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The following Report of the Director of the Observatory on the Astronomical Instruments at the Observatory and on the Time-Service of Hongkong in 1885, is published for general information.

By Command,

FREDERICK STEWART,
Acting Colonial Secretary.

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REPORT ON THE ASTRONOMICAL INSTRUMENTS AT THE OBSERVATORY AND ON THE TIME-SERVICE OF HONGKONG IN 1885.

The main purpose of the astronomical branch of the Observatory is the determination of local time, but instruments are also available for making observations of such astronomical phenomena as happen to be particularly conspicuous in this region.

Local time is determined by aid of the transit-instrument, by Troughton and Simms, of three feet focal length with object glass of three inches aperture. Two setting circles, read off by levels, are fixed on the telescope near the eye-end, an arrangement very handy for observing stars passing the meridian in quick succession. The axis is perforated for side-lamps. The pivots are made of chilled bell-metal. There is no perceptible difference between their diameters, but minute irregularities appear to exist, though too small to allow their exact amount to be determined by aid of the axis-level. The latter is used for obtaining the inclination of the axis, which is done to about one inch in thirty miles. A similar level to show seconds for use with the zenith micrometer, in the observation of differences of zenith distances on either side of the zenith, is fixed and can revolve at right angles to the axis.

The eye-piece is furnished with seven fixed vertical wires and one moveable. The latter is moved by aid of a screw, the value of one revolution of which is $60.''62$ as obtained by aid of Polaris on February 28th and April 16, 1884. The number of entire revolutions traversed by the wire is read on a comb seen in the field of vision and the decimals are read on the head of the screw, which is divided to hundredths, so that the space traversed is read off to within $0.''06$. But the moveable wire after a short time began to get entangled with the permanent wires and broke after a few months. Now although this wire materially facilitates the accurate determination of the constants of the instrument and the azimuth of the meridian-marks, this assistance would be too dearly bought, were the wires to become constantly deranged and frequently broken, so that new wire-distances &c. would have to be determined. This wire has therefore not been refixed.—The distances of the six wires from the middle wire were determined from about 19 transits of Polaris in 1884 as follows, (upper transit clamp west):—

$20^{s}.703$, $10^{s}.441$, $5^{s}.132$ | $5^{s}.245$, $10^{s}.250$, $20^{s}.725$

These values may be trusted to within a hundredth of a second.—In 1884 and 1885 transits over seven wires were observed, but since the beginning of 1886 the transits are observed over the five equidistant wires, which is much more convenient and just as accurate. There are three Ramsden eye-pieces, of which no use is made as high objects cannot be seen with them, but a long diagonal eye-piece is in constant use and is in fact hardly ever detached, to which circumstance the permanency of the seven wires may be ascribed. A bag of camphor is kept in the hollow axis of the instrument in order to keep away insects.

There are also two horizontal wires, about a minute of arc asunder, in the middle between which the object to be observed is placed. In order to observe differences of zenith-distance for latitude, the eye-piece can be revolved a quarter circumference round its axis, so that the vertical wires including the moveable wire are placed horizontal. But as the instrument is in constant use as a transit, there are no opportunities for such work, which is moreover superfluous, as the latitude was accurately determined by Colonel PALMER in 1882.

The telescope rests upon a cast-iron stand with reversing apparatus (essentially an excentric circle acted on by a lever). The latter is so perfect that any change of inclination caused by the reversion has never been perceived. The inclination and azimuth are adjusted by screws fixed on either side of the stand. The changes in these constants are probably caused mainly by expansion or contraction of the adjusting screws with changes of temperature. The stand rests on a portland stone slab (3 feet long, $1\frac{1}{2}$ feet broad and 1 foot thick), which is laid in cement on top of a brick pier, sunk 5 feet deep in the ground, where it is surrounded by a cylinder also built in brick to protect it from surface-oscillation of the ground. The part of the pier above the floor is neatly cased in teak wood and does not touch the floor.

The constants of the instrument were determined as follows in 1884 and 1885: the error of collimation, c, ($90° + c$ being the angle between the optical axis of the telescope and the axis of rotation on the side that carries the clamp) and the azimuth, a, ($90° - a$ being the azimuth, counting from south towards west, of the westend of the axis) were determined from observations of Polaris in connection with stars near the equator or on some occasions by observations of stars near the zenith and near the southern horizon. The inclination, b, or the altitude above the horizon of the westend of the axis was obtained by aid of the level.

We have then:

$$\Delta T = \alpha - T - a \sin(\phi - \delta) \sec \delta - b \cos(\phi - \delta) \sec \delta \mp c \sec \delta .$$

Where T is the observed clock-time of the mean of the transits over the wires, reduced middle wire, ΔT the clock-correction, α the right ascension and δ the declination of the star, ϕ the latitude of the observatory. Upper or lower sign is to be taken according as the clamp is or east of the meridian, and when the star is sub polo $180° - \delta$ must be substituted for δ.

