paper.

In the accompanying diagram six fixed electro-magnets are shown, having alternate poles, opposite to which, and at a very short distance, are placed three other electro-magnets so arranged with opposing poles as to form three nearly closed circuits. Coils of wire are made to revolve so as to cross the intervals between these opposing poles, and the electric currents induced in the moving coils are made to pass round the electro-magnets.

IV. "Further particulars of the Transit of Venus across the Sun, December 9, 1874; observed on the Himalaya Mountains, Mussoorie, at Mary-Villa Station, Lat. 30° 28′ N., Long. 78° 3′ E., height above sea 6,765 feet, with the Royal Society's 5-inch Equatoreal." Note III. By J. B. N. Hennessey, F.R.S. Received October 4, 1879.

1. The object of the present note is to add to Notes I and II* some particulars of the transit not detailed in those notes. The latter contained only sufficient extracts from my observatory notes in connexion chiefly with the three contacts which I observed; as, however, various other facts, besides the contacts, were developed in course of the transit, and elicited remarks from me at the time, it seems desirable that a complete transcript of these observatory notes should also be put on record; both in connexion with what hereafter follows, and also to meet any possible future requirements of details, such as expressed by Captain Tupman in his discussion of the mean solar parallax.†

* See "Proc. Roy. Soc.." Vol. xxiii, pp. 254, 379.

† Royal Astronomical Society, "Monthly Notices." Vol. xxxviii, p. 452.

Observatory Notes.

1874. December.								Remarks made by Observer at the time.
Chronometer Time.				Greenwich Time.				
d.	h.	m.	s.	d.	h.	m.	s.	
								Ingress.
								Beautifully clear morning. No haze. Eye-piece 125. Two coloured glasses giving a neutral or bluish field. Missed the 1st external contact.
8	19	18	0	8	14	6	35	Venus' edge on sun boils somewhat; it is, however, distinctly visible.
		20	0			8	35	Venus' outer edge, *i.e.*, against sky, distinctly visible, because of a narrow edging, or ring of light, around some 30° of that part of it furthest from the sun.
		20	50			9	25	The light ring now extends around the whole of that part of Venus' edge against the sky, and is some 3″ in width; it is brightest where furthest from the sun.
		22	33			11	8	The light ring against sky is well seen, and looks undeniably like Venus' atmosphere; width some 4″; definition excellent.
		23	0			11	35	The light ring against the sky can be plainly traced *in continuation* around Venus on the sun, where however it is made visible chiefly by the *movements* occurring in it of minute bright specks, and also because it boils. The entire ring is full of these minute bright specks, which appear and disappear rapidly, dancing about with little flashes. Definition excellent.
		24	28			13	3	Light ring against sky wider.
		25	10			13	45	,, ,, quite distinct.
		26	26			15	1	,, ,, quite bright.
		28	34			17	9·0	Transit of Venus' dark edge across the sun's limb, *i.e.*, 1st internal contact.
		29	10			17	45	Transit, by estimate, of outer edge of Venus' light ring (that was against sky) across the sun's limb. No ligament or pear-drop seen, *though expected and carefully watched for.*
	22	0	0	8	16	48	36	Brilliantly clear sky; light breeze from south.
		32	0		17	20	36	Spectroscope set up, adjusted, and used. Slit placed across Venus' *centre* gave a black band all along the length of solar spectrum. Slit placed tangential to Venus' disk, gave a faint, narrow glimmer of light, slightly brighter than solar spectrum, instead of black band; no displacement of solar lines in glimmer.
								Egress.
								Eye-piece as before, 125. Of the two coloured glasses used for Ingress, one

1874. December.								Remarks made by Observer at the Time.
Chronometer Time.				Greenwich Time.				
d.	h.	m.	s.	d.	h.	m.	s.	
								Egress. now changed for a red glass; field now red and less lighted than at Ingress. Definition sharp and excellent. No boiling visible around sun's limb; some boiling round Venus' lower limb and still less around upper limb. Removed the red glass and substituted a blue one, when the boiling round Venus became quite visible. Removed the temporary substitute and restored red glass, as before, and thus watched the further progress of the transit.
8	23	9	0	8	17	57	36	About $\frac{1}{4}$ of Venus' diameter from contact. No ligament visible.
		11	38		18	0	14	About $\frac{1}{6}$ of Venus' diameter from contact. No ligament visible.
		12	40			1	16	About $\frac{1}{8}$ of Venus' diameter from contact. No ligament visible.
		15	8			3	44	Less than $\frac{1}{12}$ of Venus' diameter from contact. No ligament visible.
		16	0			4	36	About $\frac{1}{20}$ of Venus' diameter from contact. No ligament visible.
		16	57			5	32·6	2nd internal contact.
		22	0			10	36	Light ring now visible around Venus' limb against sky.
		34	0			22	36	No boiling around Venus' or sun's limb.
		37	30			26	6	Venus' limb against sky only faintly seen.
		40	0			28	36	Light ring has been invisible for some time; was seen for only a short time after 2nd internal contact.
		44	14			32	49·6	2nd external contact. No ligament visible thereafter or at any time before.

