Astronomy. — *"Preliminary investigation of the rate of the standard clock of the observatory at Leyden* HOHWÜ *N°. 17 after it was mounted in the niche of the great pier."* By Dr. E. F. VAN DE SANDE BAKHUYZEN.

1. In a preceding paper on the clock HOHWÜ 17 I communicated the investigations I had made on an inequality of a yearly period noted in its rate which does not depend on the actual temperature.

Besides the periods 1861—1874 and 1877—1898 I discussed also the period 1899—1902 when the clock had been mounted in the hall of the observatory in a niche cut out for this purpose from the great pier. From the mean daily rates during periods of about a month each, I derived formulae for the rate in two different ways, and this research clearly brought to light that during this period the rate of the clock had become considerably more regular than before and now satisfies high demands.

Since that time the same formulae have been compared with the daily rates observed during much shorter periods and an investigation has been undertaken about the barometer coefficient, for which purpose the monthly rates were less appropriate.

The latter calculations have so clearly shown the excellence of the clock also with regard to its rate during periods of a few days, that it seemed to be of interest briefly to give here the results to which they led.

2. The results we obtained from the previous investigations may be resumed thus.

Under all the conditions in which the clock HOHWÜ 17 has been placed, its rate, after correction for the influence of the temperature, has always shown a residual yearly inequality. As the former influence had been derived from the yearly variation of the temperature, the residual inequality must necessarily show a difference of phase of three months with respect to the temperature.

If the influence of the temperature had been derived and accounted for in the form $c_1 (t - t_0) + c_2 (t - t_0)^2$, whether we had found for c_2 a small negligible value, as in the period 1862—1874 or an obviously real quantity as in the period 1899—1902,, the residual inequality could with sufficient accuracy be expressed by a simple sinusoid. If on the contrary only a linear influence of the temperature had been accounted for, while an investigation of c_2 showed it to have an appreciable value, the residual inequality showed a half-yearly term besides. This could be expected; for as long as only the yearly variation of the temperature is concerned, a quadratic influence of the latter and a half-yearly inequality are completely equivalent.

3. For the rate of the clock during the period 1899—1902 I derived in the first place the formula:

$$D.\ R. = -0^s.169 + 0^s.0140\,(h - 760).$$
$$-\ 0^s.0253\,(t - 10^0) + 0^s.00074\,(t - 10^0)^2.$$
$$+\ 0^s.0465\ \cos 2\pi \frac{T - May\ 3}{365} \quad \ldots\ldots\ldots \quad I)$$

secondly the formula:

$$D.\ R. = -0^s.157 + 0^s.0140\,(h - 760).$$
$$-\ 0^s.0220\,(t - 10^0) + Suppl.\ inequal \quad \ldots\ldots \quad II)$$

The supplementary inequality in the second formula was represented by a curve. Yet it can as well be represented by a yearly and a half-yearly term. We then find:

$$Suppl.\ Inequ. = +\ 0^s.0471\ \cos 2\pi \frac{T - Apr.\ 29}{365}$$
$$-\ 0^s.0198\ \cos 4\pi \frac{T - Apr.\ 16}{365} \quad \ldots \quad II)$$

From the term depending on the square of the temperature found by the first method of calculation and from the yearly variation of the temperature in the clock-case, which is approximately represented by

$$t = +\ 11^0.6 + 6^0.54\ \sin 2\pi \frac{T - May\ 4}{365}\ ^{1)}$$

we derive for the half-yearly term

$$-\ 0^s.0158\ \cos 4\pi \frac{T - May\ 4}{365}$$

which is in sufficient agreement.

The two formulae must however give different results, as soon as the accidental variations of the temperature become of importance, and therefore it was of interest to compare the rates during short periods with either.

4. Hence two comparisons were made for the three years 1899 May 3—1902 May 3. [2])

1) For the next term we find: $+\ 0^0.55\ \sin 4\pi \dfrac{T - June\ 9}{365}$.

