

Note on the Method of Reduction of the Paris Wireless Rhythmic Signals. By R. A. Sampson, M.A., D.Sc., F.R.S., Astronomer Royal for Scotland. (Plate 13.)

The purpose of the following note is to draw attention to the method of reduction of the Paris wireless rhythmic time signals, as given in the publication *Réception des Signaux Radiotélégraphiques*, 2nd edition, 1913, p. 65. It appears that this method hardly utilises all the information which the observation of the coincidences supplies, and that this might be remedied with very slight additional work. Taking the example given as an illustration, the numbers observed are as below:—

Coincidence.			Break.		Number of Signal r.
h	m	s	m	s	
10	7	31			[51]
			7	40	60
	8	21			[102]
			8	39	120
	9	10			[152]
			9	38	180
	10	0			[203]
			10	37	240
	10	50			[254]*
			11	36	300

* By a misprint this is given as 264 in the model, p. 65.

The numbers in the third column corresponding to the breaks, or last signal, are, of course, data. The numbers in [] corresponding to the coincidences are deduced as explained in the pamphlet. The method of reduction is then to take the mean interval between coincidences,

$$\frac{1}{4}[50^s + 49^s + 50^s + 50^s] = 49^s \cdot 75,$$

and, increasing this by a unit, enter the tables given with interval $1 - 1/50 \cdot 75$, and extrapolate for the first and last signals by applying to the first and last observed coincidences the entries for 50 and 46 intervals respectively, obtaining

$$10^h \ 7^m \ 31^s - 49^s \cdot 015 = 10^h \ 6^m \ 41^s \cdot 985$$

and

$$10 \ 10 \ 50 + 45 \cdot 093 = 10 \ 11 \ 35 \cdot 093$$

as the moments when the first and the three-hundredth signal respectively were sent out.

It will be noticed that the only use which is made of the second, third, and fourth coincidences is to obtain the intervals, and finally, when the intervals are meant, the observations of these coincidences are eliminated completely. The method which I propose, and which we use at Edinburgh, is to obtain the intervals as above, and then extrapolate for the first and the three-hundredth signal from each observation of coincidence separately.

It will result from the method of deriving the interval that the

moment of the first signal calculated from the last coincidence, and that of the last signal calculated from the first coincidence, will agree. The remaining three are completely independent, and appear to me a valuable proof of the observation, offering material that will occasionally lead one to adopt a correction of one or two hundredths of a second to the times indicated from the first and last coincidences alone. The sum is very quickly done with the aid of the published tables, and in the example referred to above the necessary figures would run :—

Coincidence.	Number of Signal.	Corrn.	First Signal.	Corrn.	Last Signal.
h m s			m s		m s
10 7 31	51	(- 50)		(+ 249)	
		- 49 ^s .02	6 41'98	+ 4 ^m 4 ^s .09	11 35'09
8 21	102	(- 101)		(+ 198)	
		- 1 ^m 39 ^s .01	41'99	+ 3 ^m 14 ^s 09	35'09
9 10	152	(- 151)		(+ 148)	
		- 2 ^m 28 ^s .02	41'98	2 ^m 25 ^s .08	35'08
10 0	203	(- 202)		(+ 97)	
		- 3 ^m 18 ^s .02	41'98	+ 1 ^m 35 ^s .09	35'09
10 50	254	(- 253)		(+ 46)	
		- 4 ^m 8 ^s .01	41'99	+ 45 ^s .09	35'09
		Adopt	6 41'98		11 35'09

It will not escape remark that this close confirmation arises from the approximate equality of the observed intervals between coincidences, and that upon occasions when all four intervals are equal, every figure is in agreement with every other; so that a test more or less equivalent to the above can be obtained without actually reducing the second, third, or fourth coincidences, by a mere inspection of the intervals. But in my opinion the reduction is worth making.

As not very much has hitherto been published regarding results obtained at different observatories by reception of wireless time-signals, it may be of interest to record the figures from Edinburgh during the past month. It may be explained that the error of the standard mean-time clock Riefler is obtained by comparing its prick upon the tape of the Fuss chronograph with that of the standard sidereal clock; the stroke of the chronograph is then the standard of time by Riefler. Riefler drives a controlled clock, which carries low down on its pendulum a very small wheel which makes a very brief contact by striking upwards an agate knife-edge at each beat. Wires are led to the observing table and round the primary of an induction coil. The primary slides within the secondary, and the terminals of the secondary are led to the telephone. By this means the loudness of the tick can be controlled, and its length can be controlled by regulating the contact. The resistance of the secondary must be much greater than that of the telephone, or the external signals will be weakened. Between this tick in the telephone and the time of stroke of the chronograph there is a definite lag. This is measured by mounting

close to the observing table and to the chronograph a free pendulum, which makes a tick at each oscillation and is regulated so as to gain about one beat in about fifty-five upon mean-time seconds. The coincidences of this with the controlled tick in the telephone and the stroke of the chronograph can be taken in a satisfactory way for several minutes in succession. The lag is determined each night by these means, and appears to vary slightly between $+^s.10$ and $+^s.15$, according to the state of regulation of the contact. It is at present determined about half-past ten each night, and applied at the value found to the following set of observations. In this series there is a break at March 12, as the contact wheel was changed at this date; the correction for lag was not satisfactorily determined until March 20, and between March 12 and 20 it is applied at the constant value $+^s.11$.

