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Το Βυζαντινό Ωρολόγιο και Ημερολόγιο

The Byzantine Portable Sundial-Calendar

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- Παναγιώτης Παπασπύρου, Εθνικό και Καποδιστριακό Πανεπιστήμιο Αθηνών
  Panagiotis Papaspirou, PhD candidate of the Section of Astrophysics, Astronomy and Mechanics of the Department of Physics of the National and Kapodistrian University of Athens.
  e-mail: p.papaspirou@academy.edu.gr
- Διονύσιος Κριάρης, Μαθηματικός, Κατασκευαστής Λειτουργικών Αντιγράφων Αρχαίας Ελληνικής, Ελληνο-Ρωμαϊκής, Βυζαντινής και Αραβικής-Ισλαμικής Τεχνολογίας.
  Dionysios Kriaris, Mathematician, Manufacturer of Functional Instruments of Ancient Greek, Greco-Roman, Byzantine and Arabic-Islamic Technology.
  e-mail: d.kriaris@academy.edu.gr

Περίληψη

Το Βυζαντινό φορητό ηλιακό Ωρολόγιο – Ημερολόγιο, το οποίο περιέχει μηχανισμό με γρανάζια, ανήκει στα σπουδαιότερα ιστορικά ευρήματα, και έχει την δύναμη να εντυπωσιάζει τόσο τον ερασιτέχνη, όσο και τον επαγγελματία ιστορικό και φιλόσοφο της επιστήμης, της τεχνολογίας και της πληροφορικής. Η σπουδαιότητα του οργάνου οφείλεται στην εμφάνιση του ενσωματωμένου σε αυτό αστρονομικού μηχανισμού με γρανάζια, η δεύτερη ιστορικά καταγεγραμμένη εμφάνιση ενός τέτοιου αστρονομικού υπολογιστικού μηχανισμού, ο οποίος ακολουθεί σε εμφάνιση, μετά τον περίφημο Μηχανισμό των Αντικυθήρων, αρκετούς αιώνες αργότερα. Ένας παρόμοιος μηχανισμός με γρανάζια απαντάται στον Αραβικό Αστρολάβο - Ημερολόγιο, σχεδόν έξι αιώνες μετά από το Βυζαντινό φορητό ηλιακό Ωρολόγιο – Ημερολόγιο, και στον Γαλλικό Γοτθικό Αστρολάβο, ο οποίος έπεται έναν αιώνα του Αραβικού Αστρολάβου-Ημερολογίου. Αν και ο τύπος του φορητού ηλιακού ωρολογίου στην εμπρόσθια όψη του οργάνου είναι τυπικός για την εποχή του, όσο και για μία ευρεία ιστορική περίοδο, η οποία περιλαμβάνει την Ύστερη Αρχαιότητα και την Πρώιμη Βυζαντινή εποχή, ο αστρονομικός μηχανισμός με διάταξη γραναζιών μας παρέχει τόσο μία ιστορική ένδειξη, όσο και έναν ιστορικό σύνδεσμο, αλλά και μία ιστορική γενεαλογία τέτοιου τύπου μηχανισμών, οι οποίοι προορίζονται για να επιτελούν αστρονομικούς υπολογισμούς. Η γενεαλογία αυτή έχει τις ρίζες της στην Ελληνιστική περίοδο, συνεχίζει στην Βυζαντινή περίοδο και διαδίδεται στον Αραβικό και Ισλαμικό πολιτισμό, ενώ εισάγεται μετέπειτα και στον Ευρωπαϊκό Μεσαιωνικό πολιτισμό. Η τεχνολογική ικανότητα, αλλά και η νοοτροπία, τόσο των κατασκευαστών (ωρολογοποιών), όσο και των χρηστών φορητών συσκευών τέτοιου βαθμού πολυπλοκότητας θα μπορούσε να συνεισφέρει στην αυτογνωσία της δικής μας αναπτυγμένης τεχνολογικής εποχής, μίας εποχής ραγδαίας μετάβασης προς μία νέα τεχνολογική επανάσταση, η οποία συγκρίνεται μόνο με την Βιομηχανική Επανάσταση.

