The British Sundial Society

BULLETIN

No. 97.2 APRIL 1997

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COVER ILLUSTRATION:

"Queen Mary's Dial", 1633, in the Queen's private garden at Holyroodhouse Palace, on the occasion of the British Sundial Society visit on 5th April, 1991. Lt. Colonel Colin McVean on left.

B U L L E T I N

OF THE BRITISH SUNDIAL SOCIETY

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EDITORIAL

This is the last Editorial I shall ever write for the Bulletin. I sometimes glance at the four or so inches occupied by the full run of the Bulletin on its shelf and wonder if the amount of effort put into producing it was worthwhile, and how many silk purses I could have made out of sows' ears in the same time.

It is one of the disadvantages of being an Editor in that you can never actually read a copy of the Bulletin, you have gone through the contents so often before publication, that it is entirely familiar in all its parts. In future I shall be able to read the Bulletin and write letters about a comma being in the wrong place, or about a three-letter word has been misspelt, or even write a letter pointing out the glaring errors of some unfortunate contributor, with the same aplomb as telling someone he has a boil on the end of his nose.

I had no idea at all, when I brought the Bulletin into being on my Amstrad Word Processor, of how much dialling material there would be available for publication. I had not seen a great deal of it my lifetime and presumed it must be very limited in extent, so at the beginning I actually pondered on how to ration out the material at my disposal, in order to keep a newsletter of a modest number of pages, viable over a period of time. The first year or so seemed to confirm this view, for I got few contributions to begin with, and perforce must use my own material. There were three very stalwart supporters then, Andrew Somerville, Réne R.-J. Rohr of Strasbourg, and Peter I. Drinkwater who unfailingly made contributions.

It was one of the saddest moments in the history of the Bulletin Sundial Society when Andrew Somerville died, taken away before he could see the first printed version of the Bulletin, for this was a mighty step into the unknown and depended upon a great increase in membership to be able to pay for it. That increase in membership was both rapid and considerable, for the printed version of the Bulletin attracted further members to the fold. I am sure that Andrew would have been more than pleased with the great progress of the BSS made to date.

I myself have passed my "sell-by" date by over four years, when given until Christmas 1992 - "if I was lucky" in October 1992. Only the week before I had been pronounced "perfectly fit". As an adult I have never been fond of Christmas anyway, and have little faith in doctors, so I just carried on. However age and health have made the decision for me, and so I must, reluctantly, relinquish the reins to someone else. I wish my successor, and the Society, every success in the future; and here give my sincere and grateful thanks to all those whose learned contributions enabled me to produce a Bulletin of not only a great and varied, but sustainable, interest over the period of the last eight years. *Vale, non sum qualis eram,* which applies to most sundials also. (Farewell, I am not what I once was), for the benefit of those without Latin.

Charles K. Aked
Honorary Editor

PORTABLE DIALS - STARTING A COLLECTION.

JOHN MOORE

The portable dial comes in many forms both fine and more commonplace. An ideal collection should perhaps encompass as many types as possible, or it may just concentrate on one particular type of dial, or dials from a particular country. Collections of antiques require money, but even on a relatively small budget, a worthwhile collection of portable dials may be started. A personal collection of dials is very rewarding, and affords the owner much pleasure, particularly with regards to research. It is fun and instructive to dig out the Maker's details by browsing through some of the excellent directories of instrument makers.1, 2, 3. It is even more fun to actually use the dial, and find out exactly what every calibration mark is used for. Sometimes, we find something new, and this should be reported as an article in the BSS Bulletin, or at least as a letter to the Editor. Even if it seems an obvious comment, it may not have been noted by anyone else and could lead to further important discoveries about dialling. Remember, there are very few people who know much about Portable Dials. If we are uncertain of our facts, these may be posed as a question, and a Member somewhere is almost certain to come up with some sort of reply. Much of this research is also possible from collections to be found in museums, but access is never as free and convenient as in a personal collection. Even so, visits to museums will prove rewarding, and allow comparisons to be made with dials from those in one's own collection. It is always rewarding to find that a dial in your own collection is better in some respect than a similar one in a museum. Don't necessarily keep that to yourself. The curator will be interested to see it and how it differs from the museum's copy.

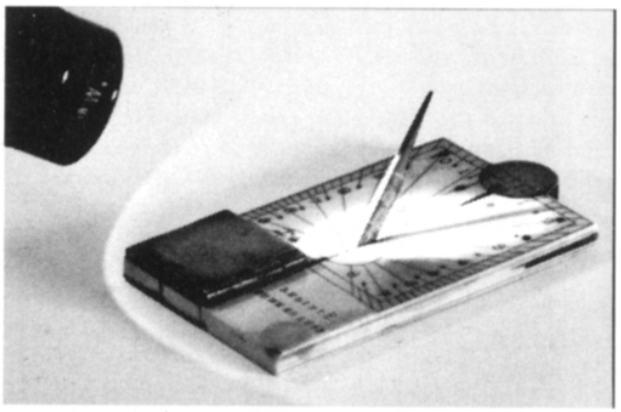


FIGURE1: A simple hand torch being used to check out a bone sundial.

Prior contact with the curator of a museum may allow hands-on inspection of their treasures, and this is a good way to really get to know these dials. It is essential, for the complete understanding of them, to be able to hold them, and, if necessary, place them in the sunshine to see exactly how they function. In a museum, this is seldom possible, so take a small hand torch to mimic the movement of the sun through the sky and throw a clear shadow of the gnomon on the dial's face. (Fig.1.) Did it really work this way? Find out for yourself such things as why silver is such a poor metal to use for a dial plate. See how easy the ivory dials are to read. Try to line up the dial by its compass, and estimate its subsequent accuracy. Try to use a Universal Equinoctial Ring dial, then imagine how difficult it would be to use outside with the wind blowing, or even worse, on the pitching deck of a ship. Learn to appreciate the fine engraving on a genuine Butterfield dial and see how it differs from some of the more dubious ones to be found. This detective work adds greatly to our appreciation of all portable dials.

Most collections begin in a modest way, usually with a not-so-good example of a rather common type of dial, its condition generally being limited by the amount of cash that is available. Some collectors even begin with home made dials or with some of the modern reproductions. If they are correctly made, they will be invaluable in understanding their function. Avoid at all costs dials which are incorrectly or poorly made. They do nothing for anyone.

THE FIRST DIAL.

A good type of dial to start a collection is the relatively common diptych dial in wood with paper scales. Most of these were made in Germany in the mid 1700's to early 1800 by one or two fairly well known makers. They were commonly made by Stockert or Beringer, although these makers were also known for somewhat better dials. These wooden diptychs, (Fig.2.), may be found, not infrequently in auction catalogues, in scientific antique shops and even antique fairs, at prices below £100. The wooden plates are covered with printed paper scales. They have a string gnomon, sometimes with fixing holes so that the string may be set to different latitudes. They were made in large quantities, but relatively few have survived in pristine condition, so expect the paper scales on most to be dirty and maybe worn.

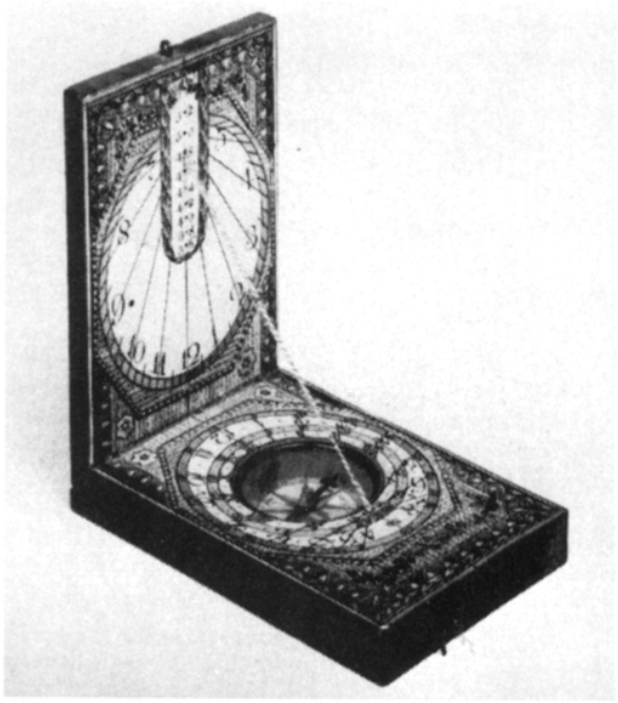


FIGURE.2:Wooden Diptych Dial by Stockert.

Another type that many will find a good 'starter' is the 'Ansonia Sun Watch' from the USA. This was made around the turn of this Century, and was sold by The Ansonia Clock Company into many parts of Europe, as well as the USA. One was seen recently made specifically for the Scottish market, with a list of mostly Scottish towns and subsequent 'high' latitudes. Ansonia were one of the largest makers of mass produced clocks in the late 1800's and these were exported in large quantities to all corners of the World. Their pocket dials too were made in numbers, often intended for a specific part of the Earth. The Ansonia dials may frequently be found at even lower prices than the wooden diptychs.

There are several such 'simple' dials that may be found by the diligent collector that will kindle the collecting instinct.

A word of caution is in order here, because a collection could soon start to take up a lot of cash as the collector's aspirations increase. Collecting is addictive, a fact that is acknowledged, even by collectors of stamps, beer mats or even train spotters. Others just collect money.

THE SECOND OR LATER DIAL.

Once the bug has hit, the collector may turn his eye to some of the older and more attractive dials that are still quite readily available. A good second stage dial is to be found amongst the many types that came from Augsburg towards the end of the 18th Century. (Fig.3.). The smaller and simpler dials by Schretteger, Vogler, Muller and a few others can be picked up at auction for £250 - £400 each. Sometimes these dials are found in lots of two or more, where one may be incomplete. These multiple lots often go for relatively small sums and are a way of obtaining a good base collection. Those that are not in good condition may be traded up at a later stage. These Augsburg dials are simple to use and are remarkably accurate. They are also reasonably hardy, with many of them surviving the last 250 years with little degradation. They often come with their original carrying cases of leather or card, and some may still contain the original paper instruction sheet that was sold with them. Despite their simplicity, they are well made and at least one should be in every collection.

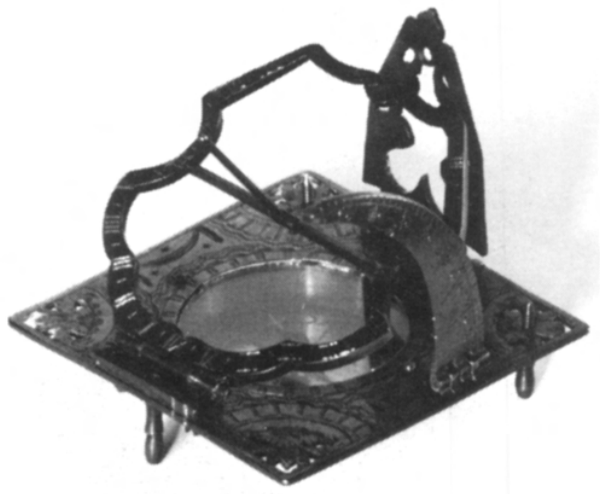
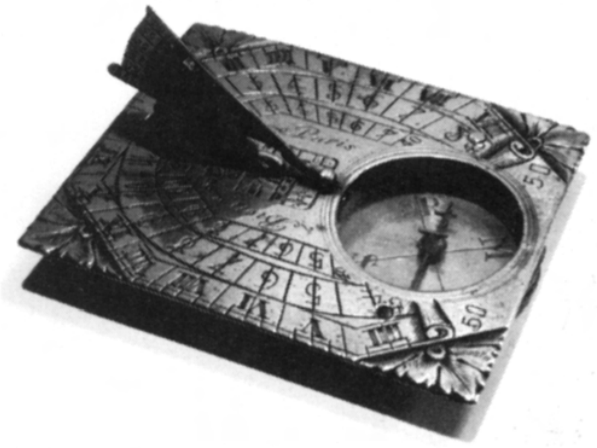


Fig.3. Simple Augsburg Dial by Vogler.

THE NEXT STAGE.

There are very few dial collectors who have not at some time or other, coveted the wonderful 'Butterfield' dials that are often seen in most scientific museums and virtually every book on portable dials. These are relatively common and the simpler ones can be obtained for less than £1000. Because these are so attractive, they have been extensively copied and faked, so the buyer should exercise great caution with them. If in doubt, it is best to obtain the advice of someone who is familiar with them before purchase. To the experienced eye, most fakes stand out quite clearly. To the novice, one 'Butterfield' looks just like any other. It is not until several are placed side-by-side that the wrong dials become obvious. If uncertain of a dial, avoid it, especially if it has the 'Butterfield' signature. Look for a dial with a lesser known name on it as copies usually carry the more well known names such as Butterfield and Bion. There were at least 40 makers of this type of dial, so there is a wide choice.[MJC1]444. Another solution is to buy a Butterfield or Bion of a 'non-standard' type. These were less copied. Oval Butterfields are quite rare, as are rectangular Bion's. (Fig.4.).



FGURE 4: Rectangular 'Butterfield' Dial by Nicholas Bion.

The brass 'Butterfields' are much less common than the silver ones, and for this reason they frequently fetch almost the same amount of money. The brass ones were probably made in much larger quantities, but being of a non precious metal, many must have been scrapped over the years. They are, of course, less desirable to all but the most serious of collectors. Brass being a harder metal than silver, actually wears less, and anyone interested in the engraving quality will find the brass ones of more interest. However, avoid those that have been extensively cleaned with abrasive metal polish.

THE COLLECTION FORMS.

The Universal Equinoctial Ring Dial may be the next step in a collection. These are also found relatively frequently, and cost between £400 and £2000+, depending on their maker, condition and material. An unsigned brass ring dial, perhaps with its suspension ring missing will go for the lower of these figures. If this cost is still considered prohibitive, there are occasionally ring dials found without the bridge. These are not much practical use as the bridge carries the gnomon. However, a handy collector would be

FIGURE 5: Universal Equinoctial Ring Dial by Stammer of Sacrow.

FIGURE 6: Poke Dial.

able to make a replacement part so that the dial could still be used. Remember that all such replacement parts must not be allowed to deceive a subsequent owner. For this reason, mark them with the replacement date. A dial in silver, or silver gilt, carrying a good early maker's name will easily exceed the top figure shown, as will some of the larger diameter dials that are occasionally found. The dial by Stammer, (Fig.5.), is brass with the inner ring silvered making a pleasing two-tone design. This is one of the more 'up-market' ring dials.

Poke dials are much simpler, (Fig.6.) but few have survived, hence their cost is inordinately high. However, these are sometimes found at reasonable prices. The author has seen some that have been found in the ground by a metal detector. These lacked the gnomon band and were badly pitted from corrosion, but the important thing was that their markings were still clearly legible. These would possibly sell for only £30 - £60 each. These make an excellent buy unless pristine pieces only are allowed in the collection.

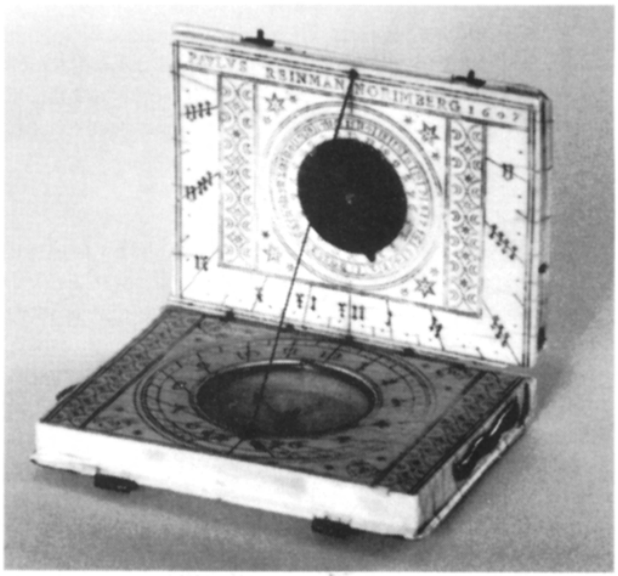


FIGURE 7: Book Form Ivory Diptych Dial by Paul Reinman, Nuremberg.

The Ivory Diptych Dial is also quite popular. The ones for Nuremberg are more plentiful than those from Dieppe. Some of those from Nuremberg are quite small and simple and may be found for less than £600, but the average price for these dials will be around £1500 each. One such as the book form dial by Reinman, (Fig. 7 & 8.), would be at least £4000.

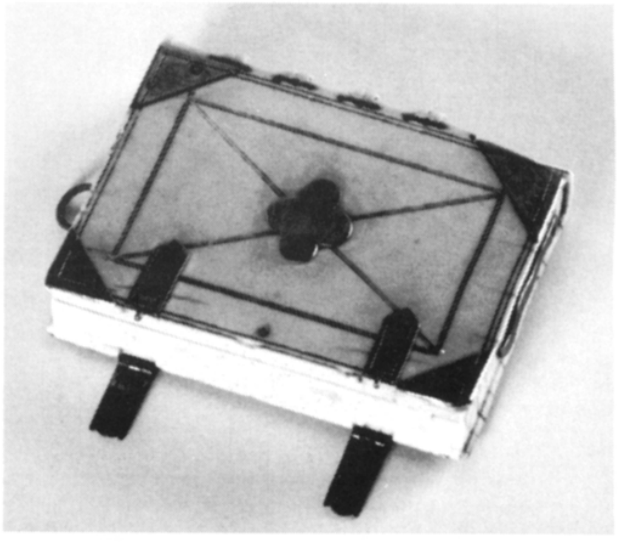


FIGURE 8: Book Form Ivory Diptych Dial when closed.

The ivory dials from Dieppe, being made in smaller quantities than those in Nuremberg, will normally be somewhat more expensive. The larger Nuremberg dials, covered with multiple scales, perpetual calendars and sometimes pictures, will command price tags of £5000 to £10000 or more, so are outside the means of the average private collector. However, many of these may be inspected closely in most of our horological and technical museums.

THE ULTIMATE DIALS.

The sky is really the limit in a collection of any form of antique. Naturally the rarer forms from the best makers always fetch the highest prices. Examples of high priced dials will be found by looking through the better auction catalogues.5, 6, 7, 8. The author remembers an Ivory Pillar Dial that was for auctioned at least 10 years back, where the auctioneer's valuation was a healthy £3000. In the event, this dial made £35,000! A pillar dial with paper scales such as that by Gottfried Reiff, (Fig. 9.), would fetch a more modest sum of around £4000.

FIGURE 9: Pillar Dial by Gottfried Reiff, Nuremberg.

The Double Crescent dials by Martin and Willebrand are a great treasure, and are seldom to be found except in museums. Where they do come up for sale, expect to pay in excess of £15,000.

The large Standing Ring Dials10 made by makers such as Rowley are prize possessions. There are very few around, and these, when they are to be found will command prices of £30,000 to £50,000.

There are many other types that will also come into this 'expensive' category, and prices for these can only be guessed at.

THE JOY OF COLLECTING.

As the collection progresses, the collector will become more aware of some of the less usual dials. If they look 'right', then they should be collected. Several unique dials come to light each year. These may come from unexpected sources. Maybe a dealer who sold you the first Butterfield may call and tell you about an exciting dial that he has acquired. You may be given first refusal. Buying from a dealer is more expensive. At auction you are competing with him. When he has bought the dial, he will need to mark its price up so as to make a reasonable working profit. This will be normally 20% to 50%. However, a good dealer becomes known throughout the antique trade, and dials often find their way to him before reaching the auction room. He may therefore be able to offer something special. If you know a good dealer, rely on his judgement. Most are honest and reliable, but always treat an unknown or a new dealer with suspicion. If a dealer does not specialise in instruments, the dial that he has may be a bargain. On the other hand it is more likely to be overpriced and even wrongly described. Worst of all, it may not be a 'right' dial.

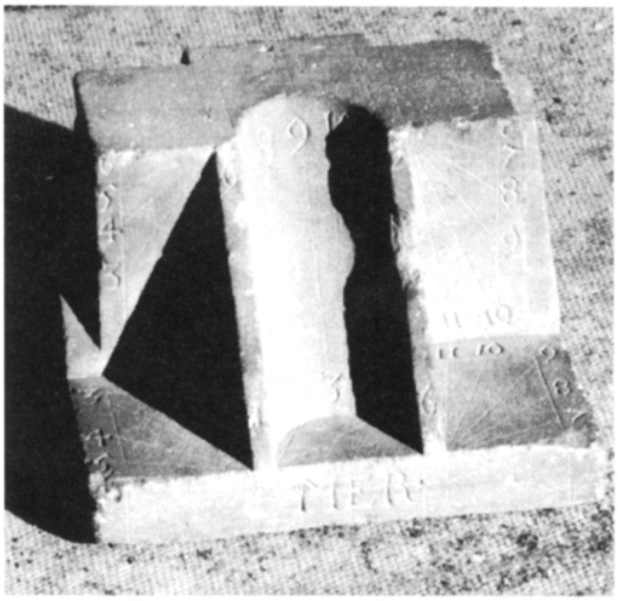


FIGURE 9: Early stone Polyhedral Sundial c1700

Another joy, is that of finding something for sale that is not what it is described as. We, as collectors, should know what we are looking at. The dealer or auctioneer has many objects to appraise, and will not necessarily have an in-depth knowledge of them all. The polyhedral dial, Fig. 10, (admittedly, not a portable dial), was described in the auction catalogue as 'without gnomons'. We as sundial enthusiasts know immediately that most of its sharp edges are used as gnomons, so it IS complete.

Auction descriptions are sometimes completely wrong. The dial in Fig. 11, was described as 'a 19th Century

vertical dial'. That description could not be more wrong. Firstly it is a horizontal dial. The hour lines run the wrong way for a vertical dial and run around the dial plate by more than 180°, i.e., beyond 6am and 6pm. The stand has been added later. It is actually an early quadrant. Closer investigation shows that the round sun dial is much earlier than its '19th Century' description. It is actually late 17th Century. The quadrant too is of beautiful design, exactly contemporary with the sundial volvelle. This was a rich and rare find for the lucky collector.

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ACKNOWLEDGEMENTS.

The author would like to thank Christies South Kensington for their permission to reproduce the photograph used in Fig.

FIGURE 11: 17th Century Quadrant / Sundial.

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BOOK REVIEW

IL CONCHINCOLLO, L'ANTICO OROLOGIO DI RAVENNA. Mario Arnaldi, 128 pages, 28 illustrations, plus 5 in an appendix. Plain white Astralux covers with book jacket bearing illustration of Hercules holding a dial in place of the earth. 17 x 12 cm. Edizioni Essegi, Ravenna. 1996. ISBN 88-7189-205-4. Price 15,000 Lira (about £7.50). Italian text.

This is the story of the reconstruction of the Conchincollo of Ravenna by Mario Arnaldi. It commences with the erection about two thousand years ago of a gigantic statue of Hercules by the Emperor Augustus Tiberius at Ravenna, by the people as "Conchincollo" (hollow on the neck) supporting a sundial in the form of a shell. This statue was completely destroyed in the earthquake of 1591. Arnaldi has researched the history of this monument and unravelled a good part of the mystery surrounding it.

The book commences with a foreword by Franco Gabici, the Director of the Ravenna Planetarium, whilst the first illustration shows the surviving piece of the colossal statue - the lower part of the left leg and foot, now preserved in the National Museum of Ravenna. Arnaldi's account goes through all the designs of Hercules, and in particular, those supporting a sundial in the hemispherical form or "shell like".

On page 90 Appendix I gives the practical details of construction of a horizontal hemispherical sundial (7 pages plus 4 diagrams).

Following the main text and Appendix I are ten pages of note, the references in the text are given in superscript

and are almost invisible. On page 110 is the reconstruction of the Conchincollo as envisaged by Arnaldi. It is shown here rather than describe it in words.

There follows a considerable bibliography (4 pages), before Appendix II which deals with the mathematics of the hemispherical sundial by Guiseppe Zuccalà. First the mathematical treatment is elucidated before giving a Basic programme listing covering ten pages, plus five diagrams. The book closes with a listing of contents.

This is the most pleasant small book the reviewer has handled in many years and is well recommended. A great pity there is no English version.

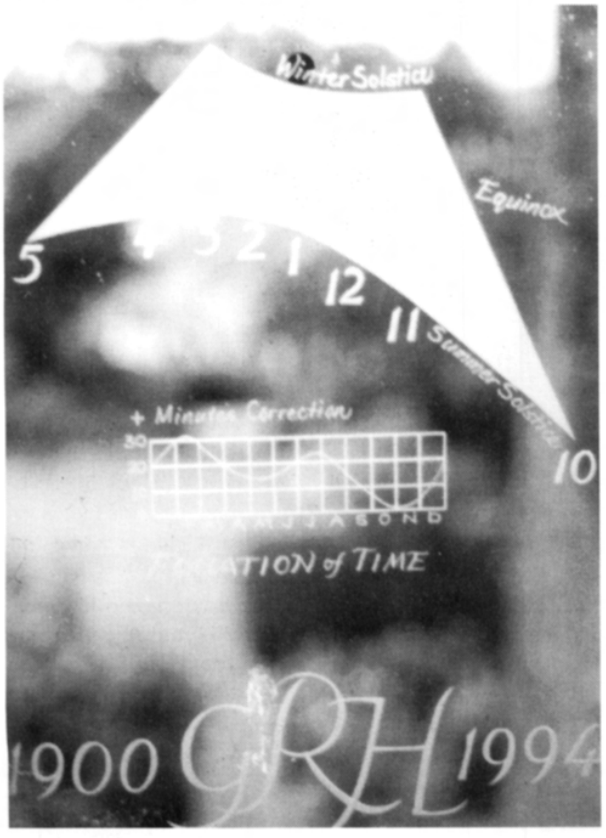
CHARLES K. AKED

THE GEORGE HIGGS MEMORIAL WINDOW

DAVID YOUNG

On Saturday 6th July, 1996, at the Tollbooth Art Centre, Kirkcudbright, a short ceremony was conducted to celebrate the life and work of Mr George Higgs. George was our oldest member who died just before his 94th birthday in February, 1994, after a very active life culminating in his last years with an intense interest in making and restoring sundials. He also worked closely with his friend and neighbour, David Gulland, a professional glass engraver and together they were responsible for making unique engraved glass sundials, George doing the mathematics and delineating the dial.

When our Patron, Lord Perth, suggested some twelve months ago that an appropriate celebration of George Higgs' life would be to have an engraved window placed somewhere in the town in which he had lived, it was natural that David Gulland should be asked to be responsible for it. The BSS Council readily agreed and a fund was opened for this purpose. Over £400 was contributed by Society members and close friends and members of his family. After some research it was decided that the window should be installed in the town`s Tollbooth Art Centre under the care of the Stewartry Council who had readily given permission. The design submitted by David was enthusiastically received; it consisted of four panes, three depicting some of the dials George had restored and the fourth being an actual dial of the type they had both made together. For the sundial it was necessary to check the orientation of the window and to calculate the hour lines and gnomon-spot position. George's son, John Higgs, found his father's hand held computer and by entering the appropriate data was able to furnish the information to engrave on the dial.



After some weeks of work the four panes were finished and fitted in the window. Fortunately I had intended to travel to Scotland at the time of the ceremony and I was therefore able to officially hand over the window to the Chairman of the Stewartry Council in my capacity as Secretary of the Society. Many of George Higgs' family and friends were present and admired the skilful work done by David Gulland and agreed that this was a fitting tribute to George Higgs.

Kirkcudbright is in a very beautiful part of Scotland and if any member should find themselves nearby I would recommend that they visit the Tollbooth where they will find the window on tthe second floor at the rear of the building. The Tollbooth Art Centre is usually open to the public during normal day time hours and is well worth a visit.

Note: For more information about the life of George Higgs, please see Bulletin 94.3 page 50.

FIGURE 3

B.S.S. NORTHERN IRELAND TOUR

DAVID YOUNG

FIGURE 1: The Group at Dunpatrick

"You're actually going to Belfast for a *holiday?* or "Northern Ireland - *rather you than me!*" were the sort of remarks when we told friends about our proposed sundial safari. However, any misgivings we or indeed any other members of the party might have had was quickly dispelled in the first few hours of our arrival. Airport security was a little different from any other airport in the U.K. The people we met could not be more friendly, we saw no evidence of bomb damage, soldiers on the street and I only remember seeing one Bobby on his beat during the whole week.

We all arrived from different directions to be met by Philip Adam and his wife and Noreen Blair, the representative from 'Guidelines' , who were responsible for the detailed arrangements of the programme suggested by Philip. After settling in at the Queen's University Halls of Residence, we were escorted to the University Common Room Club a little way down the road for the first of our very comfortable and nicely served evening meals. This was followed by an interesting talk by Dr Ann Hamlin on the ancient dials of Ulster.

Our first full day took us by coach to the Ards peninsular, that long tongue of land to the east of the city. We stopped at Mount Stewart House where we were given a conducted tour and most of us managed to find a few minutes for a coffee and excellent home made biscuits at the tea shop. Then on to Portaferry where we were fascinated by the collection of slate dials laid out at the antique shop of one of our members, Mr D.H. Dunlop, and his clock workshop at the rear. After a rather protracted lunch at a nearby restaurant we returned to the Halls via the Ulster Folk Museum where their collection of sundials were specially displayed for us. This evening we were treated to a talk by Owen Deignan on the Sundials of the Irish Lighthouse Service. Altogether a fine start for an exciting week.

On the next day, Monday, we again took the coach for a spectacular ride along the Antrim coast stopping at Carnfunnock to see the Time Garden there. This was established in 1990 by Basil O'Fee (an early member of the society) in a public garden featuring a number of varied types of dial set in a truly beautiful situation near the port of Larne. Apart from a group of dials including one of Gordon Benoy's liquid filled glass dials, there is a long, high brick wall featuring a number of vertical dials showing various types of dial furniture, such as unequal hours, hours in the day, direction of the sun etc. These were rather similar to those that were once fixed on the wall of the old Greenwich Observatory. It was therefore no surprise to learn that these had been delineated by our Chairman! After lunch came a visit to the Giant's Causeway with its intriguing basalt hexagons. Here we were lucky enough to see it in a burst of afternoon sunshine which unfortunately had been rather shy of appearance up till then. The day ended with a brief stop to see a large elegant horizontal dial (largest in Ulster?) situated by the seafront at Portrush. The following day we were at liberty to explore Belfast as we wished. A rather curious start to the day occurred with the arrival of a fleet of taxis intending to ferry us to the city centre in place of the usual coach. We had just started to board the taxis when the coach which was supposed to be unavailable , arrived! It was left to the organisers to tell the taxi drivers that their services were no longer required - it must be to their considerable credit that they departed with smiles on their faces! It has to be said that this minor hitch was the only one in all the complex arrangements for the week made by Noreen and her colleagues. The day finished after a visit to the nearby Botanic Gardens and Ulster Museum, with a reception by the Principal of the University at the Canada Room at Queen's where an excellent meal was provided, followed by a talk on 'Comets' by Dr Alan Fitsimons.

On Wednesday we went southwards to Nevan Fort in County Armagh, ancient seat of kings and the earliest capital of Ulster, then on to the city of Armagh. Here we were given a choice of visiting the Museum, the Planetarium and the Cathedral; many of us managed all three. At this point I missed some of the activity, for our tour guide, Noreen, had arranged with Radio Ulster for a live interview on a midday news programme. Now this job would normally have fallen (thankfully) to our Chairman but as he was not with us, I was judged the senior officer present and had to play the second eleven role. Whisked off, on arrival at Armagh, I was sat in a tiny studio with a telephone, a microphone, headphones on the table in front of me and a row of coloured lights and switches opposite. The only person present then told me to telephone the Belfast Studio and they would tell me what to do. He was obviously eager for lunch, shut the door and left me to my own devices. After some confusion when I was asked what programme I was supposed to be on (I hadn't a clue), I was told to put the headphones on and for ten minutes or so the news programme was relayed until the item started about this strange group of people who had come all the way to Northern Ireland to see (of all things) sundials! Hopefully I said the right things and at the end of the interview I was asked to take off the headphones and when leaving the studio turn off the cooker switch by the door! This action left the whole place in darkness and I left the empty building after working out how to open the electronically locked front door, to join the rest of the party at the nearby Planetarium. I was in time to join a conducted tour of the "Eartharium" in the observatory grounds which by means of models gave a global view of the earth and its place in the universe. The scale was linear for the solar system but after passing Pluto, had to be changed to logarithmic in order to limit the total length of the trail to about half a mile. We climbed up to one of the domes of the observatory to see the intricate and highly polished brasswork of the old telescope, much to the joy of the astronomers amongst us. Then while the party went to the Planetarium itself to see "The Seven Wonders of the Sun" the writer had to do another interview for a BBC Radio 5 programme, this time conducted via a public telephone in the vestibule. Altogether another busy and rewarding day!

Our last full day was again south of our base at Queens, to the town of Downpatrick, but a surprise stop was arranged 'by special request' to visit the tenth century Monastic Site at Nendrum. here in the ruins was one of Ireland's ancient dials, albeit partly reconstructed. We had lunch at Downpatrick Museum, once the County Gaol built at the end of the eighteenth century. We were shown more interesting slate dials before going on to the nearby Cathedral, the reputed (and disputed!) burial place of St.Patrick. The two hundred year old cathedral incorporated both portions from the twelfth century and the sculptured capitals of the columns between the nave and the aisles are particularly fine. A surprise treat for us here was an organ recital given by Philip Adams' daughter. The day's tour finished in a most satisfactory way by a visit to Castlewellan where we were shown a vertical dial and a fine, beautifully engraved bronze horizontal. Lastly, we were conducted round the Arboretum by the head gardener, Mr Sam Harrison, at which the highlight was a glorious avenue of Eucryphia in full bloom.

After our last evening meal at the Common Room Club we were entertained by the daughter of our host, this time with a selection of songs sung unaccompanied by herself and a group of friends. Then, when thanks had been given to Noreen Blair for her attention to all our needs, Ian Wootton gave an amusing speech where he offered his thanks, on behalf of the whole party, to Philip and his family who had helped in so many ways to make our week truly memorable. To mark the occasion, Ian then presented them with bottles of wine cunningly disguised as Indian Clubs!

