ASTRONOMISCHE NACHRICHTEN.

N^o. 666.

Schreiben des Herrn Professors *A. D. Bache* an den Herausgeber.
Washington 1848 December 26.

Dear Sir.

Will you do me the favour to lay before the readers of your journal, an abstract of a report of Dec. 15th. addressed officially to me by Mr. *Sears C. Walker* one of the assistants of the Coast Survey.

In my letters of February 7th of this year, (see Astr. Nachr. Nr. 632). I have referred to the process in use in the telegraph Operations of last year. The operations of the Coast Survey in 1848, conducted by Mr. *Walker*, have been carried on between Cambridge & New York in connection with Prof. *Bond* and Prof. *Loomis* a distance of two hundred and fifty miles, and between Philadelphia and Cincinnati in connection with Prof. *Kendall* & Prof. *Mitchell*, for a distance of seven hundred and fifty miles.

The process this year has been varied from that of the last, by the more extensive use of the direct exchange of star signals as they are called. These are made by the astronomers at the two stations, by tapping on a telegraph key, at the instant of the bisection of a zenith star, by one of the wires of a transit instrument. This tap of the finger gives a two-fold indication of the date of the event. It gives a visible imprint of the date on the running fillet of *Morse's* Electromagnetic telegraph register, and an audible beat of the armature against the receiving magnet. This year the visible record has not been used, and the comparisons of the receiving magnet-beats with the observing clock-beats has been made by the use of the ear alone. The uncertainty attending the estimates and comparisons through the medium of the ear, has induced me to urge on Mr. *Walker* the importance of availing himself of the visible imprint, and of all the precision which is incident to it. Mr. *Walker's* attention having been called to the importance of this object, he has recently matured his method, and has made it the subject of the report, of which I have the honour to forward to you, an abstract.

The earliest use of an electromagnetic clock noticed in his report is that of Mr. *Wheatston*, referred to in the Proceedings of the Royal Astronomical Society for November 19th 1841. The circuit in Mr. *Wheatston's* clock is made and broken by the use of an insulated circular metallic disc put

on the arbor of the seconds hand. Alternate intervals of one sixtieth of the circumference are made of a nonconducting substance. The disc is connected with one pole of a galvanic battery and a delicate spring connected with the other, presses gently on the disc, and makes and breaks the circuit once every second.

Mr. *Steinheil's* description of his invention is found in your valuable astronomical Jahrbuch for 1844. The particular machinery for making and breaking circuit does not appear to be there described.

Prof. *Bond* has recently proposed to make the galvanic circuit by the contact of insulated portions of the pallet and escapement wheel. Finally Dr. *Locke* of Cincinnati has employed in his experiments an uninsulated wheel of sixty teeth placed on the arbor of the seconds hand. Each tooth when horizontal, strikes against the handle of a platinum tilt hammer, weighing about two grains, and knocks up the hammer, which instantly falls back to a state of rest on a platinum bed. The fulcrum of the hammer and the platinum bed are affixed separately to a block of wood. The rising and falling of the hammer breaks and restores the circuit. The whole time taken for this alternation is about one tenth of a second.

Either of these four methods enables us to make and break circuit once in a second. All the methods with the exception perhaps of the third, effect this purpose without injury to the machinery or rate of the most delicate astronomical clock.

These alternations are brought to bear on *Morse's* electromagnetic telegraph in the ordinary mode now in practice at all the offices in the United States. The register proposed by Mr. *Walker* delivers about an inch of the fillet of paper in a second of time. The rate of delivery is controlled by a *Fraunhofer* centrifugal clock. By connecting together the primitive clock and the telegraph register we are enabled to form what may be called the automatic clock register, which consists of a graduated fillet of paper on which each second is composed of an indented line of about nine tenths of an inch and of a blank space for the remaining tenth. I enclose a short specimen of one of these fillets of paper,

graduated automatically by Dr. *Locke's* clock on the 17th of November last, on a line from Pittsburg to Cincinnati of four hundred miles in length.