Summary

The Byzantine portable sundial with calendrical gearing belongs to the most important historical findings, influencing both the interested layman and the professional historian and philosopher of science, of technology and of informatics. The reason of its importance is the appearance of the gear mechanism embodied within the instrument, the second-oldest historical appearance of such an astronomical computing device following several centuries later the famous Antikythera Mechanism. A gearing of the same purpose is found on the Arabic Astrolabe-Calendar, almost six centuries after the Byzantine Sundial-Calendar, and on the French Gothic Astrolabe, which, as an artifact, is dated one century after the Arabic Astrolabe-Calendar. Although the type of the portable sundial on the front face of the instrument is common for its era, and for a broad historical period including Late Antiquity and the Early Byzantine period, the included gear mechanism provides a historical clue, a historical link, and a technological lineage of such gear mechanisms indented for astronomical purposes, which starts from the Hellenistic era, continues to the Byzantine era. and transports to the Arabic and Islamic civilization. From there it is imported to the Medieval European civilization. The technological ability and mentality of both the manufacturers (horologists) and the users of such complicated portable instruments may contribute to the self knowledge of our modern advanced technological era, an epoch of a rapid transition towards a new technological revolution, comparable only to the Industrial Revolution.

Λέξεις-Κλειδιά: Βυζαντινό Ωρολόγιο-Ημερολόγιο, Κάθετο κυκλικό ηλιακό ωρολόγιο ύψους, Αστρονομικός μηχανισμός με γρανάζια, Υπολογισμός αστρονομικών κύκλων, Σεληνο-ηλιακό ημερολόγιο, Μηχανισμός εμφάνισης του Ηλίου και της Σελήνης, Τεχνολογική γενεαλογία αστρονομικών μηχανισμών με γρανάζια

Keywords: Byzantine Sundial-Calendar, Vertical disc altitude sundial, Astronomical gear mechanism, Computation of astronomical cycles, Lunisolar calendar, Sun-Moon display, Technological lineage of astronomical gear mechanisms

1. Description of the Byzantine Sundial-Calendar

> Humanity cannot afford to lose out of its inheritance any part of the best work which has been done for it in the past. All that is most beautiful and most instructive in Greek achievement is our permanent possession; one which can be enjoyed without detriment to those other studies which modern life demands; one which no lapse of time can make obsolete, and which no multiplication of modern interests can make superfluous.
>
> Richard Claverhouse Jebb

> Civilisation loses its treasures by an unconscious process. It has lost them before it has appreciated that they were in the way of being lost; and when I say 'its treasures' I mean the special discoveries and crafts of mankind.
>
> Hilaire Belloc [Ron, 2007]

The reconstruction of the Byzantine Sundial-Calendar from the original fragmentary instrument in 4 pieces, acquired by the Science Museum, London, was performed by M. T. Wright [Field & Wright, 1985a].

The front face of the Byzantine Sundial-Calendar comprises a common and widely distributed type of a portable (travelling) sundial, inscribed with a degree scale for setting to the user's latitude, at the outer rim of the disc, and a month scale for setting the Sun's declination for the time of year, given by two inner concentric circular sectors listing the abbreviations of the names of the months of the Julian calendar, used by the Byzantines. The upper inner circular sector lists the names of the months, from January to June, and the lower from July to December.

The front face of the instrument also incorporates a reference table listing the names of 16 cities and provinces around the Early Byzantine Empire alongside their corresponding latitudes. These circular semi-sectors contain the abbreviation of the town or province, accompanied with its latitude given in whole numbers of degrees and in Greek numerals. A smaller circular scale, offset from the center, displays the days of the week, which are symbolized by the heads of the Greco-Roman god ruling the day (Sun for Sunday, Moon for Monday Mars for Tuesday, Mercury for Wednesday, Jupiter for Thursday, Venus for Friday, and Saturn for Saturday).

The user of the instrument moves a stem in the day scale in order to move the calendar forward each day, engaging the pointing devices on the back face of the instrument for displaying correctly and with considerable accuracy the day of the month, the phase of the Moon (the waxing and waning of the Moon), as well as the position of the Sun and the Moon in the Zodiac, along the 12 constellations, by calculating the value of the tropical year and of the synodic month, correspondingly. The Byzantine Sundial-Calendar comprises two independent parts, or functions, a sundial for use at various latitudes, and a geared calendar device.