* * * * * *

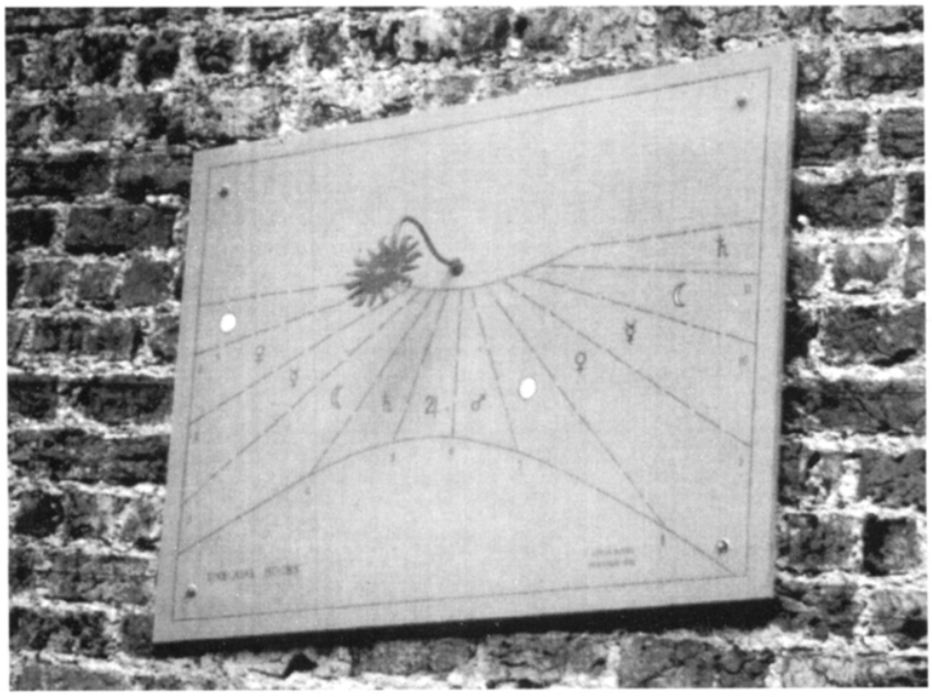


FIGURE 2: Sundial on the wall in the Time Garden

MASS DIALS - IN THE VALE OF THE WHITE HORSE

MARGARET STAINER

Fourteen members and friends of the B.S.S. Mass Dial Group took part in a lively informal meeting in and around Wantage, Oxfordshire, on Saturday 14th September, 1996. It was a perfect day for a dial viewing, sunny and windless. Frank Poller, who kindly arranged the meeting, has been a meticulous recorder of the mass dials of the Vale of White Horse for several years and shared his enthusiasm with BSS members.

The group met at the Methodist Church Hall in Wantage, under the chairmanship of John Ingram. Members introduced themselves to each other, and were delighted to find two or three 'new' members who had not previously attended a Mass Dial meeting. Edward Martin, the registrar, then spoke of the initial problems of getting his records computerised: the programme was so long and detailed that there was insufficient space for the actual data-base: only 24 dials could be accommodated, leaving hundreds of carefully gathered records waiting in the queue until a larger computer became available! Edward is now coping with the backlog by means of a simplified version, giving an input of 100 dials a week (or thereabouts); this will make possible the circulation of frequent updates of the register and minimise unnecessary duplication of effort among the recorders.

Edward was pleased to find, by a show of hands, that 2 or 3 of those present were computer-literate: potential helpers in the work.

Edward then showed us some slides of mass-dial 'oddities': anomalies such as octaval lines on one side of the vertical and decimal the other side: or different spacings above and below the horizontal.

Next David Young spoke. He briefly mentioned the BSS meeting in Northern Ireland from which he had just returned, then spoke of forthcoming meetings for which plans are well-advanced: the Society's AGM in Penrith in mid-April 1997, and a week-long meeting in Germany in late July, 1997, based in Frankfurt.

David then went on to show us some of his excellent slides of Saxon sundials, including the famous Bewcastle Cross (better 10 years ago than now), and the Kirkdale Dial. The morning session was rounded off by Frank Poller, who told us of plans for the afternoon.

The party set off in 5 cars, westwards to the charming country church of St. Mary the Virgin, Childrey. One good clear mass dial in the transept wall, and one and another possible in the chancel wall were duly inspected. The group then visited Uffington Church (outside only) and admired its splended octagonal tower, and noted its roundels (which once held the external consecration crosses) and the wall dial with a rusty iron gnomon: this noble church is called the Cathedral of the Vale. Then on to our main objective, Woolstone Church, where Frank Poller showed us the numerous external and interior dials, and an horologist from the village a few that Frank Poller had missed. Besides the clear dial near the west end of the south wall, and a faint one between transept and vestry, there are more than 6 mass dials around the priest's door which possibly was once a small south door in the nave, and is now the door into a modern vestry. Two dials on the inside of the church aroused particular interest and discussion. They may have been simply re-used blocks of dressed stone for restoration of window frame and door frame; but we speculated about Frank's idea that in their present positions they could have been functional as dials by means of sunlight entering through windows on the south wall of the church, one such window having been lost when the transept was built.

FIGURE 1: Respectful admiration for a Mass Dial

FIGURE 2: . . . . and (even) for a Modern Horizontal

Close to the church at Woolstone stands a handsome red brick house with a well-kept front garden colourful with autumn perennials, and a horizontal sundial, which the house owner kindly allowed us to view. It is a brass plate, only about 20 years old, on an attractive and much older stone plinth. David Young rapidly took notes and measurements to record it for Ian Wootton's register: dedicated diallists never miss a chance!

The party returned to Wantage by a more northerly route close below the hill bearing the famous Bronze Age White Horse, of which we had a good view, though (we are told) it looks even better from 200ft. up in the air. Back at Wantage Methodist Hall there were tea-and-biscuits, and at about 4.15 the group dispersed, well satisfied with the day.

The Mass Dial Group gives warm and hearty thanks to Frank Poller for organising the programme, and making all the arrangements, with the careful attention to detail which ensured a successful and smooth-running day.

AN ANALYSIS OF SOME MASS DIALS OF SUSSEX AND KENT

C. M. LOWNE

INTRODUCTION

The simple sundials which are found on the stonework of medieval churches and are called 'mass dials' or 'scratch dials' appear in many different guises. A few have a complete or nearly-complete set of well-defined lines in one arrangement or another: the dial at Wadhurst (grid reference TQ640319, Figure 1) is an example. The majority of dials are faint, weathered or incomplete and it is often uncertain whether the incompleteness is due to erosion of the stone or if the dial never had any more lines than are now present. Figure 2 is a photograph of a typical dial of this latter sort at Herstmonceux (TQ642102). Another distinction may be made between those dials which are relatively crude and those which show more careful construction. The former sometimes have lines which are distorted or do not pass through the gnomon hole, which is itself shallow and worn by the repeated insertion of the horizontal gnomon. At the other extreme, the better dials have clear straight lines, are accurately laid out, and have a deep carefully-drilled gnomon hole. It is tempting to think that the rougher dials were drawn by a priest or an acolyte to serve their immediate purposes, and that the better ones were laid out by a mason using his tools and are perhaps more general-purpose dials. Many dials, however, are not readily distinguishable in this way.

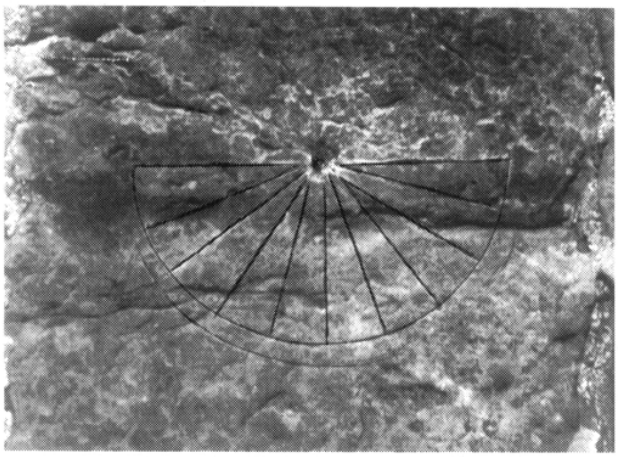


FIGURE 1: Mass dial at Wadhurst, East Sussex

FIGURE 2: Eroded dial at Herstmonceux, East Sussex

It is generally accepted that mass dials were not intended to indicate the time of day as we now understand it, with the day divided into twenty-four hours of equal duration. More probably, they were meant to indicate the proper times for certain events to take place, or to subdivide the interval from sunrise to sunset into fixed proportions ('seasonal hours'), functions which they performed, not accurately, but well enough for the simple purposes of those far-off days.[1]

The intentions of this analysis were firstly to find out what types of dial are represented and secondly to derive a method of classifying individual dials within these types, with some indication of the quality of the match. The dials selected for analysis occur within East Sussex (with a few from over the border in West Sussex) and in south-west Kent including Romney Marsh. I visited 148 churches, of which 64 produced a total of 93 dials. Eighteen of these were rejected because of poor quality (too badly eroded, or repositioned dials where the original orientation is uncertain). Five more dials with a complete circle of 24 small pits form a type of their own and were not included. Seventy dials remained for analysis.

DERIVATION OF LINE ANGLES

The line angles were measured to 1° from photographs. In exposing the negatives I took care to avoid distortion by ensuring that the camera was square to the dial face with the gnomon hole centred in the frame. In a few cases where the dial is high on the wall and the camera had to be tilted, the measures were corrected to remove the effect of foreshortening.

I found difficulty in measuring the angles directly on the photographic prints as the protractor divisions tended to confuse or obscure the more indistinct dial lines: it was preferable to trace the photograph carefully and measure the tracing. In this way the most probable position of a line could be better judged. Often the traced lines could be extended back to intersect in the centre of the original gnomon hole, thus avoiding the need to estimate the centre of a worn hole. In those cases where a line does not pass centrally through the gnomon hole I read the angle parallel to the line. From repeated measurements of typical dials I found my measuring error to be ±0.5° for the better dials and ±2° for the poorer.

Dials with 'pits' or 'pockmarks' were measured directly from the prints. Except where otherwise noted, for simplicity all time-marks are referred to as 'lines'.

MEASURING CONVENTION

My convention is that the west-pointing horizontal line (the line indicating 'sunrise', assuming a horizontal gnomon) is designated as the zero position with angle 0°. The line angles then increase anticlockwise (following the diurnal motion of the gnomon shadow), reaching the vertical noon line at 90° and the east-pointing horizontal 'sunset' line at 180°. Lines above centre, (which can never be struck by the gnomon shadow), have angles between 180° and 360°.

They were excluded from the general analysis but are considered later. The sunrise, noon and sunset lines are also excluded as they are in general accurately placed. Sunrise and sunset lines are in any case of doubtful utility: for half the year from vernal to autumnal equinox the sun rises and sets north of the plane of a south-facing vertical dial and cannot cast a shadow on the dial at that time. For the other months some of the horizon is likely to be hidden by local obstructions such as trees or buildings. Possibly the horizontal lines were included to facilitate the placing of the other lines or perhaps just to improve the appearance. More than half of the dials are missing one or the other or sometimes both.

TYPES OF MASS DIAL

At the outset, the dials can be divided into two broad categories: those which are more-or-less symmetrical about the noon line and those which are unsymmetrical. The former type show a regular line pattern (sometimes with the odd missing or additional line) and tend to be the better quality dials. Unsymmetrical dials vary in their properties: there are dials which have a different pattern of lines in the morning and afternoon quadrants, others have fewer lines in one quadrant than the other. Sometimes one side has no lines at all: where this happens it is generally the afternoon quadrant which is blank.

Several types of dials are known. The most important are:

Octaval: sunrise-to-sunset interval divided to eighths with 22½° angles between lines.
Decimal: divided to tenths, 18° angles.
Duodecimal: divided to twelfths, 15° angles.
Equal-hour or 'scientific' dials, with appropriate variable line intervals.

The first stage of my analysis therefore consisted of an examination of all the dials to check for possible fit into any one of these types. Those familiar with the appearance of mass dials will not be surprised to learn that only a few can be fitted unequivocally into one or other of the systems.

ANALYSIS OF INDIVIDUAL DIALS

It is obvious that dial lines suffer positioning errors and are not placed precisely at the intended angles. For the analysis I adopted an approach based on probability theory, designed to take into account the errors of line positions and to allow for any missing lines. In essence, the method consists of deriving values for the probability of a dial belonging to each of the various types and comparing these values to obtain the most likely type for the dial. There were complications: as mentioned above, some dials appear to be of different types for the morning and afternoon lines, others seem to possess half-interval lines in their system. These were all treated as special cases. The few good-quality dials hardly needed further investigation, but were included to provide a check on the reliability of the method.

The first step in the analysis of a dial is to calculate R, the root-mean-square (rms) residual of the lines from their nominal positions in each of the dial systems. Each line has a difference (r) from its proper position: the values of r are squared, summed, the total divided by the number of lines (n) and the square root taken:

$$R = \sqrt{(\Sigma r^2/n)} \qquad \text{Eq. 1}$$

The smaller the value of R the better is the fit of the dial to that particular dial type. Overall, the best-fit values of R for individual dials range from ±0.7° to ±5.7° with a median value of ±2.9°.

For all values of R, the 'relative probability' P of the fit of the dial into each type is obtained by comparison with a 'standard dial'. This has all lines present and an rms line error S: the relative error (t) of a dial is then R/S. I selected a value of ±3° for S based on the median error noted above. The formula for P is:

$$P = \sqrt{(n/N)} \times e^{-0.5t^2}/e^{-0.5} \qquad \text{Eq. 2}$$

where N is the theoretical number of lines within the two quadrants of the dial (10 for duodecimal, 8 for decimal and 6 for octaval dials) and n is the actual number as before. The factor $\sqrt{(n/N)}$ is designed to reduce the value of P for incomplete dials and e is the base of natural logarithms (2·718...).

From the formula, the value of P will obviously be 1.0 for a dial with R=S (t=1) and all lines present: it will be <1 for a dial with missing lines or R>S°. In the case of a perfect dial the maximum value of P would be 1·65.

For dials with apparent different calibrations in morning and afternoon, each half-dial was differenced separately in each system and the combined values of r used to derive R. Where it was necessary to invoke the presence of half-interval lines, the value of N was adjusted accordingly: for example, N=22 for a duodecimal dial with half-intervals. In a few cases where arbitrary half-intervals were used merely to fit a dial into a system for comparison (for example matching a dial with ten lines into the decimal system) the resulting value of P was reduced by multiplying by a factor $\sqrt{0{\cdot}5}$.

From the derived values of P for each dial, a value Q is calculated to indicate the reliability of the match of the dial into the system represented by the largest value of P. Calling the largest value P_1 and the next-largest P_2, the dial quality will depend on the actual value of P_1 and the amount by which it exceeds P_2:

$$Q=\sqrt{P_1}x(P_1-P_2) \qquad \text{Eq. 3}$$

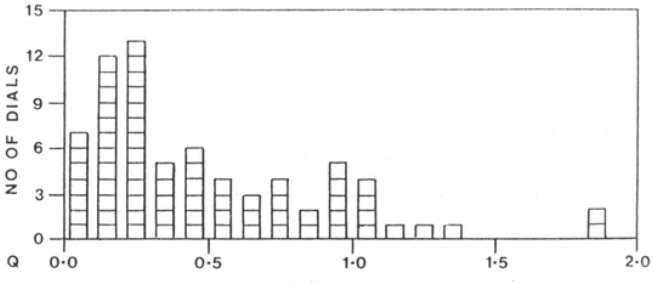


FIGURE 3: Numbers of dials in bands of 0·1 Q

The values of Q obtained range from nearly 2 for the most accurate dials to 0 where $P_1=P_2$. Figure 3 is a plot of the derived Q-values and the number of dials which occur in bands of Q of width 0·1. The skew distribution, with the number of dials peaking in the low values of Q and tailing off towards higher values, is just what one would expect in

an analysis of this nature.

The Q-value can only be taken as a guide, not a definitive representation of the quality of a dial. A small difference in R can can make an appreciable change in Q, and a broad-band classification system is all that can be justified. The Q-values are assigned to five class bands with appropriate descriptions to indicate the likelihood of a dial belonging to the system represented by P_1. The median value of Q is 0·4 and this was adopted as the boundary between the better and poorer dials for the classification bands shown in Table I:

Table I: Classification bands of Q

Class			
	a	>0.79	Highly probable
	b	0.60-0.79	Probable
	c	0.40-0.59	Possible
	d	0.20-0.39	Doubtful
	e	<0.20	Indeterminate

RESULTS OF THE ANALYSIS

The analysis showed that all the types of dial mentioned above are present, although octaval and equal-hour dials are very weakly represented. The summary of Table II gives the total number of dials attributed to every type in classes a, b, c, and d, of Q-value.

Table II: Number of dials in each class and type

Class	a	b	c	d	Total	%
Dial Type:						
Duodecimal	9	3	5	10	27	39
Decimal	3	3	2	3	11	16
Octaval	-	1	2	2	5	7
Mixed calibration	3	-	1	1	5	7
Equal-hour	1	-	-	2	3	4
Totals	16	7	10	18		
rms line error	±1.9	2.8	2.4	3.2°		

Nineteen dials (27%) are in class e. The bottom line of Table II is the overall rms line residual (with my measuring error removed) of all the dials in each class. Nearly 40% of the dials are attributed to the duodecimal system, and half of the class a and b dials are to be found in this group. Class a dials include all the obvious ones noted earlier together with some others. Decimal dials are quite well represented, but only one probable octaval dial is present. Of the mixed-calibration dials, one is duodecimal in the morning and decimal in the afternoon, two are the reverse of this, while one is octaval in the morning and duodecimal in the afternoon. One dial has decimal and octaval lines intermingled.

Most of the 19 dials in class e have only a few lines, but others are included with a larger number of poorly-placed lines which are a more-or-less equal fit into two types, leading to a low value for Q. I have searched for any systematic patterns of lines among these dials, with no success: the overall distribution seems to be quite random. This does not imply that the pattern on every dial is random: the presumption is that each individual dial maker had some pattern in mind but others were working with different requirements. Church premises were also used for community purposes: in particular the porch or a room over it was often used as the village school room. Some dials may relate to such secular usages.

The analysis revealed the presence of some minor sub-types:

Dials with corresponding lines on either side of noon missing, leaving an incomplete but symmetrical dial. Six dials appear to come into this category but there is no consistency as to which lines are omitted. Weathered dials where lines may have been lost were not considered for membership of this sub-type. Of the six dials four have lines in the decimal and one in the duodecimal system. The sixth dial with two lines near 45° and 135° will fit either octaval or duodecimal. These may be called 'abbreviated dials'.

The second sub-type consists of dials with a line or lines within about ten degrees of the noon position, closer than any dial type (except equal-hour) would require. On some dials the line replaces the normal closest line, on others it is an extra line. Sometimes the noon line is missing. Twelve dials appear to show this characteristic, and the average distance of their close lines from noon is 8° ±2°. This range includes the half-interval angles of decimal and duodecimal calibrations and is not very different from that of octaval, so (in the absence of knowledge as to the intended angles) these lines were analysed as half-intervals in the tested systems. Four dials appear to be duodecimal, two are decimal and one is octaval. The other five are indeterminate. Most have the additional line on the morning side so that it indicates a time shortly before noon. Possibly this was the time for mass on saints' and other special days.

I have searched for types of dial which exist in other parts of the country, for example ones with lines at 20, 40 and 60° either side of noon.[2] None has been found.

THE MISSING LINES ON DUODECIMAL DIALS

Thirteen unweathered duodecimal dials in classes a, b, c, and d, have one or more lines missing. Table III lists the missing lines, with the morning and afternoon quadrants superposed:

Table III: lines missing on duodecimal dials

Angle°	15.165	30.150	45.135	60.120	75.105
No.	16	9	9	4	12

There is a tendency for the lines furthest away from and nearest to noon to be omitted in comparison with the others, but it is difficult to suggest any convincing reason for this. Again we must assume that individual makers had their own requirements.

LINES ABOVE CENTRE

Thirteen dials, in addition to those with a complete circle of pits, have a total of 39 lines or pits above centre. Of these, 33 lines on 11 dials are diametrically opposite to a lower line to within ±3° (rms difference). The majority of these

dials are duodecimal: seven of them and the duodecimal half of a mixed dial account for 25 of the upper lines. In no instance are all the lower lines duplicated in the upper section. Possibly the presence of an upper line indicates a time of special significance.

INDIVIDUAL DIALS

Space will not permit a full listing of all the dials and their attributes, although such a list is available and I should be happy to send a copy to anyone interested. A few of the more interesting dials may be mentioned.

The dial at Lamberhurst (TQ681366), has lines and pits interspersed. The lines are a good fit to the duodecimal system (rms error ±1·6°) with the outermost pair omitted. The pits are at duodecimal half-intervals, (with one or two omissions) and also fill in the two missing lines, but are not so accurately placed (rms error ±2·7°). My interpretation is that the dial originally had only the full-interval lines and the pits were inserted subsequently by eye estimation.

A duodecimal pit dial at Chiddingly (TQ545142) has a gnomon hole which is double behind the wall surface. One branch runs horizontally in the normal way, but another runs upwards at approximately the latitude angle.

At Salehurst (TQ749242) the duodecimal dial has the remnants of Roman numerals within a double ring surrounding the lines. II and III can be discerned, in the positions they would occupy on an equal-hour dial.

The one class a decimal dial is that at Wadhurst (Figure 1). This dial is high on the wall of the 15th century south porch and so must have had a fixed gnomon: in fact traces of it are visible in the hole. By the chancel door is another decimal dial, very worn and presumably much older. It is an intriguing speculation that the design of the old dial was copied when the new porch was built.

One of the few dials which appear to have an octaval calibration, that at Telscombe (TQ406034, Figure 4), has an unusual feature. The pits in the morning quadrant are placed in three pairs, and the distance between the members of each pair is equal to the diameter of the gnomon hole. If the gnomon had the same diameter as its hole, the shadow would fall between the marks of each pair at the octaval hours. Unfortunately the afternoon pits are nowhere near so regularly placed and are not all at the same distance from the centre.

The only equal-hour dial of good quality is the well-known one at Litlington[3] (TQ523020, Figure 5). A deep groove along the noon line shows where a triangular gnomon has been fitted. It is perhaps rather doubtful whether the dial is a genuine medieval artefact, the high accuracy of the lines (rms error only ±0·8°) and their clarity suggest a later origin. Additionally, the lines were laid out over an ordinary mass dial: until fairly recently traces of this could be discerned among the deeper equal-hour divisions, but have now virtually disappeared.

Two doubtful equal-hour dials at Rolvenden (TQ844312) and Tenterden (TQ884334) are a reasonable fit to the system in the morning hours (rms errors ±3·2° and ±2·8°), but the afternoon lines are incomplete and less accurate. Both are high on the south porches and must have had fixed gnomons: however there are no signs of holes for bracket fixings to support inclined gnomons. The churches are only 3 miles apart and the dials may have had a common origin.

Of the mixed-calibration dials, Alfriston (TQ522030, Figure 6) is a good example. This dial has certainly been recut, but most of the original lines extend faintly beyond the ends of the deep cuts, enough to show that the recutting was done accurately along the old lines. The morning quadrant is duodecimal but the afternoon is decimal. The church leaflet notes that the dial has been fitted with a modern gnomon, but this is now missing.

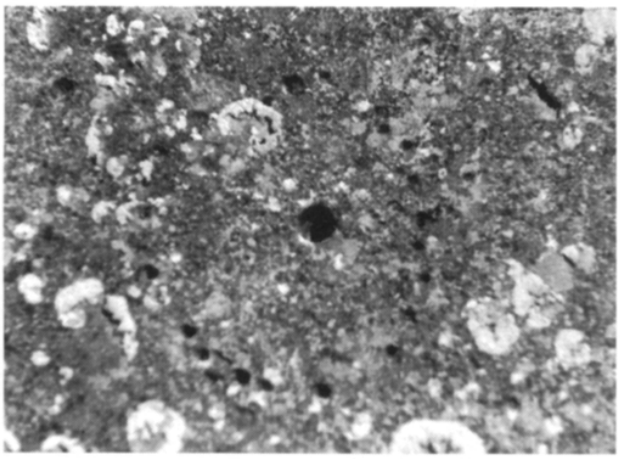


FIGURE 4: Possible octaval dial at Telscombe, East Sussex

FIGURE 5: Equal-hour dial at Litlington, East Sussex

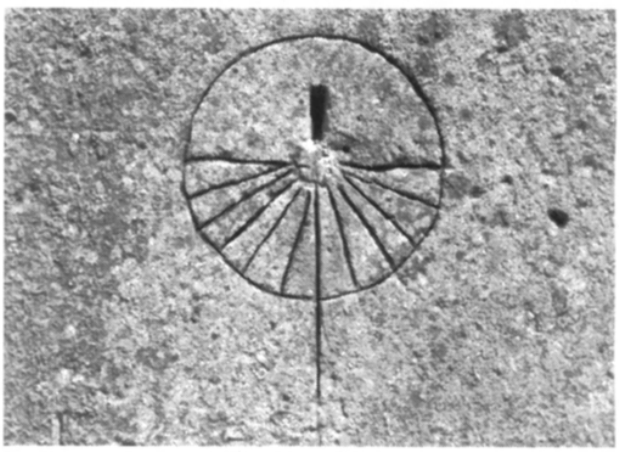


FIGURE 6: Mixed-calibration dial at Alfriston, East Sussex

DIALS WITH CIRCLES OF PITS

As mentioned earlier, five dials have a complete circle of 24 small pits. They are quite accurately laid out with rms errors between ±1·5° and ±3°. Two at Litlington are puzzling: they are set at 90° to each other on a single stone of a diagonal buttress to the north wall and face north-east and north-west where the sun can only reach them for a limited time in summer early and late in the day. They may have been repositioned.

ANALYSIS OF DIALS BY DATE

It is doubtful if an accurate date can ever be assigned to any mass dial. Even if that part of the church where the dial appears can be dated, there is no certainty that the dial is contemporary with the building: it could have been added later. Or it may well be earlier, building stones were valuable and were often reused: many dials are now upside-down or face directions other than south! It is however probable that the better-quality mason-drawn dials were made while the builders were still on the premises. Although the date for any one dial must be uncertain, it seemed worthwhile to try to obtain a general picture by assuming that each dial is contemporary with its location on the church, or (for repositioned dials) with the original structure. The dates were combined in broad bands so that errors will in the main cancel out. In Table IV the building dates of most of the churches visited are given (in century bands) and the numbers and percentage proportions of them which carry a dial or dials.

Table IV: dates of churches and numbers with dials

Century	11	12	13	14	15	16
No of churches	3	32	55	38	10	2
No with dials	0	15	21	23	5	0
Porportion (%)	0	47	38	59	50	0

The 11th and 16th century churches are small in number and possess no surviving dials. Disregarding them and making the reasonable assumption that most if not all churches originally had dials, the proportions indicate that about 50% have survived and that there has been only a small loss of early dials in comparison with later ones. This strongly suggests that the dials now extant may be taken as a representative sample of the whole population of dials constructed over this period. The sample should reflect the original distribution of dials by class and type and show if this changed over the years.

In Table V the dials are listed by date and quality class, including those rejected from the analysis. The few 15th-century dials are combined with those of the 14th century. The number of dials is given and (in brackets) the percentage proportion to the total of that date.

Table V: dials by class and date

Century	12	13	14+15
Class a	1 (5)	3 (10)	11 (30)
b	3 (16)	1 (3)	2 (5)
c	2 (11)	6 (21)	3 (8)
d	5 (26)	6 (21)	5 (14)
e	4 (21)	9 (31)	6 (16)
Rejected	4 (21)	4 (14)	10 (27)

The proportion of class a dials appears to have increased markedly with time, from being the least numerous class in the 12th century to the most numerous in the 14th and 15th. Most of the gain has come from classes b and d. The proportion of the total of class e. and rejected dials has remained almost constant at just over 40%.

Table VI summarises in the same format the total number of dials of the three main types in classes a, b, c, and d. Dials with mixed calibrations are included under each of their types, with half attributed to each.

Table VI: dials by date and type

Century	12	13	14+15
Duodecimal	4½ (41)	10½ (65)	14 (67)
Decimal	5 (45)	3 (19)	5 (24)
Octaval	1½ (14)	2½ (16)	2 (9)

This shows a small but significant rise in the proportion of duodecimal and a corresponding loss of decimal dials. The apparent reduction in the proportion of octaval dials is probably not significant because of their small number.

Bearing in mind the uncertainties in dating and the rather small number of dials, these results can be taken as no more than an indication of the general trend of dial development.

'CANONICAL-HOUR' DIALS

The original purpose of mass dials was to show the times of church services, in particular those of the 'divine offices' at the seven 'canonical hours'. The history of these is confused by later revisions, but the original arrangement seems to have been:

Matins	Between midnight and dawn
Prime	Dawn
Terce	Mid-morning
Sext	Noon
Nones	Mid-afternoon
Vespers	Sunset
Compline	Between sunset and midnight

The names of the daytime canonical hours, implying third, sixth and ninth, clearly reflect the division of the daylight period into twelfths. Obviously only the times of these three, with sunrise and sunset, could have been indicated by a dial. The basic canonical-hour dial would possess lines at 0°, 45°, 90°, 135° and 180° in my convention. Only one of my dials appears to have this layout, that at West Firle (TQ471071), and even here the noon line is missing. This dial is on a 12th-century Norman doorway now situated on the north side of the church. Other early dials of this type could be expected: perhaps they have been disguised by having extra lines added as requirements altered. The dial at Hellingly (TQ581123) is one where this may have occurred.

THE ADVENT OF EQUAL-HOUR DIALS

It is possible that for a few of the duodecimal dials we are witnessing something of the transition to equal-hour dials from the old seasonal-hour type. It is not known when the knowledge of the time-keeping properties of the equal-hour

dial reached Britain. When it did arrive, descriptions of the concept and the necessary design of dial would most likely have spread only slowly among the remote and isolated parishes by word of mouth, with all the uncertainties and misunderstandings that such a dissemination would imply. South-facing duodecimal and equal-hour dials are both divided into twelve parts and it would be a natural step to try to convert the one to the other. Perhaps at Chiddingly the effect of an inclined gnomon was tried and at Lamberhurst the half-hours were inserted to try to improve the accuracy of reading, while the Salehurst dial was numbered in the 6am to 6pm sequence. Other dials may have had similar modifications which have left no permanent record. The two doubtful dials at Rolvenden and Tenterden may be other examples of a slow and uncertain progress of the system. A few equal-hour dials I have noted on church stonework clearly show their mass-dial antecedents by having incised lines without numerals. One at Mayfield (TQ586271) has small pits at the line ends which is a common mass-dial feature.

THE CONSTRUCTION OF DIALS

Very little evidence remains of the methods by which dials were laid out but some conjectures can be made. Taking the more accurate dials first, and assuming that they were made by stonemasons, the vertical noon line would have been drawn with the aid of a plumb-bob and the horizontal lines positioned from this by a square. A mason would have had among his tool-kit, not protractors, but sets of angle templates which could be used to fill in the intermediate lines. Alternatively, the right angle between vertical and horizontal could be divided by stepping round the arc with compasses and adjusting these until the required angle was obtained. An rms error of a degree or two could easily have been achieved by either of these methods, as in the class a dials of Table II.

It may be that some dials were drawn by eye estimation of the angles. Horizontal and vertical lines could be quite accurately placed by eye and then the other hour lines inserted. I have drawn up dial patterns in this way and find that my rms error of an estimated line position is $\pm 2^1/_2°$, in good agreement with the errors for class b and c dials.

It is likely that the dials which do not fit any pattern were not drawn geometrically but empirically by marking for future use the position where the gnomon shadow fell at the required time. If done in this way the angle of a line will vary according to the time of year: for example a line drawn at mid-morning would be 35° from the horizontal at the summer solstice but only 22° in mid-winter.

GENERAL COMMENTS

The analysis has revealed some other aspects of mass dials and their properties which deserve comment.

For many dials the afternoon marks are fewer in number and less accurately placed than those in the morning quadrant. In other cases the morning lines are more distinct than the afternoon ones and appear to have been recut: Warehorne (TQ990325) is an example. Were the afternoon services or other events of less importance than the morning ones?

Some dials have a circle or semi-circle enclosing their lines: occasionally the circle is double. This could be just a design or construction feature, as the dials concerned are generally not unusual in any other respect. On the Salehurst dial the Roman numerals occur within a double circle: possibly on other dials the figures were painted in and such circles can be regarded as the ancestors of the chapter rings of numerals on clock faces.

A number of churches have two or more dials. Omitting the equal-hour and class e dials, five churches have dials of the same type (three with duodecimal and two with decimal dials) and six have dials of differing types (four with duodecimal plus decimal, one with duodecimal plus octaval and one with decimal plus octaval). Of the eleven decimal dials noted in Table II, no less than nine occur in the presence of another dial, either another decimal or one of a different type.

In considering the use of mass dials one essential requirement is often forgotten: the sun needs to be shining. Even in south-east England, the total duration of sunshine throughout the year is only about 40% of the possible annual total. There is no reason to suppose that this ratio was any different in medieval times, so that anyone hoping to make a time reading from a dial had overall three chances in five of finding it useless under a cloudy sky! Obviously the prospect of a clear sky would be better in summer than in winter, when two or three weeks might pass without a glimpse of the sun. We may never know if other arrangements were made for such circumstances. Probably in cloudy spells most reliance was placed upon the human circadian clock. Mechanical clocks were introduced in (probably) the 13th century, but are most unlikely to have been common in rural areas. Mass dials continued to be made for about another 200 years after the first clocks appeared. The time-keeping of early clocks was so erratic that frequent regulating by a sundial was necessary, and, apart from the noon line, a mass dial would have been quite useless for this purpose.

ACKNOWLEDGEMENTS

My thanks are due to Mr. Colin Lindsay for ideas and suggestions during the early stages of this analysis, and to Mr. Edward Martin for his encouragement to write this article. My wife accompanied me on many dial-hunting expeditions and discovered dials which might otherwise have been overlooked.

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Author's Address: 24 Ditchling Way, Hailsham, East Sussex, BN27 3LU.

17-23

A STORY OF NATURALISED DUTCH TWINS

BY TH. J. J. VAN DEN HEILIGENBERG

This is the story of two sundials, both made in England but now residing in Holland. They are called Zwacht and Zwelf. Zw for Zonnewijzer (sundial) and acht and elf for eight and eleven. Their family name is Pilkington & Gibbs, which was the name of the firm that made equatorial sundials in Lancashire between 1906 and 1920 or thereabouts. Some were also made by other manufacturers under licence, and some of these were made on the Continent.

Twins they may be, but clearly of different gender. Zwacht, the elder of the two, is of sturdier build than his sibling, and clearly male. Named after his year of construction (1908) which is inscribed on his face, he came to me in 1983 after an eventful youth about which he remains silent. His arrival was joyfully announced in our Dutch Sundial Bulletin, issue 18, page 921, and he is registered in the Dutch Index[1] as "Utrecht 13".