The sun is observed through a circular opening (larger than the object glass) in a white screen.

The total number of transits observed in 1884 amounted to 505, including 55 transits of P 25 of the Sun and 19 of the Moon and also a number of southern stars. The inclination of the was observed 150 times.—The total number observed in 1885 was 313, including 14 transits of P 20 of the Sun and 7 of the Moon and also a number of southern stars. The inclination of the ax observed 117 times.

The values of the constants in 1884 and 1885 are exhibited in the following table. Whe values are given under the same date, the last one was obtained from Polaris sub polo. Where is drawn, it indicates that the instrument was adjusted.

Date.	c.	b.	a.
1884.			
Oct. 5,	−1″.65	+2″.27	+12″.6
„ 6,	−1 .80	+0 .37	+13 .7
„ 21,	−1 .50	−1 .60	+14 .9
„ 22,	...	−1 .10	+15 .6
„ 23,	−0 .75	−2 .35	+16 .4
„ 25,	−1 .50	−2 .22	+13 .3
Oct. 31,	...	−2 .12	+ 4 .6
Nov. 4,	...	−1 .05	+ 6 .2
Nov. 5,	...	+2 .95	+ 5 .4
„ 5,	−1 .65	...	+ 3 .6
„ 8,	−2 .25	+1 .52	+ 3 .9
„ 13,	...	+3 .20	+ 6 .8
„ 22,	−0 .60	−4 .78	+ 5 .2
„ 23,	−1 .20	−3 .67	+ 3 .7
„ 24,	−1 .50	−4 .63	+ 4 .3
„ 25,	−2 .25	−4 .45	+ 4 .5
„ 27,	−1 .35	−2 .45	+ 6 .8
„ 28,	−1 .05	−3 .40	+ 5 .1

Date.	c.	b.	a.
1884.			
Nov. 29,	...	−3″.70	+ 4″.3
„ 30,	...	−3 .15	+ 7 .5
Dec. 1,	...	−2 .85	+ 6 .9
„ 7,	...	−5 .50	+ 3 .2
„ 9,	...	−5 .15	+ 4 .8
„ 9,	...	−6 .72	+ 4 .9
„ 10,	−1. 35	−7 .03	+ 6 .8
„ 10,	...	−5 .57	+ 4 .8
Dec. 11,	...	+0 .42	0 .0
„ 11,	...	+1 .60	− 1 .5
„ 12,	...	+0 .70	+ 2 .7
„ 13,	...	−0 .83	+ 1 .3
„ 15,	...	+1 .77	− 1 .9
„ 19,	...	−0 .50	− 0 .2
„ 21,	...	+0 .20	− 2 .2
„ 22,	...	+0 .87	− 2 .1
„ 26,	...	−0 .26	+ 1 .3
„ 28,	...	+1 .03	− 3 .8
„ 29,	...	+1 .67	+ 2 .3

Date.	c.	b.
1885.		
Jan. 2,	−1″.05	+3″.50
Jan. 4,	...	+0 .40
„ 5,	−1 .20	+0 .45
„ 20,	...	−2 .20
„ 22,	...	−2 .78
Mar. 5,	...	−3 .45
„ 15,	−0 .45	−7 .70
Apr. 13,	−0 .90	+3 .42
June 7,	−1 .05	+2 .62
June 25,	−2 .10	− 3 .47
„ 26,	−2 .25	− 3 .42
„ 27,	−2 .25	− 4 .07
Oct. 2,	−2 .10	− 2 .95
„ 29,	−2 .40	− 5 .00
Dec. 8,	−2 .25	− 9 .93
„ 29,	−1 .05	−13 .92

A disc of white enamel with black cross mounted on a metal plate with movement by screws is fixed on a slate slab, which is cemented into a solid masonry pier built about 70 feet n the transit instrument. It is observed through an object glass of about 66 feet focal length, w fixed in a brass plate just inside the northern shutter.—There is also a meridian mark 11354 the south, which may be observed across the harbour except of course at night or in foggy weath has the form of an obelisk and is marked with a vertical black line between two black circles.

The shutters of the transit room are a foot wide, quite sufficient for an object glass of 3 aperture. The room has 6 windows and 2 doors to equalize temperature but was unfortunately b the wrong side of the observatory, the windy side, before my arrival here.

The standard sidereal clock by E. DENT & Co., was described by the makers as being of the best possible construction and the study of its rate affords therefore a testimony of the quality of work at present issued by that firm.—It has a cast iron back, which is firmly screwed to iron b cemented in the pier placed in the clockroom. The pendulum has the zinc and steel compensat originally designed for the Transit of Venus Expeditions. The dial is painted black with white h and figures. The dead-beat escapement is executed with the greatest care. It has also a g contact apparatus omitting one second each minute, with horizontal and vertical adjustments works a three-current relay by aid of one or two bichromate cells. A sympathetic electro-m dial in the transit room is worked by a strong current through the relay.