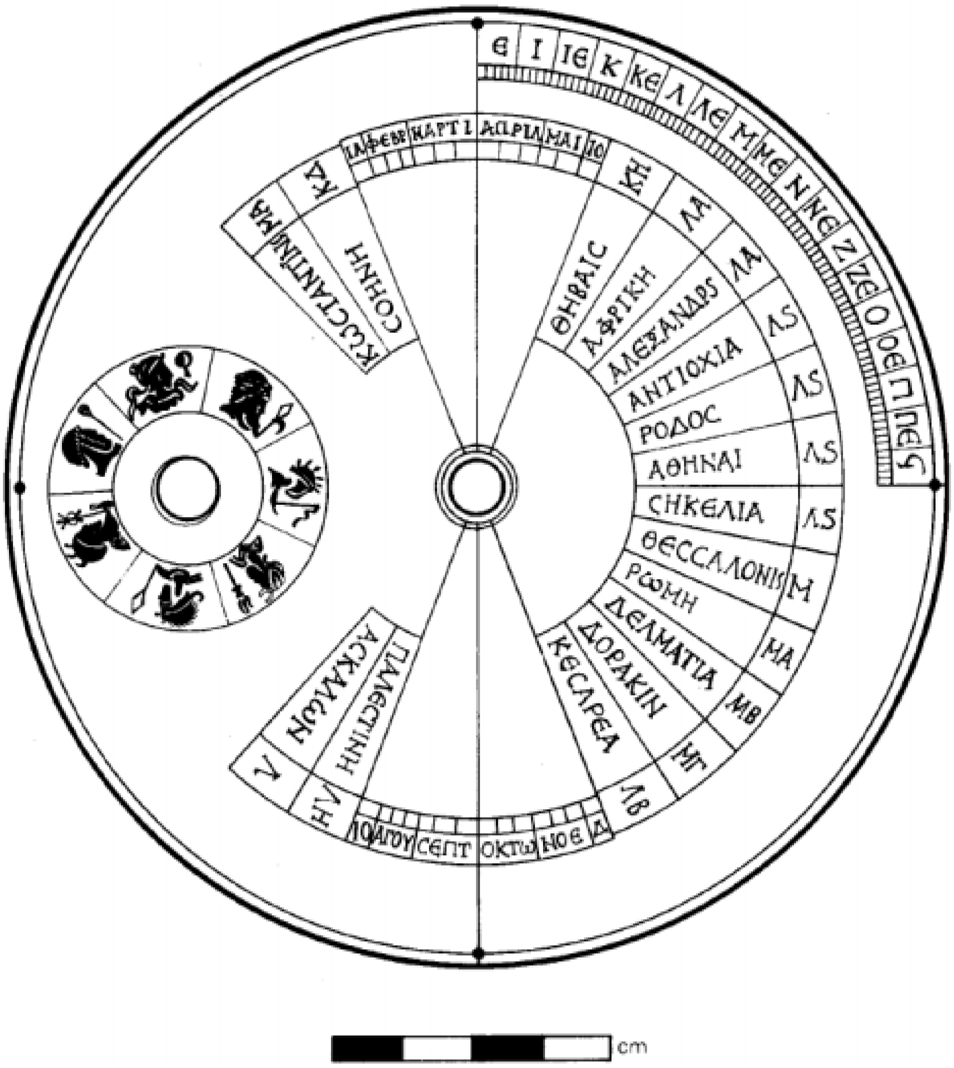

Figure 1: Byzantine Sundial-Calendar, engraved side of front plate [by Field & Wright, 1985a, p.92].

Fig. 2: Byzantine sundial-calendar, front face, (reconstruction and photo courtesy by Dionyssios Kriaris).

Fig 3: Byzantine Sundial-calendar, detail of front face, showing the upper scale of the months from January (IA) to June (IC), (reconstruction and photo courtesy by Dionyssios Kriaris).

Fig 4: Byzantine Sundial-calendar, detail of front face, showing the outer scale given in degrees of latitude, with upper scale for 5^0, and inner scale for 1^{0,}, given in greek numerals. The pointer of the arm of the instrument is set to the degree of the corresponding latitude of the user (reconstruction and photo courtesy by Dionyssios Kriaris).

