

The Dial.

[This article, which we are publishing in two parts, is of particular interest in that this year marks the bi-centenary of the present Sundial. Canon Gray, in his history of the College, cites an account by Cole of the "very elegant Sun Dial with all ye signs" painted in 1733. "This," as Cole says, "is no small ornam^t to ye Court to enliven it." The article is written by Professor E. H. NEVILLE of Reading University, and is reprinted from the *Dial* of 1912.]

COULD the stars be seen during the day, so that the position of the Sun among them was directly seen, it would be found that while little change in this position was perceptible from hour to hour, yet in the course of a year the Sun made a complete circuit of the heavens, following through the constellations a path unchanged from year to year. The stars lying in the immediate neighbourhood of the Ecliptic, as the Sun's path is called, were grouped by the imagination of observers thousands of years ago into twelve constellations, the Signs of the Zodiac, and if nowadays we find it hard to see the shapes of fiery dragons or immortalised heroes in the skies, yet the Latin forms of the old Greek names are still used by astronomers, and the Sun is still said to be at the first point of Aries on that day in March which is exactly twelve hours long from sunrise to sunset. It is from that day that the Sun's journey is held to commence, but though it would be very convenient for astronomers if the year began then, or at any rate if the beginning of one of the months was on that day and if the Sun passed always from one Sign to another as the end of one month gave place to the beginning of the next, yet the effect of repeated "reforms" of the civil calendar has been to

deprive it of all astronomical significance, so that the birthday of the Sun is on March 21st, and the Sun spends part of each month in one Sign and part in the next—as those of us who have studied Chaucer even only so far as the first dozen lines of the Prologue to the *Canterbury Tales* have had to learn.

Let us now look at the Dial, endeavouring to forget the border, which has no astronomical value save the obvious one that the hour of the day is to be read from the position upon it of the shadow of the style.

Immediately inside the blue border, is the scale from which the time of day is most accurately to be read. This scale is divided into quarter-hours, but the divisions for quarter to ten and for quarter past two are missing; it is true that both of these lines would fall very close to other lines serving different ends, but as a similar conjunction has not been held to necessitate the suppression of the mark for quarter to two, the omission is probably due to a failure on the painter's part at some restoration to notice the double mark on the design he was copying. All the marks on this scale should be divided towards the centre of the golden sun at the top of the dial, the point where the style whose shadow indicates the time leaves the stone. This direction has usually been approximately taken, but there is a very considerable error in the mark for quarter to three and in those between five and six.

Passing inwards now from the sides, we find columns from which we may read, in a manner presently to be explained, the position of the Sun in its annual path and therefore the month of the year. Here are brave auto-graph pictures of the twelve Signs, the Ram, the Bull, and the rest, whose names and order are embodied in many mnemonic doggerel verses. One such verse we

may perhaps quote as a model for any rhymesters who may see these verses :

The Ram, the Bull, the Heavenly Twins,
And next the Crab the Lion shines,
The Virgin and the Scales,
The Scorpion, Archer, and the Goat
The Man that Bears the Watering Pot
And Fish with glittering scales.

Another poem on the same theme will be found under the heading "Zodiac" in Brewer's Dictionary of Phrase and Fable, but as the writer there has a weakness for writing complete sentences, the artistic value of his effusion is not great.

We have called these pictures autographed, for each bears the symbol associated long ago in astrology with the corresponding Sign. Unfortunately certain of the pictures bear more than one signature, and though these signatures are clear enough and quite well known, being those of certain of the planets, the reasons governing their positions in the set of pictures are by no means obvious.

In connection with what we have already said of the lack of any astronomical meanings in our present months, it will be noticed that the month divisions are so far from coinciding with the Sign divisions that the names of June and December have actually been split, so that the Ju to the right of the Twins is continued by the veins to the left of the Crab while the bar to which the Goat's tail is pointing is only the end of the word which begins under the Archer's cave with Decem.

To the man in the street, and to the untrained classic, the conception of a universe in which other things are much as we know them but the Sun has no motion among the stars, probably offers no difficulties. The

scientist, however, knows that in a universe where the Sun would be at rest among the stars, the laws of motion and the law of gravitation would all be different from the laws we have, so that the problem of the high-jumper might not be how to clear any height he wished, but how to be sure of returning to earth after the performance, while the delights of a water-chute and of the Cresta run must be alike unknown. On the other hand a universe in which the Sun's path is disposed symmetrically with regard to the Pole star—so that an observer at the North Pole, having the Pole star always overhead, would have the Sun always just half above and half below the horizon—is as easily imagined by the Astronomer Royal as by the Chancellor of the Exchequer, only the former, knowing the infinite improbability of so particular an arrangement, is the less surprised of the two that it has not happened to us.