2) In this and the following calculations the supplementary inequality for formula II was read from the curve.

Within that period I could dispose of 182 time-determinations at average intervals of 6 days, giving 181 values for the daily rate. We can assume as mean error of the result of a time-determination, largely accounting for systematic errors such as variations of the personal errors of the observers, $\pm 0^s.04$.

I do not give here in full the results of the comparison of these 181 observed rates with the two formulae and only lay down the mean values found in both cases for a difference: observation—computation.

I found:

$$\text{Formula I} \quad \text{M. Diff.} = \pm 0^s.0333$$
$$\text{〃} \quad \text{II} \quad \pm 0\,.0344$$

Hence this mean difference is nearly the same for the two formulae; indeed, if the three years are kept apart, it is found to be a little greater for formula I in two of the three years.

We may therefore say that the two are in equally good agreement with the observations and for the investigation of the barometer coefficient it was sufficient to use either.

I chose formula II (linear influence of the temperature) and I proceeded in the following way. The rates reduced with that formula to 760 m.m. and 10° and freed from the supplementary inequality were divided into five groups according to the barometric pressure and for each group the mean of those reduced rates was calculated. The results are laid down in the following table, where the first column gives the number of rates from which each mean has been derived.

Number.	Barom.	Reduced. D. R.	O.—C.
17	752.8	$-0^s.174$	$-0^s.002$
31	757.6	162	+ 02
68	762.6	154	+ 01
44	767.4	145	+ 02
21	772.2	141	— 02

From these results I derived as correction for the barometer coefficient:

$$\Delta\, b = +\, 0^s.0017$$

while I found for the daily rate for 760 mm. — $0^s.160$. With these values we obtain a very good agreement with the observations as appears from the differences obs.—comp. contained in the last column of the foregoing table. Hence it appears that the value for the barometer coefficient $b = + 0^s.0157$ is determined with great precision [1]).

For the constant term of the formula we find from all the rates $-0^s.161$, while, if we put $b = + 0^s.0157$ also in formula I, the constant term here becomes $-0^s.173$.

5. With the formulae thus modified:

$$D.\ R. = -0^s.173 + 0^s.0157\,(h-760).$$
$$-0^s.0253\,(t-10^\circ) + 0^s.00074\,(t-10^\circ)^2.$$
$$+ \textit{Supplementary inequality} \quad . \quad . \quad . \quad . \quad . \quad . \quad (Ia).$$
$$D.\ R. = -0^s.161 + 0^s.0157\,(h-760).$$
$$-0^s.0220\,(t-10^\circ) + \textit{Supplem. inequal.} \quad . \quad , \quad (IIa).$$

we have again compared all the observed rates and this time the comparison has been extended to 1902 Sept. 20 i. e. till almost five months after the period from which the formulae were derived. Besides the observations have been compared with a third calculation. This we obtained by applying the formula II*a* so that we did not use the actual mean temperature but that of five days earlier. It is obvious that in doing so also the value of the supplementary inequality must be altered. An assumed lagging behind of the influence of the temperature of five days is equal, so far as the general variation of the temperature (as found above) is concerned, to $0.27 \times$ the yearly supplementary term. Hence the latter had to be diminished by this part of its amount. The formula thus modified I call II*b*.

The results of these three comparisons are given in full in the following table. The first column gives the dates of the time determinations, the next column gives the mean temperature for the period between the date of one line above and of that on the same line, while the third, fourth and fifth columns give the differences between the observed rates for those periods and the computations I*a*, II*a* and II*b* respectively. These differences are expressed in thousandth parts of seconds.

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1) According to the investigations of Mr. WEEDER a value little different from this follows for the period 1882—1898.