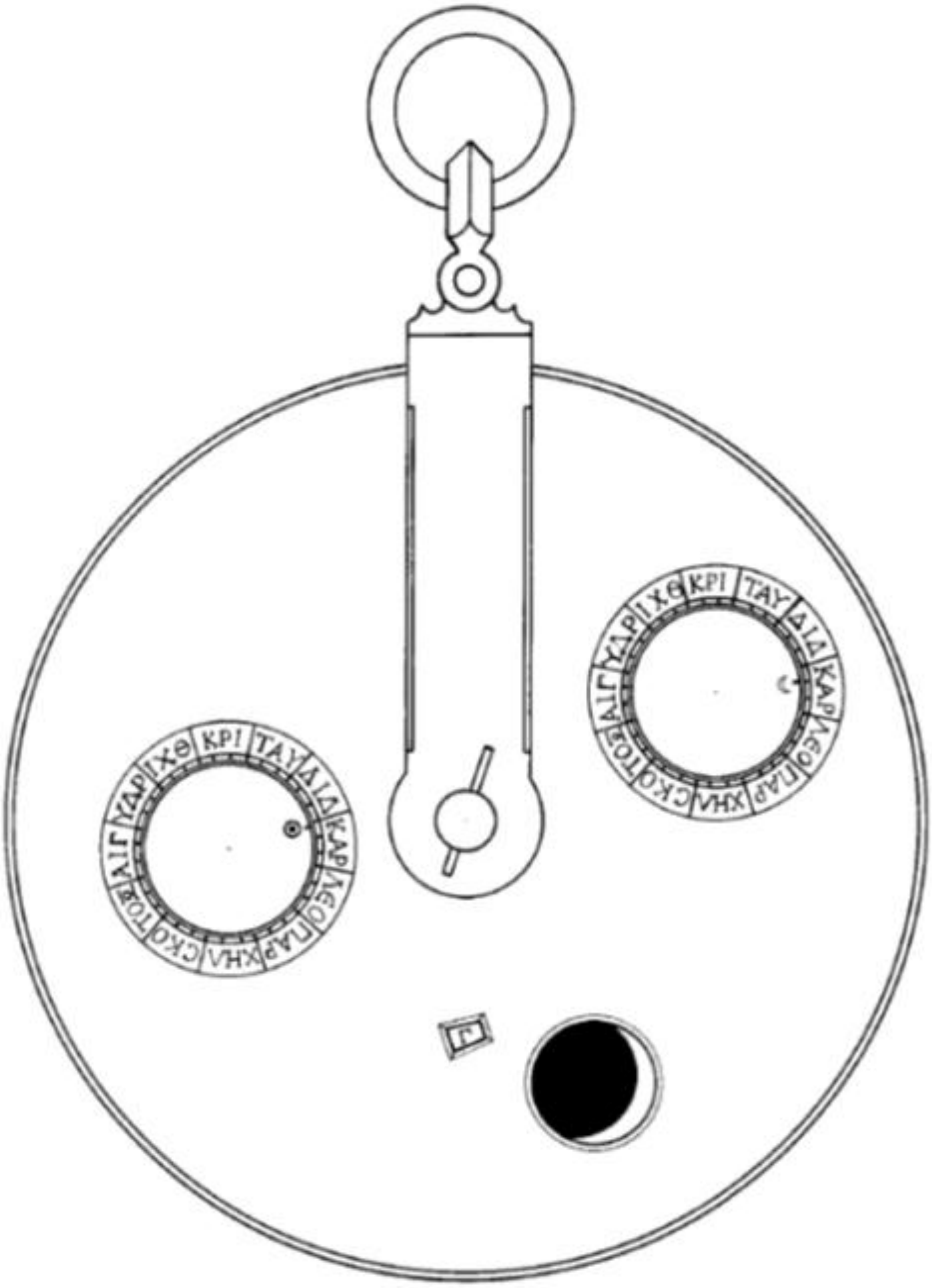

Figure 5: Byzantine Sundial-calendar, conjectural reconstruction of back face of the instrument. The Sun is indicated by the symbol of the circle, the Moon by the symbol of the half-crescent, the Zodiac in both cases is divided in the twelve houses with their abbreviations given in Greek letters, and the phase of the Moon is indicated visually on the lower part of the face. The number of the corresponding day of the month is given within the small box, in Greek numerals [by Field & Wright, 1985a, p.130].

Fig 6: Byzantine sundial-calendar, back face (reconstruction and photo courtesy by Dionyssios Kriaris)

Fig 7: Byzantine sundial-calendar, detail of back face showing the Solar display (reconstruction and photo courtesy by Dionyssios Kriaris)

Fig 8: Byzantine sundial-calendar, detail of back face showing the Lunar display (reconstruction and photo courtesy by Dionyssios Kriaris)

Fig 9: Byzantine Sundial Calendar, photograph of original fragment of the front face of the instrument. © Science Museum / Science and Society. [Alison, B., 2013, April 17].