Zwelf is of a finer and more elegant build, and is clearly a lady. As such she does not advertise her age, so she has been named after the year in which she migrated to the Netherlands. I have been her guardian since 1984, but I know the story of her life, which is pure and unblemished, if a little dull. She has not yet registered with us but never-the-less has let it be known that she would like to be registered next to her brother, Zwacht, as "Utrecht 13A".

I like to set sundials against the economic and social background of their times. As well as giving a picture of the times in which they were made, this can give details of the methods and machinery available to the makers, and the how and the why of its making. So this story of Zwacht and Zwelf also includes something of the history of the company that made them, and where they first faced the sunlight. A company which got off to a promising start and was successful, but which sadly floundered into oblivion after some sixteen years.

Now, to present Zwacht and Zwelf to you, and in order to do this, we look to the family archives of their parents, Pilkington & Gibbs. These archives consist of an illustrated prospectus which was sent by the makers to relations and clients. In plate 1 we see Zwacht at about half past eight on the morning of the 10th of February. He is reclining in a very relaxed position, waiting for the arrival of the sun, which, he has decided, will on that day shine through the

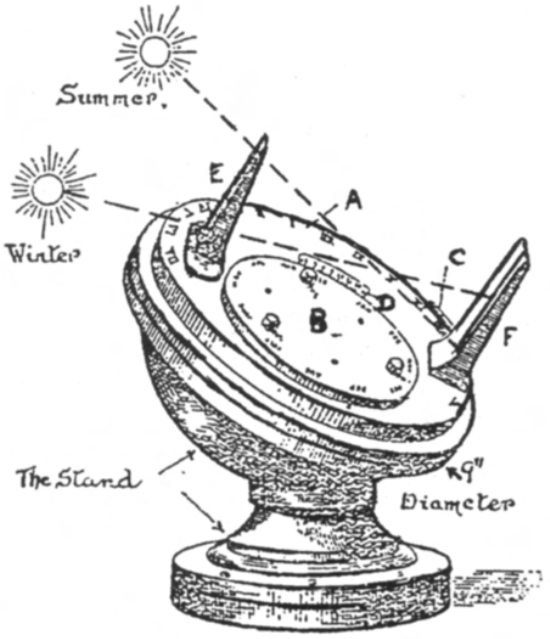


PLATE: 1

winter (lower) aperture. If you listen carefully, you will hear him whispering:

"Being your slave, what should I do but tend
Upon the hours and times of your desire[2]

Plate 2 shows Zwacht in a bird's eye view and in full action at eight minutes past two on Christmas Day, and due to Christmas the hour figures are upside down. Plate 3 shows a rather severe image of Zwacht in profile taken from another family album. The embonpoint, i.e. the sturdiness of Zwacht, is clearly visible, while Plate 4 shows the much more elegant hip section, rather wasp-like, of which little Zwelf is very proud.

I cannot supply the reader with recent photographs since my two children are very vain and don't want to pose, maintaining that their deep bronze skin tones are not photogenic. Stubborn, certainly, but here parental discipline wanes.

C'est l'heure de bien faire

On the 8th May, 1906, George James Gibbs (of Brownedge, Bamber Bridge, near Preston in the County

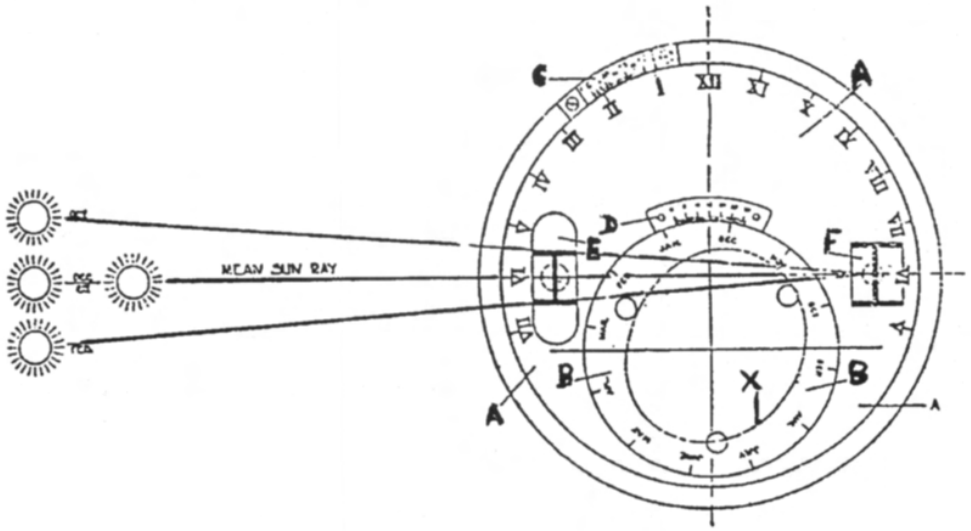
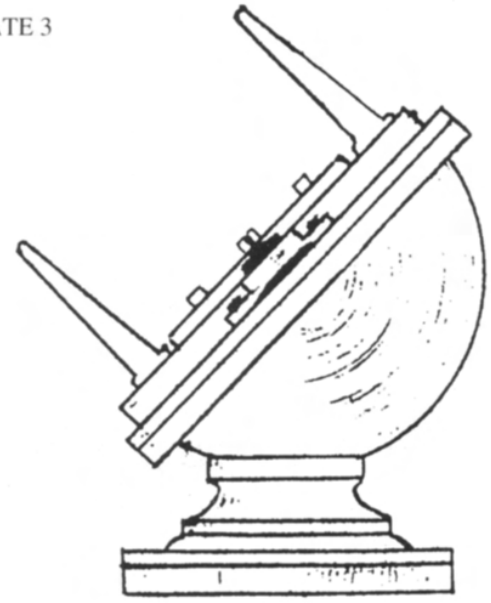


PLATE 2

PLATE 3



Palatine of Lancashire) obtained the patent for an equatorial sundial, which he called a Heliochronometer.[3] The first presentation of the instrument took place at a meeting of the Royal Society, a famous and respectable institution that needs no further introduction. The invention was much praised, thus obtaining publicity elsewhere and Gibbs was invited to demonstrate his invention all over the country. The influential British Astronomical Society (29th May 1907) was one of the first learned societies to show an interest, but it was followed by others, such as The Royal Scottish Society of Arts and The Yorkshire Philosophical Society.

George Gibbs was a consultant engineer and astronomer. He appears to have had good social and intellectual abilities. From the Preston Year Books of the period we know that he was a member of several professional organisations. At one time he was the Director of the Jeremiah Horrocks Observatory, in Moor Park, Preston, which is still in existence.

He was also President of the Preston Scientific Society and today, if you are in the Preston area you could go and look in Preston Museum and Library Community Hall, where there is a Foucault's pendulum, in working order, constructed by Gibbs (though the base plate is new). An outing to near-by Woodplumpton is worthwhile as it was there that Gibbs restored the vertical reclining dial on the east-facing wall of St.Anne's church. It is quite a large dial, being at least a metre wide. The dial reads from V1 to V (6 a.m. to 5 p.m.), and is adorned by the rather unimaginative and unoriginal proverb "Sic transit gloria mundi". From a photograph I date the dial around the beginning of the 19th century.

In 1906 Gibbs had a real problem in as much that he lacked the capital to develop his invention for the commercial market. That capital was essential and was obvious. His heliochronometers were no lightweights: Zwacht and Zwelf weigh in at 19 and 15 continental 'pond', or pounds (of 500 grams each) respectively, or 9 and 7 kilograms. They are made up of 15 different parts, excluding nuts and bolts. All these had to be cast and machined in various ways, which required a small factory with workmen and the necessary machinery. All in all, quite a large investment.

Gibbs' solution to the problem was to associate himself with someone who could provide the capital and he entered into a partnership agreement with one William Renard Pilkington who, like himself, was an engineer. Together they set up on business as "Messrs. Pilkington & Gibbs, Scientific Instrument Makers, of 7, Lune Street, Preston, Lancashire".[4]

Very little is known of Pilkington. From such local records as there are, he does not appear to have taken much interest in the local community, though he lived quite near Gibbs at Dowry House, Bamber Bridge, near Preston.[5] Maybe he travelled a lot as it looks as if, in addition to supplying the capital, he was responsible for the sale of the Heliochronometers, which, as we shall see, was on a world wide basis. This no doubt demanded that he travelled far and wide as the salesman of the business.

The relationship between the two partners is typified by the name Pilkington preceding that of Gibbs, but on the dials is inscribed - at least on the early ones - "G. J. Gibbs Invenit". Zwacht is so inscribed but Zwelf not any more. As we shall see, a serious controversy developed between the partners, which culminated in 1911.

See the little daystar moving, life and times are worth improving

Even after all these years it is possible to see with what energy they worked to expand the enterprise. Looking at the sales side we see that in 1908 a firm in Munich, "Rainiers", makes Heliochronometers "with the greatest of precision from the original design of the Englishman

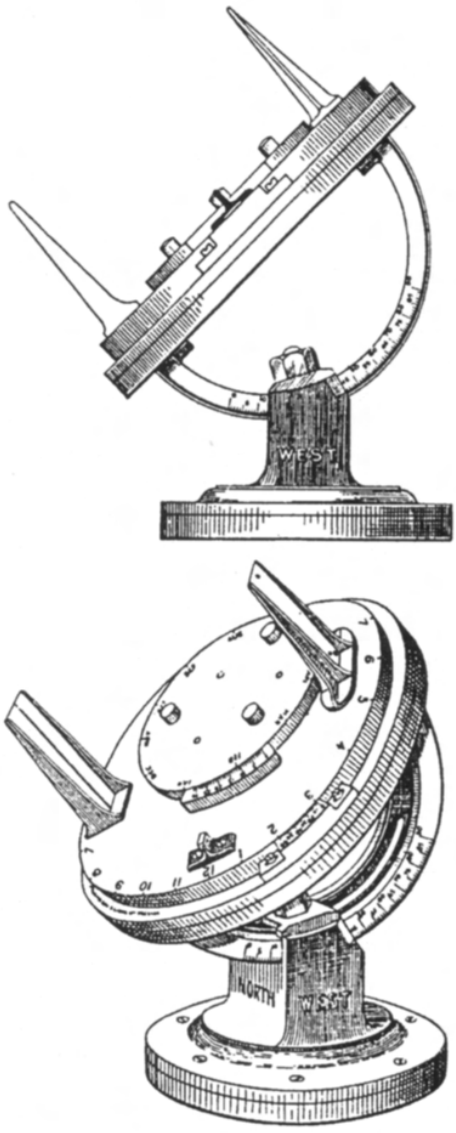


PLATE 4

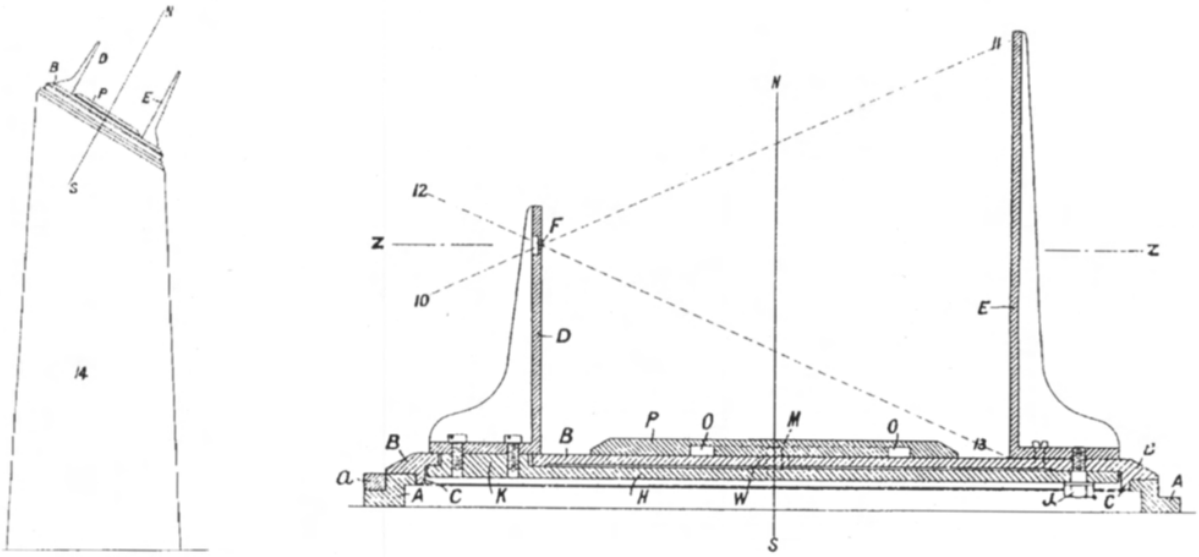


PLATE 5

Gibbs".[6] By 1910 there is an agent in New Bond Street, London, though the name is not known. In the same year the internationally known trading firm, Negretti & Zambra, takes the Heliochronometer into its collection.[7]

In 1909 the firm of Blass & Groenewegen became agents for Pilkington & Gibbs in the Netherlands[8] and finally, in 1911, my own Zwelf comes to Holland and is collected from the agent, (Alex Schroot, of Westeinde 191, The Hague) by her first foster-father. At the time Alex Schroot is alleged to have remarked "Don't be deceived by the name",[9] to which Zwelf, blushing and with downcast date-disc may well have replied "What's in a name? That which we call a rose, by any other name would smell as sweet".[10]

In fact, judging by the list of distinguished clients that was included for PR purposes in the firm's sales brochures, there must have been many more sales points and licence holders. The last list comprised no less than 20 countries world wide. Naturally a number were within the Empire, but Tsarist Russia, Cuba, Egypt, the Argentine, Morocco and the USA are all there.

The list of clients is ranged according to protocol and strict social precedence. First, of course, is His Majesty the King, of Windsor Castle.[11] Following him we find the authorities and the magistrates, followed by the aristocracy. One notes with interest that a French Marquis is ranked below an English Countess, but above the "Rt. Hon. The Speaker of the House of Commons". After the aristocracy come the military in order of rank, a few scientists including some professors, and finally the plain "Esquires". In this latter group there is a Leopold de Rothschild of Ascot (as yet no title), the President of the Singer Sewing Machine Company of New York and, surprisingly, a Dutchman, F. Scheffer, Esq., of Oosterbeek, Holland. Sport was represented by the Pau Tennis Club in France and the Royal Yacht Club on the Isle of Wight. I notice amongst the clergy a Ukrainian monk, Titus de Podosky Esq. of Monasteriszcze, Kiev, Russia.[12]

We could say, with some reason, that on the world of the Pilkington & Gibbs sundial, as on the Empire, the sun never set. It is quite remarkable to build such a company in five years, and a tribute to the worth of Gibbs' Heliochronometer.

Solis et Artis Opus

This development of the market is reflected in the development of the product. Illustrations 5 and 6 are reproductions of the original drawings attached to the Patent Documents of 1906. A comparison of these with illustrations 1, 2 and 3 (1907 to 1908) immediately shows a good many differences:

The indications of date and minute indices are no longer engraved on the date disc (P, plate 6) and the hour disc (B, plate 6), respectively, but rather on arc segments (C and D, plate 1 and 2) which are appropriately engraved and are secured adjacent to each disc. Much engraving is thus avoided and the indicated time intervals can be reduced from 10 to 2 minutes - drilling an extra (winter) aperture in one of the visors means that the other visor (E, plate 5) can be reduced in height.

The numbering of the hour disc as indicated on the patent drawing (plate 6) is extended and is also altered from Roman to Arabic numbers. Zwacht has from V1 to V11 (6 a.m. to 7 p.m.) and Zwelf has Arabic numbers from 5 a.m. to 7 p.m.

Later on we find 24 hour numerals (two times 1 to 12) around the complete circumference of the hour disc. This has to do with the setting of the dial for different geographical longitudes. A certain but very modest variation in the longitude setting had already been provided for in the patent application. The slots numbered 17 on plate 6 allowed a small shift of the sector, indicated there with *a*. Thus the setting could be varied between 2½ degree East and West of Greenwich.

However, it must have been quickly realised that this was inadequate, as such a small variation could not even show Preston, let alone the whole of the UK. Zwacht therefore has already a wider range. Some extra holes are drilled and tapped along the rim of disc A, which could receive the tiny bolts numbered 16 on plate 6. Therefore Zwacht can already read local time from 5° East to 4° West. By increasing the number of extra holes Zwelf has a still wider range: from 35° East to 32° West. The final development of this facility was to provide an index, that covered the entire circumference of the dial and on which the owner could have engraved various place names "to tell time at some instant at various parts of the Globe (or British Empire".[13] This model was therefore appropriately named and sold as an "Empire Heliochronometer".

Mia vita e il Sole; dell 'uomo la vita e Dio
Senza esso e l'uom, qual senze Sol son 'io

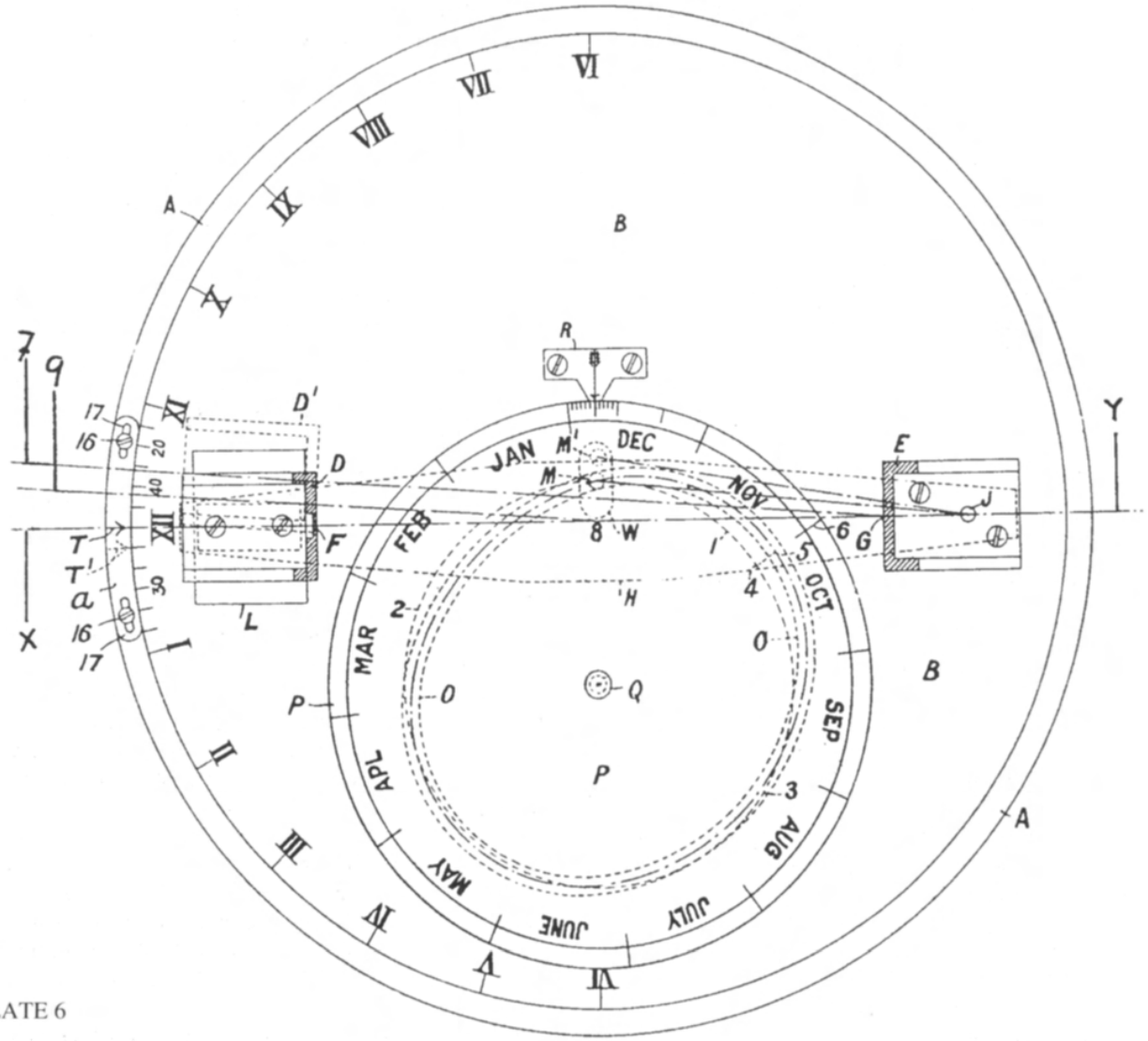


PLATE 6

This ability to deal with any longitude naturally led to a request for the same ability to deal with any latitude. This was not catered for in the original design and production. Prior to this modification, and according to plate 5, the sundial was to be placed on a plinth which had been made with the correct equatorial angle, each plinth or stand being made on site, in the garden or on the owner's terrace, to suit the particular latitude of the property. As this was not very practical an adjustable "stand" was added to the dial (plate 1) which, together with the longitude adjustment previously referred to, allowed the instrument to be factory set for both the latitude and longitude of the buyer according to details supplied by him. All the new owner had to do was to supply a horizontal base for the dial by way of a plinth or column for instance, and then, having set the day and the month on the dial, to turn the instrument on its base until the clock time was indicated.

Zwacht works in this way, though limited to latitudes between 44° and 56° N. In order to change the setting to a new latitude a tedious operation has to be performed on the mounting bracket inside his tummy; this has to be opened-up and a sturdy nut loosened before the adjustment can be made with the help of a special tool, an inclinometer or the like. To simplify this, the tummy is first provided with an external scale for latitudes from 30° to 60°; for the tropical model for 0° to 45°. Later on, the need for this operation was overcome, the dial fitted with an open, semi-circular mounting bracket in place of the enclosed tummy. This enabled latitude settings from 0° to 90° to be set easily by the slackening of a large nut, the resetting of the markings on the mount to the desired latitude and a final tightening of the nut and bolt. Zwelf (plate 4) is of this pattern and she appears truly fair and elegant.

In its final development the body of the instrument (i.e. the hour disc and above) turns on a horizontal axis, perpendicular to the meridian plane.

Ut Hora sic Vita

The development of the instrument led to an extensive range of models; at least on paper. The well illustrated brochures, complete with their poetic offerings for inscriptions, published in 1909 and 1910, offer at least seven. All were adaptable to the Northern or Southern hemispheres and, if required, the bronze top could be gilded.

Various "extras" were offered, including a rich assortment of pedestals, various engravings (proverbs, family crests, monograms etc.). A glass or copper dome to cover the instrument at 12 shillings and sixpence seems to have been a bargain. Half sized models were made[14] but this was probably a later development, as they are not mentioned in the prospectus.

A P & G dial was not cheap: the average instrument - like my Zwelf - cost ten guineas[15] in 1911, without any accessories. It is perhaps risky to compare that cost with the possible cost today, having regard to the cost of living index,[16] because it is such a rare item. But if the

comparison is made, the result for 1995 is a present day cost of £630. Converted to Dutch guilders the equivalent is fl 1700. Even if these calculations are badly out it seems that P & G were targeting the affluent sector of the market, to include the happy few of the upper crust, including the American sewing machine manufacturer as one of the subsponsors and with the Ukrainian monk as surely the least likely and most inexplicable of clients.[12]

Let me now tell you something of the past of my two dials. Zwelf's face is the very image of simplicity; a sign of her authenticity. On plate 4 it will be seen that her only make-up can be the engraved name and address of the afore-mentioned sales agent Alex Schroot, which appears like a beauty spot on her date disc. Along the edge of the disc is inscribed the name "Pilkington & Gibbs Ltd. Preston, England", and the four cardinal points of the compass are engraved on the small square pedestal. Finally, a small 0 indicates the setting of the minute sector (C, plate 2) for GMT. The practice of factory setting-up the instrument for the latitude and longitude of its destination had clearly been discontinued.

What was the reason for Zwelf to emigrate?

In 1894, or was it '95, a Mr L. de Ruyter of Jutfaas, a small village near Utrecht, bought the steam tram enterprise "Stoomtram - en Bargedienst Vereeniging" of Utrecht, and later, of Jutfaas. He became managing director and held this function until 1912.

In 1911 his son, L. de Ruyter Jr., was nominated assistant managing director and it was on that festive occasion that his father presented him with a sundial: Zwelf. One year later father retired; his son succeeded him as managing director. The junior manager was capable and experienced. The steam trams ran on time thanks, no doubt, to Zwelf, and the company flourished. He had a handsome residence built next to the tram depot, where he also had his office, with Zwelf standing in the south window.

L. de Ruyter Jr. had only one son, yet another L. de Ruyter, who eventually succeeded his father after reading law at Utrecht University. The company now traded under the name of "N. V. Transport Company De Twee Provincien". Thus, the younger De Ruyter eventually inherited Zwelf; he remained a bachelor all his life, living in the family home with Zwelf who stood on a plinth in the conservatory.

After his death in 1983, the author was presented with Zwelf from this good friend as he had done a small repair by making a tiny missing bolt for it on his lathe.

Veritas Temporis Filia

The face of Zwacht is more lined than that of his sister. The year of his construction, as well as no less than five Latin proverbs, are inscribed. I quote these, with translations:

PERREUNT IMPUTANTUR
They pass away and are imputed
AD SOLIS **LIMI**NA **CALCUL**O
I measure within the limits of the sun
HIC AD SOLIS **LUCE**M **SCI**ES
Here you may know from the light of the sun
HORAE **DISCRIMI**NA **CALCUL**O
I measure the period of an hour
I DIEM **CI**TO **CALCUL**A
Measure quickly one day

The first three are inscribed on the hour disc, the other two in the middle of the date disc, surrounding the year "1908", all in capital letters. Some letters are, as indicate above, larger than others. The larger ones form four chronograms. If the larger letters are read as Roman numerals (I=1, U=V=5, L=50, C=100, D=500, M=1000) and added, we come four times to a sum of 1908, the year of construction of the dial. It is clear that Zwacht stopped reading Shakespeare in favour of classics, with mathematics as an extra subject.

Contrary in the case of Zwelf, we miss the inscription of the name of a sales agent, and so assume that he came directly from Preston to his first home, before he travelled across the sea to Holland. The company stamp is now "Pilkington & Gibbs Ltd., Preston", without the addition of "England", which also indicates an inland destination.

As with Zwelf, there is a mark on the edge: "G", for the GMT setting. But next to it is another mark of a different setting, made at the factory to indicate the setting for the first owner. This tells us that at the first location the time is 8 minutes later than at Greenwich, so it must have been located about 2° East of Greenwich. "About", because the 2° eastern meridian runs up the east coast of England.

J'Avance

A bit of keyhole surgery inside Zwacht revealed more. On the inner surface of the round belly I found two figures, written in white chalk, as clear as if they had been written yesterday. One, 1908, was clearly the year of construction. The other, it was not difficult to guess, was the latitude of the site for which it was originally to be set by the factory: 53°. From the patina one can see that this original setting has never been altered.

Alas, alas, at 53° N and 2° E there would have been herrings swimming around in the old days, where nowadays there are gas platforms. No place where a young sundial can thrive. We come ashore however, assuming that the first owner did not take his co-ordinates too seriously. The most plausible first site is then the north-eastern part of Norfolk.

One should look for a residence of someone, fairly well heeled, for whom the year 1908 must have had a special meaning: taking up residence, marriage anniversary, or something like that. The Latin texts or chronograms do not appear in the assortment in the P & G prospectus. They would therefore have been commissioned by the first owner. We don't achieve anything by this knowledge and in fact the track gets lost here.

At some time in the past Zwacht has been removed from his pedestal and has wandered, always accompanied by his copper hat or dome. But he seems to have been well cared for, always his hat on when it rained, which has left him with a beautiful coat of patina. In 1983 he became a ward of a salesman, who was much taken by him, and it was with the travelling salesman that he came to the Netherlands, eventually to find care and attention under my roof.

A clock the time may wrongly tell
I never if the sun shines well

Let us now revert to the Pilkington and Gibbs business enterprise, which we left in 1909/10 in what seemed to be in a flourishing state. But the downturn was imminent, and there were a number of reasons for this. A first cause was the rapid development of radio telegraphy, invented by Marconi a decade earlier.[17] Up to this time opportunities for the correction of clocks were somewhat limited. The official time signal was sent by (wire) telegraph to railway stations once a day, but this left large areas of the countryside without a regular means of checking their time-pieces, and a precision sundial such as the

Heliochronometer, correct to a minute, which could give the official time without adjustment tables, etc., fulfiled a real need. With the arrival of the wireless the system became redundant.

A second reason for the decline of the firm were the differences between the partners, which stemmed from the fall in sales attributable to the wireless. This must have affected Pilkington more than Gibbs. Pilkington had provided the capital, which was at risk, whereas Gibbs, as the holder of the patent, would always be in receipt of royalties. Additionally he had other, paid, employment outside the sundial enterprise.

Things came to a head when, in 1911, Pilkington produced his own patent for a sundial which he called the Sol Horometer. It went into production as a Pilkington & Gibbs product, but now with the inscription "W.Renard Pilkington, Inventor". George Gibbs had been totally unaware of this instrument and its patent and he must have been furious with his partner. On filed documents[18] we find sharp remarks in his handwriting, and not surprising too: the Sol Horometer looked suspiciously like the Heliochronometer (plate 7). Also Pilkington seems to have made sure that not many more Heliochronometers were put on the market. He undercut the price of the Heliochronometer by 10% and had a new brochure printed in which the claimed advantages of the Sol Horometer are clearly spelt out. Not altogether an honest business. In the brochure the lavish illustrations of gardens of English manor houses (still the homes of the rich) with sundials on a variety of mountings, show however mainly Gibbs Heliochronometers. It also informed the reader as to where "our" sundials were demonstrated, including such prestigious bodies as the Royal Society.

This was all very misleading. The old list of clients is reproduced, headed by H. M. The King, but now with a note that Sol Horometers or (the underlining was made later in pencil by Gibbs) Heliochronometers have been supplied to them. It is noted that Pilkington manages to get the address of the business altered. The old Glover's Court where the company had been established is now called Sundial Court or, occasionally, Sundial Crescent.

There was not much that Gibbs could do about all this. His own patent had not been infringed, for, although the Sol Horometer looked rather like the Heliochronometer, it was essentially and sufficiently different in the mechanism which automatically made the correction for the equation of time, as well as in the arrangement for reading off the time.

It is later than you think

Zwacht and Zwelf therefore have a cousin, named Sol, but also a Stip, after his foster father named Stiphout. Sol-Stip came to stay with me for a while to tighten the family bonds, and plate 7 clearly shows the family likeness.

Sol has Zwacht's robust belly and, according to the family album, has a variety of sisters as elegant as Zwelf. The stand is the same for all models, the differences occurring on the faces of the various types.

The surface of Sol is a solid disc surrounded by a flat ring, on the same equatorial plane, which can be turned. Both disc and ring show date divisions, running from January 1st to December 31st, on the adjoining edges. The divisions on the ring vary slightly from those on the disc, the purpose being that the instrument is set by turning the ring slightly each day so that the dates on both sides coincide. This adjusts the instrument for the equation of time. A quite different arrangement from that of Zwacht and Zwelf, where the adjustment is effected by movement of one of the visors by means of a cam concealed within the body of the instrument, see plate 2. Both solutions are technically admirable. The Sol system means that the surface must be fully engraved: two calender engravings from day to day, all the hour marks from IIII to VIII, divided into 5 minutes graduations, which, in later models, were refined to allow the instrument to be read to 2 minutes. In addition there is the name of the maker and a compass card. Plate 7 shows that there is just about room for a short motto. The Sol Horometer therefore looks more stylish than the simple Zwacht and Zwelf.

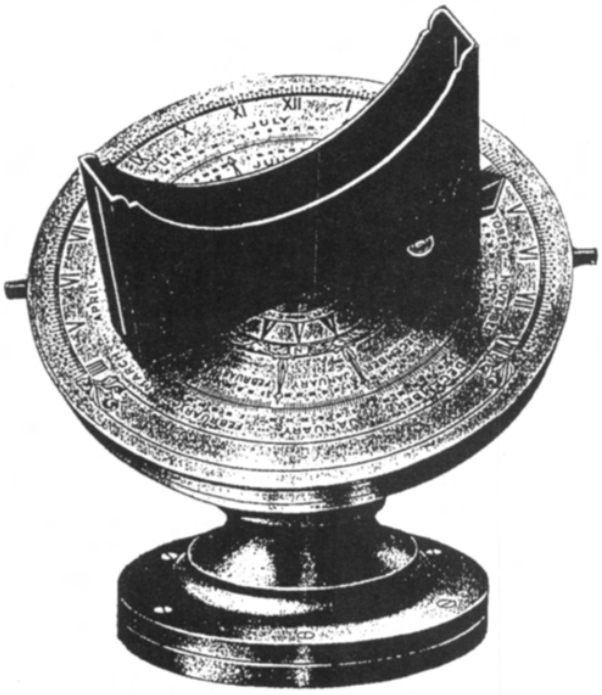
The other essential difference concerns the system to read off time. With Zwacht and Zwelf *the* (summer or winter) light passes through an aperture in one of the visors and falls as a spot of light on a vertical line engraved on the other. It works well and can distinguish a minute of time. However, when the light is hazy and the sunlight diffuses, it can be difficult to see the spot. With Sol, the problem has been overcome as the two visors have been assembled as a unit, forming - as it were - a peep box set on the top of the dial. The visors that form the short sides of the box have a small slot cut into them, and when the box (which is painted matt black internally to avoid reflections and further diffusions of the light), is carefully pointed at the sun, the light falls through both slots and the box remains almost dark. But a minute movement of the box results in a clear shaft of light appearing on one side or the other of the opposite slot, both slots being very narrow. This system enables the time to be resolved to an accuracy of a minute. Under the box an arrow indicates the hour and the minute. Repositioning to other longitudes can be achieved by fixing arrow and box in different angles to each other. Marinus Hagen pointed out to me that whereas with Zwacht and Zwelf the hour dial shifts along the index, with Sol-Stip this is just the opposite. That is why the hour numbers on Zwacht and Zwelf, seen from above, run anticlockwise (plate 2), whereas with Sol-Stip they run clockwise (plate 7). In my opinion the reading arrangement is better on Sol-Stip than on Zwacht and Zwelf.

I believe that after 1911 almost no Heliochronometers can have been sold. Though not many, some Sol Horometers will have come to the market. One sees them, not too often, at auctions etc. But in fact, in 1911/12 the market for sundials had disappeared with the need.