	Temp.	Obs. — Ia	Obs. — IIa	Obs. — IIb		Temp.	Obs. — Ia	Obs. — IIa	Obs. — IIb
1899					1899				
May 3					Nov. 12	+12.6	— 12	— 14	— 28
» 12	+10 5	— 11	— 18	— 10	» 20	11 0	— 3	— 8	+ 3
» 17	12.0	+ 33	+ 23	+ 9	» 28	10.8	— 42	— 51	— 63
» 30	12.7	0	— 12	— 1	Dec. 7	10.4	— 9	— 22	— 19
June 3	13.0	— 17	— 32	— 40	» 13	6.8	+ 83	+ 83	+140
» 8	14.8	+ 43	+ 33	— 3	» 16	3 7	+ 76	+103	+170
» 14	14.8	+ 27	+ 14	+ 23	» 19	3 0	— 19	+ 16	+ 52
» 22	15.4	+ 36	+ 22	+ 12	» 23	2.3	— 24	+ 21	+ 31
» 27	16.5	+ 20	+ 11	+ 5	» 31	3.1	— 52	— 19	— 38
July 7	16 5	+ 7	— 3	+ 7	1900				
» 11	16 4	— 17	— 29	— 28	Jan. 8	5.3	— 32	— 26	— 62
» 14	18 1	+ 57	+ 57	+ 13	» 20	5 4	— 44	— 39	— 36
» 17	18.6	+ 56	+ 60	+ 29	» 25	6.0	— 36	— 36	— 62
» 25	19 6	+ 78	+ 91	+ 71	Febr. 4	6 1	— 12	— 9	— 2
» 31	19 6	+ 39	+ 50	+ 60	» 8	4 9	— 22	— 6	+ 8
Aug. 3	19 4	+ 30	+ 38	+ 45	» 20	4 3	— 28	— 2	+ 3
» 9	19 6	+ 66	+ 76	+ 71	March 2	6 9	— 4	0	— 28
» 14	19 1	+ 21	+ 28	+ 44	» 9	6 3	— 18	— 7	+ 23
» 21	18 7	+ 26	+ 30	+ 34	» 16	6 7	— 40	— 30	— 34
» 26	17 7	— 3	— 4	+ 12	» 20	6 8	— 30	— 20	— 10
Sept. 3	18 3	+ 17	+ 25	+ 11	» 26	6.6	— 25	— 12	— 1
» 8	18 3	+ 9	+ 22	+ 18	» 30	6 1	— 45	— 26	— 7
» 13	17 7	+ 34	+ 44	+ 50	April 2	6 0	— 52	— 32	— 18
» 21	16 3	— 14	— 9	+ 7	» 4	6 1	— 38	— 19	— 11
Oct. 5	14 4	— 35	— 32	— 24	» 12	7.2	— 12	— 1	— 11
» 9	13 1	+ 3	+ 7	+ 15	» 18	9 0	— 29	— 29	— 49
» 16	11.9	— 9	— 5	+ 8	» 21	9 9	+ 37	+ 34	+ 25
» 19	11.4	— 42	— 37	— 30	» 24	10 7	+ 17	+ 9	— 11
» 24	10 9	— 19	— 14	— 17	» 28	10 1	— 16	— 20	— 1
» 31	11.4	— 15	— 12	— 35	May 1	9 8	+ 14	+ 10	+ 35
Nov. 5	12.3	+ 4	+ 6	— 21	» 4	10.4	— 71	— 77	— 83