Fig 10: Byzantine Sundial Calendar., photograph of the original fragment (detail of the gearing). © Science Museum / Science and Society. [Alison, B., 2013, April 17].

2. The Solar-Lunar Gear Mechanism of the Byzantine Sundial-calendar

The calendar Sun and Moon display of the Byzantine Sundial-Calendar has many common features with the corresponding ones found in the Antikythera mechanism [Freeth et al., 2006], as well as in the Arabic Astrolabe-Calendar and the French Gothic Astrolabe. An analogous gear mechanism is analytically presented in the work of Al-Biruni titled as “Book on the Full Comprehensiveness of the Possible Methods for Constructing the Astrolabe” [Hill, 1985].

This general type of astronomical computing devices, together with the examples of the various orreries, by using the same gear planning philosophy and by serving the same astronomical function, belong to the same genus of computing astronomical devices [Lin &Jan, 2016]. They also belong to the same mathematical, astronomical, technical and metallurgical tradition of the Ancient Greco-Roman civilization. This tradition starts already from the Classical and Hellenistic epoch, continues its transmission to the Arabic and Islamic civilization, and flowers up-raptly in the European Middle ages. There, the technology, the know-how and the mathematics of such complicated geared instruments and astronomical clocks plays a crucial role for the Scientific Revolution, the Industrial Revolution and the Age of Sailing [de Solla Price, 1974] by imposing the strict demand of measuring time with great accuracy, and by organizing the role and the function of the state according to the results given by various types of clock devices.

Measuring the motion of the Moon around the Earth relative to the distant stars leads us to the sidereal period, the time required for the Moon to return to the same position against the background of stars, while measuring the motion of the Moon around the Earth relative to the Sun leads us to the synodic period, that is the time between successive recurrences of the same phase of the Moon. The sidereal month, that is the orbital period of the Moon around the Earth, and the synodic month, are of unequal duration due to the unequal time of revolution of the Earth around the Sun. and of the Moon around the Earth. Since the synodic month depends upon the cycle of phases of the Moon, it is simple to observe and measure. The tropical year is defined as as the interval between two successive passages of the Sun through the vernal equinox, which is the period in which the annual cycle of the seasons recurs. The synodic month lasts of about 29.53059 days, the sidereal month of about 27.3229 days, while the tropical year of about 365.24219 days. Since 12 synodic months are short of the tropical year by 10.87 days, long cycles are needed in order to reconcile the lunar and the solar calendars, with the most successful attempt given by Meton of Athens, who worked Euctemon. Taking the synodic month as 29.5 days, and the tropical year as 365.25 days, Meton constructed his cycle based on the assumption that 19 years correspond closely to 235 synodic months, therefore devising a cycle of full 30-day and of hollow 29 months. The Metonic cycle gives a definite rule for the intercalation of moths into a lunar calendar to keep in step with the seasons, and also an improved long-term value for the tropical year [Maran & Ubell, p.92]. These kinematic astronomical characteristics describing the length of the durations of the astronomical cycles of the Sun and the Moon with respect to the Earth play a crucial role for the design of the lunisolar calendars.

They also built the mathematical core for all of the previously mentioned Sun- Moon displays, found in the Antikythera Mechanism [Anastasiou, 2014], the Byzantine Sundial-Calendar, and the Arabic Astrolabe-Calendar. In the case of the Byzantine Sundial-Calendar, and all the other similar astronomical computing devices, the kinematic characteristics of the mechanism generate specific rate of transformations [Lin & Jan, 2016].

The Solar-Lunar gear mechanism uses some basic principles of gear trains. In a simple gear train the axes of rotation of each gear is fixed, and each shaft has only one gear. The addition of each intermediate gear reverses the direction of rotation of the final gear, while in a sequence of gears trained together the ratio, or the final rotation period, depends only on the number of teeth of the first to the last gear [Timings, 2006].