Now in either of the suggested circumstances the path of the Sun through the sky during the day, the hours of sunrise and sunset, and the position of the Sun at noon, would be the same on all the days of the year. But in fact these things depend only on the distance of the Sun from the Pole star, sunrise being earlier, sunset later, and the noonday sun more nearly overhead, the nearer together the two are. And the form of the Ecliptic is such that from the day in December when the Sun escapes the Archer to the June day when he is caught by the Crab his distance from the Pole star is steadily diminishing, while from June 21st to December 22nd, the distance grows again. Accordingly any particular distance and its consequences will be found on two days in the year, one between June and December, the other between December and June, while

in the first case the day will be followed by a day when the distance is greater, in the second case by a day when the distance is less than the given distance.

Two more remarks, and we shall be in a position to understand almost all that our dial has to tell us. The path of the Sun in the sky determines and can be read by the path of the shadow on the wall of any object fixed at a convenient position in front of the wall; and so on the style and on the level with the line marked Horizon on the wall, we have a little ball, the path of whose shadow tells us the path of the Sun. Moreover the daily paths of the Sun and shadow are such that if we know one point on a path we know the whole path for the day.

Thus the whole reading is something as follows. The position of the shadow when we look tells us the path on which it lies. This path tells us the path of the Sun. The Sun's path tells us his distance from the Pole star and also the times of sunrise and sunset. Lastly the distance tells us that the Sun must occupy one of two ascertainable positions in the Ecliptic, and therefore that the date must be one of two dates which can be calculated with no great difficulty. But unless we happen to know in which half of the year we are, we must wait a day or two and see if the Polar distance of the Sun is becoming greater or less. When we know that, the date is known without ambiguity.

But of course we are not left to make all these calculations for ourselves. The whole shadow-path for a day is pointed on the dial, and the corresponding hour of sunrise is actually told us at the left-hand end of the track—where the line crosses the vertical band marked *Ortus Solis*—while on the right we have a column marked *Longitudo* telling in technical language

of the Sun's position in the Ecliptic. But partly for the amateur's sake and partly for love of the picturesque, whoever planned the dial did not stop here. By a happy chance a shadow-path has two ends—we commend this evidence of design in the universe to the Paleys of to-day—and so on the right the path ends in a picture of the Sign, and is marked also with the date which in the first half of the year corresponds to the path, while on the left are Sign and date for the second half.

Naturally the shadow-paths cannot be given for every day of the year. What are given are the paths for the days, one in each month, when the Sun moves from one Sign to the next. These are the green curves of the painting, and we have only to glance at the dial to see how with them to guide us, any other actual path can be quite accurately imagined. And so we can on any sunny day find the shadow of the ball, make a mental picture of the path on which it must lie, and from the places where this path ends the various scales determine the rule of sunrise and the two dates which, so far as a single observation can indicate, are equally possible. It may be added that in the column Longitude the figure 10.0 is completely out of place, as it should be against the shadow-path on which the Water-bearer appears to be treading. To many of us the time of sunrise is of little interest, but we may often wish to know that of sunset. All that is necessary is to remember that 12 o'clock is *mid-day*, and although the Sun is not a perfect time-keeper, if we assume that sunset is as long after noon as sunrise is before noon, we shall have information sufficiently near the truth to enable us to keep out of the clutches of both policeman and proctor.

(to be concluded).

THE DIAL.

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TO most of us, Latin is an easy language to forget. And so, although we have all perforce had some acquaintance with Latin in the past, and although it is the Latin for "Sunrise", not the English for "Ortus Solis", that we have already noted on the face of the Dial, yet when we see there such groups of letters as S E B S it is for an English explanation that we first look. And this is fortunate, since it is in English and not in Latin that the meaning of these groups is to be found. The groups are the signs attached to a number of vertical lines which cross our Dial, and they are nothing more mysterious than the initial letters of the names of various points of the compass, from East-South-East on the left to South-West on the right. Like all the details of the Dial except those which give us merely the time of day, these lines give us their information by means of the ball on the style. The letters associated with any particular line tell us the direction of the Sun when the shadow of the ball is on that line. Thus if on occasion we find the shadow to be on the line which is drawn downwards from the first O of the word HORIZON, we know that anyone then facing the Sun is looking South-East by East. Of course in general the shadow will not lie precisely upon one of the lines, and an estimate must then be formed, from the position of the shadow between two verticals, of the precise direction, between the two corresponding points of the compass, in which the Sun is situated.