	Temp.	Obs. — I*a*	Obs. — II*a*	Obs. — II*b*		Temp.	Obs. — I*a*	Obs. — II*a*	Obs. — II*b*
1900					1900				
May 10	+12.1	− 12	− 22	− 43	Oct. 19	+12.6	− 7	− 3	+ 34
» 14	11.7	− 16	− 26	− 3	» 29	11.6	− 9	− 6	− 3
» 23	11.2	− 19	− 30	− 12	Nov. 3	11.8	− 50	− 48	− 67
» 26	12.5	− 11	− 22	− 46	» 7	11.3	− 13	− 13	− 14
June 2	13.0	− 27	− 40	− 43	» 16	10.3	− 1	− 2	+ 6
» 9	14.9	− 9	− 19	− 44	» 23	9.2	+ 22	+ 20	+ 22
» 12	16.3	− 26	− 31	− 48	» 27	8.8	− 12	− 14	− 20
» 18	17.3	+ 33	+ 33	+ 15	Dec. 7	8.3	+ 21	+ 17	+ 14
» 23	17.1	− 29	− 33	− 21	» 10	8.9	− 62	− 75	−106
» 28	16.6	− 11	− 20	+ 2	» 15	9.3	+ 23	+ 6	− 14
July 2	16.2	− 46	− 58	− 45	» 19	9.5	+ 50	+ 29	+ 14
» 10	16.3	− 31	− 43	− 36	» 29	8.7	+ 55	+ 34	+ 42
» 13	16.4	− 29	− 40	− 40	1901				
» 17	18.1	+ 18	+ 18	− 24	Jan. 3	7.4	+ 69	+ 57	+ 64
» 21	19.8	+ 31	+ 46	− 4	» 6	5.2	+ 96	+103	+162
» 25	20.8	+ 41	+ 68	+ 39	» 11	3.1	+ 59	+ 91	+146
» 31	20.7	+ 11	+ 35	+ 36	» 14	3.0	− 32	+ 2	0
Aug. 7	19.0	− 39	− 35	− 4	» 17	3.2	+ 27	+ 57	+ 50
» 11	17.5	− 43	− 51	− 21	» 23	4.7	+ 37	+ 51	+ 18
» 14	17.1	− 63	− 74	− 61	Febr. 1	6.8	+ 47	+ 43	+ 18
» 17	17.6	− 46	− 51	− 60	» 4	6.0	+ 26	+ 31	+ 49
» 23	18.8	+ 4	+ 12	− 25	» 11	5 1	+ 32	+ 46	+ 67
» 28	18.4	− 28	− 22	− 11	» 20	4.4	+ 15	+ 39	+ 55
» 31	17.4	− 34	− 34	− 8	March 5	5.4	+ 28	+ 44	+ 27
Sept. 4	16.9	− 25	− 27	− 20	» 13	7.2	+ 4	+ 9	+ 14
» 12	16.4	− 48	− 48	− 44	» 21	7 2	− 10	− 3	+ 1
» 16	16.2	− 32	− 29	− 35	» 25	6 3	+ 1	+ 47	+ 50
» 19	16.5	+ 3	+ 11	− 1	Apr. 1	5.8	− 28	− 6	+ 13
» 29	16.4	− 31	− 20	− 27	» 4	7.3	− 5	+ 6	− 24
Oct. 6	15.3	− 24	− 14	− 6	» 7	8.2	+ 12	+ 16	− 14
» 16	14.6	− 12	− 3	− 3	» 17	9.3	+ 3	+ 9	2