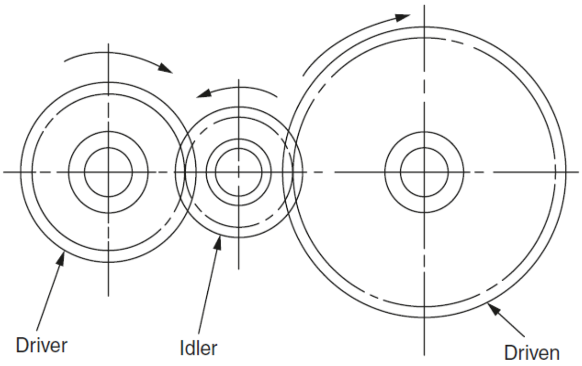

Fig 11: Schematic diagram of a simple gear train. The relative speed of the gears by the fraction between the number of teeth on the driven gear by the number of teeth on the driver [by Timings, 2006].

If any of the intermediate shafts carry more than one gear, then we encounter a compound gear. The number of teeth on the intermediate years will influence the speed ratio of the final gear, which serves the role of the desired output of the device. The use of a compound gear train can multiply the successive ratios of successive paired gears, while the final output value is a successive multiplication of fractions of whole numbers [Timings, 2006].

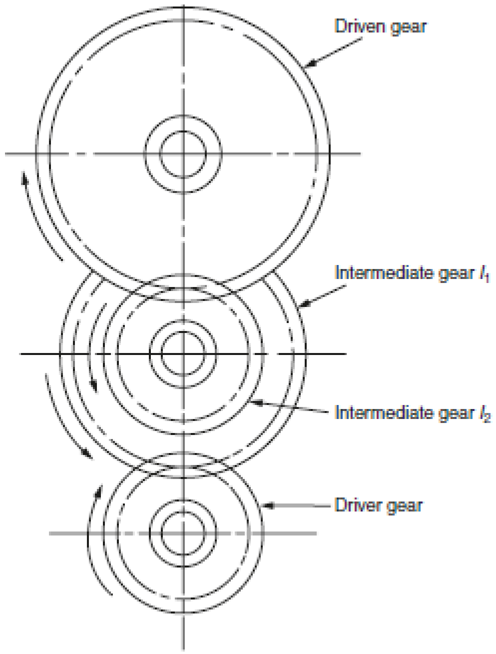

Fig 12: Schematic diagram of a compound spur gear train. The intermediate gears on a compound gear train influence the overall relative speeds of the driver and driven gears, while both intermediate gears revolve around the same shaft and rotate at the same speed [by Timings, 2006].

The gear device of the instrument expresses the length of the tropical year, the length of the synodic month, as well as the phases of the Moon. The user of the instrument can move a stem in the day scale in order to move the calendar forward each day. This is accomplished by the help of an arbor with a seven-lobed ratchet, and pinions of 7 and 10 [Field & Wright, 1985a].

The Moon gear of the Byzantine Sundial-Calendar for displaying the day of the month has 59 teeth. On the outer margin of the gear Greek numerals from 1 to 29, and then from1 to 30, run. The Moon gear is moved on one tooth each day by the user, making a full rotation in 59 days. This corresponds to two successive synodic months of 29 and 30 day duration respectively. [Field & Wright, 1985b; Wright, 2006].

The Moon in the Zodiac dial displays the Moon traveling around the Zodiac in about 27.3 days by the combined action of a gear mesh of one pair of gears with 10 teeth and 39 teeth correspondingly, driven by the gear with 7 teeth on the input shaft of the instrument. With numbers, this becomes: 39/10 x 7 = 27.3 days.

The Sun in the Zodiac dial displays the Sun on its path around the Zodiac, in its apparent motion in longitude, in 366.42 days. This is achieved by the use of a compound gear train consisting of the Moon gear, with 59 teeth, a gear with 19 teeth arranged on the same shaft with the Moon gear, which drives a gear with 59 teeth. This gear carries a gear with 24 teeth, driving a gear with 48 teeth, the output gear. With numbers, it becomes: 48/24 x 59/19 x 59/7 x 7= 366.42 days.

Both the Moon and the Sun are shown in their apparent motion in longitude.

The Moon-phase display consists of the Moon gear rotating behind an aperture, while the design on the gear is so contrived that as it turns the visible portion gives an approximate representation of the waxing and waning of the Moon. This is the first Moon phase display previously recorded [Wright, 2006].