Mr. *Walker* proposes to distinguish the beginnings of fives, tens and noughts of seconds etc., of fives, tens and noughts of minutes and of hours, by a gradual increase of the length of their respective blank spaces, and shortening of the indented lines. For this purpose he proposes to use three of Dr. *Locke's* toothed wheels or three of Mr. *Wheatstons* discs, with their peculiar accompaniments on the arbors of the seconds, minutes and hour hands, respectively. These remarks contain the general description of the automatic clock register.

The process of imprinting relatively on this register the date of any event, is very simple. It is only necessary to tap with the finger on a break circuit key, at the instant of the event, and a short blank space is inserted in the midst of the indented line of the automatic clock register. The beginning of the blank space marks the date of the tap. If this occurs nearly at the same time with the automatic clock blank, still its date is identified. For insulated events, such as the phases of an eclipse or occultation it is proper to dwell with the finger on the key for a line longer than that of the automatic blanks so as to be certain of cutting off a portion of the indented line. The fillet of paper with the automatic graduations and the imprinted dates of events, is cut off at a convenient time, labelled and filed away for reading off at leisure. This is done to the hundredths of a second by the use of a graduated scale of a translucent substance, or better still for hygrometric reasons, of a portion of the fillet of paper itself. A correction can be applied to the fraction of a second read off for relative rate of the clock on an inch scale of the register, if necessary. Unless however the error of rate of the paper delivery exceeds two seconds per minute, the error of reading off will not exceed on the average the hundredth of a second.

Mr. *Walker* gives the following estimate of the advantages which his method of imprinting dates of astronomical events has over the ordinary process of associating together the sensations of sight and hearing in the mind and of writing down the same in the journal of the Observatory.

- 1) The practice required for learning the art of tapping on the Key at the instant of a bisection of a star or comet or planet's centre or disc by the wire of a transit instrument, is far smaller than that of the ordinary mode of observing with the eye and ear. A few hours by Mr. *Walker's* method takes the place of months or years by the other.

- 2) The precision of each imprinted date is almost twice as great as that of the ordinary record. The intimate connection between the nerves and sensations of sight and touch is well known, as is also the dullness of perception of the organ of hearing both in regard to time and space. The gain by substituting the touch for the hearing, with freedom from mechanical error of printing is nearly two-fold.
- 3) The number of observations of bisections admits of a seven-fold multiplication at a single culmination of a star, or in a given portion of time. The time usually employed in counting clock beats, in associating together the sensations of sight and hearing, and in writing down the date of a single bisection is about fifteen seconds. Where the counting of beats is dispensed with and the recording is mechanical, two seconds of equatorial interval is ample and one and a half seconds practicable, for the purpose of tapping on the Key.

These considerations induce Mr. *Walker* to presume upon a gain of some ten-fold in the use of his method of printing the dates of heavenly bodies, whether singly or relatively in pairs.

In order to make the precision of the level and other appendages of the transit instrument commensurate with the increased precision of the mean of these numerous printed dates of bisections, Mr. *Walker* recommends a transit instrument having for its frame a box of cast iron. The number of levels to be from four to six on each side. The number of the actual readings of the levels is to be determined by circumstances. Mr. *Walker* prefers in the use of instruments not too cumbersome, to apply the principle of rapid reversals, even on equatorial stars, with adjustability of one of the sockets of the pivots, especially for the operations of the Coast Survey.

In the case of the telegraph operations for longitude it may be fairly concluded that a single transit of a circumzenith star signalled successively at two stations, with readings of six levels, before and after reversal, (nearly in the position of the observation) and with twenty bisections before and as many on the same wires after reversal, will give the maximum of precision of the method. The primitive astronomical clock may be rated at the central station, at the Coast Survey Office, and the automatic clock register and printed signal register be made there also. Triplicate check registers may be made at the two stations if desired. There is no limit to the length of the line between the stations. Several thousand miles or even the earth's circumference might no doubt be compassed, if a line of that length could be constructed. The requisites for certainty of success are good insulation of the telegraph wires and sufficient force of galvanic

batteries. The experience collected by Mr. *Walker* on this subject from trials on the line from Philadelphia to St. Louis embraces in the air line and return circuit under ground, one tenth of the earths circumference in extent, and shows that fifty of *Grove's* pint cups for every thousand miles of extent are amply sufficient for the supply of galvanic force. Thus far the longer the line, the more complete has been the success.