	Temp.	Obs. — Ia	Obs. — IIa	Obs. — IIb	—	Temp.	Obs. — Ia	Obs. — IIa	Obs. — IIb
1901					1901				
Apr. 20	+ 9.3	+ 21	+ 20	+ 35	Nov. 1	+11.9	+ 6	+ 8	+ 11
» 23	10.5	+ 38	+ 32	+ 12	» 4	10.6	+ 26	+ 29	+ 48
» 29	11.6	+ 49	+ 41	+ 24	» 15	9.9	+ 15	+ 19	+ 11
May 3	11.7	+ 13	+ 4	+ 18	» 22	9.6	+ 37	+ 35	+ 37
» 8	11.6	— 5	— 15	— 3	» 26	9.0	+ 53	+ 50	+ 51
» 11	11.5	+ 1	— 8	+ 8	Dec. 6	8.4	— 3	— 7	— 10
» 14	11.7	— 1	— 11	- 3	» 16	7.8	+ 9	+ 1	+ 7
» 20	11.9	— 8	— 19	— 12	» 25	5.5	+ 1	+ 7	+ 25
June 2	14.0	+ 15	+ 5	— 15	1902				
» 7	16.4	+ 17	+ 14	0	Jan. 5	6.6	— 6	— 11	— 43
» 18	15.6	— 30	— 39	— 10	» 11	8.6	+ 20	0	— 19
» 25	15.3	— 28	— 42	— 43	» 18	8 1	— 24	— 40	— 30
July 3	16.8	— 16	— 24	— 38	» 28	7.9	+ 18	+ 5	+ 5
» 10	17.7	— 19	— 22	— 30	Febr. 1	6.4	+ 36	+ 37	+ 70
» 15	19.1	— 6	+ 3	— 24	» 7	4.9	— 3	+ 13	+ 45
» 20	19 8	— 2	+ 14	+ 2	» 12	4.6	— 44	— 24	— 15
» 31	20.2	+ 1	+ 21	+ 23	» 15	4.2	— 36	— 11	0
Aug. 9	19 5	— 28	— 18	— 11	» 20	3.2	— 68	— 29	— 2
» 12	19 6	+ 14	+ 25	+ 16	» 24	4.0	— 7	+ 23	+ 12
» 16	19.4	— 4	+ 7	+ 3	March 4	5.6	— 14	+ 1	— 25
» 22	18.9	— 37	— 30	— 22	» 10	7.0	— 15	— 9	— 23
» 27	18.5	— 25	— 18	— 13	» 14	7.1	+ 9	+ 16	+ 25
Sept. 5	16.8	— 24	— 27	— 7	» 19	7.7	+ 12	+ 15	+ 12
» 16	15.8	— 22	— 23	— 26	Apr. 3	8.3	+ 12	+ 14	+ 21
» 20	15.5	+ 9	+ 11	+ 16	» 8	8 2	— 3	+ 1	+ 11
» 26	16.2	+ 20	+ 29	+ 7	» 12	8.0	- 14	— 7	+ 8
Oct. 1	16 7	— 5	+ 9	— 8	» 18	9.3	+ 32	+ 31	+ 16
» 11	15.5	+ 6	+ 18	+ 30	» 25	11.3	+ 41	+ 34	+ 10
» 16	13.1	+ 7	+ 12	+ 32	» 28	12.1	+ 37	+ 29	+ 26
» 22	12 9	+ 2	+ 6	— 4	May 3	11 0	— 6	— 14	+ 22
» 26	12.6	— 16	— 13	— 16	» 9	10.7	+ 2	— 7	+ 12

	Temp.	Obs. — Ia	Obs. — IIa	Obs. — IIb		Temp.	Obs. — Ia	Obs. — IIa	Obs. — IIb
1902					1902				
May 24	+10.4	— 10	— 18	— 9	July 31	+17.1	— 52	— 63	— 55
» 31	12.7	+ 26	+ 12	— 13	Aug. 5	16 8	— 54	— 68	— 61
June 11	15.9	+ 37	+ 32	+ 16	» 11	16 9	— 40	— 53	— 56
» 17	14.6	— 34	— 48	— 19	» 15	16.0	— 52	— 70	— 50
» 23	15 1	— 13	— 29	— 34	» 20	16.5	— 14	— 28	— 38
» 28	16 8	+ 7	0	— 28	» 25	16.8	— 49	— 55	— 66
July 5	18.4	+ 14	+ 18	0	Sept. 3	17.1	— 16	— 19	— 36
» 12	17.9	— 20	— 21	— 7	» 8	17.8	— 25	— 18	— 31
» 15	17.4	— 31	— 38	— 21	» 14	16.7	— 19	— 16	— 3
» 23	17.7	— 26	— 32	— 47	» 20	15.2	— 27	— 28	— 7

From these differences we derive the following mean errors of a rate computed by means of the three formulae:

	Form. Ia.	Form. IIa.	Form. IIb.
1899 May—1900 April......	± 0s.0343	± 0s.0345	± 0s.0424
1900 May—1901 April.... .	345	387	447
1901 May—1902 Sept......	251	266	274
1899 May—1902 April......	± 0.0311	± 0.0327	± 0 0385
1899 May—1902 Sept......	± 0.0311	± 0.0332	± 0 0382

First let us compare the mean errors of the three formulae inter se and with the corresponding values formerly obtained for the formulae I and II with the uncorrected barometer coefficient.