This dial is an exact counterpart of the dial of the standard clock.—It was actually w 1884 and part of 1885 but the contact apparatus was found to interfere with the going of the clock. The teeth of the wheel on the second hand arbor, that press the springs while the p is not touching the pallets, being so very badly constructed that they are of unequal size eve unaided vision. The sympathetic dial had therefore to be rejected and the observations are n with a chronometer which is subsequently compared with the standard clock. While the obser are, as at present, confined to the determination of local time, the use of a chronometer is convenient as the sympathetic dial, the keeping in working order of which takes up par assistant's time. Besides, the omission of a second every hour on the dial is a serious drawback and ear-observations, of however great advantage it is in working a chronograph.

mean daily rates during ten-day periods of the sidereal standard clock are exhibited in the table, where + means losing and − gaining rate.

RATE OF SIDEREAL STANDARD CLOCK.

Period.	Rate.	Temp.	Bar.	Period.	Rate.	Temp.	Bar.
1885.				1885.			
1–10,....................	+1s.28	63°.7	30.09	June 24– 4,....................	−0s.18	82°.8	29.55
10–20,....................	.46	63 .4	.08	July 4–14,....................	.15	82 .1	.72
20–30,....................	.58	59 .3	.14	„ 14–24,....................	− .03	82 .9	.59
30– 9,....................	.60	58 .3	.02	„ 24– 3,....................	+ .05	80 .9	.55
9–19,....................	.61	59 .3	.03	August 3–13,....................	.09	80 .8	.63
19– 1,....................	.73	58 .4	.07	„ 13–23,....................	+ .13	80 .9	29.66
1–11,....................	.61	62 .0	.03				
11–21,....................	.61	62 .1	30.05	Clock stopped.			
21–31,....................	.20	70 .1	29.88	September 7–17,....................	−1 .28	79 .1	29.69
31–10,....................	1 .07	73 .7	.87	„ 17–27,....................	.24	79 .8	.84
10–20,....................	0 .90	76 .0	.83	„ 27– 7,....................	.37	80 .0	.90
20–30,....................	1 .00	74 .0	.82	October 7–17,....................	.33	78 .0	.89
30–10,....................	.02	73 .5	.86	„ 17–27,....................	.24	74 .5	.94
10–20,....................	.02	77 .0	.67	„ 27– 6,....................	1 .06	73 .7	29.96
20–30,....................	.06	80 .8	.76	November 6–16,....................	0 .96	70 .8	30.04
30– 9,....................	+1 .09	80 .7	29.73	„ 16–26,....................	.91	69 .0	.09
Clock stopped.				„ 26– 6,....................	.86	67 .5	.10
				December 6–16,....................	.95	67 .4	30.03
14–24,....................	−0 .14	80 .9	29.66	„ 16–26,....................	.93	66 .4	29.94

clock stopped in the thunderstorm of the 12th June and the rate was adjusted. It stopped the thunderstorm on the 23rd August, and the rate was adjusted after finally disconnecting ct springs. The clock has not stopped since that time.

n the rates registered between the 1st January and the 9th June the following equations of were constructed:

$$X + 8.6\,Y + 0^s.28 = 0$$
$$X + 3.0\,Y + 0^s.23 = 0$$
$$X - 7.2\,Y - 0^s.19 = 0$$
$$X - 11.2\,Y - 0^s.33 = 0$$

mean rate at 70° Fahrenheit is assumed $= + 1^s.30$, and where X is the correction to this e temperature coefficient or the change of rate for an increase of 1° Fahrenheit. The following ormal equations obtained by the method of least squares:

$$+ 4.0\,X - 6.8\,Y - 0.01 = 0$$
$$- 6.8\,X + 260.2\,Y + 8.20 = 0$$

from which we obtain: $X = - 0^s.053$ and $Y = - 0^s.033$

nsequence the rate at t degrees Fahrenheit was: $r_t = + 1^s.247 - 0^s.033\,(t - 70^\circ.)$

barometric coefficient was subsequently determined, but was found quite insensible,—a change ch in the height of the barometer causing a change of rate of apparently only $\frac{1}{30}$ of a second a t the mean height of the barometer in Hongkong falls so regularly as the mean temperature at this coefficient cannot well be separately determined. It may however be assumed to be very as the bob of the pendulum is heavy and swings in a rather large arc (about 3° 4′).

n the rates registered between the 14th June, and the 23rd August the coefficient cannot be d, as the temperature was nearly constant, to which may also be ascribed the very small rate exhibited during the summer. The rates subsequent to the 7th September will be in next year's report.