Furthermore, in 1914 the demand for bronze for the first world war would have been an additional reason as to why production would have been difficult. I think that production of bronze sundials came to a complete halt at that time. Also, I think it to be likely that no more than 200 Heliochronometers or Sol Horometers were produced. The figure is based on the high price of the product, and the fact that the production was stretched over the limited period of about six years. Also, the last published list of clients contained no more than 84 names. But I also believe that most of them have survived, despite the melting down of bronze in both world wars. The P & G dials are so solid that they can take the centuries in their stride. Well, with our acid rain, perhaps a century less, but never-the-less, all over the world, they will be there - inside or out - as a memento of (great) grandfather or the previous owner of the property on which they stand.

After 1918 the enterprise does not reappear. In 1922 a shop specimen was given or lent to the Science Museum in London, where it still stands to this day.[19] Enquiries at Companies House, London, reveal that the company was not taken over by another one; it just ceased trading and no

PLATE 7



more is ever heard of it.

William Pilkington disappears from view altogether. George Gibbs, who must have been much younger, remains active; we find his name often in the Preston Yearbooks under "G. J. Gibbs and Partners, Consulting Engineers". This firm was then established at the old address of Pilkington & Gibbs at 7, Lune Street. Gibbs himself moved from Brownedge, Bamber Bridge to The Firs, Preston Junction. The Preston Library think he remained in Preston until his death around 1960.

A day to come shows longer than a year that's gone

Here ends the story of the naturalised Dutch twins Zwacht and Zwelf, with little bit of Sol. But not without epilogue. First, my thanks to Marinus Hagen who - over the years - has been sending me any bit of information he finds about Pilkington & Gibbs.[20] He also kindly edited the text of the Dutch paper. Secondly to Anthony Eden, like me a member of the British Sundial Society, through whose Bulletin we learned of our mutual interest. He as been able to supply additional information, and - like he says - to arrange for the translation of the paper into English. The latter observation, however, is an understatement.

I would so much like to have a clearer picture of Pilkington Gibbs as persons. Where did they each come from originally? What happened to them after the first world war? How did they fare in their studies, their lives, their work? Are there descendants who could tell us more about their forbears? All this is important to trace from Holland, so it must rest for a time. Zwacht and Zwelf call out to the reader, in parting:

I stand amid ye summere flowere. To tell ye passing of the houre

* * * * *

NOTES AND ANNOTATIONS

1. Dr.J.G. van Cittert-Eymers and M.J.Hagen: "Zonnewijzers in Nederland" (Sundials in the Netherlands), p.207. Also "Register van aanvullingen" (Supplementary index), May 1989, p.8.
2. The P&G brochure contains examples of proverbs which could be engraved on the sundials to see them through life. This one is from Shakespeare's Sonnet LVII. Other mottos have been sprinkled through the text like confetti.
3. The name "Heliochronometer" is not original. E.g. Rohr (Die Sonnenuhr, p. 30) describes sundials with the same name which "bis gegen 1900" were in use by some French railway companies to set the right time on the station clocks. Plate 40 in this book shows that it concerns totally different equatorial sundials.
4. In 1907 the name was changed to Pilkington & Gibbs Ltd. In 1909 they moved to 24, Glovers Court, Preston.
5. Conforms his patent of 1911, hereafter to discuss.
6. St.J.H.Daniel, in the magazine *Clocks*, April-May 1991, Sundial Page.
7. Model found at L.J.Mennink, antiquary, of Utrecht and Amsterdam. It has a green patina and is inscribed "Negretti & Zambra", with no mention of Pilkington & Gibbs, though this might be concealed by the rather thick layer of verdigris on it. The firm of Negretti & Zambra, instrument dealers, was founded in London in 1850 and still exists.
8. Contribution from Dr. B. Spaander in the Dutch Sundial Bulletin, issue 1985, p.414/415.
9. This can only be understood if the reader knows that in Dutch the family name "Schroot" has the same spelling as "scrap metal".
10. We see: Zwelf also knew her Shakespeare. Romeo and Juliet, 2.2.
11. King George V (1865-1936, reigned 1910-1936).
12. This is an error. The author understood "Monasteriszcze" in the prospectus as "Monastery" and derived from this that Titus de Podoski was a monk, living in a monastery in Kiev, Russia. After publication of the paper in Dutch, it became clear that "Monasteriszcze" (now written as "Monastyrishche") is a reasonable large city (today), about 120 km ENE of Kiev, Ukraine.
13. Quote from P&G prospectus. Something must have been amiss on that globe.
14. One is in the Harris Museum in Preston. It was a present to the Preston Scientific Society from Gibbs, who was its Chairman. Another specimen was repaired by M. J. Hagen for his neighbour at that time, Ten Houte de Lange Jr.
15. Most prices in the P&G sales brochure are derived from the guinea, a former gold coin in England. The value was 21 shillings. The coin is no longer in use, but the unit was, at least, in spoken language, until recently still in use.
16. *Whittakers Almanac* 1992, after that price increased estimated at 10% p.a.
17. The Wireless Telegraph and Signal Company was founded in 1897 and renamed in 1900 as the Marconi Wireless Telegraph Company.
18. Today in the Preston Library.
19. Frank W.Cousins, *Sundials*, London 1969, Ed. John Baker, p.193.
20. This good friend, co-founder of the Dutch association and honorary vice-president of BSS, recently passed away. He can be characterised by the motto "What he does not know about sundials can be written in a very small booklet".

ALTITUDE DIALS AT EXTREME LATITUDES

COLIN THORNE

When I have a few idle moments (what are they?) I often amuse myself by designing dials for situations other than those relevant to myself. I have a liking for portable dials, ring dials and pillar dials in particular. In this article, the term "ring dial" refers only to the simple type, as described in my article in Bulletin 96.1,[1] and not the "universal" latitude adjustable type.

Both ring dials and pillar dials begin to have their limitations as we approach the tropics. Getting around these limitations provides an interesting exercise, particularly in the case of the pillar dial and, in the ring dial is also a partial solution to what I call "ring dial error", of which more anon.

Figure 1 shows these altitude charts as they would be drawn for a ring dial. For simplicity, I have drawn only the noon, 9am - 3pm and 6 o'clock lines. I have also drawn them for the full 12 months, rather than the more usual "folded over" double six month scale, as this clearly shows the two maximum altitude peaks which we get between the two tropics. Figure 1a is for the latitude of 23·5°N, the tropic of Cancer. This chart will be quite familiar to diallists in Britain and other places in the middle latitudes, although the 6 o'clock line only rises to 9·15°, as against the 18° on latitude 51°, and the noon line, of course, rises to the full 90°.

Figure 1b is drawn for the latitude of 15°N and shows the twin maximum altitude peaks as the sun passes over the observer's latitude on its way to the summer solstice and returns about 3 months later. There is still a small dip in the 9am - 3pm line and the 6 o'clock line reaches a maximum altitude of only 5·9°.

Figure 1c shows the chart constructed for use on the equator: latitude zero. The two maximum altitude peaks occur 6 months apart and are not at the solstices, but at the equinoxes, when the sun is directly overhead and crossing both our and the celestial equators. These two peaks are not exactly half a year apart. Due to the sun being further from the Earth between Aries and Libra, our (Northern) Spring/Summer is 7 days longer than the Autumn/Winter quarters (although it does not always seem that way on a wet Saturday in late February!). Aries to Libra is 186 days, whereas Libra to Aries is only 179. The (approximate) half degree difference on declination between, for example, Aries/Taurus and Pisces/Aries is also due to this inequality of the seasons, caused by the slight eccentricity of the Earth's orbit.

The sharp point in the noon line peak is notable. This is because the sun is passing directly overhead and its declination is at its maximum rate of change. The dial must suddenly be turned through 180° to observe the time. Figure 2 explains this graphically. This sharp peak rapidly changes to the more usual gentle curve as the sun's hour angle from noon increases.

If, on the Equator, the sun's position was plotted at

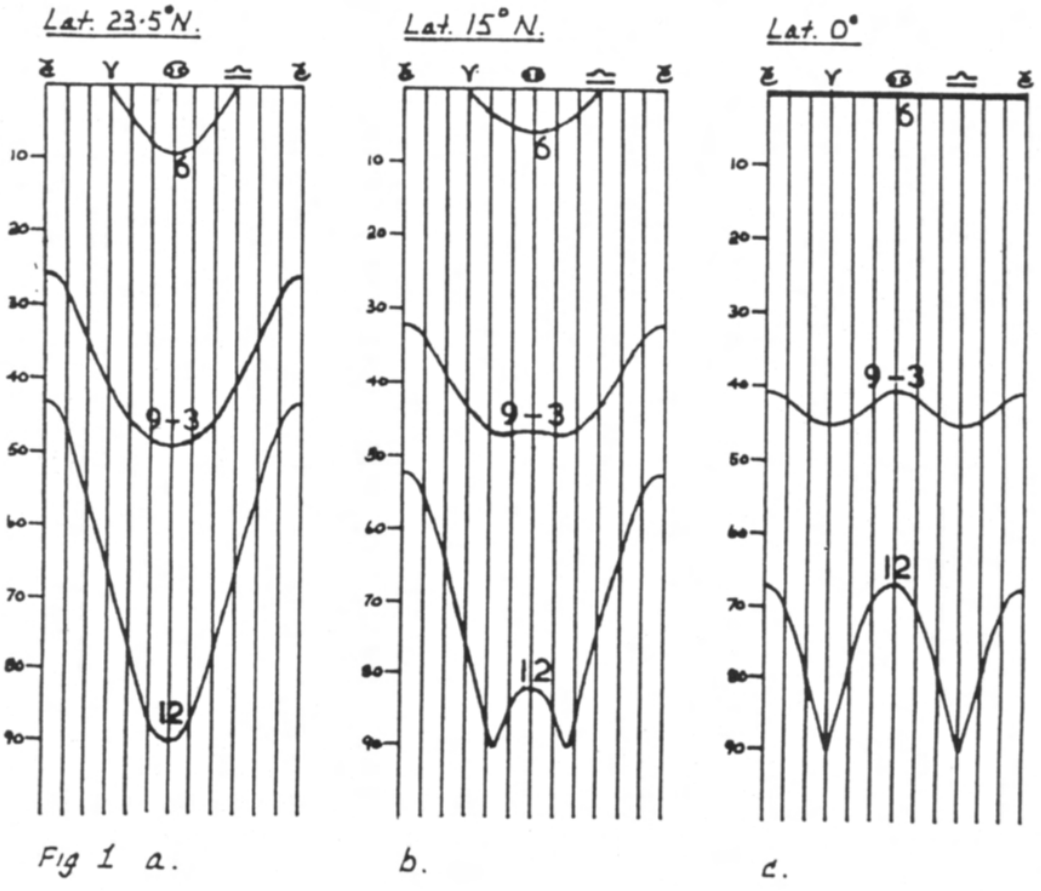


FIGURE 1: Typical Latitudes

noon throughout the year on an horizontal surface, from the tip of a vertical gnomon moved along an East-West date line, the result would be an almost perfect sine wave. This is also demonstrated in Figure 2.

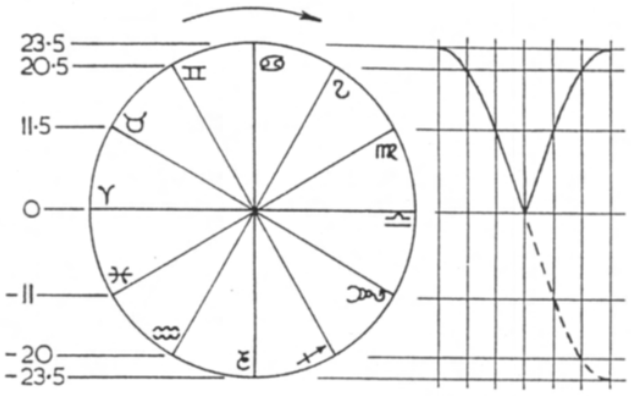


FIGURE 2

The other notable point about this chart is the 6 o'clock line. It appears on the horizon for the full 12 months. On the Equator every day is exactly 12 hours in length, as is graphically illustrated here. Just 1° North (or South) and the line will again appear for only 6 months, as we are used to seeing in the middle latitudes. It will, however, reach a maximum altitude of only 0.39°.

Another interesting point that emerges from all three altitude charts is the difference in the sun's mid-day altitudes throughout the year. In "our" latitudes the total mid-day variation in the sun's altitude between the winter and summer solstices is 47°; the sun's declination. Once you cross the tropic this starts to diminish. On latitude 15° it is reduced to 38.5°, that is, half the declination plus the latitude (23.5 + 15) and the maximum altitude is not at the solstice, but equally spaced either side of it. At the Equator, the difference is 23.5°, first North, then South. At this point the terms "summer" and "winter" seem to lose their meaning, as the sun is at its lowest mid-day altitude at both solstices.

As previously remarked, both ring and pillar dials have their limitations as the sun's maximum altitude approaches 90°. The ring dial will cast a sun spot when the sun is at 90°, but only directly beneath the gnomon hole. In our latitudes the ring is turned, on its vertical axis, slightly away from the sun, to move the sun spot towards the edge of the dial, when that is the position of the month of observation. Obviously, when the sun is directly overhead, no amount of turning the dial will move the sun spot from its position vertically below the gnomon hole, so a bit of lateral thinking is required; literally.

The first solution to this problem is to note where the sun spot is and imagine an horizontal line from that point to the date of observation. This will give you the correct time, but is open to error of interpretation.

The most obvious solution is to have, instead of a single gnomon hole, a narrow slot across the dial at that position and as long as the width of the dial will allow. This will give an horizontal line of sunlight across the scale on the dial and for ease of observation is probably the ideal solution. However, it would seriously weaken the construction of the dial at this point unless the ring were given extra width here and, for me, that would destroy both the visual and tactile beauty of the ring dial.

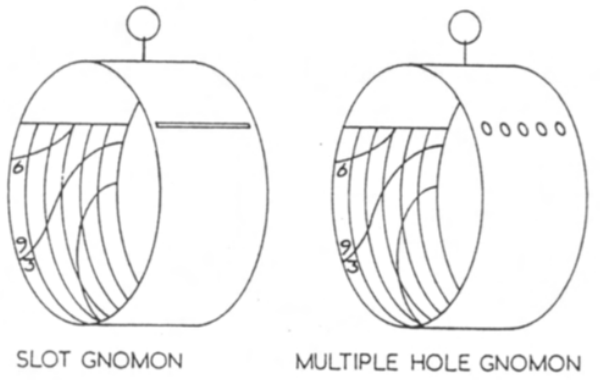


FIGURE 3

Figure 3 shows this solution and also a compromise which I would be tempted to use myself. This is a line of gnomon holes across the width of the dial, probably, but not necessarily, coinciding with the spacing of the months on the scale. It would thus be easy to imagine the required solid line of sunlight.

Pillar dials demand a completely different approach. They almost have to be re-invented. The tangent of 90° is infinity and, however tall you make your pillar, it will never tell you the Time of Tropical noon. The pillar has to assume the shape of a cone. Figure 4 shows this solution.

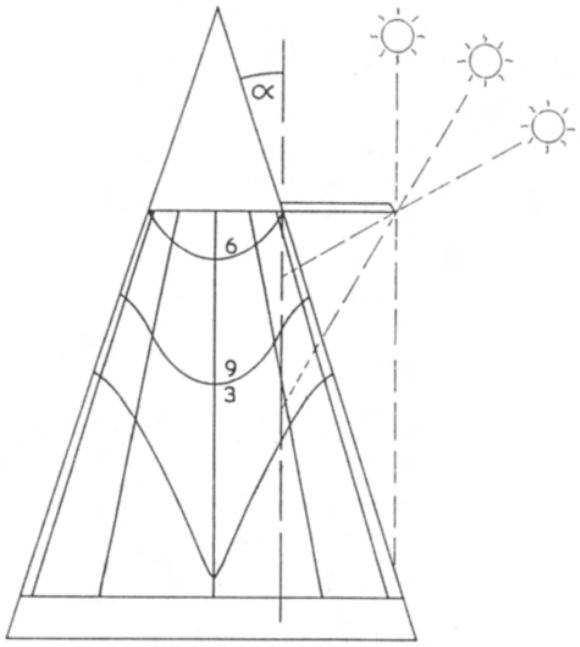


FIGURE 4: Cone Pillar Dial for use on the Equator

The cone has an inclined angle of 36°. This was an arbitrary choice, but somewhere between 30° and 40° would seem to give a reasonable shape to the cone and not unreasonable length to either the gnomon or the scale. The angle one requires is half the cone angle (α), i.e., the angle of the cone wall to the vertical; in this case 18°.

On a conventional pillar dial the height of the hour lines on the scale are determined from the sun's altitude (A) by the simple formula G·Tan A; G being the length of the gnomon, this will obviously not work here, as the scale is

not at a right angle to the gnomon, neither is it vertical. Therefore (in my best schoolboy trig)

$$H = G (\sin \alpha + \tan (A - \alpha) \cos \alpha)$$

where H = Height of hour line on the scale.
G = Gnomon length
α = Half cone angle
A = Altitude of sun.

It is obviously easier to draw the scale of the hours on a flat piece of paper than on the side of a cone. This flat sheet is a sector with an angle of $\pi \cdot$ cone angle. For a 36° cone this is 113·1°. For a demonstration model the scale can be drawn on card and the two mating edges joined with sticky tape or a few staples. For something more durable the paper scale can be glued to a solid wooden cone. Figure 5 shows such a scale for latitude zero, drawn for the full 12 month period.

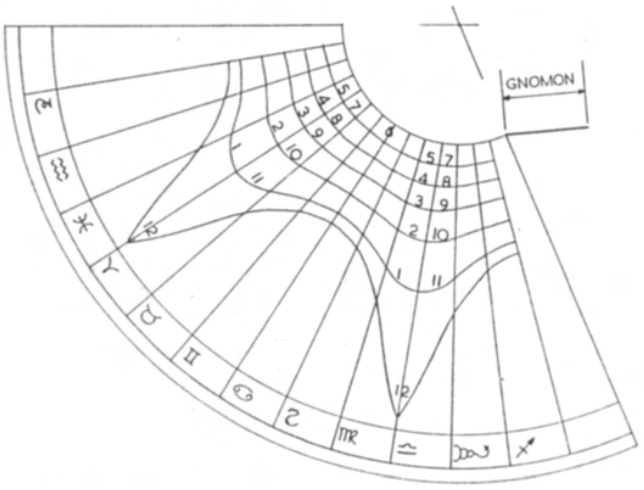


FIGURE 5: Cone Dial Scale for Latitude 0°. Cone angle 36°

The other extreme of latitude is of course the Polar regions. Figure 6a is an altitude chart for 66·5° North, the Polar circle. It clearly shows that at mid-winter, the sun is only visible for a matter of minutes. Only half the sun's disc should appear above the horizon, but atmospheric refraction[2] will enable the whole disc to be seen briefly. At mid-summer there are a full 24 hours of sunlight, refraction again ensuring that the full disc is still seen at midnight. The maximum altitude the sun will achieve is 47°, equal to its full declination.

Figure 6b shows the chart for latitude 75° North. For approximately 3 months in mid-winter the sun never rises and, for the same period in mid-summer, never sets. The sun's maximum altitude is half its declination (23·5°) plus the co-latitude (15°) a total of 38·5°.

Figure 6c is a dial for the North Pole. There is only one line because, when it is visible, the sun remains at constant altitude all day, give or take the average daily change in declination of approximately one quarter of a degree. Not much use for telling the time; but on the other hand you have a useful sun-calendar! If the gnomon is moved around until the tip of its vertical shadow falls on the line, you will have a fair approximation of the date. If the dial had a sufficiently wide scale, I would imagine it could be quite accurate.

Although the hour lines are quite close together, making reading difficult, pillar and ring dials need no modification to operate in the Polar circles, apart from allowing for ring dial error.

RING DIAL ERROR

This is a potential error inherent in the simple ring dial as normally designed and used. Those who have made the little dial in my previous article[1] need not worry too much about it, as in this small dial it is only really noticeable for a couple of hours either side of mid-day in Gemini and Cancer, and can be negated by careful observation.

Plotting the scale on the dial by using only the sun's altitude is correct. It is when we use the dial, which has one centrally placed gnomon hole, that the error arises.

The gnomon hole is placed central to the width of the dial. The normal "double 6 month" scale has the equinox dates also placed in the centre of the dial's width. There is thus no error of reading at these dates. There is also no error when the sun is on the horizon, at any time of the year, as the sun is then at right angles to the vertical axis around which we deflect, or rotate the dial. It is when the sun has some altitude and we deflect the dial slightly, to place the sun spot on one of the outer date bands, that the

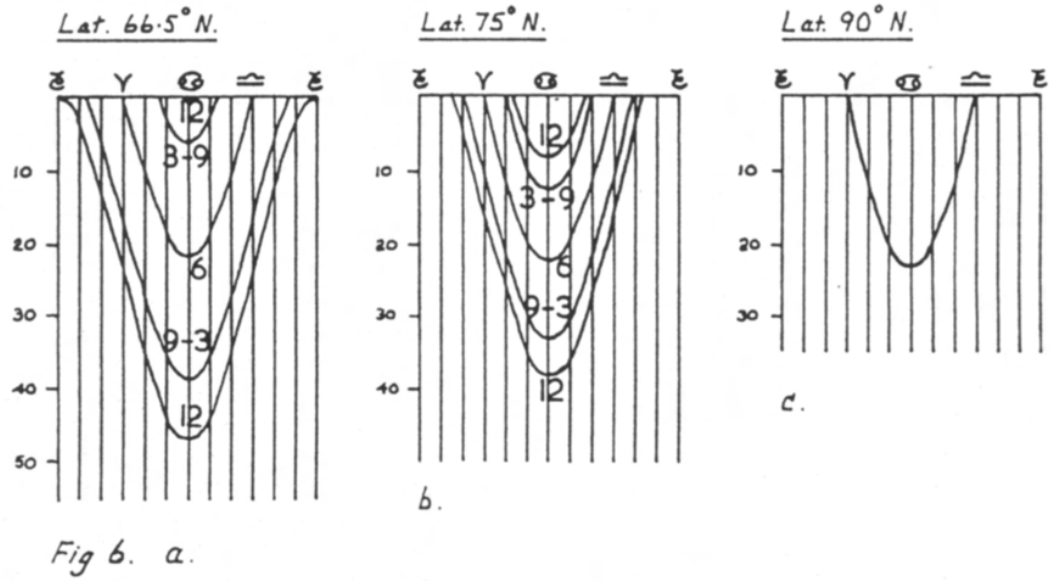


Fig 6. a.

FIGURE 6: Polar Latitudes

error, caused by parallax, occurs.

The phenomenon is simple to understand. When the sun has some altitude, it is no longer at a right angle to the vertical axis around which we deflect the dial; and when the dial is deflected, the sun is effectively looking across an ellipse. However, the major axis of the ellipse no longer coincides with the vertical axis of the dial, as it does with the sun on the horizon when, as already noted, there is no error. Thus, several angles between "fixed" points have changed.

From the sun's viewpoint, the outer month column on the scale has moved upwards relative to the gnomon hole, and the sunbeam has to travel just a little bit further to cast its spot on the scale. The result of these small changes in geometry is the sun spot falling lower on the scale, in proportion to the deflection of the dial and the sun's altitude. The dial will read fast in the mornings and slow in the afternoons. At noon the sun spot will be beyond the noon line on the scale.

I noticed this error with the first ring dial I made, a few years ago. At first I questioned my calculations and draughtsmanship but then, by viewing the dial from the sun's viewpoint, realised what was happening. The dial was a fairly large model made from card and was about 15cm in diameter. It had a wide scale relative to its diameter. Both these things accentuate the error. Thereafter I resolved to make only small ring dials (they are poke dials after all) and keep the width to no more than a third of the diameter, in order to minimise the error.

I could find no reference to this error in my dialling books. I did not even try to work out an equation for it; it looked far too complicated! After all, if this simple dial was good enough for Shakespeare it was certainly good enough for me. I thought no more about it. However, the solution eventually came almost by chance.

Following the appearance of my Ring Dial article in Bulletin 96.1, I received a very welcome and informative letter from Fer de Vries, of the Dutch Sundial Society (De Zonnewijzerkring). He enclosed a photocopy of an article he had published in their Bulletin in 1983, plus a handwritten translation in English. I acknowledge his generosity in allowing me to draw upon this article for much of what follows.

The article explains the simple ring dial and then goes on to describe ring dials with gnomon holes which are movable, according to the date. This is an interesting concept, as the scale becomes more open and easier to read. It leads me to the idea of a gnomon hole which moves in a diagonal line across the width of the dial, high over Cancer and low over Capricorn. It could eliminate ring dial error.

There follows some comments on this perceived error and then - the formula. It was originally published in German, in 1925.[3]

$$\gamma = \frac{d}{\sin h} \cdot \mathrm{Cos}\,(h - \alpha + P)\sqrt{\sin\,(2h + P)\cdot \sin P}$$

γ = offset of line of dates
P = angle of correction
d = internal diameter of ring
h = the sun's altitude
α = angle of gnomon hole (to the horizontal from centre of ring)

This formula does not approach the problem from the direction we require, we wish to know P, but a computer or programmable calculator with a 'solve' function will very

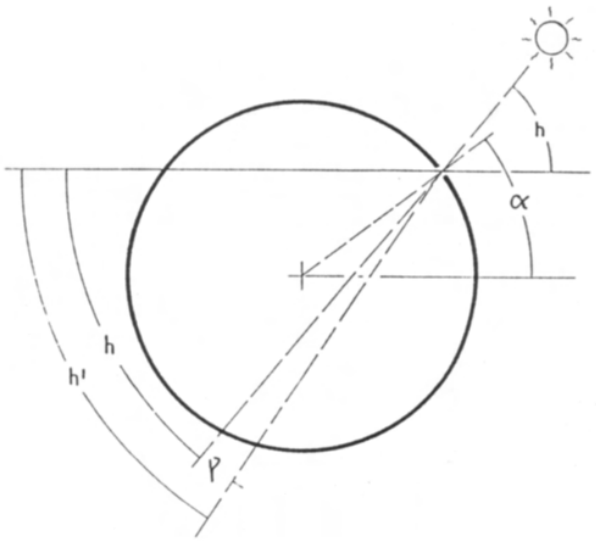


FIGURE 7

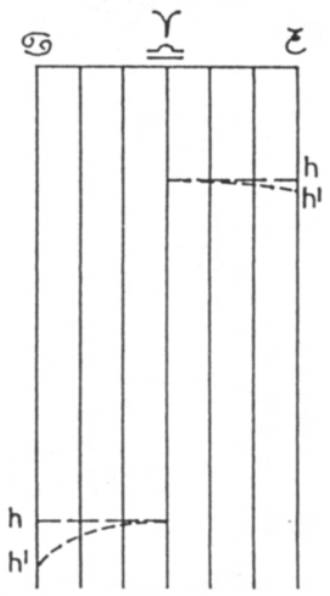


FIGURE 8: Relative Ring Dial Error at the Two Solstices (Not to Scale)

quickly tell us what we want to know. The answer is a small angle which has to be added to the sun's altitude when plotting the hour lines on the scale. Thus, the corrected hour line position, h', = h + P (see figures 7 and 8).

This necessary correction increases with both altitude and scale offset and can be quite significant on a large dial with a wide scale. If we already have a dial which does not incorporate this correction, then how do we obtain the correct time?

First, we can simply ignore it! If you have a small dial, of no more than 5 or 6cm diameter, with a scale of no more than a third of the dial's diameter in width, the error will only be noticeable around midday in midsummer. Altitude dials are in any case difficult to read accurately around midday at any time of the year. On a small dial the error will probably be less than the diameter of the sun spot.

Secondly, we can place the sun spot on the equinox line and imagine an horizontal line from that point to the date of

observation. This will give us the correct time as there is no error at the equinoxes but, as previously noted, is open to errors of observation or interpretation (but probably no worse than the error itself).

Thirdly, we can put in more gnomon holes, or a gnomon slot, as shown in Figure 3. Putting a total of just three gnomon holes would probably be sufficient as the amount of offset to put the nearest sun spot on the required date would be quite small and the error minimal. However, do not even THINK of doing this to a dial which can, however loosely, be thought of as antique, or even just "old".

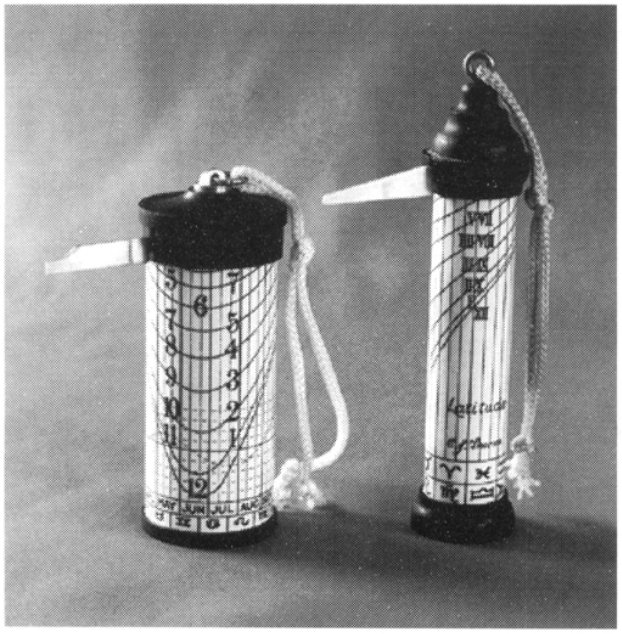


FIGURE 9: Two small pillar, or "Shepherd's Dials" for Latitude 51°N. The taller one is about 9cm high. The shorter one has a full 12 months scale incorporating an equation of time scale at the bottom. Thus the time and equation adjustment can be read simultaneously. The gnomons fold down inside the body of the dials when not in use.

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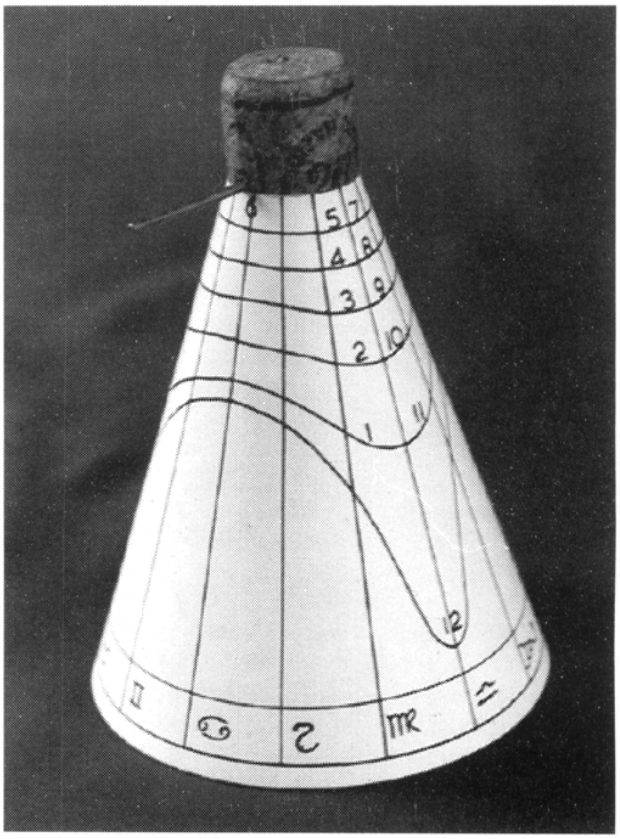

FIGURE 10: A 'cardboard and cork' model of a cone pillar dial for use on the equator.
(Note: this model is inaccurate insofar as the noon line should have a much more pronounced point at the equinox dates. See Figures 2 and 5.)

* * * * * * * * * * *

WALKER, FECIT, DUBLIN
(Continued from page 37)

William Walker	15 Temple Bar, Dublin 1775-1790
William Walker	17 Temple Bar, Dublin 1791-1804
William Walker & Son	17 Temple Bar, Dublin 1805-1819
W. Walker	17 Temple Bar, Dublin 1820-1826

There was also a Frederick Walker of Trinity Place and Clarendon Street (1832-1850), and a George Walker of Fade Street (1841-1848). They may all be related, but my money is on the Alker dynasty of Temple Bar. It is just a hunch, but I feel that the dial was made during that period. I think the later Walkers would have used their Christian name, or initial, when signing their work, to avoid confusion with other members of the same family. The big question now was: how did the dial made in Dublin, for the latitude of Dublin, end up in a flower bed in the wilds of North Devon, two hundred years later?

Later, when I returned the dial, I decided I must get to the bottom of this little mystery. My client's name actually turned out to be of Scottish origin, not Irish, in any case the dial belonged to the lady, so my first theory foundered. It seems that the sundial was given to her by her grandfather, who was an antiques dealer. All very mundane, but then she mentioned her other grandfather worked in Ireland from about 1910 until the time of the "troubles" in the early twenties. I would like to think that the dial was in the garden of his residence and on leaving Dublin, he brought the dial back to England as a memento. However I have to acknowledge that the "antique dealer" story is the correct one, if for no other reason than if it isn't, I might be accused of handling stolen property!

Like all good stories, this one has the appropriate happy ending. The sundial is now firmly mounted on its plinth, with sub-base interposed to give the required 2° recline to allow for the difference in latitude between North Devon and Dublin. The sundial is now doing its work today, for which it was made some two hundred years ago.

SUNDIALS AT THE ROYAL BOTANICS GARDENS, KEW

ALLAN A. MILLS

Three sundials are associated with Kew Gardens: a horizontal dial by Thomas Tompion, an armillary sphere by Brookbrae, and an unusual cruciform design by C.V. Boys. To explain the commemorative aspect of the first of these it is necessary to begin with an astronomical digression.

ABERRATION AND NUTATION

James Bradley (1693-1762)[1] was appointed the third Astronomer Royal in 1742, but is chiefly remembered for work carried out well before that time. As a young astronomer Bradley was sufficiently well thought of to be appointed Savilian Professor of Astronomy at Oxford in 1721, and set himself the problem of determining whether any star could be observed to have a slight motion with respect to another star, or to a fixed point such as the celestial pole, in the course of time ('proper motion'). In particular, it the Earth is indeed orbiting the Sun annually - as hypothesized by Copernicus but not proven - then this motion should be reflected as a cyclic displacement of all stars during the course of the year ('stellar parallax'). It was obvious that these motions, if indeed existing, must be very small, so Bradley realised that a telescope combining great stability with delicate and precisely repeatable measuring ability was essential. It was known that this was best achieved by suspending the simple refracting telescope of the period in a near-vertical position, a pivot near the top of the tube being embedded in a N-S wall. The entire telescope could then be moved in the plane of the meridian with a fine screw bearing on its lower end, contact being maintained by a cord and weight. Changes in the declination of a star centred upon eyepiece crosshairs could thus be accurately measured on a vernier scale against a zero established by a plumb line. Known as a 'zenith sector' this instrument obviated problems due to sagging and atmospheric refraction.