Then it appears in the first place from the values for the period 1899 May—1902 April that the correction of the barometer coefficient has markedly improved the agreement with the observations.[1]) Secondly it would appear that the quadratic formula now represents the observations a little better than the linear formula, and thirdly we find that the supposition of a lagging behind of the influence of the temperature markedly impairs the agreement.

[1]) Each of the three years separately also leads to the same result.

A consideration of the differences obs.—II*a* and obs.—II*b* shows however, that the latter conclusion does not equally hold good for all parts of the year and that the agreement with formula II*b* is especially bad in the winter months. In order to investigate this more closely, I divided the observations into groups of two months and calculated for each group the mean value of the differences, first for each year separately, then after combining the corresponding groups of the different years. The latter values follow here.

	Form. II*a*.	Form. II*b*.
January, February	$\pm$ 0s.0402	$\pm$ 0s.0549
March, April	208	214
May, June	285	284
July, August	423	368
September, October	215	232
November, December	369	559

They lead to the singular result that during the four winter months formula II *b* agrees much less with the observations than II*a*, whereas in the middle of the summer the agreement with II*b* seems to be better, and in the other months both formulae may be said to agree equally well. In this respect the different years practically lead to the same conclusion and hence we cannot say that this has been brought on by entirely accidental causes. However this may be, we are not entitled yet to assume a lagging behind of the influence of the temperature.

Let us now consider separately the results for formula I*a*, which seems to represent the observations with the greatest precision (those for II*a* do not essentially differ from them). It will be seen immediately that during the last seventeen months the rate has been considerably more regular than during the first two years [1]; a smaller M.E. has been reached although the 5 last of these 17 months were not included for the derivation of the formula. Thus the feature observed before, i.e. the gradual improvement of the regularity of the rate after the mounting of the clock, shows itself once more. The mean result for the whole period (M. E. = $\pm$ 0s.0311) may already be regarded as very satisfactory, and the great regularity represented by a mean difference of $\pm$ 0s.0251 between a daily rate from a 6 days interval and a relatively simple formula gives us a high sense of the supe-

[1]) Already at the beginning we had left out the first 4 months after the remounting.

riority of Hohwü 17 in its present state. That this regularity markedly surpasses the one reached formerly is shown also by the results of an investigation of the years 1886—87, which are among those of the greatest regularity in the period 1877—1898. This investigation was made in a similar manner as the present one, the mean interval between the time determinations used was 5 days and the mean error found was ± 0s.0365.

6. We may also investigate the rates of a clock in such a manner that only the irregularities of a very short period are considered. A simple process for attaining this is to calculate the mean value of the difference between two consecutive reduced daily rates.

Applying this method to Hohwü 17 during the period under consideration [1]) I found:

Mean difference 1899 May—1902 Sept. ± 0s.0313.
" " 1901 May—1902 Sept. ± 0s.0253.

From these mean values considered in connection with the mean errors of the rates in 6-daily and in monthly intervals formerly found we can draw some, albeit rough, conclusions about the amount of the perturbations of longer and shorter periods.

The values found, as well those for the whole period as those derived for the last year only, are given in the following table. The columns *A* contain the values found directly, the columns *B* those diminished by the amount that can be ascribed to the errors of observation, assuming ± 0s.04 as the total mean error of a time-determination. M. E. β of a 6-daily rate stands for the total mean difference from the formula I*a*, found above, M. E. α represents the error derived from the mean differences between two consecutive rates. The mean errors of the monthly rates differ a little from those of my previous paper as they now also refer to formula I*a*.