mean-time clock is similar to the sidereal standard clock but the escapement &c. is not so urnished. But it appears to go as well as the latter, the pendulums being apparently exact of one another. The dial is white with black figures and blue hands. It is not so firmly fixed second pier as the standard clock. It is furnished with galvanic contact springs, which are every hour at the exact second and send a current through a reversing commutator worked by lanché cell, by means of which the current that drops the time-ball at 1 p. is closed. Before r the clock must be set right, and that is effected by sending a current through a galvanic coil beneath a bar-magnet on the pendulum, which accelerates or retards the clock by either assisting teracting gravity according to the direction of the current, which is started and changed by aid ple commutator, made in Hongkong, as no such apparatus was supplied by Messrs. DENT & Co. anic coil in the clock-case is unfortunately not strong enough. It takes nearly an hour and correct an error of a second, though a very strong battery is used.

e clocks are fixed on brick piers built in cement and sunk in the ground, where they are pro- om surface vibrations like the transit instrument. The dimensions above the floor are 6 feet 2 feet broad. The standard clock pier is 1½ feet the other pier 1 foot thick. The clocks are facing each other and a desk with relays, commutators etc., stands between them as well as a tab which the assistant sits, when comparing the clocks, setting the mean-time clock, noting the sig returned from the time-ball etc.

The rates of the clocks are adjusted by removing or adding flat horse-shoe shaped brass we on a small shelf on the pendulums. Ten grains make a change of about a second a day in the This is of course not done to the standard clock, except when it stops, but the rate of the mean clock must be often altered and the wooden cases supplied by DENT & Co., although affording fa good protection to the clockwork, have shown themselves to be at any rate not less inconvenient i tropical climate, than they are known to be at home. Glass cases with cast-iron frames would be p ferable, so much more as they would allow the interior to be at all times visible. They would course be more expensive but would also be more durable. A glass of carbonate of potash is kept the clock-case to absorb moisture.

The reversing commutator, through which the mean-time clock closes a local circuit consists of polarized relay mounted on a base board and having two galvanometers on either side.

This polarised relay consists of a soft iron magnet mounted on pivots inside a hollow bobbi wrapped with insulated wire, and having soft iron projecting arms which work between the poles of permanent magnets. A contact lever is attached to the pivoted soft iron magnet and plays betwe two insulated contact screws capable of adjustment, and it is so adjusted that the contact lever is he by magnetic attraction against one of the contact screws (which we will call No. 1), when no curre is flowing through the insulated wire of the reversing commutator.

The local circuit, which is closed by the hands of the clock pressing the contant springs, includ a battery of one Léclanché cell, the left hand galvanometer and the insulated wire of the reversin commutator. Two other sets of batteries, of twelve cells each, are also employed,—one set for lockin and the other for discharging the electric lock of the time-ball. The negative pole of the lockin battery is connected to the insulated contact screw No. 1 in the reversing commutator, and the positiv pole of the discharging battery is connected to contact screw No. 2 of the reversing commutato The other poles of these batteries are connected to the earth.

The time-wire, through which the signal is sent is connected through the right hand galvanomete to the contact lever of the reversing commutator, and excepting during the time the local circuit is closed by the clock, it is in electrical contact with No. 1 contact screw, that is from a quarter to, til five minutes past 1 p., for at other times the time-wire is disconnected from the relay and put direct to earth so as to avoid danger from lightning. This is so much more important as the line is not lai underground nor efficiently guarded by "lightning-protectors," as suggested by Colonel PALMER in 1881.

Facing the galvanometers on either side of the reversing commutator, are contact keys. Depressing the left one closes the local circuit (in the same way as the clock does every hour) and shows the con dition of the local battery and whether the reversing commutator is acting properly. Depressing the right-hand key connects the time wire to earth, shows the condition of the locking and dischargin batteries and the observatory-connections, and when the time-wire is connected through the galva nometer to the locking battery, any defect of insulation (from the line and earth wires touching each other or other causes) is shown by a deflection of the needle. Furthermore, every part of the electric apparatus is tested by setting the lock about 12 h. 49 m. 40s. p. without winding up the ball and discharging at 12 h. 50 m. 0s. by aid of the left key. This signal also informs the assistant in the ball-tower concerning the error of his watch, which he requires to know in order to hoist the ball at the proper time. The local circuit is completely tested by observing the deflection of the galvanometer hand at some hour before 1 p. It would be an advantage to let the clock discharge the lock at some hour before 1 p. but this cannot be done as no assistant is in the tower to set the lock before a quarter to one.

Although at present the time-service is, as far as the public is concerned, confined to the dropping of the time-ball, there would be no difficulty in dropping any number of time-balls along the coast, giving hourly signals in the Harbour Office, principal clock makers shops, banks and other public buildings. If a cable were available, this could be effected by aid of the mean-time clock and the three-current relay, but in order to drive sympathetic clocks in buildings in Hongkong similar to those worked from observatories in large towns in the United Kingdom, a separate clock of a somewhat different but not very refined construction would be required.