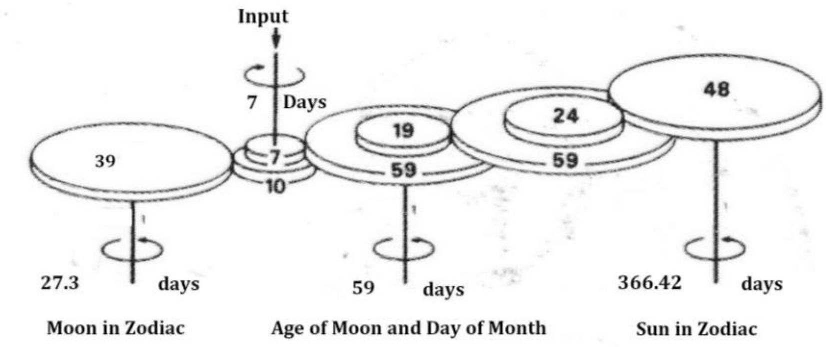

Fig 13: The calendrical gearing of the Byzantine Sundial-Calendar, and its schematic diagram (in modern form) [by Oikonomou, Nikolandonakis &Nitsiou, 2000].

Fig. 14: Byzantine sundial-calendar, front face of transparent model showing the gear device of the instrument (reconstruction and photo courtesy by Dionyssios Kriaris).

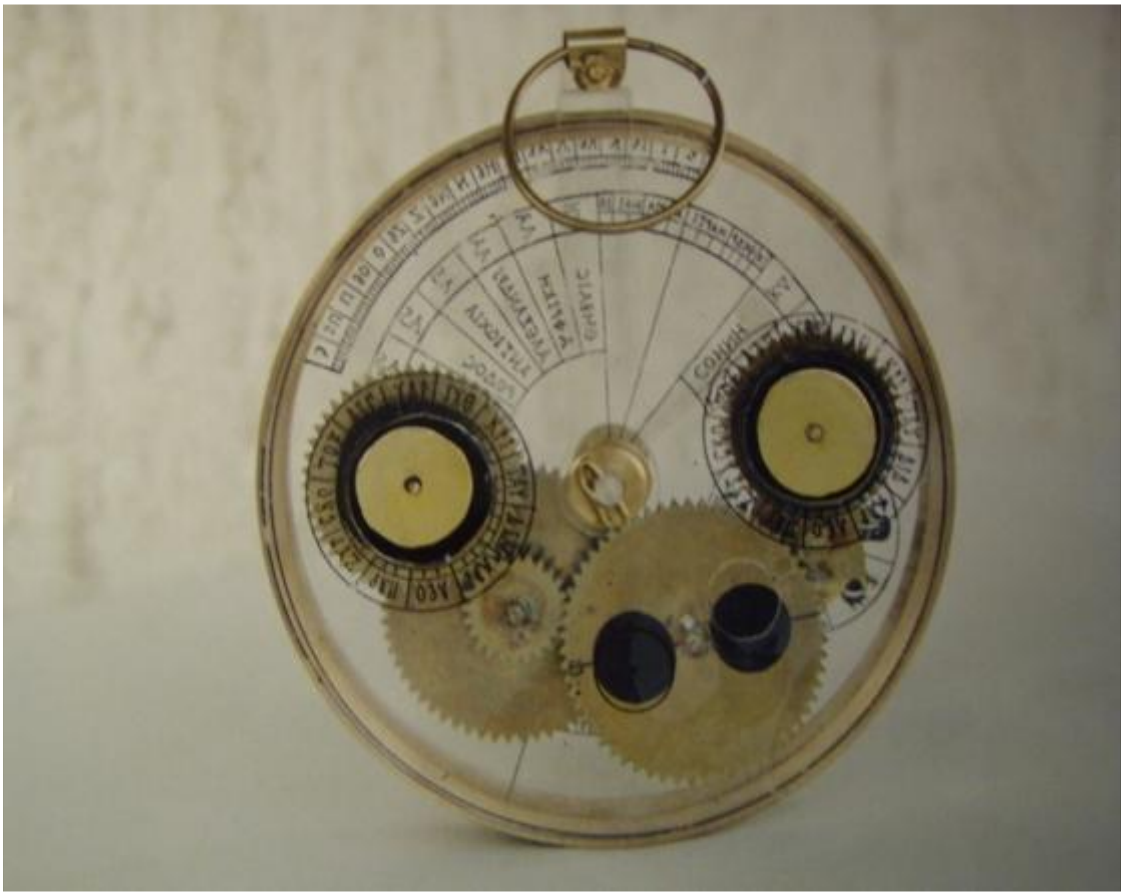

Fig. 15: Byzantine sundial-calendar, back face of transparent model showing the gear device of the instrument (reconstruction and photo courtesy by Dionyssios Kriaris).