At first, Bradley worked in cooperation with his friend Samuel Molyneux, a wealthy amateur astronomer who had erected a 24½ft radius zenith sector for this purpose at his house in Kew.[2] Here the latitude was such that the star γ Draconis passed near the zenith, and was bright enough to be clearly seen and measured as it crossed the meridian. Careful determinations begun in 1725 showed that a cyclic displacement in declination occurred over the year, describing an ellipse with a maximum amplitude of 40 arcseconds. Molyneux died in 1728, but Bradley continued his programme of regular observations with a 12½ft zenith sector erected in his own house at Wanstead. (This instrument, by Graham, is now preserved at the Old Royal Observatory, Greenwich.) He established that this motion was not the long-sought stellar parallax. Instead, it represented the fact that any telescope must be pointed along the resultant of the velocity of light from a given star compounded with the 30 km/sec velocity of the Earth in its orbit (Figure 1). This very small angle, much exaggerated in the diagram, was an important piece of evidence in establishing the Copernican theory, and proving that the velocity of light was not infinite but around 10,000 times

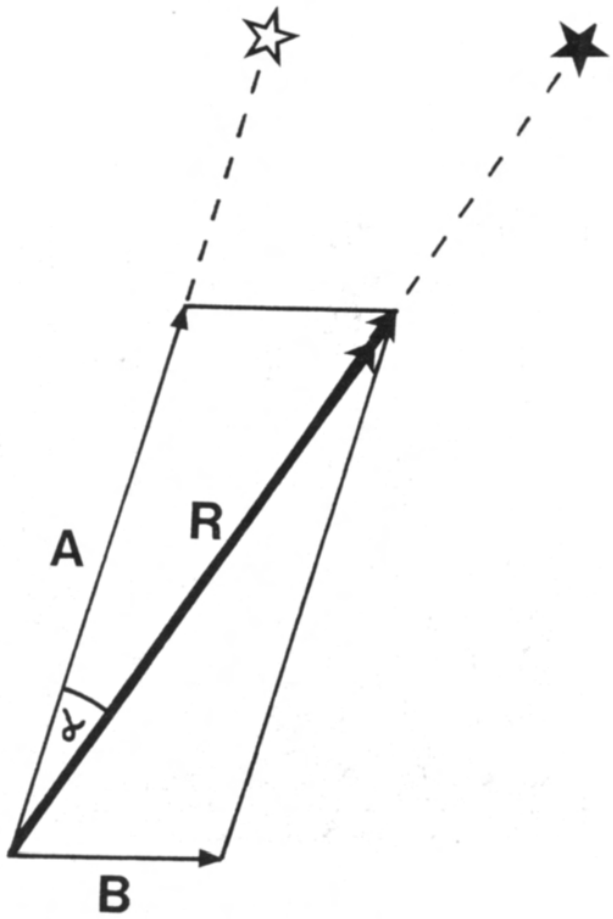

FIGURE 1: The 'aberration of light'. The direction of A gives the true direction of a star, and its length represents the velocity of light. B represents the velocity of Earth in its orbit at the instant of observation. R is their resultant, and α indicates (greatly exaggerated) the apparent displacement of the star

that of the Earth in its orbit. Bradley referred to one half of the maximum displacement (which is the same for all stars at a modern value of 20.47 arcseconds) as the 'constant of aberration' - an unfortunate choice, for it is continually confused with the aberrations of lenses.

Bradley's meticulous and truthful nature is further illustrated by his admission that, over 20 years of observations, he could not always get his aberration ellipses to close. The discrepancy was very small - less than 2 arcseconds - but his reward for not glossing over it was the realisation that the Earth's axis is continually executing a tiny 18 year wobble superimposed upon the 26,000 year precessional orbit at 23½° to the ecliptic pole. This 'nodding' he called 'nutation': it is due to the perturbing effect of the Moon.

THE TOMPION DIAL

The original Molyneux home (the 'old timber house', where the zenith sector was attached to the interior

brickwork chimneys) was replaced by Frederick, Prince of Wales, with his own much more splendid White House. Eventually though, this too was demolished and the estate incorporated into the Royal Botanic Gardens at Kew.[3,4] Sometime in the 19th century (perhaps around 1825, the centenary of the initial observations?) Professor S. P. Rigaud - the editor of Bradley's collected works[2] - suggested that the latter's early triumph of quantitative astronomical observation should be commemorated. The spacious lawn in front of Kew Palace covered the site of the Molyneux house, so a sundial was chosen as an appropriate marker.

To provide one, William IV was persuaded to agree to the splitting of a fine pair of horizontal dials that flanked the stairs to the Privy Garden at Hampton Court Palace. These beautiful dials were by Thomas Tompion,[5] being companion pieces to two of his equation clocks. One was a double-horizontal dial[6] incorporating a plain and sturdy gnomon (Figure 2), whilst that of its 'standard' companion was pierced with exquisite scrollwork (Figure 3). Both dial-plates are constructed of sheet brass over a wooden core.[7] Now very weathered and worn, they incorporate tables of numerical corrections for the equation of time and are signed 'Tho: Tompion London'. The identical pedestals in white Portland stone are also of the finest craftsmanship, taking the form of an octagonal baluster with William III's cypher - W. R. entwined and reversed - contained in an oval panel repeated on four sides.[8] They may well have been designed in Christopher Wren's drawing office.[5]

In 1832 the entire sundial shown in Figure 3 was taken the short distance from Hampton Court to Kew, and erected near the middle of Kew Palace lawn upon a hideous pile of four square steps surrounded by an iron railing.[9] It was obviously intended that no commoner should look upon this dial! In 1930 the steps and railings were replaced by a low octagonal plinth in Portland stone, incorporating an explanatory tablet that reads:

On this spot
in 1725
THE REV. JAMES BRADLEY
made the first observations
which led to his two great discoveries
The aberration of light and
the nutation of the Earth's axis.
The telescope which he used
had been erected by Samuel Molyneux Esq.
in a house which afterwards became
a royal residence,
and was taken down in 1803.
To perpetuate the memory of
so important a station
this dial was placed on it in 1832
by command of
HIS MOST GRACIOUS MAJESTY
KING WILLIAM THE FOURTH

FIGURE 2: The undisturbed Tompion dial on the terrace of the Privy Garden, Hampton Court Palace

FIGURE 3: The Tompion dial that was taken to Kew in 1832, and returned to Hampton Court in 1995. Dia of dial 1ft 8in, height of pedestal 3ft 5ins

FIGURE 4: Dial and pedestal (both modern replicas) on the lawn outside Kew Palace

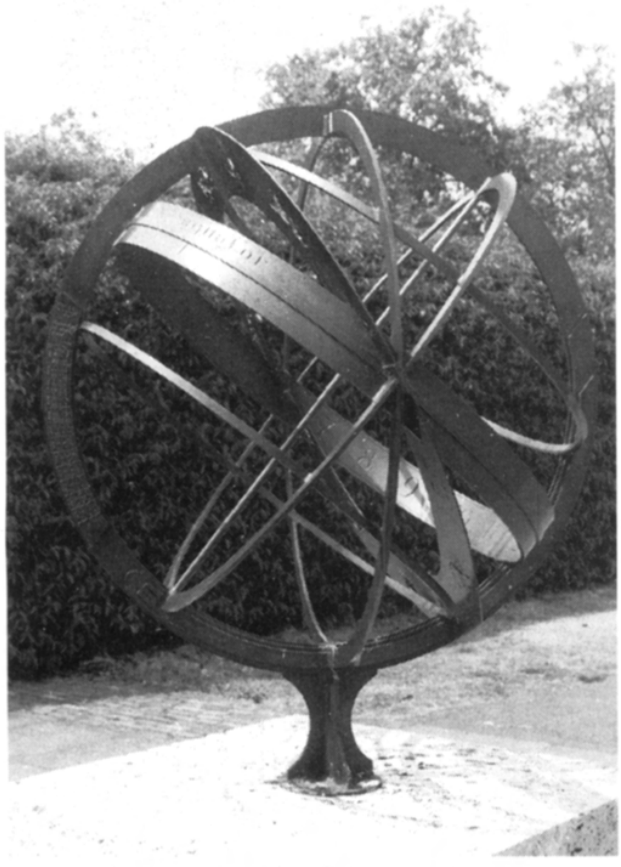

FIGURE 5: Bronze Armillary Dial by Brookbrae near Kew Palace

In 1963 the Tompion dials was replaced by a replica made to commemorate a visit of H.M. Queen Elizabeth II on the occasion of the Bicentenary of the Royal Botanic Gardens in 1959. After a sojourn on display inside Kew Palace, the original dial was returned to Hampton Court. The original pedestal followed in 1995, and the reunited pair are now again to be seen on the Privy Garden terrace. The dial and pedestal currently at Kew (Figure 4) are accurate replicas, although obviously much less weathered than the originals.

THE ARMILLARY SPHERE

Near an entrance to Queen Caroline's garden at what was originally the front of Kew Palace will be found a fine bronze armillary dial (Figure 5). Designed by Edwin Russell and made by Joanna Migdal, it was supplied by Brookbrae Ltd in 1985. The mode of operation is that of the equatorial dial, the shadow of a rod marking the Earth's spin axis being thrown upon the calibrated equatorial band. Unfortunately it appears to have been damaged, becoming displaced in azimuth and therefore reading about ½ hour in error after taking account of the equation of time.

THE CRUCIFORM DIAL

The most unusual sundial in the Kew inventory is a cruciform instrument designed by Sir Charles Vernon Boys. An inventive and versatile scientist, Boys is perhaps best remembered for the production of extremely fine silica fibre. The minute, but nevertheless highly reproducible, torque associated with this as a suspension made possible the development of highly sensitive versions of a number of scientific instruments.

The Boys sundial is best known from its inclusion in a much-quoted book by F.W. Cousins.[10] This author's illustration is reproduced here as Figure 6. The engraved

FIGURE 6: Boxed Maltese Cross Dial by C.V. Boys. In bronze, the basic unit is a 3" cube. (From a photograph taken in 1929 and reproduced by Cousins[10])

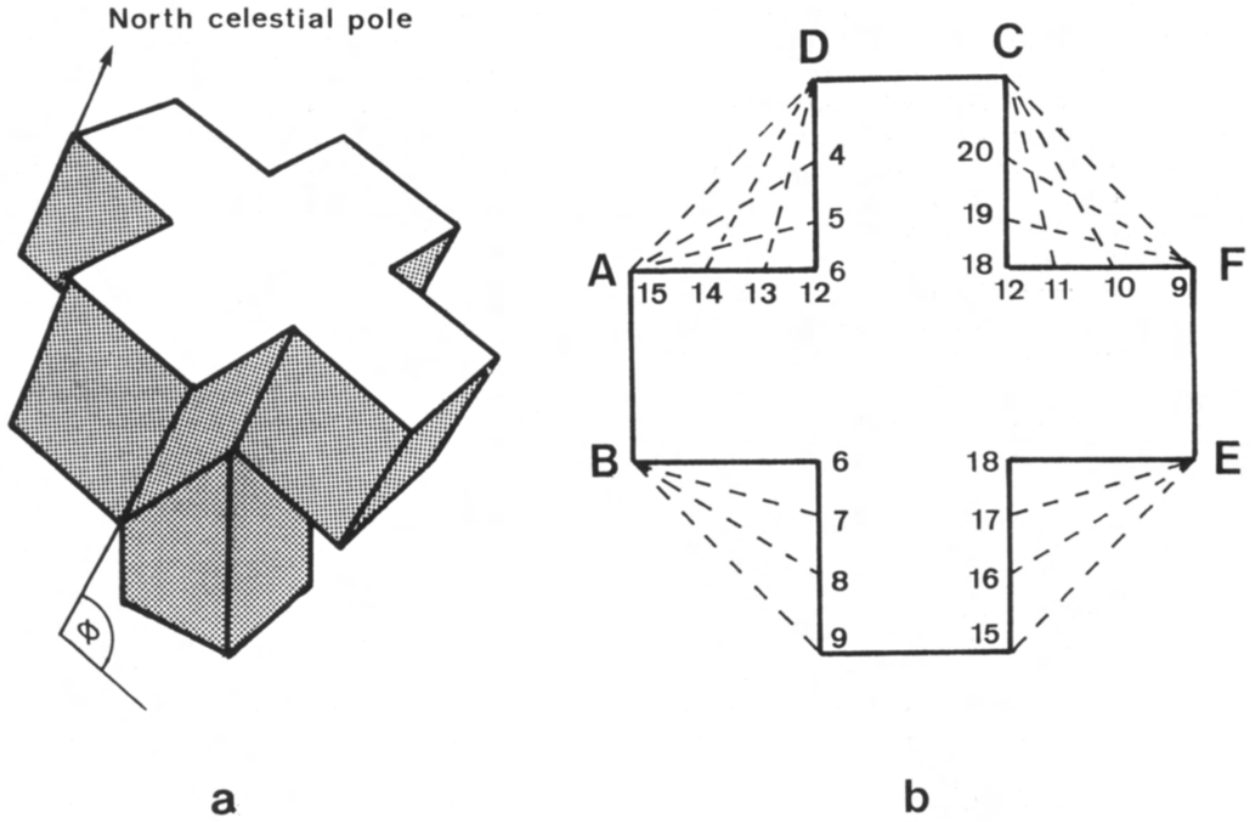

FIGURE 7: Principle of the cross dial. Edges act as a gnomons in the sequence A to F, the hours from 4 - 20 being marked every 15°

panel on the integral supporting column carries the inscription:

THIS DIAL, DESIGNED,
CONSTRUCTED & ERECTED BY
C.V. BOYS, F.R.S.
WAS PRESENTED BY HIM TO
THE ROYAL BOTANIC
GARDENS, KEW.

ENGRAVED BY H. ROUTLEDGE.

THE STONE COLUMN TAKEN
FROM OLD KEW BRIDGE
WAS PRESENTED BY
GEORGE HUBBARD, F.S.A.

THE CAPITAL & BASE
WERE SUPPLIED BY
H. M. OFFICE OF WORKS

A. W. HILL, F.R.S. DIRECTOR
- 1929 -

This text represents all that is known of the antecedents of the dial, contemporary articles[11] simply reproducing these facts. Old Kew Bridge, the balustrade of which is stated to be the source of the pedestal, was replaced in 1903.

Technically a 'boxed Maltese cross', this instrument falls within the family of cruciform dials. A few permanent versions (some with a longer upright) are known,[12,13] whilst some portable examples ('crucifix dials') are in the British Museum[14] and the Victoria and Albert Museum.[15]

The principle is described by Leadbetter[16] and repeated by Cousins[10] and Waugh.[17] It is simple enough once it is realised that the face of the cross must point at the celestial pole (Figure 7a). Various edges can then act as conventional sloping gnomons, casting shadows upon adjacent arms to register the time on non-linear tangent

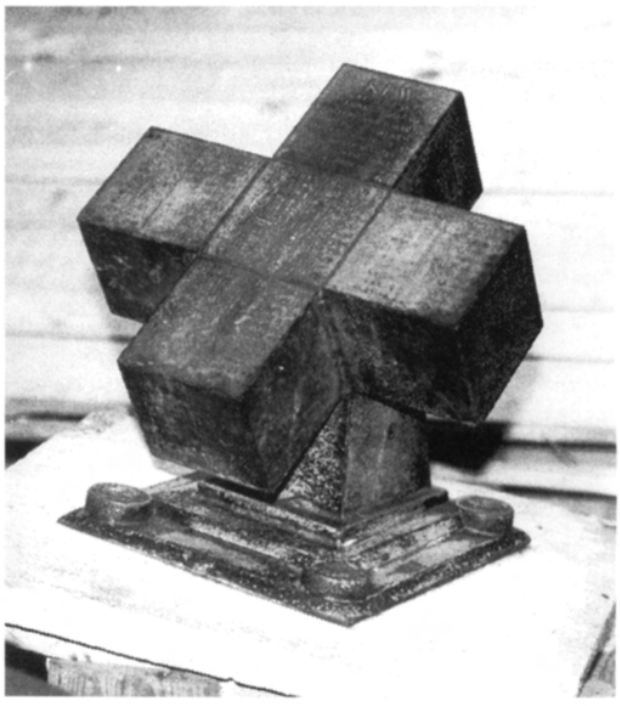

FIGURE 8: The Boys Dial, currently in store at Kew

scales (Figure 6 and 7b). The Boys dial carries equation of time corrections on its front face.

Sadly, it is not possible to view this classic dial at the present time. It is rather small - only some 9" across - necessitating a carefully chosen and protected site. Originally erected in the medicinal garden in the grounds of Cambridge Cottage, it was removed in the early 1980s before the Princess of Wales greenhouse was constructed. Now in store, the author was courteously allowed to examine and photograph the instrument in August 1996 (Figure 8). The only defect is that the balustrade used as a pedestal is broken at its narrowest section. (The skewed mounting on the top plinth existed in 1929, being apparent in Figure 6.) Unfortunately, financial considerations currently prevent restoration and re-siting of this unusual dial.

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SUNDIALS ON THE INTERNET

PIERS NICHOLSON

Members will be glad to know that the Council has decided to co-operate with an established World Wide Web site "Sundials on the Internet". The educational potential of a high-quality Internet sundial site is obviously very great, and the Society also benefits from having a major presence on the leading sundial site on the Internet. This gained us our first new member from the Internet in the first week, and we hope there will be many others!

The address (URL) of the British Sundial Society home page is: www.sundials.co.uk/bsshome.htm

Most of us have heard a lot about the Internet, but a much smaller number have actually accessed it. Main public libraries are now offering Internet access, so it's well worth a phone call to find out where you can get access.

When you get there, type in "www.sundials.co.uk" and you will get the home page of "Sundials on the Internet". This has a yellow background with blue lettering. However, some of the lettering is in red and underlined, to indicate that you can "click" on it, and move to another page. And there's a great wealth of other pages to move to. There are information pages, on topics like types of sundials, the Equation of Time, and how to set up a horizontal sundial. There is a complete Index for the last four years of the BSS Bulletin, with an automatic search facility so that you can immediately find an article by a given author or about a given place.

There is a page of "Books in Print" and one on all the national sundial societies, and there are links to many other Internet pages, including all the pictures of sundials we can find on the Internet. We have also just started putting up lists of "favourite sundials" to help visitors find sundials when they are away from home: so far we have lists for Sussex, Suffolk, Paris, Queyras and the Pays du Buech in the Hautes Alpes, and Toronto. Cornwall, Oxford, and Cambridge will probably be the next.

This is something every member of the Society can help with. If you have a list of three to eight sundials which you would show to a visiting member of the Society, please write them down, with sufficient directions for a visitor to find them, and send them to Piers Nicholson at PO Box 292, Epsom, KT17 4YP.

"Sundials on the Internet" has been a truly international enterprise. Many sundial enthusiasts round the world have made contributions to it, by writing material, making suggestions, or translating pages. There are now pages in French, German, and Spanish, and there is a complete "mirror site" with every page translated into Dutch. The British Sundial Society is glad to support this interesting new venture, and looks forward both to the tangible results of new members and to the intangibles of helping people all over the world to develop their interest in sundials.

The statistics are staggering. "Sundials on the Internet" started in April, 1996. We started a click counter on the home page on 15th June, 1996, and today (15th December) we had the 3,000th visitor. Many visitors now enter the site on one of the information pages; we now have around 1,000 visitors every month, and on average each one visits 7 separate pages. Internet traffic is growing very rapidly, so there is no doubt that this is a major new resource for "spreading the word" about sundials, and thus contributing to the objectives of our society.

RESTORATION OF AN 18TH CENTURY VERTICAL SUNDIAL

ALAN SMITH

The sundial at the Hardshaw Friends Meeting House in St Helens, Merseyside, had reached an extremely dilapidated condition by the summer of 1994. A representative of the Society of Friends noticed an article about the BSS in a newspaper and contacted our Hon. Secretary for assistance and advice in dealing with the problem of the dial, a problem which had become more acute because of the recent cleaning of the front of the Meeting House, where the sundial occupied a prominent place above the central door (Figure 1). David Young passed on the request for help to me, and I visited the site in the autumn of 1994. It was not only a pleasure to feel that the BSS could help the owners of this dial, but it was also of great interest to discover a building first erected in the 17th century, previously unknown to me, flanked by Victorian and later buildings, in the industrial town of St Helens which is notable for its chemical and glass manufactures. The adjacent structures were not present when the dial was erected and now only allow the dial to be used for two or three hours before and after noon, but this was a minor problem compared with the decayed state of the dial itself! (Figure 2.)

FIGURE 1: The Hardshaw Friends Meeting House, St Helens, Merseyside

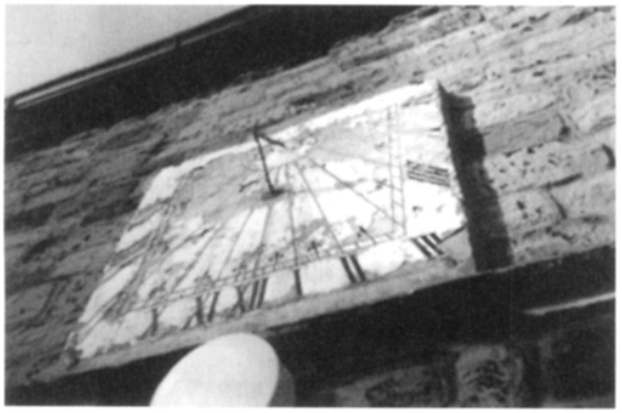


FIGURE 2: The vertical dial above the door of the Meeting House, in the decayed state it reached by 1994

The dial plate is of stone, about 1 metre square, about 6cm thick and weighing about 50kg. The stone is a sedimentary millstone or gritstone acquired by the Meeting House, according to early records, on 17 March 1692, but no detail survives about where it came from, though on 12 April 1692 an entry in the records reads: "The Dyall stone is brought to Alexander Chorley to whom it is left to be finished as he sees meet". Clearly the dial plate had been removed and replaced several times over the centuries, and one problem was that it carried the date 1753, some sixty years after the date of its supposed installation. Even this date of 1753 appeared somewhat suspect because Nikolaus Pevsner in his book *The Buildings of England: South Lancashire* (1969) says that the St Helens Meeting House was rebuilt in 1763 "(not 1753 as the sundial says)". Whether or not the stone dial plate is the same as the one mentioned in 1692, and whether or not the date 1753 is correct (or the date 1774, the ghost image of which came to light during restoration) are matters for the historians to argue about, the fact remained that it badly needed attention in 1994! Not only were the plate and markings in severe decay, but the gnomon also was not original, was badly set, broken and of incorrect length.

The first part of the job was to make a detailed study of the dial, so it was dismounted from the wall and taken to my workshop in the spring of 1995. This work was carried out by my friend and colleague Philip Irvine, a specialist in church clock and architectural restoration, well used to handling heavy weights from high walls! Examination showed that over the years the dial had been repainted at least five times, and during each repainting the accuracy of the hour lines, half-hour fleurs-de-lys and numerals had suffered. It is clear how this had happened. At each repainting a tracing must have been made before the background was painted, then the traced lines were replaced on the newly painted ground. On carefully removing each successive layer of paint it was clear that much deviation had taken place, and in parts the inaccuracy was in the order of 5 to 10mm compared with the original painting on the stone surface itself (Figure 3). There was, at this stage, no doubt that *all* the repainting had to go, a task which in many parts was easy as the paint flaked away, but other areas were very stubborn. At least the original lines of the dial were revealed and the mathematical accuracy of the markings could be determined (Figure 4).

In checking the dial it was found that the setting out of the original hour lines was very accurate indeed when compared with modern computation, taking the latitude of St Helens as 53°N. It was also clear that the dial was a *west decliner,* but only in the order of 2°, giving an offset of the gnomon base line of 1°30' to the right of the noon line. This detail was not apparent when the paint layers were still on, and had not been appreciated over the years, but the original calibrators knew it well enough because a lower

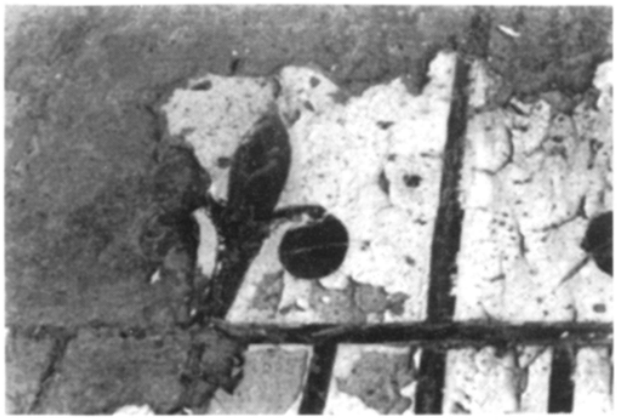


FIGURE 3: Detail showing the inaccuracy of the overpainting; note the original position of the hour line (top right) and later alteration of the fleur de lys half-hour marker

FIGURE 5: During the removal of the overpainting, the lead plug for the original gnomon bracket was revealed (lower right centre)

FIGURE 4: The dial during removal of the overpainted layers, with the original painted lines being gradually revealed

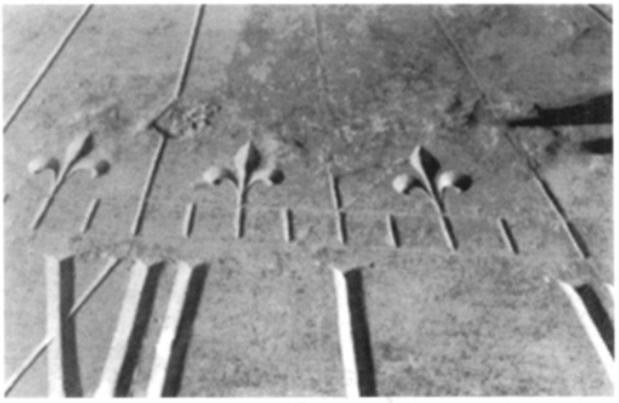


FIGURE 6: Numerals and lines carved in the stone, showing the original gnomon bracket socket, slightly to the right of the noon line

gnomon bracket socket was revealed when the overpainting was removed, in *exactly* the right place to the right of the noon line (Figure 5). The declination, of course, was also responsible for the omission of the 6.00 a.m. numeral on the dial, a fact which had confused modern observers who thought that the dial faced true south. A further problem with the dial plate was that bad weathering and decay of the stone had taken place, particularly on the eastern edge, and it was necessary to consolidate the missing and decayed areas with a modern weatherproof filling of suitable texture and colour.

The dial having been cleaned and consolidated (after several days of painstaking work) the problem remained as to *how* it should be restored. A straight repainting according to the original lines would have seemed to be the answer, but this would again have required repainting every fifty years or so in the future, with developing inaccuracies repeating themselves. After much thought and in consultation with the Meeting House representative, it was decided to *carve* the lines, numerals and half-hour markers, then to gild and paint them in a traditional manner on the natural stone surface, and of course to design and make a suitable new gnomon to replace the abject existing one. In terms of conservation (as against restoration), was this the right thing to do? The matter was weighed very carefully and in the end it was felt that (1) a dial finished in this way would enhance the restored frontage of the Meeting House; (2) the dial would be permanently cut correctly and future restoration would be straightforward; (3) that following exactly the original design would not detract historically from the 18th century evidence; (4) that the original designers would probably have approved and might well have done it themselves had the funds been available at that time. Purists might argue that it should have been kept 'as it was' and simply repaired, but against this it can be argued that the original dial *never had* a white painted ground, but was done on the natural stone. The ultimate judgement in a case like this is to decide whether or not the restored dial can be both handsomely treated and finished, and yet blend happily and sympathetically with the building on which it is mounted, and that nothing in the way of historical evidence and quality will be taken away. A full account, with a file of photographs, of the dial restoration is now lodged both in the St Helens Meeting House records and

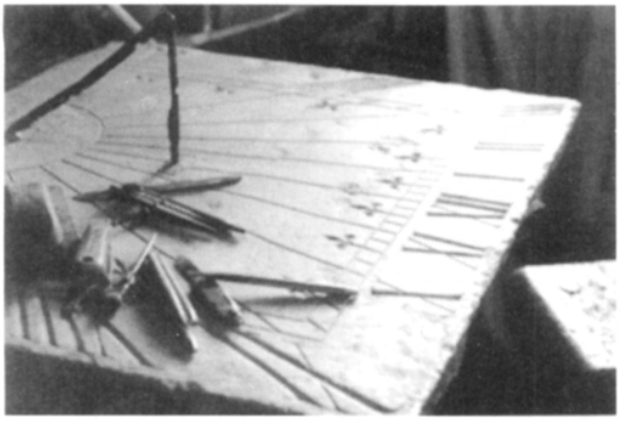


FIGURE 7: Carving of the lines and numerals, almost complete. The lines for 5.00pm, 6.00pm and the date above are still to be done. The spurious gnomon remains in place at this stage

FIGURE 8: Gilding the hour lines; on the right are the gilder's pad with some leaf on it, the knife and two 'tips' (fine gilder's brushes for handling the flimsy leaf while applying it to the sized lines)

FIGURE 9: Replacing the restored dial on the Meeting House, 31 January 1996

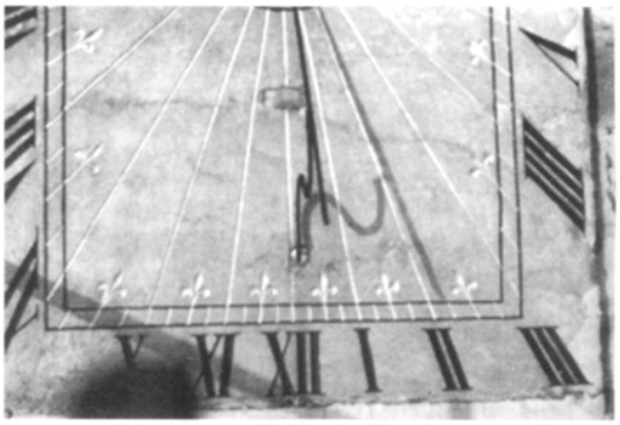


FIGURE 10: The completed dial in place, when the sun shone briefly for a few minutes after it was fixed

the archives of the Society of Friends of London.

The carving of the lines and numerals was done with traditional steel chisels and dummy, and the nature of the stone dictated my approach (Figure 6 and 7). In some parts the stone was soft and easily cut, but in others it was very hard and demanding. In places the slab was thin with layers broken off the back, and its fragility had to be respected. Before gilding the lines and half-hour marks and painting the numerals, the stone was treated with a water repellant; matt black exterior quality colour was used, and loose gold leaf was applied rather than transfer leaf which is thinner (Figure 8). Knowing the exact position of its supports I designed a new gnomon in a simple style with one curved bracket, and this was made in copper by Philip Irvine in his Southport workshop, who also fitted it in its correct holes, bedded in lead. The central hole for supporting the spurious gnomon mentioned earlier was simply filled with lead to mark clearly where it had been, and the new gnomon was painted in the same matt black as the numerals to prevent copper oxidation from forming and staining the stone. The whole process took about two months of concentrated work, and the restored dial was finally returned to its original position over the Meeting House door on 31 January 1996 (Figure 9).

The weather was dull and cold while the dial was being fixed, but when the scaffolding was being removed a brief burst of sunshine appeared, hopefully auguring well for its future. It was gratifying to note that allowing for the equation of time (just over 13 minutes slow at this date) and also for the longitude of St Helens (2°45'W i.e. 11 minutes slow of GMT) the time displayed by the dial was correct (Figure 10). Explanatory notes to help members of the Meeting House to appreciate the meaning of local time, and a graph showing the equation of time were provided, in the hope that they would make the dial more understandable today.

WALKER, FECIT, DUBLIN

C. J. THORNE

Having recently restored a longcase clock for a client, the lady of the house, on learning that I also "did sundials", produced a very dirty and encrusted object and enquired whether it was worth restoring, and if so, would I undertake to do it.

What at first glance appeared to be a lump of concrete, turned out, on closer inspection, to have a sundial attached to it, the whole object being bright green. Moss was growing on the concrete, verdigris on the dial was as thick as the brass itself, whilst the gnomon leaned over at a rather drunken angle. Long ago the dial plate had been cemented to its plinth with sharp sand mortar, which had set as hard as concrete. Bent nails had been put through the holes in the dial thoughtfully provided by its maker, and the cement had set around them many moons ago.

A still not inconsiderable number of moons ago, this cement lump had parted company with its plinth of soft Cotswold stone, and had been kicking around in the flower beds ever since. The plinth was actually still in good condition and in situ.

"Oh yes, I can certainly restore it", I said, exuding confidence to the client whilst wondering how on earth I was going to remove all that verdigris without damage to the underlying engraving. I had, naturally, assumed that there was engraving underneath! I fancied I could just make out "Dublin", and the lady confirmed that as being correct.

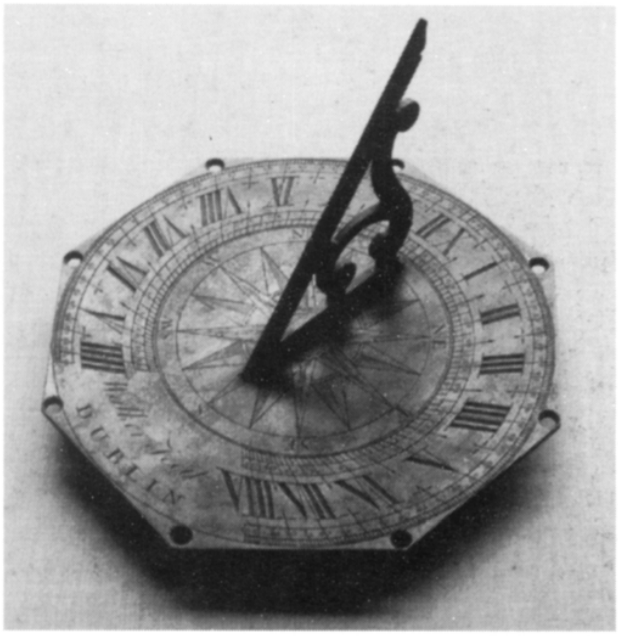
I passed some comment about removing the concrete as a first preliminary, when the object was suddenly whisked out of my hands. The master of the house then disappeared rapidly in the direction of a large brick outhouse, muttering something about "soon have that off". There were sounds of sawing and I shuddered, a hacksaw blade, given the choice of concrete or brass, will always choose the metal. However, my worst fears were unfounded, the master had cut through a couple of nails, between the brass and the concrete, the rest surrendered without a struggle as they were almost rusted through. Amazingly there was hardly a saw mark on the back of the dial!