The time-ball tower is erected on Tsim-sha-tsui Point directly facing the shipping. It stands in front of the new police-station beside the mast for hoisting meteorological signals, at the foot of which the typhoon gun, pointed towards the city opposite, is placed. In the police boat-basin, at a short distance NW of the tower, the small tidal observatory is built. The time-ball tower is about half mile distant from the observatory, with which it is, as already explained, connected by wire,—a sepa rate wire, for exchanging messages on the A, B, C, system, connecting the observatory with the police station.

The base of the tower is about 40 feet above sea level and forms a circle of 20 feet diameter. It has two stories, and the roof of the upper story is hemi-spherical. The top of the tower is about 6 feet and the top of the mast projecting through the roof about 84 feet above sea level. On the groun floor is a massive granite pier, that supports the entire apparatus. On a copper plate (connected by conductor with an earthplate in the ground outside) rests the cast iron pneumatic-cylinder of 10 inch

...l, diameter into which a piston, attached to the lower end of the rack, carrying the time-ball, ... producing a current of compressed air, that arrests the final descent of the ball without shocks ...ussion. In addition to different circular openings on opposite sides of the pneumatic cylinder, ...nished with Varley's pressure relieving valve, which enables, by means of tightening a spring, ...unt of compression produced in the cylinder to be regulated and a greater distinctness to be ...d in the signal. The spring at present is so adjusted as to cause the ball to rebound half a foot ...most a foot, which is not noticed by an observer whose attention is riveted on the very beginning ...drop, which is best observed in a small binocular. Any one who looks at the drop with his naked ...ay see the final rebound, but this is rather an indication that the very beginning of the drop was ...ccurately observed by him.—About half a pint of oil is kept in the pneumatic cylinder and the ...unt of the rebound partly depends on this oil, a greater quantity of oil or water causing a larger ...nd. Any rainwater that has found its way into the cylinder is therefore allowed to run out ...gh a tap in the bottom at a quarter to one o'clock.—The ground floor affords room for keeping the ...ological signals, when not in use.

... stair-case leads up to the upper floor, where the assistant stands when winding up the ball ... lock. The ball is hoisted by aid of toothed gearing, a lever throwing the pinion, that ... the forged iron rack in and out of gear as required. A girder passes across the centre ... ball and through the slot cut in the upper projecting portion of the mast which portion is ...eel. This girder is attached inside the mast to the upper end of the rack by which the ball ... While the ball &c. is resting on the pinion, it is of course not possible to throw it out of gear. ...on is hoisted above the bolt of the lock, which is previously set, and slowly lowered. When ... can be thrown out of gear, it shows that the piston with its superincumbent weight of nearly ...ecurely resting on the bolt of the lock.

... electric lock is enclosed in a wooden box, which covers and protects it. It has only one ...perture through which the bolt protrudes. One side is glazed and allows the interior to be ... It has also a small door through which the hammer is raised, which operation sets the lock ... the locking current.

... bolt on which the ball hangs, is liberated by a blow from the very small brass hammer acting ... a series of levers inside the lock, the time occupied in discharging which does not exceed ... of ... This sensitiveness and rapidity of action is obtained by the greatest accuracy of fitting and ...nt, so that the friction rollers attached to the levers in their discharge move over planes at an ... exactly 90 degrees. If the angle be greater, when the piston is lowered on to the bolt, the ...ll be to discharge the lock by the weight resting on the bolt, and therefore the apparatus ...e set. Should the angle be less, then the apparatus will be firmly fixed by the weight of ...esting on the bolt and a much greater force than is available will be required to discharge it, ...eight would have to be lifted through a small space before the bolt could be discharged.

VARLEY constructs these electric locks on the polarized system. The trigger is a jointed soft ...ature, which strongly attracts the poles of a soft iron magnet, wrapped with insulated wire and ... inductively magnetic by a powerful compound permanent magnet. A spiral spring attached ...d to the armature and at the other to an adjusting screw is so adjusted as to nearly overcome ...ctive force existing between the armature and the polarized electro-magnet. The time current ...rrives, polarizes the electro-magnet in the opposite direction to that induced by the permanent ...nd the effect is to release the armature, which is at once pulled away by the tension of the ...hich is however less than an ounce, and to discharge the lock with great rapidity.

... advantages claimed for the polarized system, apart from its rapidity of action and greater ...ness, is that by closing the circuit, as Mr. VARLEY does, in the first instance (when the piston ... on the bolt of the electric lock previous to the arrival of the 1 o'clock current), with say a ... current, which increases the attraction between the armature and the soft iron magnet, and ...he clock at 1 p. reverse the direction to a positive current, that reverses the polarity of the ... magnet, the trigger is electrically locked, up to the time of sending the discharge current, and ...cking current is stronger than any current likely to be produced by accidental contact with ... circuit, the greatest security is obtained, that the ball does not fall before the circuit is closed ... clock in the observatory.