*Observations of Clock Correction Paris-Edinburgh by Paris
Rhythmic Signals.*

Date.	Obsr.	Note.	Obsd. P.-Ed.	Riefler's Error.	Corrd. P.-Ed.	Chron.-Tick Lag.	Adopted P.-Ed.
Mar. 3	J.S.	...	+ '34	+ '22	+ '12		
5	J.S.	v. good sigs.	+ '40	+ '28	+ '12		
6	R.A.S.	...	+ '36	+ '28	+ '12		
<i>ib.</i>	J.S.	...	<i>ib.</i>	<i>ib.</i>	<i>ib.</i>		
7	J.S.	...	+ '40	+ '28	+ '12		
9	J.S.	...	+ '35	+ '20	+ '15		
10	R.A.S.	v. good sigs.	+ '36	+ '24	+ '12		
11	J.S.	...	+ '42	+ '32	+ '10		
New contact wheel introduced.							
12	R.A.S.	...	+ '42	+ '24	+ '18	[+ '11]	+ '07
13	J.S.	several sigs. missing	+ '46	+ '25	+ '21	<i>ib.</i>	+ '10
14	R.A.S.	...	+ '46	+ '25	+ '21	<i>ib.</i>	+ '10
16	J.S.	some sigs. faint	+ '46	+ '30	+ '16	<i>ib.</i>	+ '05
17	R.A.S.	...	+ '45	+ '26	+ '19	<i>ib.</i>	+ '08
<i>ib.</i>	J.S.	...	<i>ib.</i>	<i>ib.</i>	<i>ib.</i>	<i>ib.</i>	<i>ib.</i>
18	J.S.	...	+ '49	+ '28	+ '21	<i>ib.</i>	+ '10
19	J.S.	...	+ '47	+ '28	+ '19	<i>ib.</i>	+ '08
20	R.A.S.	...	+ '53	+ '32	+ '21	+ '11	+ '10
21	J.S.	sigs. faint, atmos.	+ '56	+ '35	+ '21	+ '10	+ '11
23	J.S.	...	+ '62	+ '37	+ '25	+ '10	+ '15
24	R.A.S.	poor obsn.	[+ '61]	+ '38	+ '23	+ '12	[+ '11]
25	J.S.	*	+ '68, + '76	+ '39	?+ '29	+ '12	?+ '17
27	J.S.	*	+ '54, + '63	+ '30	?+ '24	+ '11	?+ '13
28	R.A.S.	...	+ '49	+ '23	+ '26	+ '11	+ '15
30	R.A.S.	...	+ '38	+ '10	+ '28	+ '13	+ '15
31	J.S.	...	+ '34	+ '06	+ '28	+ '14	+ '14

* On these two days the determinations of first and last signals were accordant among themselves but discordant with the Paris determinations.

These results must be called remarkably smooth, considering

that, besides any error proper to the observation, they contain the whole of any accidental error there may be in determination of the clock corrections of the two observatories. They appear also to be quite free from personality. It seems clear that the Paris rhythmic signals have created one of the most delicate and reliable resources of astronomy.

The ordinary signals sent out from Paris and Norddeich are naturally upon a different plane; but their summary presents some features of interest. In the following table, in order to clear the results from the changes of system due to our experiments with different methods of producing a tick in the telephone, the numbers given are referred to the time of Paris as given by its rhythmic signals, by subtracting *P.-Ed.* as shown above, from *P.-Ed.* or *ND.-Ed.* as determined from the ordinary signals. These latter are the mean of all observations by both observers on each day. No distinction has been made between the Paris 10 A.M. signals, and those of 10 $\frac{3}{4}$ A.M. and 11 $\frac{3}{4}$ P.M., though these latter are relatively of much smaller weight.

Comparison of Time of Paris Ordinary Signals and Norddeich Signals with Time by Paris Rhythmic Signals.

Date.	Paris. s	Norddeich. s	Date.	Paris. s	Norddeich. s
Feb. 10	+ '09	+ '09	Mar. 12	- '10	- '11
11	'05	'15	13	'10	- '14
12	'09	'14	14	- '10	+ '05
13	'03	'14	15	+ '06	'13
14	'02	'03	16	'07	'03
15	'07	'03	17	'04	'00
16	'02	'11	18	'07	'06
17	+ '07	+ '04	19	+ '10	+ '14
. . . . .	. . . . .	. . . . .	20	'00	- '04
25	- '05	- '07	21	+ '04	- '06
26	'12	'12	22	'06	..
27	- '13	- '10	23	'03	- '04
. . . . .	. . . . .	. . . . .	24	'13	+ '08
Mar. 3	- '18	- '12	25	'01	- '01
5	'13	'20	26	'10	- '04
6	'05	'12	27	'11	'00
7	'04	'18	28	'13	- '39
8	- '14	'16	29	+ '10	- '06
9	+ '07	'08	30	- '04	+ '07
10	- '01	'17	31	- '02	- '10
11	- '08	- '13			

Apart from the Norddeich observation of March 28, the whole are comprised between $\pm 0^s.2$. Omitting this observation, the greatest discrepancy between successive days is $0^s.21$, and the average discrepancy for either series $0^s.06$.

Apr. 1914.

Erratum.

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*Erratum in Annual Report, vol. lxxiv. p. 341, first line
following the Table :*

for A.J. No. 229 read L.O.B. No. 229.