Hastily issuing a receipt for the temporary possession of the dial, it was placed in the car boot, just in case the master had something like an angle-grinder in his outhouse - just the thing for removing encrusted verdigris!

Back in my workshop I have two chemical baths for removing verdigris and tarnish from old clocks. Both have advantages and disadvantages, depending on the situation; in the case of this dial it seemed all disadvantage, however I gave it a quick soak in the weaker solution. This softened the verdigris just enough for a stiff brass brush to start having some effect. From there on it was a liberal application of elbow grease, first with the stiff brass brush, then a soft brass brush, and finally a good burnish with fine wire wool. This latter material work hardens the surface slightly as well as imparting a modest shine. The dial now had a smooth bronze-green colour with a slight sheen and the revealed engraving was as good as the day it was first done.

The second chemical bath would have quickly removed this tarnish, but I felt this would have been detrimental to the quality of the engraving, or even the long-term survival of the dial in an outdoor environment. In any case the gnomon shadow does not show up well on clean brass.

The next task was to correct the bent-over gnomon. The two tenons protruding through the dial were held in a vice and applying a controlled force to the gnomon via a block of wood. This ensured no strain on the joint between the dial plate and gnomon, with an even pressure applied to the gnomon, just in case it wanted to bend somewhere else. Slowly, but surely, the gnomon was brought back to stand at 90° to the dial plane.



It is a very nice quality dial, (see the accompanying photograph) the engraving is deep and still quite sharp, and every line is clear. In the centre of the dial is the usual compass rose. Next an annulus with 30, 15, and 7½ minute intervals, then the chapter band with nice crisp Roman numerals, oriented to be read from the outside the dial (most seem to be engraved the other way round, as with a normal clock dial). Finally a minute annulus, divided into 30, 15, and 3 minute intervals, and at the bottom of the dial, proudly engraved - "Walker fecit DUBLIN".

My client's name had an Irish connotation, however I determined to find out more if I could in particular to fix a date for the dial, which I judged to be around 1790-1800.

Having exhausted my own library and references, I consulted the BSS membership list and wrote to "our man in Dublin" Captain Owen Deignan. His prompt reply was very helpful and really told me all I could sensibly expect to learn. The main source of information is *Vulgar and Mechanick - The Scientific Instrument Trade in Ireland, 1650-1920*, by J.E. Burnett and A.D. Morrison-Low.

Several Walkers followed this trade in Dublin but the most likely seems to be a family which traded from adjacent addresses for over fifty years. All worked as mathematical instrument makers.

(Continued on page 28)

PROFILE - JOANNA MIGDAL

FIGURE 1: Joanna at work in her Studio

There are not many persons who have succeeded in making dialling a successful career, starting from scratch and on an individual basis. Joanna is one of these and the first illustration shows her busy on a project in her workshop, surrounded by photographs of her past work.

Joanna was born in 1958 and began her studies in a conventional art school, but growing disillusioned with the school's *modus operandi*, left to start a seven year apprenticeship with the sculptors Edwin Russel and Lorne McKean, following a probationary month trial period. This prepared her for her chosen career by a superb training in the technical aspects which are necessary to be able to convert the subtleties of artistic imagination and beauty into practical being. Most of us can recognise real beauty at a glance, yet cannot progress one iota towards its realisation. Joanna is one of those few who can bring beauty into being in the world of dialling.

To illustrate her versatility, a few examples of her commissions are listed here:

PUBLIC WORKS

Three metre sundial, Qaboos University, Oman; Botanic Armillary sundial, Kew Gardens; Armillary Sphere, Holland Park; Chinese Armillary Sphere, Royal Hong Kong Gold Club; Traditional Sphere, Ascombe School Sydney, Australia; Wall Dial, Street Studios, Melbourne, Australia; Sundial at Towerhill Underground Station, London; 4ft Decorative Sphere Sundial, Gosport Town Centre; Sundial incorporating the first steam train - 'Locomotion', presented by Darlington Borough Council; Knife, Fork and Spoon Sundial, Headquarters of Trust House Forte; 3 Metre Sundial, Balfour Beaty, Anglesey; Analemmatic Sundial, Thorpe Park; Larne Sundial Park, Ireland; 3 Metre Revolving Clock, Al-ain Dubai.

FIGURE 2: Armillary sphere for Royal Hong Kong Jockey Club

FIGURE 3: Commissioned by Bovis via Brookbrae, the Bovis logo is a Humming Bird

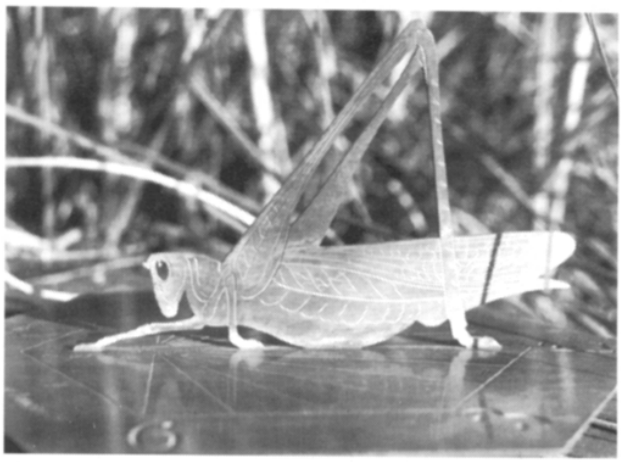


FIGURE 4: This is a Meadow Brown Butterfly gnomon, horizontal Sundial

FIGURE 5: Large Armillary Sphere Sundial in Gosport Town Centre. The design shows the French King's brother crossing the Channel in a storm

FIGURE 6: Milton Park, Oxford; this Sundial is designed to look like a scientific instrument, made in aluminium bronze. Unveiled by Michael Heseltine

PRIVATE COMMISSIONS

Goodwood House, Rosehaugh Stanhope Developments, Bovis, Cementation International, John Laing Construction, Worshipful Company of Stationers, City of London Grammar School, Keswick Estate, Peace Garden, London; Oxford University, Cadbury, Gray's Inn, London; The National Trust, The Royal Hong Kong Jockey Club and many others, too numerous to list.

PRIVATE OWNERS

Charles Jencks, the Rt. Hon. Douglas Hogg MP, The Rt. Hon. Virgina Bottomley MP.

Anyone who has had a letter from Joanna cannot but be impressed with the flowing lines of her script, and her often witty use of the English language. Those who have met her in person know what a delightful and pleasant person she is, full of enthusiasm, with a real passion for gnomonics.

IN ARTHUR MEE'S FOOTSTEPS

JOHN R DAVIS

By a pure coincidence, a few weeks before the article on Arthur Mee's "The King's England" books in the Bulletin [Bulletin 96.2 (June 1996)], fellow BSS member Aylmer Astbury sent me the results of his research from the Suffolk edition of the series. Aylmer had managed to get hold of an original edition of the guide when he lived in Suffolk and had meticulously gone through it picking out all the references to sundials and mass dials. Unfortunately, he had moved away before he had managed to investigate many of them, and so very generously passed his list over to me.

SUFFOLK

An initial look at the list reminded me that there was a dial very close at hand at Copdock church that I had never investigated. The BSS register gave its date as 1935, but in 1939 Mee had described an "ancient sundial over the porch" - could they be the same dial? Closer inspection, see Fig 1, suggests what has happened - an older dial has had an inscription "GR 1910-1935" added over the top of the existing hour lines.

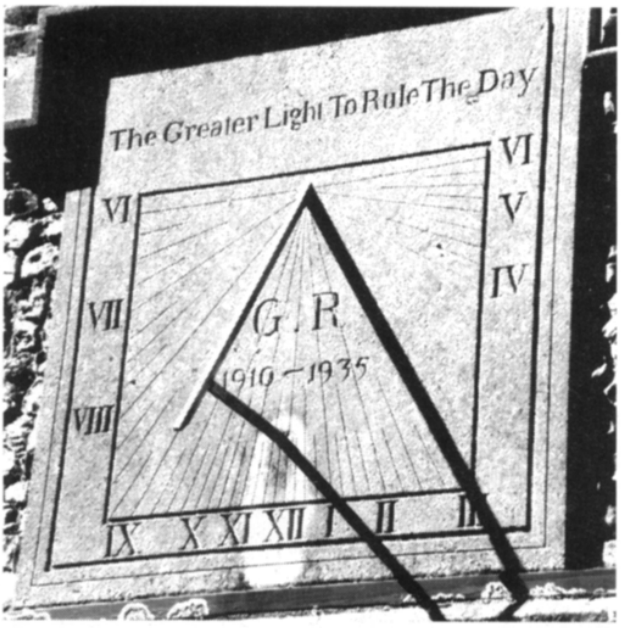


FIGURE 1: Copdock, Ipswich

Fired with enthusiasm, I set out from Ipswich one sunny afternoon with a carefully planned route to circle the north of the county taking in as many of the unrecorded dials as possible. How accurate would Mee be? The first stop was at Gisleham, where it was clear that although the dial over the porch was missing, it had once been there, see Fig 2. The evidence was that half of each angel carved in relief either side of the niche for a statue had been rudely chiselled flat to allow the dial to fit in. Talking to a local, I was informed that the wooden dial had been missing for over thirty years, having been taken down when it deteriorated beyond repair. Mee also mentioned a mass dial, and that had proved much more durable and was plainly displaying 24 lines round a full circle, see Fig 3.

The next stop was to Carlton Colville, where again I drew a blank. But the iron fixing straps for the dial were still in position. It is clear that the last half century has wrought havoc on our stock of dials.

FIGURE 2: Grisleham, Suffolk (missing dial)

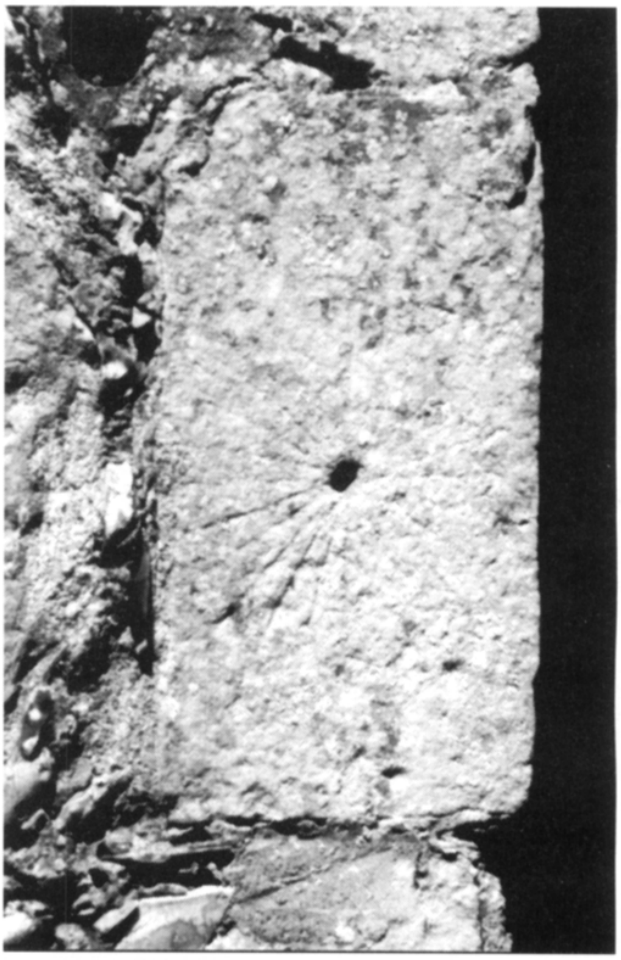


Figure 3: Grisleham, Suffolk

On to Ringsfield, and success at last! There is a very crisply cut dial over the Tudor brick porch of the tiny, secluded church of Ringshall, looking very fine at first glance. A second look, see Fig 4, though, shows that this is a fairly recent replacement dial and that, although the letter cutting is neat, the gnomon is sadly lacking, being a simple sheet metal triangle with its base set far too high, even though there is an engraved circle whose centre shows the correct position.

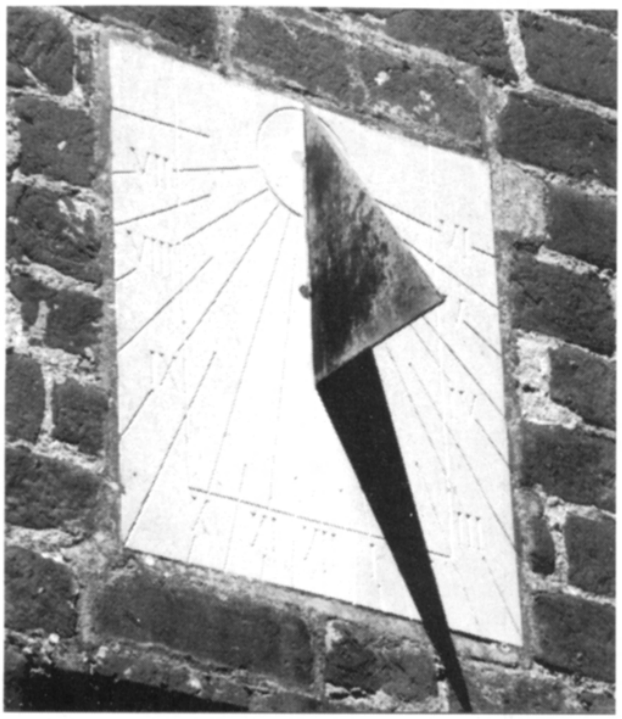


Figure 4: Ringsall, Suffolk

Figure 5: Badingham, Suffolk

After another missing dial, I found a direct south dial on the church at Badingham, see Fig 5, cut into a very solid block of stone and set on top of the porch at a 10° angle to avoid having to calculate the lines for a declining dial. Although in quite good condition, it was devoid of hour lines and furniture, and was so high it would have been difficult to read accurately without binoculars.

As the sun began to sink, my last port of call was Worlingworth. As I approached I thought that I was going to draw another blank, but then I saw a little gem of a dial just below the turreted porch, see Fig 6. The metal (lead?) dial was on an ancient wooden backing and was dated 1663. It had a very sturdy gnomon, with its thickness carefully allowed for on the noon mark, and was numbered in a strange mixture of Arabic and Roman numerals. A pair of fish were entwined above the gnomon - or is it a dragon?

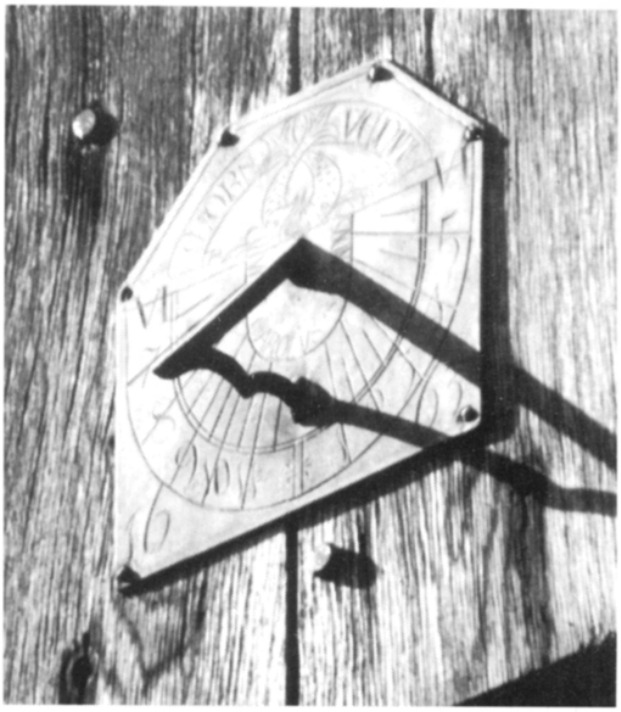


Figure 6: Worlingworth, Suffolk

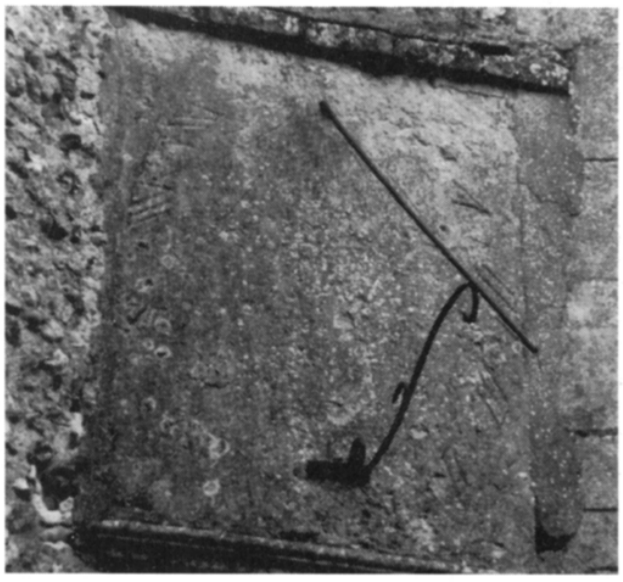


Figure 7: Witnesham, Suffolk

- but despite extending my telephoto lens to its maximum magnification, I could not make out the inscription. Luckily, Mee tells us that "its old sundial warns us in terse Latin that the night cometh..." Feeling that this was a good afternoon's work, I headed home after having clocked up around a hundred and fifty miles around the minor roads of Suffolk, including a twenty minute delay when I found my way blocked by a herd of cows.

Over the following few weeks, I worked my way round another ten or so unrecorded Suffolk dials that Mee mentioned, with a remarkably high hit rate. Some were rather ordinary - but interesting nonetheless - and several were in a lamentable condition, with cracked stones, rusted or missing gnomons, and overhung by trees. I was particularly taken with the tower at Witnesham church, where the sundial, see Fig 7, is accompanied by an ancient

one-handed clock and a substantially older mass dial which had been carefully left exposed when the tower was rendered, see Fig 8. Some of the lines on the mass dial have Roman numerals associated with them, but there are extra lines as well. A history of timekeeping on one wall! The sundial is set at an angle of nearly 45° to the buttress to allow it to be south facing, leaving a large space behind it. In 1939, Mee reported "The embattled tower, with an 18th century sundial, flows with honey in summer. From time immemorial bees have hived behind its sundial, and we are told that in the time of the harvest of the bees, when the flowers are flooded with nectar, the over-charged combs overflow on the benches in the tower." I am delighted to report that in the summer of 1996, a steady stream of the descendants of those bees could still be seen making their way behind the dial.

Great Bricett is a very quiet little timbered village (despite its proximity to Wattisham airforce base) and has an old semi-detached church. Set in its flint wall, above a filled-in doorway, is a circular stone which is very clearly a mass dial, and may possibly be Saxon, see Fig 9. It seems likely that it came from the remains of the nearby priory, as the church and its attached private house have some fine 12th century dogstooth wooden door surrounds which is also associated with it. The noon mark is set some way from vertical but, with a circular stone, this is probably accidental. The gnomon hole is well defined, and the few lines are highly asymmetric.

The 14th century church at Thwaite, still guarded by the sombre cypress trees that Mee noted, has another example of a misguided restoration attempt on a sundial, see Fig 10. When I first saw it, my immediate impression was of a mass dial, with a horizontal gnomon sticking out of the centre of the circular hour numerals like a bird's perch. It was quickly clear that this was a properly delineated direct south dial, and that the true base of the gnomon, on the V1 - V1 line, had been filled with cement! The curious thing about this dial, which is clearly old, is the second set of inverted semicircles above the gnomen. One explanation for them would be that they are constructional lines used to delineate the hour lines, but it seems strange to cut them so permanently in the dial. Are there other examples of this?

All the dials described so far are approximately south-facing verticals, but I did come across a couple of other orientations. Little Saxham is just outside Bury St.Edmunds. Mee describes a scratch dial, but makes no mention of the typical Suffolk south dial which is already in the register. The fact that he is not infallible is something of a relief, because otherwise it would mean the end of the game, there being no point in visiting a church unless Mee said there was a dial! Fortunately this is not the case and, as I found later, the accuracy of reporting can be variable. The BSS register also mentions a noon mark at Little Saxham, which I missed, but what is there is the gnomon of a direct East dial. This takes the form of a large metal "U" set out from the buttress on the end of the church, but there is no sign of the dial.

The other non-south dial that I found was at Brandon in the north of the county. This would once have been a fine direct west dial, see Fig 11. Curiously, although Mee gives the motto (now almost impossible to read) as "So Passeth the Glory of the World", he does not mention that it is west facing or that it celebrates Richard North (or Noyce) as the church warden of 1725. The aesthetics of this dial are

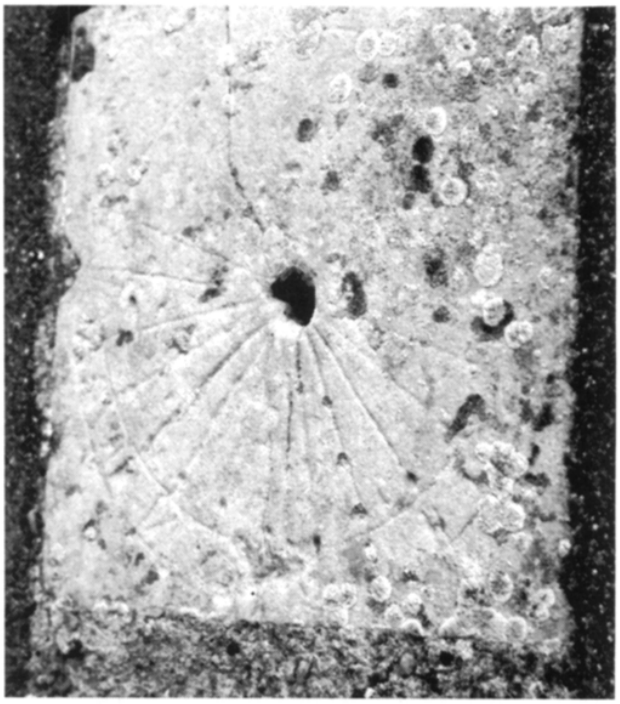


Figure 8: Witnesham, Suffolk

Figure 9: Great Bricett, Suffolk

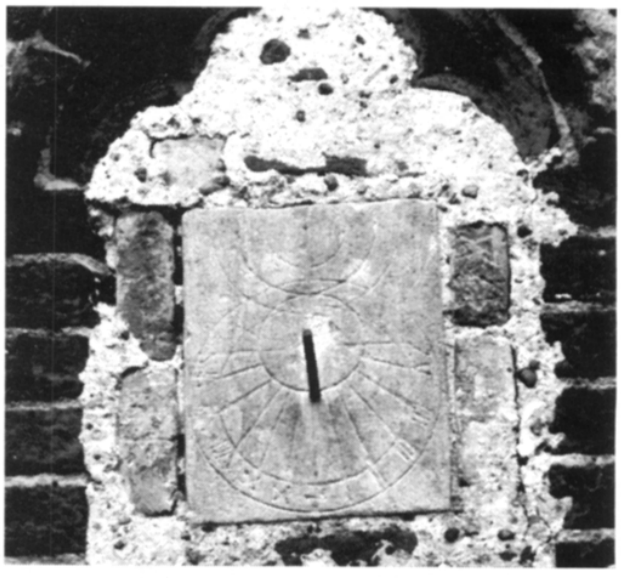


Figure 10: Thwaite, Suffolk

spoiled by the lead flashing above it and by overhead electricity lines, but it was a well made dial with 15-minute indications over the period from 2pm to 8pm. One feature which I haven't been able to account for is the hole in the centre with the remains of a metal post in it. It is in the wrong position to have been a gnomon support - could it have been a subsidiary indicator, or is it merely a fixing to the wall?

OTHER COUNTIES

Having been presented with some ready made research for Suffolk, I resolved to extend my search circle if I could. I was unsure whether other volumes of The King's England would be available, so I visited a local Ipswich antique and second bookshop. Here, somewhat to my amazement, I found numerous other counties, particularly from East Anglia (Norfolk, Cambridgeshire and Essex) as well as several others. At between £3.50 and £8.00 each, they must be the best value I have ever got. I started with Norfolk, as the entries in the Register seemed rather sparse. I learnt a form of speed reading, allowing me to get through the 470-odd pages in a few evenings, flagging any references to dials. Mee's reporter in East Anglia was obviously a methodical person with a check-list for each site, and his descriptions were written in the same logical order for each location. If a dial hadn't been mentioned when he started describing the interior of a church, then I could be sure that there was not going to be one at all. This made scanning the book much quicker, but I discovered later on that not all the county reporters operated in this way.

The first major find in Norfolk was a fine cast metal dial on the church at Quidenham, see Fig 12. Our registrar, Ian Wootten, recognised this as similar to the one at Kirkby Malzeard in Yorkshire [BSS Bulletin 96.1]. This was clearly a mass produced dial of its time, but nicely made. Although the faces are identical, the gnomons are quite different so it raises the question of whether the installers allowed for the difference in latitude between Norfolk and Yorkshire and which location the hour lines are calculated for. If there are two known dials to this design it is quite likely that there are more, so further research would be interesting.

At Banham, I nearly missed the dial entirely as the church was cloaked with scaffolding. Fortunately, a local elderly gentleman saw me walking round the church from across the green and thought he remembered where it was. What is more, he walked back to his house to fetch a stepladder so that I could scale the scaffolding and at least get a basic photograph of a plain but sharply incised declining dial.

Overall, Norfolk was not so well endowed with dials as Suffolk, but Mee still manages to mention 43 mass dials and 16 sundials, only 7 of which were already in the Register. Of the remaining 9, most were still present, although none was particularly noteworthy.

Essex was next on my list, and it was clear that a different writer had produced this edition. Whereas I suspect the East Anglian writer could have been a clergyman, the Essex writer could well have been an arboriculturist because as much attention was paid to the old yew and oak trees as to the buildings. Also, there were more descriptions of halls rather than the churches which dominated the East Anglian counties. One of these was New Hall, Boreham. Dating from 1799, the Hall was (and still is) a convent school. A letter to the headmistress

Figure 11: St. Peters, Brandon, Suffolk

Figure 12: Quidenham, Norfolk

allowed me to visit and I was taken up onto the roof to get a good view of the ancient imposing dial which had survived bombing damage to much of the house during the war, see Fig 13. There is a long Latin inscription at the base of the wall holding the dial which is contemporaneous with it. This translates into a eulogy to Queen Elizabeth 1, who granted the original Tudor house to the Earl of Sussex. The very faint date above the dial might be 1660, which would be the Restoration when the house was acquired by the First Duke of Albermarle. This is clearly a dial with much history still to be uncovered.

My greatest disappointment from the Essex book is the mention of a stained glass dial in the church at Wendon's Loft. It took me some time to find the church as it is now derelict and in the middle of a private farmyard, with ivy and Russian vine smothering the roof and halfway up the tower. I managed to clamber around the outside of the remains with the permission of a farmworker, but needless to say all the glass was missing. My enquiries continue, but so far I have drawn a blank.

Mee's Cambridgeshire drew a relatively miserable list (excluding Cambridge itself, which is a Mecca for all diallists) of only 4 sundials (3 already recorded) and 4 mass dials. Kent is much better, with 17 sundials (some already recorded) and 11 mass dials. This is a relatively low ratio of mass dials to dials, and leads me to believe that the Kent writer only mentioned mass dials if he happened to see them whereas some of the other writers dutifully looked for them. Certainly, although the splendid 1741 heavily declining dial at Ickham is mentioned, see Fig 14, the series of six neat mass dials by the priest's door goes unrecorded. The sundial itself is unusual in being placed so low on the wall (at virtually head-height) and because it appears to be accurately calibrated for BST, despite its age.

Nearby Wingham gets a long description in Mee, both for the general village with its rows of 15th century buildings and for its church, but no mention is made of the great dial on the battlements, replacing the 18th century one, or the "mass" dials dating from two different periods. One of these is a rectangular block set into a wall known to have been built over the period 1540 to 1560, with the remains of an iron gnomon clearly visible. Although unclear, this dial appears to be a hybrid between a mass dial and a scientific one, and another which I must come back to.

With winter approaching, the weekend opportunities to chase more of Mee's dials have been put on hold for a few months. He has certainly proved to be a very valuable source. Although not completely comprehensive, and a little variable in thoroughness between the counties, he has never been less than accurate and entertaining. The between-the-wars style is also quite amusing, if unfashionable, and brings home starkly how the country has altered in the intervening sixty years. Mee himself died in 1943 but, as an article on him in the Guardian in August this year implies, he would approve of modern attempts to record all aspects of the English heritage (sundials included).

Figure 13: New Hall, Boreham, Essex

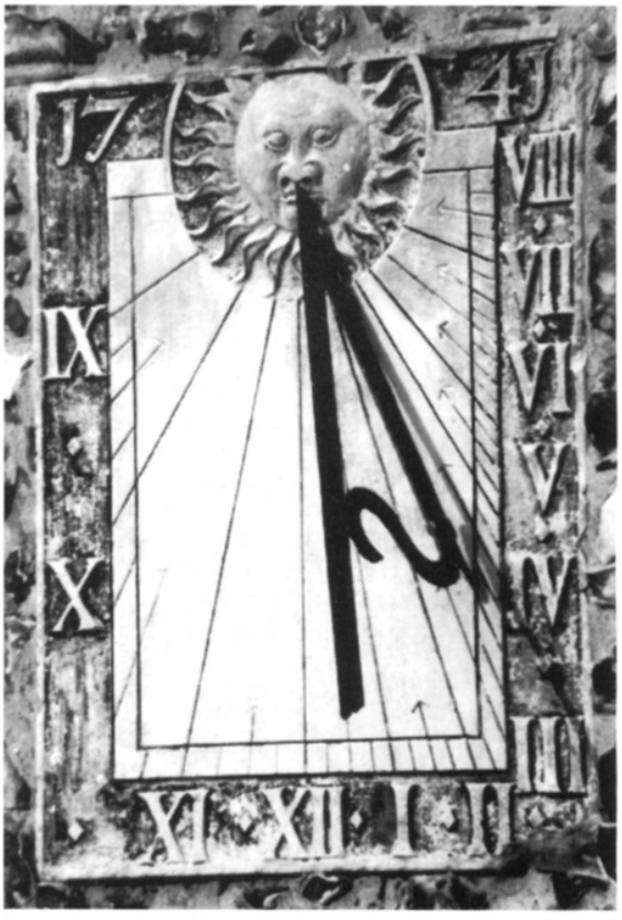


Figure 14: Ickham, Kent

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SUNDIAL SUPPORTERS - PART II

ROGER BOWLING

WHO IS KRONOS?

In Part I, I described a group of early 18th century lead figures supporting garden dials. One of these figures, the elderly, bearded, winged man was identified to me as Father Time or Kronos. Surely Father Time as we all know, or shall eventually know, is the black, hooded, cadaverous figure carrying a scythe and hourglass and haunting graveyards. So who is Kronos?

Kronos is the creation of Hesiod, an early Greek poet working around the time of Homer. His 'Theogeny' origin of the gods, is a creation myth. The union of Gaea, mother earth with Uranus, the starry heavens produced Kronos and his eleven siblings. The children quarrelled with their parents, and with a magic sickle given to him by his mother, Kronos castrated his father. the marriage of Kronos to his sister Rhea produced the Olympians, later becoming the Gods. Again there was family warring; Kronos, fearing his sons would usurp his authority, swallowed them at birth. By the trickery of Rhea, Zeus among them survived to rescue his brothers and sisters and lead them off to Mount Olympus to become the Gods. Kronos has since become the personification of time, although this role is by accident. his original name, that given to him by Hesiod, was Cronus, the crow or wily one. It is only a similarity of his name with the Greek word for time that he soon became Kronos, Chronos or Cronos. The earliest representation of him, BC590, on a frieze at the Temple of Artemis, Corfu shows him with a sickle, later to become a scythe. Since then he has been portrayed by many artists in all moods. A pleasant old gentleman is playing for the ladies in 'A Dance to the Music of Time' in Poussin's painting, but Goya in his horrific period shows 'Saturn swallowing one of his children', Saturn being the Roman equivalent of Kronos. Over the years he has mellowed almost to a figure of fun. Hogarth's last work, 'The Bathos', shows him with a broken scythe, cracked hourglass, seated smoking his pipe, the whole world around him in ruins.

It seems strange that a creation myth did not contain any representation of time, Kronos's later personification of time being accidental. Strange also that Hesiod, the poet, was also a farmer and his other work, 'Works and Days', containing instructions to a young man how to run a successful farm, show him to have had a keen awareness of time, the seasons and the best times for many agricultural tasks. I have it on the authority of Robert Graves that the name Kronos and his identity with time is fortuitous, so I cannot argue.

Kronos appeared in this country at the Renaissance firstly atop church monuments, usually paired with another figure, probably death or fame, blowing a trumpet. At this time he acquired wings, probably borrowed from angels and the hour glass borrowed from death.

The illustrations of a stained glass dial at Lullingstone, Kent (C. Daniel Sundials p.17) shows Kronos and two other figures in the decoration above the dial. This decoration is identical to a pediment above a church monument, and shows the half way stage of Kronos's travels from a church monument to garden sundial.

It was to be expected that the monumental masons should use the figure of Kronos to enhance the garden with their art, but did their rich patrons really know the evil and violent character of their appointed guardian of the sundial in their garden.

I shall not deal here with the Father Time figures depicted upon dials or sometimes incorporated into the gnomon. There are several of these, sometimes showing the Renaissance Kronos, sometimes the black hooded figure and some confusing either with the figure of death. These figures, rather than being guardians of the sundial are morbid reminders of our fate, not suitable adornments of our finest gardens.

THE FIGURES

Belton House, Grantham, Lincs. BSS Reg. 0619.

This is probably the best known of the Father Time figures with sundial. The sculptor was Caius Gabriel Cibber, 1630-1700. Cibber was Danish, coming to England at the end of the Commonwealth. He was employed by John Sone, son of Nicholas Stone. William 111 appointed him 'Sculptor in ordinary to His Majesty'. William 111 had other figures with sundials in his Hampton Court gardens, the two figures by John Nost (see Part I), but whether he employed Cibber also I do not know. Cibber married a lady with a large fortune but always had problems with money,

eventually being imprisoned for debt. Between 1687-90 he worked at Chatsworth.

There are two figures in the work, the old man, clearly Kronos, but why has he apparently uprooted the sundial and even the plinth from the ground? Is it to protect it from the infant who is grasping at the dial? I think this must be a sculpture of 'age and youth', Kronos trying to stop time passing to youth, but by his worried look he is losing the struggle. The dial is reputed to contain a moondial.

Duncombe Park, Helmsley, N. Yorks. BSS Reg. 2391.

Kronos stands looking down at the dial and resting his hands on it. The dial is on an ornate cylindrical plinth, the whole work mounted on three shallow square steps. In the BSS register the dial is described illegible but Hussey, 1967, records an inscription "Non Tardius Apperear". The sculpture is attributed by Pevsner to John Nost, creator of the Old Blackamoor and the Indian lead figures.