The experience of the Coast Survey warrants Mr. *Walker* in concluding that one transit of a Zenith star over two stations at any distance asunder, signalised with suitable instruments in the manner above described, will afford a permanent

printed record of their relative longitude within a few hundredths of a second. Such a limit may be said to rival the present state of our knowledge of the relative longitudes of Greenwich and Paris, the two oldest astronomical Observatories extant.

Both parts of the present process have been separately tested under my instructions by ample experiments on the part of Mr. *Walker* and his associates in the U. S. Coast Survey service. For the full trial of their combination, of the success of which no doubt is extertained, we now wait for the construction of instruments suited to the importance and delicacy of the operation.

A. D. Bache.

Bestimmung der Elemente der Iris mit Berücksichtigung der Störungen, von *E. Schubert*.

Um den Störungsrechnungen so viel als möglich genäherte Elemente zu Grunde legen zu können, nahm ich zwei Normalörter, den ersten und dritten, aus welchen Herr Dr. *Galle* seine in Nr. 643 der Astron. Nachrichten gegebenen Elemente

berechnet hatte und bildete dazu noch einen dritten aus Hamburger Beobachtungen, woraus ich dann noch einmal die Elemente nach der *Gauß's*chen Methode ableitete.

Normalörter.

1847 Aug. 20,0 m. Berl. Zt.	298° 2' 42" 09	−13° 39' 43" 73	} bezogen auf das mittl. Aequin 1848 Jan. 1,0. und noch mit den Störungen behaftet.
1848 Jan. 27,0 ———	346 4 55,55	− 1 42 33,94	
— Sept. 30,0 ———	133 19 23,83	+15 15 40,75	

Elemente.

1848 Jan. 1,0 mittl. Zt. Berlin.

M	330° 56' 33" 70	} m. Aeq. 1848,0
π	41 26 33,15	
Ω	259 45 19,44	
i	5 28 16,18	
φ	13 22 14,84	
lg. a	0,3776798	
μ	962" 69090	

die zu Grunde gelegten Oerter genau darstellend.

Mit diesen Elementen wurde nun zuvörderst behufs der Beobachtungen beiläufig folgende Ephemeride gerechnet:

w. Aequin.					w. Aeq.				
12 ^h m. Berl. Zt.	α .	δ .	lg. Δ	lg. r.	12 ^h m. Berl. Zt.	α .	δ .	lg. Δ	lg. r.
1848 Dec. 15	156° 15' 93	+3° 55' 82	0,24680	0,35506	1849 Janr. 10	156° 17' 17	+2° 14' 66	0,18997	
17	26,87	44,03	0,24216		12	156 4,37	12,14	0,18627	0,36899
19	36,07	32,81	0,23753	0,35709	14	155 49,77	10,45	0,18274	
21	43,52	22,20	0,23293		16	155 33,43	9,59	0,17938	0,37093
23	49,17	12,24	0,22834	0,35911	18	155 15,36	9,56	0,17622	
25	53,00	2,94	0,22378		20	154 55,64	10,37	0,17327	0,37286
27	54,98	2 54,33	0,21927	0,36112	22	154 34,33	12,00	0,17055	
29	55,13	46,42	0,21482		24	154 11,55	14,44	0,16806	0,37477
31	53,41	39,23	0,21044	0,36311	26	153 47,39	17,68	0,16582	
1849 Janr. 2	49,85	32,78	0,20614		28	153 21,93	21,74	0,16385	0,37666
4	44,44	27,08	0,20192	0,36508	30	152 55,32	26,55	0,16216	
6	37,20	22,15	0,19781		Febr. 1	152 27,68	32,05	0,16075	0,37853
8	28,10	18,00	0,19382	0,36704	3	151 59,16	38,23	0,15966	