... explained above, the electric lock is discharged at 12 h, 50 m. 0s. by touching the left hand ...he relay in the observatory. This shows, that the line &c., is in proper order and gives correct ... the assistant in the tower. At 12 h. 55 m. he begins to hoist the ball half mast. At 12 h. ...10s. he sets the lock, which is indicated in the observatory by deflection of the right hand galva... ...r, the hand of which then indicates "locked." At 12 h. 57 m. he begins to hoist the ball to the ...hen the piston touches the bolt, this is indicated in the observatory by vibrations of the galvano... ...hand, caused by the bolt alternately touching the side of the piston and falling into horizontal, ...ped groves cut in its surface. When the piston ascends above the lock, the bolt falling into ... gives an audible click after which the piston is lowered on to the bolt and the pinion thrown ... gear. From this time till one o'clock the ball rests on the bolt of the lock. This is indicated ...increase in the deflection on the galvanometer in the observatory and also on a galvanometer in ...ver situated on top of the lock, which increase is caused by extra earth-connection being ...ed through the mast &c., of the apparatus. The galvanometers are read off in both places and ...dications entered in the "time-ball journal."

The moment the clock closes the local circuit at 1 o'clock, the change of direction of the current and its almost instantaneous cessation consequent on the break of the circuit by the act of discharge, is seen on the galvanometers. Should there be any delay in the fall, both observers see this on the respective galvanometers, the needles being then permanently deflected. But so rapid in practise is the discharge and the consequent break of the circuit, that the needles are scarcely deflected at all towards the sides of the galvanometers, where the word "discharged" is engraven, and if the time elapsed between the second hand of the clock stopping at 0^{s}. and the hand of the galvanometer, giving the return signal from the tower, amounted to nearly $\frac{1}{10}$ of a second, the delay would be noticed in the observatory. The discharge of the current at 1 p. is observed on the sidereal standard clock, furnishing a final ocular demonstration of the ball dropping correctly.

The accuracy of the 1 o'clock signal depends therefore practically only upon the error of the standard clock being accuratety determined. This can always be done within $\frac{1}{10}$ of a second when the weather permits transit observations to be made the previous night. Whenever no observations are available, we depend entirely upon this clock keeping a regular rate. But although it is for this reason impossible to drop the ball without error, the latter becomes known from subsequent observations. The following table exhibits the errors of one o'clock signals in 1885, for every day on which the ball was dropped. Whenever the error was less than $0^{s}.15$, 0.1 has been entered without sign:

ERRORS OF TIME BALL IN 1885.

— means too late, + means too early.

Date.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	$0.^{s}1$	...	...	$0.^{s}1$	$0.^{s}1$	$0.^{s}1$	$0.^{s}1$	$-0.^{s}4$	$+0.^{s}2$	$+0.^{s}6$	...	$+0.^{s}2$
2	0.1	$0.^{s}1$	$0.^{s}1$	0.1	0.1	0.1	−0.2	...	0.1	+0.7	$0.^{s}1$	+0.2
3	−0.2	0.1	0.1	...	...	0.1	−0.2	...	0.1	0.1	0.1	0.1
4	...	−0.2	0.1	0.1	0.1	0.1	0.1	−0.7	0.1	...	0.1	+0.3
5	−0.2	−0.4	0.1	...	−0.2	0.1	...	−0.6	+0.3	0.1	0.1	+0.5
6	0.1	0.1	+0.2	...	−0.3	0.1	+0.3	0.1	...	0.1	0.1	...
7	0.1	0.1	0.1	+0.2	−0.4	...	+0.3	0.1	0.1	0.1	0.1	+0.8
8	0.1	...	...	0.1	−0.5	0.1	0.1	0.1	...	0.1	...	+0.5
9	0.1	+0.4	−0.2	+0.2	0.1	0.1	+0.2	...	...	0.1	0.1	0.1
10	0.1	+0.3	−0.2	+0.3	...	0.1	+0.2	0.1	...	0.1	+0.2	0.1
11	...	+0.5	−0.3	+0.2	0.1	0.1	0.1	−0.3	...	...	+0.2	0.1
12	−0.2	+0.4	−0.3	...	−0.2	0.1	...	0.1	...	0.1	+0.3	0.1
13	0.1	0.1	−0.4	+0.4	−0.3	...	0.1	−0.2	...	0.1	−0.2	...
14	0.1	0.1	−0.4	0.1	−0.3	...	0.1	0.1	...	0.1	−0.5	−0.3
15	−0.2	...	...	0.1	0.1	+0.5	−0.2	−0.3	...	0.1	...	−0.3
16	−0.3	...	0.1	0.1	0.1	0.1	0.1	...	...	0.1	0.1	0.1
17	−0.3	−0.5	0.1	0.1	...	−0.2	−0.2	−0.3	...	0.1	0.1	0.1
18	...	−0.7	0.1	−1.0	−0.3	−0.2	−0.3	−0.3	...	...	0.1	−0.2
19	−0.5	−0.9	+0.2	...	−0.5	+0.2	...	−0.3	...	0.1	−0.2	0.1
20	0.1	−0.2	0.1	0.1	−0.7	−0.2	−0.3	−0.4	...	0.1	−0.2	...
21	0.1	−0.9	0.1	0.1	−0.9	...	−0.9	+0.2	0.1	0.1	−0.3	+0.2
22	0.1	...	...	0.1	−1.1	0.1	0.1	0.1	0.1	−0.2	...	+0.2
23	0.1	0.1	+0.2	0.1	−1.3	0.1	+0.2	...	0.1	−0.3	0.1	+0.2
24	−0.2	0.1	0.1	0.1	...	0.1	+0.2	+1.0	0.1	−0.4	0.1	...
25	...	−0.3	+0.2	0.1	...	−0.2	+0.4	−0.2	0.1	...	0.1	...
26	−0.3	−0.3	+0.2	...	0.1	0.1	...	−1.0	0.1	0.1	0.1	...
27	−0.4	−0.2	+0.3	−0.2	0.1	−0.5	0.1	...	...	−0.2	0.1	...
28	−0.5	−0.4	+0.5	0.1	+0.2	...	0.1	...	+0.3	−0.3	−0.2	0.1
29	−0.6	...	...	0.1	+0.3	0.1	−0.7	...	+0.4	−0.5	...	0.1
30	−0.3	...	+0.2	0.1	0.1	0.1	−0.2	0.1	+0.5	0.1	0.1	−0.3
31	0.1	...	0.1	...	...	...	0.1	0.1	...	0.1	...	−0.4