Anglesea Abbey, Lode, Cambs. BSS Reg. 1777.

At first glance this is identical t the Duncombe Park figure but it is not, the pose being slightly different. The dial again is on an ornate plinth, but square section; the whole work also on three shallow steps but again slightly different. If the Duncombe Park figure is by Nost, then possibly this is also. I have seen no other attribution. Happily this is one of the few dials that has not been neglected. BSS register records the maker, Watkins and Smith, London. A 32 point compass rose is on the dial and a snake is incorporated into the gnomon.

St. Pauls, Walden Bury, Herts.

A "magnificent dial" is how this is described in the BSS register, 2nd Ed.June 1992, recorded by H.C. in 1983. It does not appear in the later registers but has been recently recorded. With thanks to BSS member, Richard Mallett, who visited the dial soon after my talk at West Dean, I give his description. The dial is directly in front of the house, a kneeling figure wearing a loincloth and having an impressive pair of wings, supports on his head, held by the left hand, a dial plate 60cms in diameter. The right hand holds an hourglass and the left foot treads on a leaf. The whole stands on a large square plinth, a "magnificent dial" indeed. Sadly the dial is illegible except for traces of concentric circles.

A Coade Stone Figure. Late 18th Century

BSS member, Peter Mills, sent to me after the West Dean meeting, two photographs acquired from Seago, London, dealers in antique garden sculpture. These illustrate a superb carving of a seated life-size Kronos bearing on his head what appears to be a fine dial, by J. Coggs, London

fl.1730-59. Kronos is seated on a rock, part of the sculpture, holding an hourglass. His wings are large, the details of the feathers is intricate. Indented on the base is 'Coade, London. 1792.

Coade stone was an artificial stone, the composition still appears to be uncertain, used for sculpture and architectural ornament. It was produced by the Coade Artificial Stone Manufactory in Lambeth. The business was founded by George Coade and his wife and flourished for seventy years from 1769. After George's death it was run by their daughter, Eleanor. The firm employed some of the leading sculptors of the time, and their products were always highly regarded.

The dial is not contemporary with the sculpture, why this is so I do not understand. The origin and destination of the work is not known.

Welburn Hall, N. Yorks

Pevsner, in the context of his description of Duncombe Park, mentions a sundial at Welburn Hall, nr. Malton, N. Yorks, "A statue of Father Time being part of a sundial, cf Duncombe Park". If this exists or existed there could have been three very similar sundials, possibly all by John Nost.

Illustration, 'Garden Ornament' G. Jekyll 1918

An illustration, no location given, of Kronos with sundial quite different from all the others. He is crouching holding the dial up to his eye level. He appears not to have been the usual authoritative figure, but almost cringing, begging to tell you the time.

SUMMARY

In addition to the three lead figures of Kronos mentioned in Part I, I have traced and described seven more sculptured figures of Kronos, the Renaissance Father Time. All show an elderly man, healthy, with wings and wearing a loincloth. None carry a scythe, although there are other garden figures of Kronos with scythe, but without dial. Only two of the figures carry an hourglass. Four of the figures are in gardens open to the public and all have been recorded by the BSS. The location of one figure is unknown and two are lost. It is possible that three of the figures are very similar, Duncombe Park, Anglesea Abbey and Welburn Hall. If the suggested attribution, John Nost, is correct, this would make him sundial supporter sculptor extraordinary, as he was also the creator of the Old Blackamoor and the Indian.

All these figures are first rate sculptures, and have been well cared for; they are a focal point of our best gardens. Why then are most of the dials neglected and usually illegible?

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ACKNOWLEDGEMENTS

BSS members Richard Mallett for information on the St. Pauls Walden dial and Peter Mills for information on the Coade stone figure. Anne Somerville for help with the records.

AN OPUSCULUM OF DIALLING REFERENCES

In response to various other researchers in the bibliographical field of gnomonics, The Editor has printed fifteen copies of his 3,00 entry listing of dialling references. It is in the form of three separate listings of a thousand entries each because of the limitations of the word processing system he was using at the time of collating. Each list is in alphabetical order and is followed by a chronological index. The total number of pages is over 230, the material being held in a comb binder with plastic guards to the covers, the rear cover being in Astralux. The front cover carries a colour illustration of a sundial, the whole weighing about 1 1/2 pounds.

An example of one of the entries is given here:

737. REGIOMONTANUS, Joannis. Pseudonym for Johan Müller. Scripta Joannis Regiomontani de torqueto, astrolabio armallari, regula magna Ptolemaica, baculoque Astronomico et observationibus Cometarum. (Johann Regiomontanus' writing on the torquetum, the armillary astrolabe, the great Ptolemaic rules, the astronomical staff and observations on comets). Norimbergae 1544

Regiomontanus was the Archbishop of Ratisbon, German mathematician and an astronomer. He was born in Könisberg in 1436, studied in Italy, and in 1461 travelled with Cardinal Bessarion to Italy to study the Greek language, In 1471 he settled in Nuremberg where he found a patron, Barnard Walther. These two worked on clarifying the Alfonsine Tables, from which Ephemerides 1475-1506 resulted, and which Columbus made much use of in his voyages, Regiomontanus was summoned to Rome in 1464 by Pope Sixtus to help in the reform of the calendar, whilst engaged on this task he died in Rome in AD 1476, still a young man. It is not known if he died of a fever or if he was poisoned.

After despatching ten copies to various experts throughout the world, there are five copies available to anyone wishing to acquire one at the cost of publication only - £16.00, which include inland postal charges and packing. Address:

Charles K. Aked,
54 Swan Road, West Drayton,
Middlesex UB7 7JZ.

THE PELIGNUM

NICOLA SEVERINO (ITALY)

NOTE: The present article has been greatly simplified from the original text so as to extract the information given here.

TREVIRI

The article by Rene R.-J. Rohr - "Portable Sundials in Ancient Rome", BSS Bulletin 94.2, pages 42-45 has encouraged me to take the opportunity to write about a portable sundial in a mosaic of the pavement of an ancient Roman villa at Treviri, preserved in the Landesmuseum of Trier. Figure 1 shows an old man holding a sundial in his hand, composed of two parts presented like an opened book (probably made of marble). There is a gnomon in the highest part, with a series of hour lines engraved on both parts. That is the sum total of what can be seen in the mosaic, and all we currently know on this strange sundial.

FIGURE 1: The Treviri Mosaic

It is not known if this type of sundial is mentioned in the famous list of dials by Vitruvius in the IXth book of his treatise *De Architectura*. The text of this treatise has been greatly modified from the ancient manuscripts up to the XVIth century. The authorative translation of Jean Soubiran, with his excellent commentary, published for *Belle Lettres* in 1969, also cannot be considered totally faithful. Many of the points in this treatise lend themselves to different and subjective interpretations.

One needs also to consider the translation and comments of the studious Claude Saumase, who lived in the Borbogna in the XVIIth century. He, in his *Plinianae [Excerciationes]*, emends many passages of the works of Pliny and Vitruvius. As the Marquis Bernardo Gallant, he published a translation of the books of Vitruvius, in which he includes some important items extracted from the precious codices, which today cannot be found. For example, he states that in the Vatican Codex I, in place of the dial "Plintiunm [sive lacunar]", he has written "[phantium sive lacunas]", and that many of the dials have strange names, of which it is almost impossible today to guess their form, or their etymology. Furthermore, in a Codex seen by Saumase, it appears that other ancient writers also paid attention to gnomonics - . . . *Hunc eundem alio loco Scopinian ab Syracusis vocat, et multas res organicas, et gnomonicas numeris. naturalibusque rationibus inventas, et explicates tradit reliquisse . . . Inter eos qui gnomonica vel organica aliqua reliquerunt, recenset ibidem Aristarchum, Samium. Philolaum, et Archtam Terentinos, Apollonium Pegraeum, Eratosthenum, Cyrenaem, et Archimedum.*

I may upset the beliefs of diallists, but I do not believe it would be good for the history of gnomonics to exclude the names of "Gonarco" and "Engonation", which have remained unchanged in all the ancient editions. But this is another question of which more will be written about in the future. During my regular gnomonical researches in the Library of the Montecassino Monastery, (Italy), I discovered a 1730 edition of *Exercitationes Vitruvianae primae hoc est - "Joannis Poleni commentarius de M.Vitruvii Pollionis . . ."* In this book is an inclusion entitled: *"Anonymus scriptor vetus de architectura compediosissime tractans, Vitruvius quae et celeri locupletius, quidem ac diffusius tradidere cum annotationibus Joannis Poleni"*. This important section contains the valuable and unique description of an unknown sundial that appears to correspond with that shown in the ancient mosaic, and a description of the Hemicyclium (surely the most ancient description of this dial today). The text that includes Poleni's comments is probably based on the XXIX chapter of the principal work of the ancient writer Cezius Faventinus, who lived in the IVth century. The exact form of the "Pelignum" described by Vitruvio is not known today, although in modern descriptions it is a dial formed from two tablets of marble whose form resembles an axe. This figure is derived from the form of the declination lines which divide the dial into two symmetrical parts. But in reality this description is more fitting for another dial described by Vitruvius, called the Arachnen; or perhaps in reference to the "Discum", the discovery of which is given in the excellent example described by Francis Pater in 1823.

Thus the description of the Pelignum corresponds more exactly in reality to that of the sundial visible in the mosaic at the Landesmuseum. This is easily demonstrable from the text of Faventino, as we shall see shortly. The Plinthium word of Vitruvius could be a modification of the original word Pelignum, but this is only an hypothesis on my part. The Pelignum is made from two tablets of marble probably joined at the side by a hinge so they could be opened and closed like a book. This solution is very likely as the sundial could then be easily transportable. There are other particulars which allow us to identify the sundial of the mosaic in the Landesmuseum with the Pelignum in Faventino's book:

1 Faventino speaks about a coincident edge with the sixth hour. This edge is naturally the joining edges of the two marble tablets.

2 The two marble tablets are widest above and narrower below.

3 The [gnomon] is installed in the largest angle of the joint, and slightly inclined.

4 The two marble tablets are of equal dimensions

5 The number of hourly lines is twelve, from the first to the eleventh.

6 The line of the sixth hour coincides with the vertical conjoined sides. The hourly lines are extended on the upper parts of the tablets and are shorter on the lower surfaces.

These few but important details are sufficient for

identification of the Pelignum of Faventino with the mosaic sundial of the Landesmuseum. Finally it is stated in the use of this instrument, "You set the side of the sundial that indicates the tenth hour against the East (Equinoctial), as is known in many places, from the examples . . .". Faventino informs his reader that the Pelignum is not a very exact dial in these words - "because of the inequality of the space between the hour lines, the exactness of this dial cannot be pretended".

Considering the words of this ancient writer, the dial should be oriented so that the conjoined edges are vertical and in the plane of the meridian. In this way the right hand tablet that contains the tenth hour [temporaria] is exactly turned in the direction of East (see Fig 2). Furthermore, when the Sun transits the local meridian, the gnomon shadow is vertical and coincident with the inside edges of the two tablets (see Fig 3).

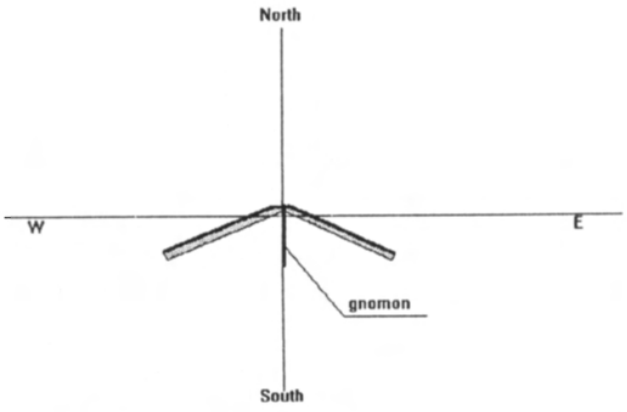

FIGURE 2: Orientation of Pelignum Dial

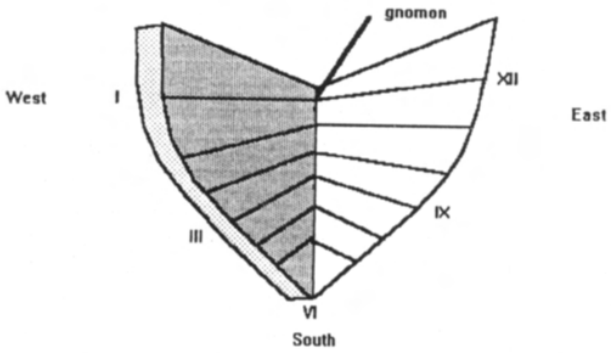

FIGURE 3: Shadow of Sun crossing the local Meridian at noon gives vertical shadow on conjoined edges of tablets.

During my gnomonic researches at Montecassino, I have only been able to discover two other representations of this type of sundial. The first of these (Fig 4) is to be found in the IIIrd book of the encyclopaedia *Thesauri Antiquitatum Romanarum Graecarumque* of the 15th century. It is reported as being seen in an ancient calendar described by "Lambecio" of the IVth century. The illustration represents a naked June observing the hour on the sundial installed on a pedestal. This could be taken as an indication that various types of Pelignum existed, both portable and fixed. Unfortunately the gnomon is not visible in the illustration. The same design is repeated in the *Supplement [au livre de] Antiquite* . . . of Richard Monfaucam (Plate X, page 34) of 1724. The author expresses his admiration for the unknown dial "Le quadrant Solaire est d`autant plus remarquable,

FIGURE 4: June observing the hour on a fixed Pelignum sundial

que je me scai si on trouve quelque autre dans les monuments des anciens qui nous restent".

The last representation of the Pelignum was reported by Paul, Priest of Rocasecca (an Irish priest who lived in Rome). The Pelignum was sculpted on a sarcophagus circa AD 253-260, preserved today in the Christian Museum (Fig 5).

FIGURE 5: A Pelignum sundial carved on a sacrophagus circa AD 253-260 (in the middle, next to the left-hand head)

It remains to be discovered if the Pelignum is a sundial invented by the Romans, or if it was inherited from the Greek culture. Meantime I am satisfied that I have explained the mystery of the sundial in the Landesmuseum.

For further information, please consult the author's treatise *History of Gnomonics,* see below - *Storia della Gnomonica,* Italian text.

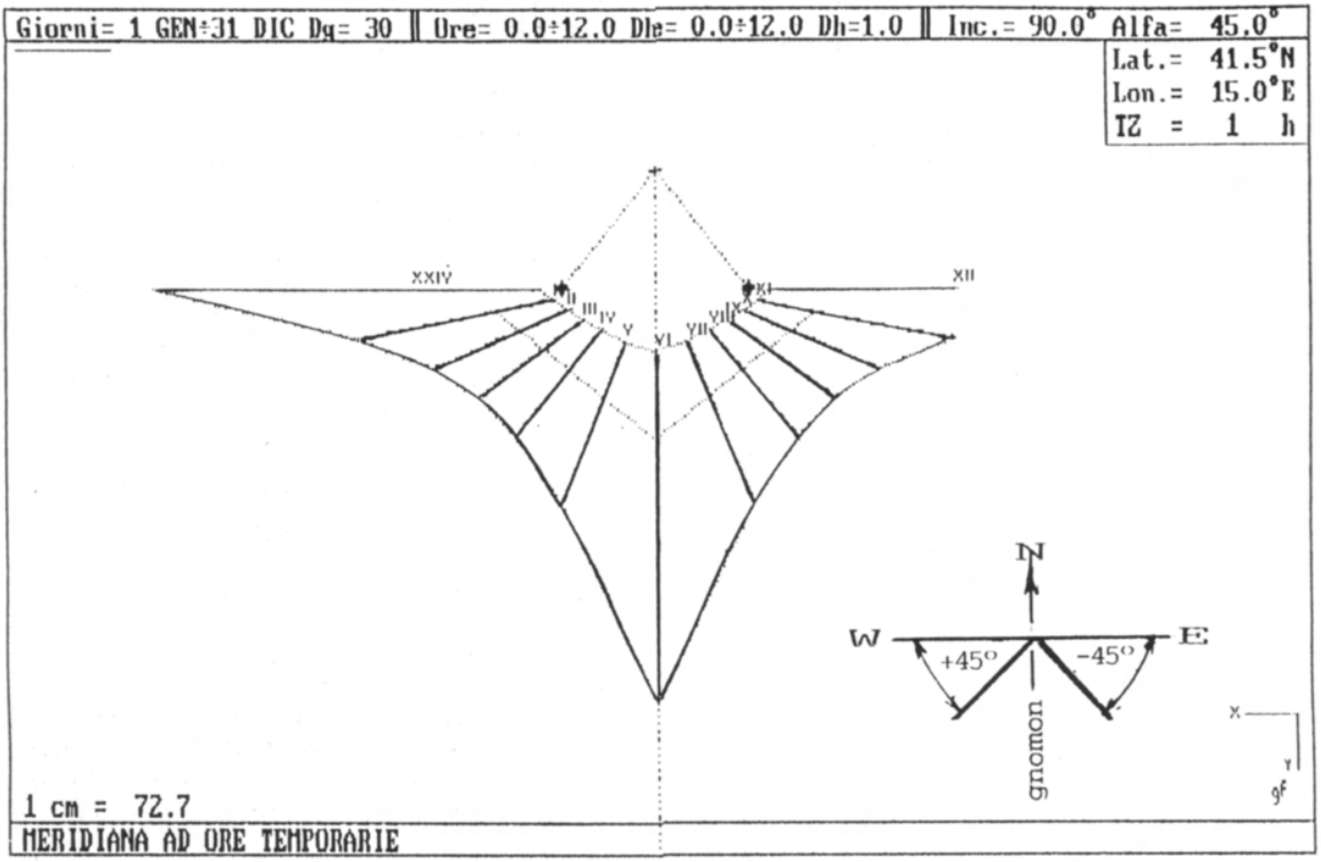

FIGURE 6: A computer designed sundial showing temporary hours in a similar fashion to a Pelignum sundial

APPENDIX

The Pelignum of C.Faventius is shown here in Fig 6 as a computer design, combining two sundials of temporary hours, one declining at 45°W, the other -45°E. It is approximately equal to the Pelignum of the mosaic from Treviri, but not to the aesthetic form because the Treviri sundial does not have the Winter/Summer Solstice lines.

I have examined the article by Philip Pattenden - "Sundials in Cetius Flavius" (see bibliography) and consider he is in error in believing the Pelecinum (Pelignum) to be a horizontal sundial. He was apparently unaware of the Treviri sundial, the Lambecio calendar and the sarcophagus shown here in Fig 5, at the time of writing his article.

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PATTENDEN, Philip, "Sundials in Cetius Flavius", *Classical Quarterly* XXIX (1979), pp 203-212. A very scholastic essay on the Pelecinum (Pelignum) and the hemicyclium.

ACKNOWLEDGEMENTS:

The author wishes to thank the Librarian for allowing him access to the dialling literature in the Benedictine Father's Library in the Abbey of Montecassino (Italy), and to Charles K.Aked, Editor of the BSS Bulletin, for his collaboration and interest in my gnomonic researches.

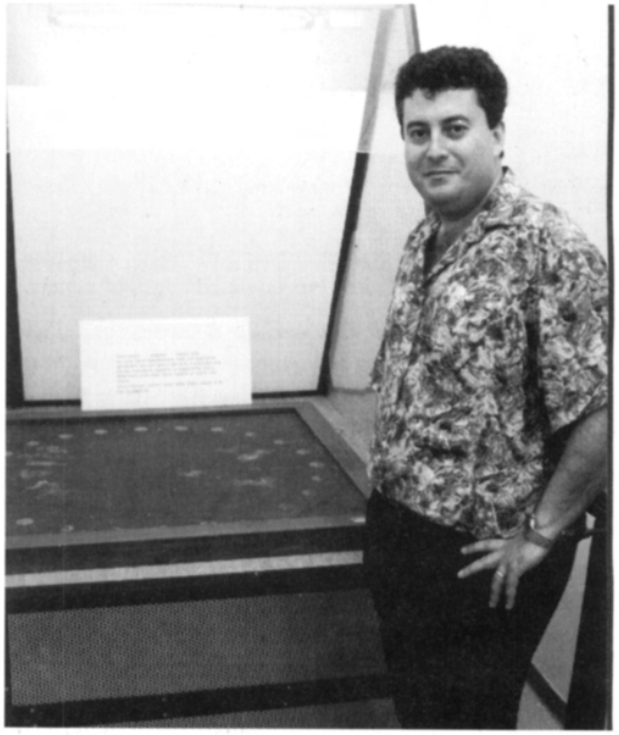


FIGURE 7: The author standing by one of the Sciatheric Tables of Kircher

QUEENS' COLLEGE SUNDIAL

CHARLES K. AKED

In going through the miscellania of my correspondence recently, I came across some details sent to me by the late Dr. Marinus Hagen in respect of the Queens' College Sundial, Cambridge, and thought they might be of interest also to BSS members.

First of all a letter sent by Andrew Somerville to the Bursar of Queens' College, printed here in full, will set the scene:

The Bursar
Queens' College
Cambridge

9 November, 1986

Dear Sir

Queens' College Sundial

In the booklet by G. C. Shephard describing the Queens' College sundial, he says (p.10) that the column headed "Longitudo" gives the right ascension of the sun, but that the designer has made an error and a correction is necessary. This statement has been repeated in other books (see Rohr - annotation by Hagen) and the suggestion has even been made that the figures on the dial should corrected when it is next repainted.

I belong to the Dutch Sundial Society (De Zonnewijzerkring) and Dr. M. J. Hagen, until recently the secretary, has pointed out to me that if the term "Longitudo" is interpreted as meaning the length of the day, then the figures are correct as they appear and no correction is necessary. If they were truly Right Ascensions, which in any case is *not* the same as longitude, they would run from 0-12 and 12-24 in two columns and would not be limited to 8-16, as appears on the dial.

It is quite common for the length of the day to be marked on sundials, especially on the Continent, and more so than Right Ascension, so I am sure he is right on this point. He is too modest to write to you himself, claiming that his English is not good enough (which is not true!) and that he would "sound like a Dutch schoolmaster!", but I thought you would like to have the point drawn to your attention, especially if there is any question of altering the figures when the dial is repainted. After all, it is one of the finest dials of its type in the world and it is a pity for its designer to be misrepresented.

Yours sincerely,

Dr. A. R. Somerville, F.S.A Scot.

The Bursar of Queens' College replied to Andrew Somerville's letter as follows:

12 November 1986

Dear Dr. Somerville,

Queens' College Sundial

Thank you for your most interesting letter of 9 November. The history of the sundial and its design is a pet project of mine as I was intrigued to receive your suggestion* on the meaning of the "longitudo" column.

I am currently under pressure to produce a new booklet on the sundial at a more popular level- appropriate, say, to the visiting tourists, who find Shephard's booklet too formal. If I ever get round to this, I shall certainly include your description of the longitudo column. It sounds much more convincing to me.

You may wish to know that we have produced a computer plot of what the sundial ought to look like it is were entirely accurately drawn. This plot confirms Shephard's supposition that the unlabelled black lines spreading out from the centre of the horizon line are indeed close approximations to subdivision of the day into "temporary hours" rather than mean hours.

Yours sincerely,

Dr. R. D. H. Walker

* Here Andrew Somerville wrote "Not mine - yours" because he sent a copy of this to Dr. Hagen, who wrote "Note of Andrew in his letter to me". There is a note also in Dutch which I cannot interpret.

There were other matters discussed in this letter, and Dr. Hagen included a copy of M. M. Scarr's pamphlet which was sold at the Porters' Lodge of Queens' College, Cambridge. Here are some of the comments made by him:

In the pamphlet there is a printer's error: page 6 - Longitudino should read LONGITUDO, as it is painted on the dial.

There was an error on page 51 of the Bulletin, in the note, *Quantitor dia* should read: Quantitas die/noctis (plural - dierum/noctium).

I have seen several dials on the Continent of Europe with these annotations and in the books of Rohr *Die Sonnenuhr* and *Les Cadrans Solaires* you can find them eg:

Page 98, Fig. 100, Peter Anich (many dials by him); page 114, Fig. 199 - Table; page 115 Sebastian Munster - *Quantitas dierum atone noctium*, page 184, Fig. 289, 1792 Table. Page 205 Groningen, 1731. On the left side vertical: Opgank = ortus. Near the column a banderole with "De Lengthe der Dagan" = Length of Day. On the right side, horizontal: Ondergank - occasus.

In the book *The Ivory Sundials of Nuremberg* by Penelope Gouk, there are also many sundials inscribed with the length of the day and the night: page 19, Fig. 16e.a.

In a personal letter to me dated 26th May 1995, Dr. Hagen wrote about his first visit to the Old Court of Queens' College, stating:

"So, at my first visit to the Old Court of Queen's College I could not agree with the explanation of Mr. Shephard in his pamphlet: Longitudo is not the same as Right Ascension; we have not to add or subtract with 180; there is no confusion between vernal and autumn points. The numbers 120 etc. are not in degrees, but I think the painter (of the dial) has forgotten the interpunction (point between figures); we have to read 12.0 as in the Moontable and so we have in the column Longitudo the length 8.0 hours, 9.0 hours, etc; and at the end, in summer 16.0 hours.

(Right Ascension is the distance at the equator, Longitudo is the distance on the ecliptic).

It is curious that Cousins also gives the notation of Shephard, with the Right Ascension, and Rohr in his books

as well, and Rohr regrets the 'fault' had not been corrected at the restoration ... Sorry.

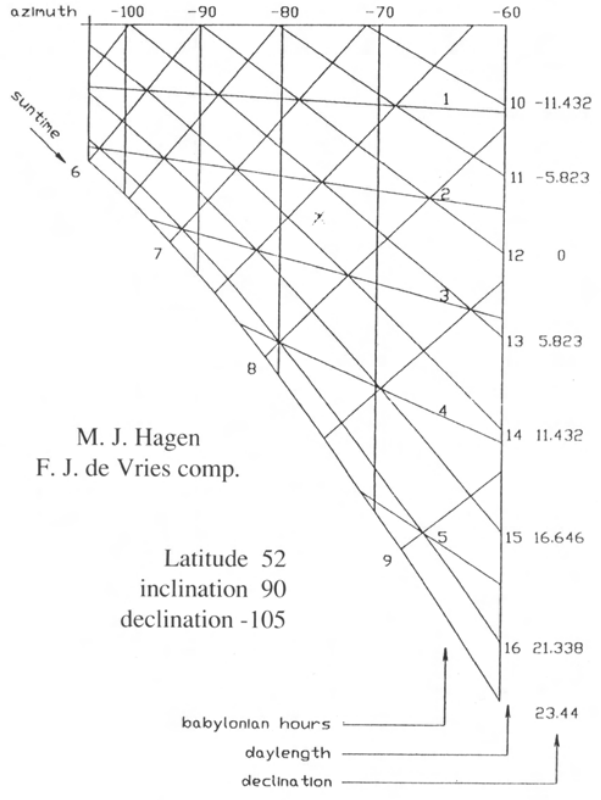
In 1985 I wrote my annotations to Andrew Somerville and I asked him to intervene in this matter with the Bursar of Queens' College. I thought Andrew would have a better reception than a simple tourist from Holland.

Yet all people are unanimous. This dial is one the most beautiful sundials in the world! - And I was happy with the correct meaning of 'Longitudo'.

Chris Daniel has published in *Clocks* of November 1989 an article about a big sundial in Hesketh Park, Dartford. There are 11 day curves. These are not for the beginning of the signs but they are also curves of the days with a length in whole hours, with numbers 8 to 16, the numbers of the 'longitudo dierum'. In the next issue of *Clocks*, Chris made a correction.

Now I have found another dial with curves for the length of the days: Merton College Chapel, Oxford, described by you (Charles Aked) in BSS Bulletin 93.2 page 40. You write: "R. T. Gunter could not explain the dial". Nevertheless his namesake Edmund Gunter has pointed out the construction of these lines in his book *Use of the Sector*, etc., published 1624. On pages 159-161 - 'Parallels of the length of the day'. The dial at Merton College was constructed in 1629, so says the postcard on sale at the College. And Edmund did not use a computer ...

The lines numbered 1 to 5 are not declination lines but hour lines for the Horae Ab Ortu, the Babylonian hours. The text on the postcard is totally wrong: Declination lines are not used for the construction of hour lines, it is the other way round. If we construct the curves for the length of the day, we can easily profit from it to draw the Babylonian hour lines by connecting the crossings, but this is not the purpose of the longitudo curves.



The Merton College, Oxford, Sundial.

I have discussed these matters with our Secretary of the Dutch Society, Fer de Vries and he has supplied me with a diagram produced on a computer and I send you a copy.

At our visit during the Oxford BSS Conference, it was raining, but early in the morning, next day, I took some nice pictures of this 'obscure' dial.

And now I will end with the words of Denis Schneider on page 51: Bravo for the BSS and its Bulletin, and in my own words: Bravo for the Editor.

Best wishes from
Marinus J. Hagen

* * * * * *

The preceding indicates the acuteness of Dr. Hagen in spotting errors in those things which most of us take for granted. As the writer of the article on the Merton College Chapel sundial, I must admit to being less than critical in the interpretation of the dial markings, the power of the printed description in appearing authoritative is overwhelming. Experience should have made me more careful of the work of others, it is essential to look at the subject in critical detail as Dr. Hagen habitually did, and not take anything as gospel until proven. In my own defence it must be said that the article was prepared when the person who had volunteered to do so had not submitted anything after more then three years. So if anyone goes back to the Merton College Chapel sundial article, the points made by Dr. Hagen need to be taken into account, perhaps it would be best to insert a copy of the relevant part of this present text with the article in Bulletin 93.2, page 40; together with Mr. de Vries computer generated diagram.

* * * * * *

CONCLUSION

Dr. Hagen did not wish the material here to be published as a letter in the BSS Bulletin, I suppose that being such a modest man, he did not care for the fulsome praise (though well-deserved) in Andrew Somerville's letter to the Bursar of Queens' College. So the material has been brought together to form this short article so that his findings on the Cambridge Moon Dial are recorded for posterity. I have not noted these corrigenda published elsewhere, and in view of the great number of Scarr's pamphlet sold over the years, it is important to keep these corrections in mind against the next restoration of the Moon Dial so that the proposals to make corrections to the dial are not carried out where none are required. I only wish that I had been aware of Dr. Hagen's comments when I wrote the article published in BSS Bulletin 94.3. pp. 2-6, however this was written long after the BSS Conference in Queens' College in September 1991. Nevertheless, on checking my account, I see that I have allocated the duration of the daylight hours between sunrise and sunset to the "Longitudo" indications and the time of the sun's rising against the "Ortus Solis", although I failed to notice that the hour and minute figures of the longitudo scale were not separated by a dot, not surprising since the dial was showing signs of deterioration as long ago as 1991. Personally I hope a more competent painter is employed for any future restorations.

MOVING A RECLINING EQUIANGULAR SUNDIAL TO ANOTHER SITE

B. D. YALLOP

SUMMARY

The RGO Tercentenary at Herstmonceux can be installed at Cambridge and remain equiangular. All that is required is an anti-clockwise rotation of 1°.343.

1. INTRODUCTION

A reclining equiangular sundial with vertical gnomon was erected in the walled garden at Herstmonceux to commemorate the tercentenary of the founding of the Royal Observatory at Greenwich in 1675. The sundial was designed by Gordon E.Taylor (1975). When the RGO moves to Cambridge in Spring, 1990, the intention is to install this sundial in a prominent position near the new RGO Building. The sundial is made of stainless steel, it weighs about a ton and is mainly of a rigid construction. It would require major rebuilding, for example, to change the inclination of the gnomon to the dial or the inclination of the dial to the base plate, which is horizontal for Herstmonceux.

This paper discusses the problems of erecting such a rigid reclining equiangular sundial at another site.

Atkinson (1962 and 1976) pointed out that if any sundial is moved to another place by a translation in space (*i.e.* without rotation) then it will record the same time because sunlight falls on it in the same way (if it falls on it at all). Moreover, all sundials must have their individual polar axis (which may or may not be defined mechanically) parallel to the Earth's axis of rotation and this is the only degree of freedom left. Thus the time could be changed to read the time at the new longitude by an appropriate rotation about the polar axis.

From this general theorem we can see that if a sundial were moved to another site and it was rotated about the polar axis to compensate for the longitude difference then at the new site it would appear that the sundial had been tilted about the east-west axis by the difference in latitude between the two sites. Moreover, physical properties of the sundial such as the length of the gnomon and hour angle limits would not change and its basic characteristics would not change.

Bearing in mind these general considerations we will now investigate in more detail the special case of equiangular sundials.

2. THEORETICAL CONSIDERATIONS

Equiangular sundials are a subset of an even larger class of sundials called projected equatorial sundials (Ernst, 1986). It helps to understand the properties of equiangular sundials by first considering the more general class of projected equatorial sundials. The equator circle with a gnomon pointing along the polar axis is an equiangular sundial. If the equator circle and the polar axis are projected by parallel projection in any direction, a family of sundials is produced. The gnomon lies along the direction of projection, and the plane of projection, which may lie in any direction, is the dial plane. The gnomon is moved along a date line in the dial plane which is always parallel to the projection of the polar axis on the dial plane.