2. This record was obtained by means of the following agency. My friend, Mr. W. H. Cole, M.A., audibly counted seconds, and named the minutes as completed, from a large chronometer, before which he was comfortably seated, say six feet from the equatoreal. Baboo Cally Mohun Ghose, with paper and pencil, took up a position by my side; he mentally followed Mr. Cole's counting, and noted down the instant I made a remark, together with the words I uttered. In the absence of remarks, the Baboo noted the number of each complete minute as it was declared, a reckoning which was checked by inspection of the chronometer and otherwise from time to time, so as to render the adoption of a *wrong* minute practically impossible. Thus all that remained for me to do was to look intently through the telescope of the equatoreal and declare exactly what I beheld. We three individuals were all enclosed within the canvas walling of an observatory tent

only eight feet square, the top of the tent being removed, No sound broke the enforced stillness that prevailed; the sky was brilliantly clear, and all cause for anxiety, as to clouding over, or the driving of the equatoreal, or on any other account, was completely absent; while the events in question were plainly seen to progress so gradually and deliberately that there was not the smallest occasion for hurry or confusion of any kind, nor did any occur. Unlike a solar eclipse, when every second is of the utmost importance, there was plenty of time for every purpose. Under these circumstances, I repeat, it was practically impossible that any blunder in recording could be committed.

3. Subsequently, when Colonel J. F. Tennant, F.R.S., was reducing his observations, taken at Roorkee, he wrote to me,* pointing out that there was apparently a blunder of three minutes in the recorded time of my first internal contact. I was well aware of this anomaly, and had previously alluded to it in Burlington House, when taking part in the discussion that followed the reading of my Notes I and II before the Royal Society in 1875; so that with the full knowledge I possessed of all the facts of observations, I found it out of my power to adopt Colonel Tennant's very natural suggestion, that the three minutes in question were due to a blunder in recording.

4. It appears desirable to add a few words as to this anomaly. If due to a record-blunder, then, it will be seen from the observatory notes preceding, the identical three minutes' blunder must have been repeated in no less than eight independent preceding times recorded; and this notwithstanding that, from our contiguity of position, both Baboo Cally Mohun Ghose and myself availed ourselves of ample opportunity to check Mr. Cole's declarations of complete minutes; a conclusion which amounts to assuming practically that three individuals independently concurred in the erroneous records of nine different times, which were equally wrong by three minutes. This is by no means probable.

5. If, on the other hand, the anomaly be ascribed to blunder on my part in visible recognition of the contact, or briefly to contact-blunder, the following evidence in my favour may be adduced by comparing my intervals of contact with those observed by my friend the (late) Rev. H D. James, M.A., who was stationed only nineteen miles from me to the north-west.†

* See also his Report to Government, p. 41. 1877.

† At Chakatra, lat. N. 30° 43′, long. E. 77° 54′, height 7,300 feet above sea "Proc. Roy. Soc." Vol. xxiii, pp. 381–384.)

Contact.	Hennessey.						James.					
	Time.			Interval from 1st.			Time.			Interval from 1st.		
	h.	m.	s.	h.	m.	s.	h.	m.	s.	h.	m.	s.
1st Internal..	14	17	9	..			7	41	20			
2nd „ ..	18	5	33	3	48	24	11	30	15	3	48	36*
2nd External	18	32	50	4	15	41	11	57	25	4	15	44*

Mr. James was not in a position to obtain absolute time with any great accuracy, but this does not vitiate his *intervals*. There is every reason to accept these as accurate, for Mr. James was quite familiar with the telescope, which was his own property, and was accustomed to study celestial objects. The accordance of these intervals (by 12 seconds and 3 seconds) is sufficient proof, apart from needless reduction, that if a contact-blunder of three minutes was committed in my first time, about the same occurred in Mr. James's. This, as a blunder, is, to say the least, highly improbable.

6. I think, therefore, it may be claimed for both Mr. James and myself that neither of us committed any blunder, as such, whether of record or contact. On the other hand, I confess my inability, at present, to account for the anomaly.

7. Turning briefly to the preceding observatory notes, it will be seen that, for purposes of emphasizing the visible absence of the expected ligament, I roughly estimated the intervals from 2nd internal contact (when the ligament was intently looked for) on five occasions in terms of Venus' diameter; thus, $\frac{1}{4}$th to $\frac{1}{20}$th diameter. If, for purposes of very rough comparison, we contrast these roughly estimated fractional diameter-intervals, with corresponding fractions of the observed interval between 2nd internal and 2nd external contacts, there result as errors in the former:

Error of	$\frac{1}{4}$th	diameter	+68 seconds.
„	$\frac{1}{6}$th	„	+46 „
„	$\frac{1}{8}$th	„	+52 „
„	$\frac{1}{12}$th	„	−27 „
„	$\frac{1}{20}$th	„	−25 „

which is confirmatory to some extent of the absence of gross error in the times of these two contacts.

Mr. James's letters to me in original is attached.

Excerpt from Mr. H. D. James's letter, above referred to.

"Chakatra, N.W.P., December 9, 1874.

"Through your kindness in sending me a diagram of the planet's

* Intervals corrected for watch rate, giving "perhaps a minute in 12 hours."

progress across the sun's disk I had as satisfactory a view of it as was possible. My son was with me. At 6.56 we noticed the sunlight on the snowy range. Ten minutes and twelve seconds after that we saw the rim of the sun rising above the mountain which intervened between us and the horizon. We kept an eye on Mussoorie and Landour, and thought they had but two minutes' advance of us in seeing the sun. Eighteen minutes and ten seconds after our first glimpse of the sunlight, Venus began nibbling at the rim of the sun. Between this and her entire entrance on to the disk was twenty-seven minutes and ten seconds; that is, we saw her external contact at 7° 14′ 10″, and her internal contact at 7° 41′ 20″. When she was about half way on, we both noticed a fringe of white light illuminating that rim of the planet which was yet on the dark sky. When she went off, we noticed the same fringe of light, but for a much shorter time, and when only about one-eighth of her had passed the sun's disk. The internal contact for departure took place at 11° 30′ 15″, and the external at 11° 57′ 25″, as near as it was possible to say, for there was a sort of flickering, which rendered it difficult to fix on the precise moment of contact.

"The spots on the sun were but insignificant, in magnitude about the same as yesterday, though in position very different."