The probable errors of the signal in the different months of 1885 (with the average amount of clouds added in parenthesis) were as follows:

January $0^{s}.18$ (69), February $0^{s}.27$ (94), March $0^{s}.16$ (70), April $0.^{s}15$ (76), May $0^{s}.29$ (74), June $0^{s}.13$ (74), July $0^{s}.20$ (74), August $0^{s}.24$ (75), Setember $0^{s}.15$ (65), October $0^{s}.16$ (50), November $0^{s}.14$ (46), December $0^{s}.19$ (43).

As stated in the time-ball notice, the ball is not dropped on Sundays or on Government Holidays. On the 6th of January it failed at 1 p. (the single cell of the clock circuit failing to act) but was dropped at 2 p. On the 20th and 21st April thunderstorms prevented the working of the apparatus. On the 13th June the wires of the coil of the lock were found to have been fused by the lightning on the previous evening but the ball was dropped at 2 p. On the 27th August notice was given that the ball would not be dropped for a few days owing to damage done by the thunderstorm on the 25th, and it was not dropped on the 27th, 28th and 29th. From the 7th to the 20th September inclusive the apparatus was not worked owing to fever among the staff of the observatory. It is seen, that the signal never failed to act on any day in 1885. It failed partly (ball dropped at 2 p.) on 2 days. Thunderstorms prevented the signal on 5 days and illness among the staff on 12 days.

As stated in the Annual Report, the lock sent out with the time-ball was not fit to drop the ball, the blow of the hammer failing to liberate the bolt unless the spring was tightened so excessively as to make the equilibrium of the hammer unstable. Under these circumstances the dropping of the ball was effected by administering a blow to the hammer at the very instant when the current arrived from the clock, which was successfully accomplished by Mr. FIGG till the 12th June, when the coil was fused by lightning. From which time till the 20th November the ball was dropped by hand, the signal being observed by myself in a telescope. Since the 22nd November the ball has been dropped by means of the new lock, which is much stronger and gives great satisfaction.—The time-ball apparatus, clocks etc., were not ready till after my departure, and do not seem to have been sufficiently tested in London.

Two mean-time chronometers (Dent No. 39946 and 40917) and one sidereal (Dent No. 40912) are kept in the same room as the clocks. They are compared on Mondays and Saturdays shortly before 1 p. Their daily rates (+ means losing, − gaining rate) were as follows:—