If the gnomon is inclined at the same angle to the dial plane and the equatorial plane, then an equiangular sundial is produced from a projected equatorial sundial. The equiangular sundial designed by Taylor has two additional

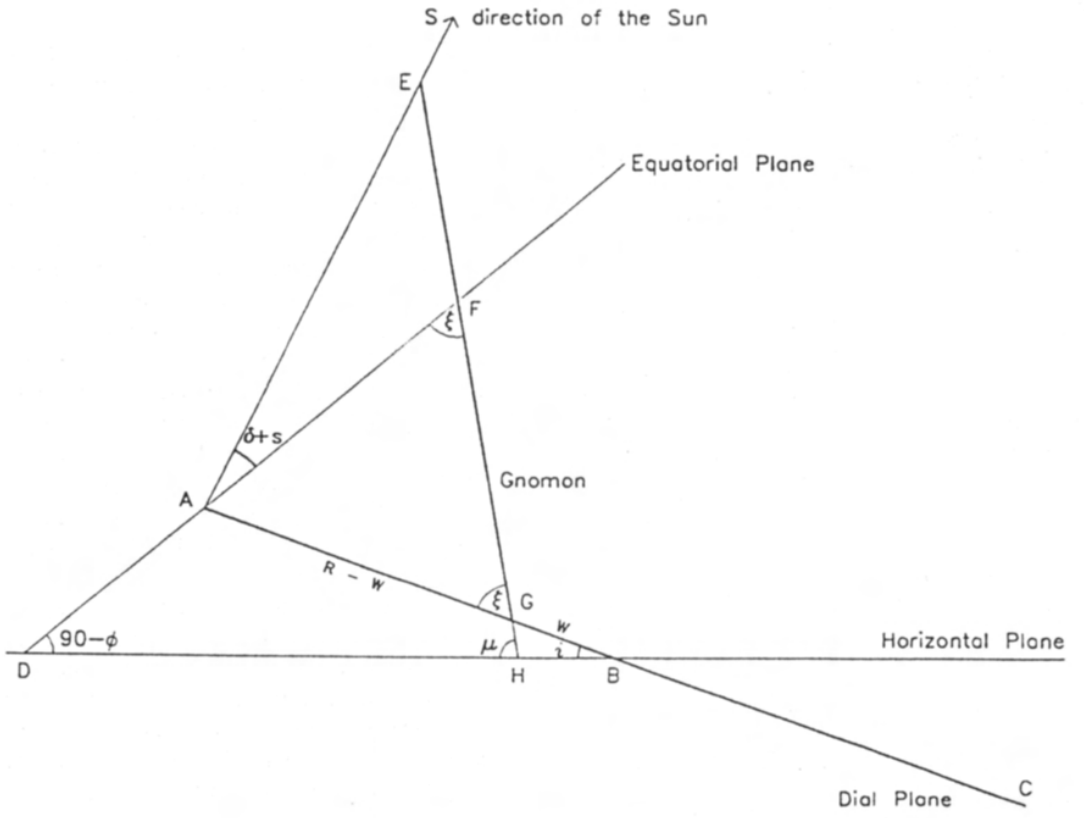


FIGURE 1: Meridional cross-section of a reclining equiangular sundial

special features (i) the dial plane is inclined to the equator plane by a rotation about the east-west axis, *i.e.* the normal to the dial plane has been confined to the meridian and (ii) the gnomon is vertical.

The first feature is the reason why it is referred to as reclining, and the date line lies along the intersection of the meridian with the dial plane, otherwise it would be referred to as declining-reclining and the date line would lie in the direction of the polar axis projected in some other direction onto the dial plane.

By rotating the dial plane about the gnomon a declining-reclining equiangular sundial would result. It would remain equiangular because the inclination of the gnomon to the equator and gnomon to the dial plane would still be the same. Complications arise, however, because the polar axis of the sundial would move; consequently the date line would move and in general it would move relative to the dial. The rigid construction of the tercentenary sundial would not allow such an independent movement of the date line relative to the dial plane. Therefore we will now confine attention to reclining equiangular sundials.

3. BASIC FORMULAE FOR RECLINING EQUIANGULAR SUNDIALS

The basic formulae were given by Taylor (1975). They are reproduced here using the same notation but fewer variables. Figure 1 shows the meridional cross-section of a reclining equiangular sundial. AES is the direction of the upper limb of the Sun at noon. ABC is the dial plane with centre B, radius R = AB = BC. The displacement of the gnomon EFG along the date line W = BG. The equatorial plane AF meets the horizontal plane at D. For an equiangular sundial, X, the inclination of the gnomon to the dial plane (angle AGF) is equal to the inclination of the gnomon to the equatorial plane (AFG).

In triangle ABD,

$$A\hat{D}B = 90 - \phi$$

$$ABD = i$$

where is the latitude, and i is the inclination of the dial plane to the horizontal.

$$D\hat{A}G = 2\varepsilon$$

Hence

$$2\varepsilon = 90^{\circ} + \phi - i$$

It can be shown that the displacement W of the gnomon along the date line is given by

$$W = R \tan \delta / \tan \varepsilon$$

where δ is the declination of the Sun.

The point E along the gnomon, is the point which will produce a shadow on the edge of the dial, at A, at noon on any date. Using the sine rule in triangle EAG the length of the gnomon EG is given by

$$EG = (R - W) \frac{\sin(2\varepsilon - \delta - s)}{\sin(\varepsilon - \delta - s)}$$

This length is a maximum (G) at the summer solstice, when the declination of the Sun is a maximum and $E\hat{A}F = \delta + s = +23^{\circ}\ 26'.5 = 15'.7$ where s is the semi-diameter of the Sun. Thus the length of the gnomon must be at least G. It can also be shown that the hour angle limits m in hours for the upper surface of the dial is given by

$$m = \frac{1}{15} \cos^{-1}\left(\frac{\tan \delta}{\tan 2\varepsilon}\right)$$

The maximum limits will also occur at the summer solstice. The line of the gnomon EFG meets the horizontal plane at H. From triangle GBH

$$\mu = i + \varepsilon$$

Where μ is the inclination of the gnomon to the horizontal. In the special case of a vertical gnomon, $\mu = 90^{\circ}$.

4. THE EFFECT OF A CHANGE OF LATITUDE

Consider the effect of moving a reclining equiangular sundial to another latitude keeping ε fixed. Equation (1) tells us that to remain an equiangular sundial i must change by the same amount as ϕ. In the move from Herstmonceux to Cambridge the latitude difference is (52° 12'.8 - 50° 52'.2) = 1°.343. From equations (2), (3) and (4) the quantities W, G and m will not change since they depend only upon ε and δ.

Note that these conclusions were arrived at more easily by applying the general theorem of Atkinson on sundials in section 1.

Equation (5) tells us the obvious fact that if the gnomon is vertical at Herstmonceux and the sundial is tilted at Cambridge then it will no longer be in the vertical.

Thus the solution is to make a prism wedge of angle 1°.343 to fit under the base plate of the sundial when it is installed at Cambridge. The extra tilt of the sundial in an anti-clockwise direction about the east-west axis will provide the only visual reminder that it was purpose built for another site. It would require a major modification to the sundial to make the gnomon vertical for Cambridge.

ACKNOWLEDGEMENTS

I would like to thank Miss C. Y. Hohenkerk for helping me explore the geometry of equiangular sundials and for making many useful suggestions and comments, and for producing Figure 1 on the VAX 11/750.

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Margaret Stanier expects to take over the editorship of the BSS Bulletin in April 1997. From April 1997 onwards, please submit material for publication in the Bulletin to:

Margaret Stanier, 70 High Street, Swaffham Prior, Cambridge, CB5 0LD.
Telephone: (01638) 741328; Fax: (01638) 743956

A note of 'Instructions to Contributors' appears in BSS Bulletin 96.2, page 2. Please note that material should be written in English. (Short articles in French or German can be accepted, for translation.)

This year (1997) a number of the Bulletin may appear in July. Material intended for publication in this number should reach the editor by April 30th 1997.

IMMANUEL HALTON

CHARLES K. AKED

In the Journal of the British Astronomical Association 106, 1, published 1996, is an excellent article by Patricia M. Barber on Immanuel Halton and his astronomical and mathematical studies. Included in this article are details of his sundial interests, for he was active in 17th century when dialling formed one of the minor recreations for a mathematical practitioner.

BRIEF BIOGRAPHICAL DETAILS:

Immanuel Halton was baptized on 24th April 1628, being the eldest of ten children of Miles and Dorothy (née Wybergh) Halton, in Greystoke Parish Church, Cumberland. Greystoke is about five miles west of Penrith. He was educated at Blencowe Grammar School. At the age of twenty, in March 1647/8 (old style calendar), he entered Gray's Inn, London; in order to gain a grounding in law to prepare him to administer the family estate.

HALTON'S DIALLING INTERESTS

At Grays Inn, Halton's astronomical interests began to emerge, for in a letter dated May 1650, written to Samuel Foster, Professor of Astronomy at Gresham College, he gave a brief account on the mathematical aspects of calibrating a reflecting sundial - finding the "Pole of the Glasse, . . . the reflected Axis both of the Æquator and Horizon , . . . as also the reflected Horizon, . . . Æquator and Tropicks . . ." and thence "the tracing of their hour-lines" because in our last discourse, there was something started of Reflexed Dialling, the Theories whereof I told you, I thought I could manifest in 2 or 3 Diagrams, and we not having the opportunity *promter locum locum ambulandi datum,* to designe the same, whereof you seemed a little earnest, is the occasion of this . . . (letter).

Halton's 'reflex dial' is what we should today refer to as a reflecting sundial where a mirror is positioned on a window sill to give an image of the sun upon the ceiling or wall of a room. Figure 1 is taken from Samuel Foster's *Miscellanies* Appendix XVI, published 1659, giving details of the device and the *modus operandi* to mark out the dial within the room. Of course most housewives would object to an array of lines on the ceiling and walls, so the wise dialling enthusiast would have confined himself to delineating such a dial within the confines of his study. Halton recognized this and ends his letter by giving details of his much more "house-friendly" reflecting sundial which he was using himself and "which by one single hour-line, (and that placed at pleasure, which will prevent the soiling of Hangings, Cupboards, or such things in a Room), shall most readily give you the hour, and actually (if your Room be large), every day in the year. The instrument - being set near the North side of a Wall or Tower, yet so that the Sun may shine thereon, and the reflection be made in the shadow".

There is no record extant of Halton leaving Gray's Inn but in another letter written somewhere between 1652 and 1659 he states ". . . not had the conveniency for using that great brasse Quadrant, near four feet Radius . . . and which indeed . . . was importable (not portable), for those reasons I took occasion to part with it, yet now I fancy to my selfe I have so much of Vacation, as by turns to observe the Sun's Somer Solstice, and Æqinoxes.

The year 1652 saw the death of Immanuel's father Miles and his burial at Greystoke. In the same year the Earl of Arundel died, and the son Henry Howard assumed the responsibility of the Arundel estates although not the eldest son, because of the incapacity of his eldest brother. Through family connections, Immanuel and Henry probably knew each other and were of the same age. On Immanuel's memorial inscription in South Wingfield Parish Church, Derbyshire, it states that on his return from Holland he "Served that Noble Person in the Station of Auditor for the space of XX years".

On 13th February 1659/60, Immanuel married Mary Newton, daughter of John of Oakerthorpe, Derbyshire Eventually they went to live in Wingfield Manor although it was partly ruinous through being partially dismantled in the Commonwealth period. In 1678 Immanuel actually purchased the house.

JOHN FLAMSTEED

Flamsteed as a youth lived at Denby, near Derby, about twelve miles south of South Wingfield. He was a self-taught astronomer and was introduced to Immanuel Halton by Flamsteed's cousin Wilson. In Flamsteed's words - "At Lenten Assizes, 1666, on the Sabbath, after the evening prayers, I was visited by Mr. Immanuel Halton of Wingfield Manor . . .".

Flamsteed showed Halton his mathematical papers on astronomy, which naturally interested him greatly. They found they had a mutual interest in solar astronomy, and when Flamsteed calculated the partial eclipse of the solar eclipse of 1662, and recorded observations of the solar eclipse of June 22nd, 1663 (Julian Calendar, July 2nd Gregorian calendar), at 6.44 am. It is the early bird . . . Obviously solar eclipse were more common in those days for another occurred on October 25th 1664. But Flamsteed was not to become the first Astronomer-Royal for another nine years, being appointed in 1675 by Charles II, the year before Greenwich Observatory was built.

Whilst still an amateur astronomer Flamsteed carried out the observations which allowed him to calculate the exact length of each solar day. The results were embodied in a three-page letter (written in Latin) to Immanuel Halton regarding the inequalities and equations of the natural days. After the latter's approval, the tables were printed. Not surprisingly, for a first attempt, there were a few errors.

In a letter of Christmas 1673, Flamsteed wrote "Lately in discourse with Mr. Halton, he was pleased to shew me a straight-line projection for finding the hour by inspection, the sun's declination and height being given, but concealing the proportion from which it was derived,gave me occasion to vary it . . .". The elevation of Flamsteed to the post of Astronomer-Royal lead to a reduction of correspondence with Halton.

HALTON'S SUNDIALS

When Halton first went to live at Wingfield Manor, he converted the old Banqueting Hall into a residence for his family, and here he placed sundials on either side of the arched doors. They must have been merely painted on the stone, for in the photographs examined by the writer, only the gnomons remain to tell the story of what was once delineated there, it has not been possible to find suitable illustrations for the dials.

VADE-MECUM DU GNOMONISTE

3.5 INCH DISKETTE IN FRENCH BY M. PIERRE JOSEPH DALLET

This admirable and truly comprehensive set of programs compatible with DOS or windows, covers the design of a wide range of sundial types and also includes an Astronomical Section with valuable solar information.

Dial types included rectangular horizontal, vertical and declining dials; polar, analemmatic, scaphe and bifilar types and also Dials based on altitude or azimuth including a so-called Pyrennean Shepherds Dial. The Dials could be reproduced graphically on the Screen or printed in the form of Tables ready for plotting. A wide choice of Hours was available for the Dials including Sun (described as "True" in the programs), Greenwich and even the historic Babylonian, Italian etc. Hours.

The Astronomical Section gives details of the sun's position (altitude, azimuth, declination etc.) for any given date, time and location with times of sunrise, sunset and meridian transit. The Section also includes other items of astronomical interest including the Julian Day, Year Day and the Zodiac signs and Seasons.

There are two main difficulties in trying to assess a Program written in an unfamiliar language. Firstly one has to wrestle with the language itself, armed in the reviewer's case only with all-but-forgotten schoolboy French. Then there is the difficulty of trying to interpret technical conventions and symbols in the programs which so often differ from country to country. The second of these was perhaps the more difficult in the present instance and prevented the successful penetration and interpretation of about one third of the available programs.

The reviewer spent several days trying out the various programs which yielded to his efforts and comparing them with programs gathered from his own and other sources. He was pleased to find very satisfactory agreement throughout.

He was particularly interested to note the Author's treatment of plane rectangular dials of all types, first by pre-determination of the dimensions of the enclosing rectangle and then by plotting the hour angles linearly as x and y co-ordinates along three sides of the rectangle. The shadow angles were also recorded on the tables of results and provided a useful method of checking the xy co-ordinates. The Reviewer has been using a similar - though not identical - method for some time past and again found very satisfactory agreement. The Author's method, which is at present restricted to hourly divisions on the sides of the rectangle, would be further enhanced by additional subdivisions of the time (1/2 hour, 1/4 hour etc.) as could readily be achieved.

M.Dallet is to be congratulated on his set of programs which he charmingly dedicated to all lovers of sundials and on which he has invited comments. The reviewer will be accepting his invitation.

PETER LAMONT

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BOOK REVIEW

MATHEMATICKA GEOGRAFIJA SA GNOMONIKOM. Milutin Tadić. 292 pages. Many illustrations. Thin card covers. 29 x 20.5 cm. Publisher - ABC grafika, Beograd (Yugoslavia), 1996. ISBN 86-7563-042-3. UDK 528.2 (075.8), 529.78 (075.8).

The receipt of this book was the first intimation to the reviewer that Dr. Milutin Tadić and his family had survived the recent war in Yugoslavia, although they are now classed as "refugees", having lost everything in the war. He now teaches Mathematical Geography and Cartography at the University of Pristina. This good news of Dr. Tadić's survival gave great personal pleasure to the reviewer.

The meaning of the title is "Mathematical Geography with Gnomonics", the book being written in the Serbian language. Chapter 1 deals with the basics of Spherical Trigonometry, the next 12 chapters dealing with its use in calculations of the surface of the globe in geometric-geographical terms.

Page 232 opens the gnomonic account and it is good to see that Dr. Tadić still retains his sense of humour, for he has included cartoons to lighten the text. His treatment of dialling is standard but he has illustrated his account with actual sundials he has designed and made himself. Practical details of construction are included, with such items as finding the declination of a wall. This chapter comprises a book within a book.

There is a page of bibliographical references, many of which are unknown to the reviewer who has compiled a list of 3,000 references himself, the largest in the world. It goes to show the futility of any single person trying to deal with such enormous masses of material on his own.

On page 279 is a list of dialling terms in Serb, English and Russian. One might suppose that some of the text can be unravelled with the help of this guide. The Serb term for sundial is sunčanik, gnomon is unchanged, izlazak sunca is sunrise. The diagrams are in a universal language.

If the work was in the English language, the reviewer would unhesitatingly recommend purchasing it, but he fears the Serbian language is an insurmountable barrier to an English reader. The Editor can supply Dr. Tadić's address to members.

READERS LETTERS

SCOTTISH SUNDIAL

A friend in Coupar Angus (3° 16' W and 56° 33' N) has a brass horizontal sundial with a broken gnomon, which used to be in her garden. It is severely worn but the date is clearly readable as 1770.

I enclose a part drawing of the dial which records as much as I can decipher, (cannot be shown as it covers an A3 sheet). I am puzzled that the engraved Longitude and Latitude do not match the location where it was said to be sited Lat 56 Deg. and Long 2 Deg. I make this position to be somewhere in the North Sea of Arbroath. The maker's name is too badly weathered to be read, all that is visible is John Ju . . . , and Tou . . Mil . . Ho . . . , 1770. The dial bears a motto in copper plate script - "O Precious Time that Waiteth None but Swift doth fly away, Thy Chariot Wheels Run very Fast to Bring the Later Day".

The month divisions are marked 0-31, and I guess the "sun slower" and "sun faster" are to indicate how much the dial is ahead or behind clock time. A curious feature is that the Roman hour numerals use 1111 for 1V and 1 1 with a thin oblique line through them for X. The gnomon was elaborately engraved and shows evidence of possible gilding.

The dial plate was removed after vandalisation of its pedestal. It would be nice to know what best to do with this unusual sundial.

FRANK COE

EDITOR: I have replied to Mr Coe's letter. As on the dial the time of noon for London is shown five minutes before local solar noon, the dial is obviously intended to be West of the Greenwich Meridian, hence not in the North Sea. Unfortunately Gibraltar is shown as 5 minutes after noon; but as there is about 5° of latitude between London and Gibraltar, there should be a time difference of about 20 minutes and not 10. As noon is equidistant from these indications, the dial is intended for 2.5° West on the mainland.

The motto fills me with misgivings, one would expect a sundial delineated as well as Mr. Coe outlines on his drawing, to be furnished with a Latin motto or more in keeping with its quality, the one given seems Victorian. The copper plate writing of the motto is of Victorian origin too. It is traditional for clockmakers engraving sundials to use IIII on sundials instead of IV.

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CROSS DIAL, BRAMDEAN

Readers may have been mystified by my opening paragraph in my article on the Bramdean Cross Dial in Bulletin 96.3. The following information may help put this in perspective.

I write a regular 'sundial corner' for the British Society for the History of Mathematics (BSHM) Newsletter, and am responsible for the printing and distribution of the magazine. The spring 1995 edition featured an article on the Saxon sundials of Hampshire, and I was going to follow this with an article on scratch dials, the cross dial struck me as of being of more interest to the target audience. This explains the mathematical references and requests for the 'Old Sundials' cigarette cards (I do not expect BSS members will wish to part with any!).

The information received about William Legge (1803-1872) mentioned that he was educated at Christchurch, Oxford, from 1821-1827, and was Rector of Ashstead, Surrey, from 1826 until his death in 1872. Why his memorial took on such an exotic form remains a mystery.

One BSS member, Colin Lindsay, provided me with a list of cross dials in the UK which is more complete than the only other one I mentioned.

My grateful thanks to the BSHM for giving permission for the article to be reprinted in the Bulletin. The annual subscription to the BSHM is £12 (retired or student membership £6). Enquiries should be made to the Membership Secretary, June Barrow-Green, Faculty of Mathematics, Open University, Milton Keynes, MK7 6AA.

PETER RANSOM

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LIGHTHOUSE SUNDIALS

On the occasion of a visit to Scotland's Lighthouse Museum at Fraserburgh, I was most interested to find three horizontal sundials. It appears the manned lighthouse built before the provision of the BBC time signal was provided with a sundial to allow the keepers to set the station clocks. They were usually mounted on a stone or cast iron column and placed behind the principal keeper's cottage.

From the three sundials on display, I obtained the following:

1. TOD HEAD Lighthouse, Latitude N56o 53', made by Adie and Wedderburn, Edinburgh. (In good condition).
2. GIRDLENESS Lighthouse, no maker's name or details, well worn.
3. KINNARD HEAD, again no details, well worn.

D. SCOTT-KESTIN

EDITOR: For some years I took details of all the lighthouse sundials I came across, unfortunately the only detail I can locate is for DUNNET HEAD, the most northerly lighthouse on the mainland. The dial there had Latitude 58° 40' 12", Longitude 03° 22' 36" but no makers name legible. I contacted the Chart Department and Public Relations Department of Trinity House but never got any answers in spite of promises. There is a similar dial at the nearby port of Scrabster, both being on cast iron columns, and pretty weather worn from being in such exposed positions. The illustration is of the Dunnet Head sundial.

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Editor: The following is a letter sent by the Chief Executive of the Baltic Exchange to our member Mr. John McCrindle, dated 20th June 1996:

Dear John,

I am writing to thank you, on behalf of the Exchange, for the beautiful sundial that you made for our retiring Chairman, Alan Harper.

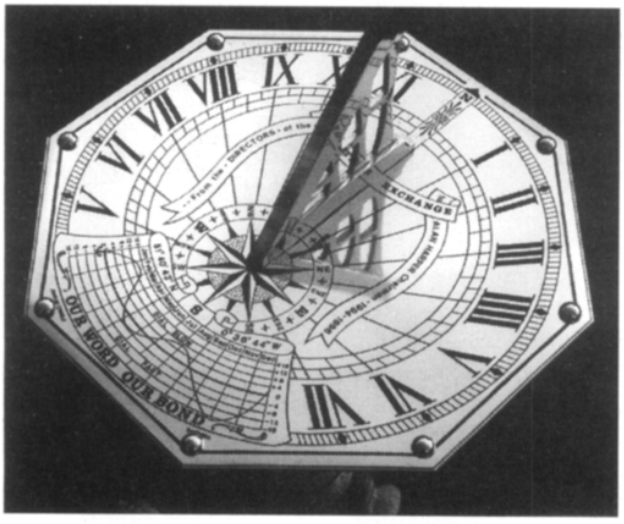
As I told you on the telephone, this is one of the most lovely pieces of work I have seen in a long time. You can imagine the delight as the Chairman and his wife opened this at the dinner on Tuesday night. Everyone was astonished by what you had achieved and thought it was not only a fitting gift but a delightful and permanent way in which Alan could recall his time as Chairman of the Baltic Exchange.

Thank you again for producing such fine workmanship against a very tight timetable. Alan is planning to have lots of fun setting up the dial and I have told him of your offer to chat on the phone if he needs it.

Thank you again for such a superb dial.
Yours sincerely

Jim Buckley, Chief Executive
Baltic Exchange

The illustration shows the excellent workmanship of John McCrindle, the quality speaks for itself.



DOUBLE DIAL

In the main street of Ampleforth, North Yorkshire, the remains of a combined sundial/clock can be seen set into a wall, see photograph. The markings of the sundial are all but extinguished, the clock figures I-XII have fared rather better. Around the large hole which held the clock mechanism is the unnecessary identification "SUNDIAL AND CLOCK", below is the motto: "TIME IS SHORT, DEATH IS SURE, THEREFORE PREPARE TO MEET THY GOD".

No one can remember when the curious combination was last in working order.

Margaret Whitaker

EDITOR: Judging by the way the sundial hours have disappeared, it seems it must have been delineated for temporary hours only. Does anyone have any knowledge of this apparently unique example.

A POTTER'S PEDESTAL

It is the pedestal, the creation of amateur potter Elizabeth Smith that warrants the sundial being shared with BSS Bulletin readers. It consists of three separately fired cubes, upper and lower about a foot cube. The centre one is reduced slightly in size to avoid what would otherwise be a rather less interesting monolith.

The heavily "grogged" clay, giving a pleasing texture and colour, and the high firing temperature have ensured frost protection.

Belloc's amusing couplet (less 'and'), "I am a sundial {and} I make botch of what is done far better by a watch", is ingeniously presented to be sorted out by the viewer. The applied lettering is inventively designed and more stylish than any sketch can convey.

The sundial stands in Mr. and Mrs Smith's delightful garden in Hampshire, I wonder what other uniquely designed pedestals await discovery.

FRANK POLLER

DIALOGUE

DE ZONNEWIJZERKRING

Bulletin 97.1 opens with an account of the meeting at Utrecht on 21 September, 1996, which was attended by 25 members. A member is studying Greek and Roman sundials and hopes to publish the results of his researches in due course. A sundial exhibition is planned for the Mensinge museum in Roden, opening at Whitsun and closing mid-September, 1997.

A description is given of three horizontal sundials made in the eighteenth century by Anton van Cuyck. These were made from a metal alloy of 60% lead and 40% tin (a form of pewter), it is now beginning to disintegrate. The author traces the history of the maker and describes the area where the dials were made.

A sundial on the tower of Vlaardingen Church is described, with a discussion on whether it is correctly delineated for its setting. There follows a note on a Little Ship of Venice sundial in the Museum of the History of Science at Geneva. A commentary of the West Church at Amsterdam is given, this was the official meridian of the Netherlands prior to 1937.

A mathematical discussion on the use of a cycloidal gnomon for horizontal sundials is given, followed by notes on sundials employing crossed wires. A further dial, without a gnomon, using Flexiglass with a mark on it, casts a time indicating a shadow on white paper placed on a windowsill.

A sundial using the French Revolutionary Time System is discussed, a drawing of it is provided. On 20th September, 1996, a sundial was placed high on the Martini Tower in Groningen.

The list of fixed sundials in the Netherlands continues, each example is described briefly and this section is followed by a review of current dialling literature occupying eight pages, the BSS Bulletin is adequately covered with regard to contents.

Tables of the Equation of Time and the sun's Declination for 1997 are included. A list of the articles in Bulletins 95.1 to 96.3 conclude the issue.

E. J. TYLER

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ASTRONOMIA

This is the journal of the Unione Astrofili Italiani based in Padova, Italy. A small section is devoted to the activities of those interested in gnomonics. The September/December issue contains an account of the VII seminar on gnomonics held at Bocca di Magra on the 29th - 31st March, 1996. Much of the account is concerned with the use of the Internet and the site run by the gnomonics section of UAI. Nine regions of Italy have been given co-ordinators to look after the gnomonic interests. Further information can be obtained from:

Francesco Azzarita, Via Fanelli 206/M, 70125 BARI (e-mail: azzarita@teseo.it).

A second article deals with a review of literature and the formation of a National Archive of Sundials proposed by Nicola Severino of Roccasecca. Again it seems that this will eventually be available on the Internet.

For details contact:

Mr. Nicola Severino, Rassegna UAI Stampa sulla Gnomonica, Via Lazio 6, Roccasecca Statione (FR)

If you write to him in English, use short and simple sentences, he is in the process of learning the language.

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ANCAHA

In the Autumn/Winter 1996 issue of the French ANCAHA Bulletin No. 77 (the title cannot be given the full for it is impossibly long), is an article entitled "The 'Solar Ship' of Autoroute A9". this describes a monumental sundial which, by its shape and size, conjures up the appearance of a ship. The dial has a diameter of 26 metres, so it is on the large scale. Odile Mir was responsible for the sculpture. Denis Savoie for the gnomonics, and Robert Queudot for the engineering.

The dial has two styles separated at some distance from the dial itself, so it is really two dials, one for the morning and one for the afternoon. It was inaugurated in October, 1993. Details of the monumental sundial and the illustrations take only three pages, the rest are devoted to informing the reader of the corrections to obtain French legal time from the local solar time indications, i.e. Equation of Time, Longitude correction and to allow for "Summer Time". This is probably necessary for the Bulletin and is intended for clock and watch enthusiasts who are not familiar with the principles of sundials. A brief glossary of terms follows and illustrations of the various types of dials.

Like the sundial, the article is in two parts. A colour illustration is given on the cover, it really is a most impressive structure. No risk here of any vandal wrenching the gnomons off unless he has a pound or two of Semtex. In size it is reminiscent of the instruments of Jai Singh but of infinitely clearer indications. It really is a most splendid solar instrument, worthy to stand amongst the very best created in this century, and a great credit to its designers and makers. It is a tribute to the Spirit of Mankind.

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SOCIETE ASTRONOMIQUE DE FRANCE

Bibliography Gnomonique No.16 for September, 1996, lists a great many articles in various journals, with a very full listing of the articles appearing in the BSS Bulletin, mostly from February, 1995, onwards. It really brings home the vast amount of information contained in the BSS Bulletin over the years. A list is given of the sundial searchers and 143 of these have examined 16,167 sundials!! Of these 10,755 examples were different, obviously some overlap is inevitable.

The nineteenth Conference of the Commission des Cadrans Solaires was held 12th October, 1996, in Paris. Many speakers gave short lectures on a variety of gnomonic topics. In the afternoon M.De Graeve, from Belgium, spoke about the construction of 12 sundials at Gens in the province of Linbourg. 30 projects were examined by the selection jury on 30.10.1996. It was hoped to get permission to print a catalogue containing 9403 dials. later there was the projection of a great many transparencies.

A list of the 116 members of the Commission des Cadrans Solaires is given, plus a map of the whole of France divided into regions and the number of sundials in each of them, this includes Corsica which has 32. Another map of France shows the distribution of sundials by number in a Department. In another list showing the contributors, there are three names who have garnered details of over 1500 sundials each.

This is the first Bibliographie Gnomonique received by the Editor. It illustrates the intense level of gnomonical activities in France by a very limited number of enthusiasts.

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ZONNETIJDINGEN

Issue 96.03 from the Belgian Sundial Society (another BSS) contains 18 pages, 3 of which are blank. The first article by P. Oyen, deals with the construction of a sundial with equal angle hour lines and a shadow projector of two rods at right angles placed a few inches away from the dial plane. The intersection of the two shadows is the point of indication, corresponding to a point gnomon.

The second article is concerned with a horizontal sundial at the Vivat Foundation which is a home for mentally handicapped adults, and which celebrated its 20th anniversary in 1996. The sundial was designed by Julia Lyssens in co-operation with Patrick Oyen: the patients helped to make the ceramics parts of the sundial. The hour numbers very from light to dark to indicate the passing day, and against each hour is shown the activity which the patients should be engaged in, since this is more meaningful to the patients who have no concept of a time system. Nevertheless an Equation of Time Table is included and the formula for obtaining Central European Time is shown which demands a certain amount of mental agility.

The third article is Part 1 of four instalments, and deals with Elliptical, Circular and Linear Dials. It is a treatment of the analemmatic dial so that it can be set upon any plane, with a style set in any direction. First the analemmatic dial upon a horizontal plane with a style pointing north is dealt with, the treatment being mathematical. This leads on the case of the horizontal plane with a declining style, and finally the construction of the axis of symmetry. Any BSS member who would like a copy of the English version, contact the Editor, enclosing a pound remittance to cover costs.

An article by R. J. Vinck deals with the setting out of a horizontal dial and an analemmatic dial. It was strange to see a review of the book on German and Swiss Sundial co-authored by Philipp, Roth, and Bachmann, for it is now two years since it appeared. Then follows a short article on Datum Lines, e.g. Greenwich, and time zones, all essential for diallists in order to show the correct clock time from local solar time. Another book review follows this - *Cadrans solaires des Haut-Alpes*, it is a 16 page pamphlet issued by the Department of Tourism. Three dials are shown as examples.

Page 14 gives details of a visit to Rupelmonde by De Zonnewijzerkring on 22nd June, 1996. The BSS Bulletin, NASS Compendium, and other journals, are mentioned but not reviewed. Finally, on page 15, details of a number of sundials in Vlaanderen are listed but with no illustrations. Pages 16-18 are blank, whilst the rear inside cover lists the officials and addresses of the Belgian Society.

Altogether a clearly set out and attractive Bulletin.

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ANALEMA

This is the Bulletin of the Spanish Association of the Friends of Sundials based in Madrid. Issue No. 17 for May-August 1996 contains another interesting collation of dialling articles. The reason why the Editor can detail these with confidence is not a growing understanding of the Spanish language, but because page 2 is devoted to "Abstracts" provided in the English Language.

Page 3 commences with an account by M. M. Valdes of the hours of Monks Prayers, he investigates the hour by hour timetable of the Benedictine Order adopted in 1120. But these rules became less effective with increasing latitude and the monks had to find other devices to be able to know the time, besides the ubiquitous mass dial.

Nothing new under the Sun? A metric ribbon like a dressmaker's tape, graduated with linear values of tangents and cosines has been devised for setting out sundials declining up to 70° in a few minutes. Ingenuity at its very best.

C. Esteve Secali presents a comprehensive description of the sundial at the Monastery of San Jeronimo. It is a triple dial with three orthogonal gnomons. It was made in the year 1763 and is signed Airaldo, perhaps a Latinised version of Ayrault, a French priest who became a victim of the French Revolution. This sundial has never been reported before.

Gnomonics in verse by P. Dantillo is extraced from the work *Varia Commesuración para Esculatura y Arquitectura* published in 1585 and in many editions up to 1773. Chapter VI is devoted to sundials and the author versified the dialling rules.

A short article give formulae to convert horizontal equatorial coordinates and vice-versa. A. de Vicente gives his first article on his new vectorial gnomonic theory, a delight for mathematically inclined gnomonists. It all looks very promising.

There is a page giving the values for the Equation of Time and Declination for 1977, calculated by the ubiquitous M. M. Valdes.

There is much more in the issue, space precludes further details.

MWS

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Mr. Charles K. Aked
54 Swan Road
WEST DRAYTON
Middlesex UB7 7JZ
[Editor]
Tel: 01895 445332

Mr. Graham Aldred
4 Sheardhall Avenue
Disley
STOCKPORT
Cheshire SK12 2DE
[Council Member]

Mr. John Churchill
55 Rushington Avenue
MAIDENHEAD
Berkshire S16 1BY
(01628) 27882

Mr. C. St. J.H. Daniel
57 Gossage Road
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Tel: 0181 3178779

Wing Cdr. John Ingram
Polnish
40 Imber Road
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Mr. E.R. Martin
West Lodge
Thicknall Lane
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Tel: 01562 882709

Mr. R.A. Nicholls
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Mr. P. Nicholson
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[Membership]
Tel: 01229 889716

Mrs. Jane Walker
55 Sevenacres
SOMERTON
Somerset TA11 6HG
[Education]

Miss R. J. Wilson
Hart Croft
14 Pear Tree Close
CHIPPING CAMPDEN
Gloucestershire GL55 6DB
[Sundial Makers]
Tel: 01386 841007

Dr. I.D.P. Wootton
Cariad Cottage
Cleeve Road
GORING-ON-THAMES
Oxon RG8 9BD
[Registrar]
Tel: 01491 873050

Mr. D.A. Young
Brook Cottage
112 Whitehall Road
CHINGFORD
London E4 6DW
[Secretary]
Tel: 0181 529 4880

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