Of the lines on the face of the Dial, one group alone remains to be discussed. This group consists of a number of narrow black lines radiating from the mid-point of the Horizon line. It is easy enough to state in technical language what angle it is that these rays help us to record; but perhaps the clearest expression we can use here is that they enable us to say at any time where the Sun would have been did it behave like the Sun of our earliest schooldays, rising in the East, and passing overhead at noon (instead of never coming within twenty-eight degrees of the zenith!), to set with deadly monotony due West.

Below the border of the Dial proper, and forming, there is architectural evidence to suppose, no part of the original design, are three rows of numbers. I have known the imagination of the undergraduate cicerone rise to a hundred different heights in explanation of this table of figures. Whether any one of the hundred solutions was swallowed by the fair relation to whom it was offered cannot be ascertained. The real object of the extension is to enable the Dial to play the part of a Moon-dial as well as that of a Sun-dial, in a manner which we must explain.

If we could see traced out on the sky the path of the Sun during a whole day, the Moon would always be found in or close to that path; and the distance of the Moon ahead of the Sun would be simply proportional to the Moon's age, a new Moon being extremely near the Sun (an eclipse of the Sun can take place only when the Moon is new, a fact of which not every writer of fiction seems to be aware), a full Moon half a day's journey away, and the Moon as it dies at the end of the Lunar month overtaking the Sun to commence again. We take the Lunar month to consist of thirty

days. Thus, for example, a five-days-old Moon has completed one sixth of its monthly course and is therefore one sixth of a day's journey ahead of the Sun in the sky. Suppose further that some wakeful inhabitant of the Old Court sees that the Moon, five days old, is casting the shadow of the style across the hour-mark IX, he knows that in one sixth of a day, that is, in four hours' time, the Sun will reach the place in the sky now occupied by the Moon, and will therefore cast the shadow of the style across the figure IX. That is, in four hours' time it will be nine o'clock; it is now five.

But what, the reader asks, has the mysterious table to do with all this? Indeed the part it plays is quite trivial, I fear. It saves us the labour of calculating from the Moon's age the number of hours and minutes by which Moon-time is in advance of Clock-time; and since an addition or subtraction of a round twelve hours, that is, of half a day, makes no difference to Clock-time, the addition to or subtraction from the Moon's age of half a Lunar month, that is, of fifteen days, leaves unaltered the amount by which Moon-time exceeds Clock-time. The entries for the second half of the month would therefore be a repetition of those for the first half; and so, instead of actually repeating the figures, the designer of the table has shown the two ages to which the same entry applies, putting the number of hours and minutes of excess in the second row while the corresponding ages of the Moon in the first half of the month are in the first row and the corresponding ages of the dying Moon are in the third row. Thus the process of using the Dial as a Moon-dial is as follows. First ascertain roughly the age of the Moon; this can be told with sufficient

accuracy for our present purpose, by mere notice of the phase of the Moon ; the first half-moon is $7\frac{1}{2}$ days old, the full-moon 15, and the second half-moon $22\frac{1}{2}$, but the phase is changing more rapidly when about half the disc is illuminated, so that the Moon is already 5 days old when the breadth of the crescent is only a quarter of the total diameter, and is only 10 days old when three-quarters of the face is bright, similar remarks applying also to the phases in the second half of the Lunar month. Now look in the first or third row of the table for the entry nearest to the estimated age of the Moon, and the corresponding figures in the second row give the number of hours and minutes by which the reading given by the shadow of the style is in advance of Clock-time. Subtracting then the second row reading from the shadow reading, having first added twelve hours to the latter if it does not already exceed the former, we find the actual time, by a process interesting perhaps but certainly not very accurate, for not only would an error of less than a day in our judgment of the Moon's age be sufficient to modify the result to the extent of three-quarters of an hour, but also the motion of the Moon, though the account we have given of it is the best possible first approximation to its description, is so irregular, and the Moon itself is so near to the Earth, that readings at the same time of night and at the same age of the Moon may differ, at different seasons of the year, by almost as much as, though not by more than, half an hour ! The reader who infers from the moon-lit Dial a time differing by less than an hour from that announced on the Clock above it, will have every reason to be satisfied with his performance !

We have now learnt to extract from the shadow on

the Dial, whether by day or by night, all the information which it can afford. Let me conclude with three queries which may occur to the interested observer and to which the writer among others would be glad to learn the answers. What is the meaning of the number 6.34 in the Longitudo column close to the symbol for the Twins? What are the relations between Venus and the Bull, Mars and the Ram, and so on, that are responsible for the appearance on the Dial of the symbols for these Planets close to the pictures representing the respective Signs? And what are the figures of eight which are to be found in a number of places?

E. H. N.

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