	1899–1902.		1901—1902.	
	A.	B.	A.	B.
M. Diff. of two 6 d. r.	± 0s.0313	± 0s.0267	± 0s.0253	± 0s.0193
M. E. α of 6 d. r.		189		137
M. E. β of 6 d. r.	311	297	251	233
M. E. of monthl. r.	209	208	164	163

[1]) The rates were reduced by means of formula II*a*, but a reduction according to I*a* would practically have led to the same result.

Although these calculations are inaccurate owing also to the fact that the intervals between the time determinations often differ rather much from 6 days, yet it is evident that the M. E. β are much larger than the M. E. α and hence that considerable perturbations of long period exist, as, indeed, a glance at the table of the obs.—comp. also shows. It would be possible to account tolerably well for the values found for the three different mean errors by assuming, quite arbitrarily of course, that there are two kinds of perturbations, one constant during 6 days and another constant during a month. We should then have to assign for the whole period an average value to both of $\pm$ 0^s.02 and for 1901—1902 alone one of $\pm$ 0^s.015.

There are not many clocks about which investigations have been published, which allow us directly to compare the regularity of their rates with that of HOHWÜ 17 and most of these embrace but a short period.

An investigation extended over 4 years about the standard-clock of the observatory at Leipzig DENCKER 12 has been published by Dr. R. SCHUMANN [1]). He uses 224 time determinations at mean intervals of $6^1/_2$ days and derives for the rate a formula containing a linear influence of the temperature and of the barometric pressure and besides a term varying with the time elapsed since a zero-epoch. As mean value of the difference obs.—comp. he finds $\pm$ 0^s.059 and there is no evidence of a residual yearly inequality. I calculated also the mean value of a difference between two consecutive rates and found $\pm$ 0^s.055.

In the latter respect we possess also data about the four normal clocks of the Geodetic Institute at Potsdam. An investigation by Mr. WANACH [2]), about the rates during last year gave the following mean differences between consecutive rates after correction for the barometric pressure, while the temperature was kept very nearly constant:

STRASSER 95	$\pm$ 0^s.054
RIEFLER 20	$\pm$ 0 .062
DENCKER 27	$\pm$ 0 .047
DENCKER 28	$\pm$ 0 .049.

These values are considerably larger than that for HOHWÜ 17, but respecting the Potsdam clocks we must keep in view that DENCKER

[1]) R. SCHUMANN. Ueber den Gang der Pendeluhr F. DENCKER XII. (Ber. Sächs. Gesellsch. d. Wiss. 1888).

[2]) Jahresbericht des Direktors des Königlichen Geodätischen Instituts für die Zeit von April 1901 bis April 1902, pg. 35.

27 and 28 had lately been cleaned, while STRASSER 95 during the period of observation had twice been replaced and meanwhile had been exposed to great differences of temperature. For DENCKER 12 at Leipzig also some perturbations from outside shortly before and during the period under consideration are noted.

7. For a clock which is used for astronomical fundamental determinations the regularity of the rate during the 24 hours of the day is of the very highest importance, but it is obvious that only long continued observations reduced with the greatest possible care can give us any information on this subject.

As yet I can only state that we may confidently expect HOHWÜ 17 not to be inferior in this respect to other clocks kept at constant temperature, seeing that, while the amplitude of the yearly variation of temperature has diminished comparatively little in its present place, the daily variation has almost entirely disappeared.

This will be seen from the following values of the difference between the temperature at 4 o'clock in the afternoon and the mean of the temperatures of the preceding and the following 8 hours in the morning. These differences taken for about 240 days have been combined in 6 two-monthly groups, and their means follow here:

	Temp. 4h—Temp. 20h.
January, February	+0°.09
March, April	+ 0.13
May, June	+ 0.12
July, August	+ 0 20
September, October	+ 0.14
November, December..	+ 0.08

The mean difference is greatest in summer, but even then very small, while no difference ever reaches to 0°.5.

(October 22, 1902).