Period.	Rate of Chronometer Dent No.			Temperature.
	39946	40912	40917	
1884.				
November 3- 8,...	$+5^s.44$	$-1^s.94$	$-1^s.16$	76°
,, 10–15,...	5.36	2.44	1.56	73
,, 17–22,...	4.88	2.40	1.56	69
,, 24–29,...	3.18	2.96	1.90	62
December 1- 6,...	4.20	2.20	1.36	65
,, 8–13,...	3.80	2.64	2.00	62
,, 15–20,...	3.84	2.48	1.98	64
,, 22–27,...	2.36	2.42	2.08	62
,, 29- 3,...	3.54	2.62	1.94	63
1885.				
January 5–10,...	4.28	3.16	1.70	63
,, 12–17,...	4.16	3.20	1.96	59
,, 19–24,...	3.94	3.08	1.98	59
,, 26–31,...	2.22	3.38	1.96	60
February 2- 7,...	2.74	3.16	1.72	58
,, 9–14,...	1.74	4.16	0.92	60
,, 16–21,...	0.62	3.78	1.98	59
,, 23–28,...	4.30	3.60	2.18	58
March 2- 7,...	1.84	2.60	1.86	63
,, 9–14,...	0.30	3.40	1.50	61
,, 16–21,...	0.62	3.18	1.34	63
,, 23–28,...	2.58	2.20	0.94	71
,, 30- 4,...	6.86	1.84	0.60	71
April 6–11,...	4.42	1.56	0.68	76
,, 13–18,...	2.88	1.16	0.48	76
,, 20–25,...	4.22	1.46	0.68	73
,, 27- 2,...	8.22	0.56	0.56	74
May 4- 9,...	5.74	1.60	0.88	74

Period.	Rate of Chronometer Dent No.			Temperature.
	39946	40912	40917	
May 11–16,...	$+5^s.04$	$-1^s.34$	$-0^s.82$	77°
,, 18–23,...	6.36	0.76	1.00	78
,, 25–30,...	6.68	0.36	1.00	81
June 1- 6,...	5.44	0.78	1.14	81
,, 8–13,...	6.64	0.92	0.92	79
,, 15–20,...	5.02	−0.64	0.74	81
,, 22–27,...	5.36	...	0.64	82
,, 29- 4,...	5.14	...	1.22	83
July 6–11,...	5.68	...	1.24	82
,, 13–18,...	5.38	...	1.36	82
,, 20–25,...	4.84	...	1.14	84
,, 27- 1,...	5.08	...	1.18	80
August 3- 8,...	5.04	...	1.24	81
,, 10–15,...	5.40	...	1.32	81
,, 17–22,...	4.96	...	1.16	80
,, 24–29,...	4.36	...	1.46	82
October 19–24,...	3.56	−4.18	2.36	76
,, 26–31,...	3.10	2.32	2.38	73
November 2- 7,...	2.94	0.68	2.52	73
,, 9–14,...	3.10	3.08	2.46	71
,, 16–21,...	3.34	3.52	1.96	70
,, 23–28,...	1.10	3.10	3.08	66
,, 30- 5,...	2.86	2.56	3.60	69
December 7–12,...	3.56	2.18	3.28	68
,, 14–19,...	4.04	1.44	2.98	64
,, 21–26,...	3.32	3.02	2.96	69
,, 28- 2,...	1.32	4.22	3.08	61

It appears that the rates do not, at least within the limits of temperature here observed, follow the law represented in Lieusou's formula, which is adopted at the Observatory of the Mersey Dock and Harbour Board in Liverpool. But they may be approximatety represented as follows:

Dent No. 39946: Daily Rate $= +\ 3^s.64 + 0^s.148\ (t - 70°)$

,, ,, 40912: ,, $= -\ 2.06 + 0.130$,,

,, ,, 40917: ,, $= -\ 1.60 + 0.041$,,

The first named chronometer is generally useless except as a hackwatch, although occasionally it goes well for a long time, particularly when the temperature does not vary much.

The Lee Equatorial is described by Admiral SMYTH in the "*Speculum Hartwellianum*" and the "*Celestial Cycle*" and particulars concerning the magnifying powers of the eye-pieces and the scale-values of the micrometers are to be found in "*Copernicus*" (Vol. II p. 93). It is erected on masonry piers not isolated from the ground floor, which is covered by chunam, in a circular structure of 15 feet diameter, the walls of which are 7½ feet high. The roof is made of wooden girders covered by canvas painted white. Owing to the length of the polar axis (12 feet) the telescope is very unsteady, any change of position of the observer causing the images to vibrate in the field. A MCLEAN's star spectroscope with low-power eye-piece combined, by JOHN BROWNING has just been adapted to the telescope, the object-glass of which appears to be still in good condition.

Sir W. THOMSON's automatic tide-gauge arrived early in the year, but has not yet been erected and worked for want of funds.

The Andromedes were observed on the 27th November. The radiant determined from the tracks laid down was at 10 p. about 40° North Declination and 27° Rightascension, but its diameter was at least 3°. Between half past ten and half past eleven Mr. FIGG counted 665 shooting stars. It was estimated that about 2000 an hour were visible, beginning shortly after sunset. Most of them were very small, the brightest generally of the 2nd magnitude. Few were as bright as the 1st magnitude and none observed was brighter. They were yellowish but did not leave permanent tails behind. There often came a lot at one time followed by a lull. Some were seen near the radiant but none quite stationary. Many long tracks were observed.

W. DOBERCK,
Government Astronomer.

Hongkong Observatory, 24*th April*, 1886.