Fig 16: The Moon-phase disc of the Byzantine Sundial-Calendar, Science Museum, London, inv. no. 1983-1393. The Greek numerals of the days can be seen on the outer rim of the gear [by Wright, 2006].

Fig. 17: Byzantine Sundial-Calendar, model of the gear mechanism, in 2:1 scale model size (reconstruction and photo courtesy by Dionyssios Kriaris).

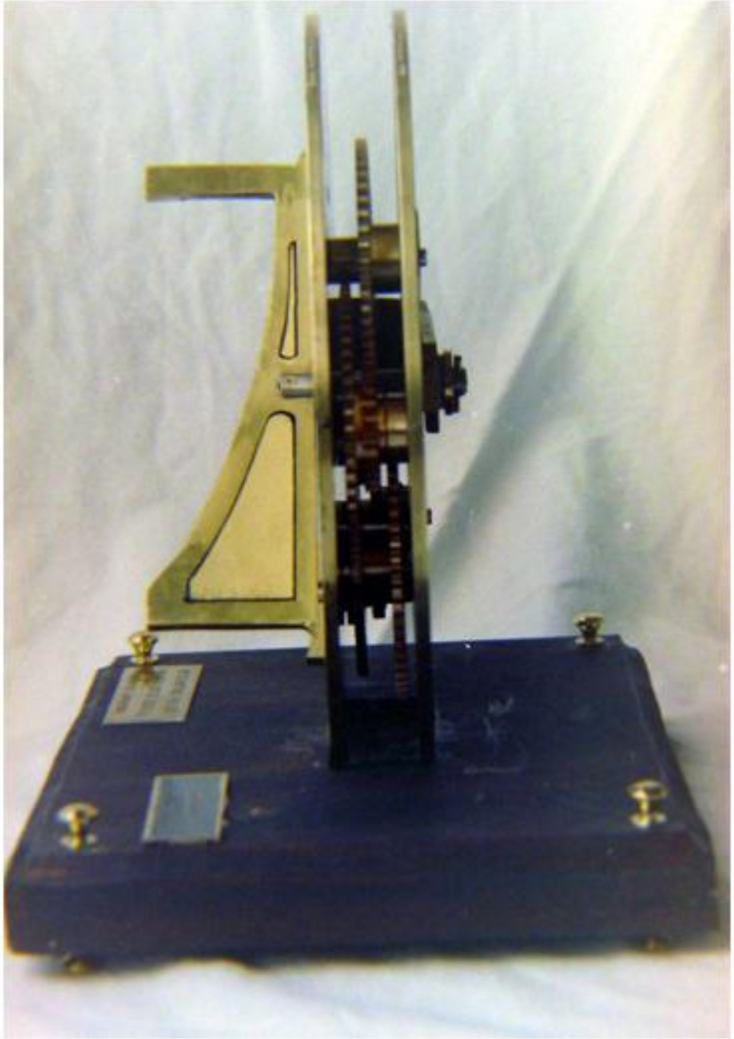

Fig. 18: Byzantine sundial-calendar, perpendicular view of the instrument showing the implementation of the calendrical device, (reconstruction and photo courtesy by Dionyssios Kriaris).

3. The Sundial of the front face of the Byzantine Sundial-calendar

The sundial, by definition, measures solar time by attributing a unit of time to the rotational angle of the Sun to its daily trajectory on the celestial sphere, and this angle is interpreted as time from the lococentric view of the user. The sundials indicate the temporal, or unequal hours, where the day is divided into 12 equal parts, regardless the variation of the duration of the day during the seasons and the months of the calendar. The main components of a sundial are the dial plate and the gnomon (style or shadow-caster), where the shadow of the Sun falls upon the dial table. The sundial plate also incorporates an engraved grid of lines and curves indicating the temporal hours for each day of the month and of the year. The end of the casted shadow of the gmomon meets the lines or curves of the corresponding temporal hours, in order for the user to estimate the time [Savoie, 2009].

The temporal hour lengths depend on the angular distance of the Sun on its daily path between its position at the considered time and its position at noon, when the Sun crosses the local meridian [Szokolay, 2007].

The type of the sundial appearing on the front piece of the Byzantine Sundial-Calendar is attested by a several examples, such as the Roman sundial or the Memphis sundial. This type of portable sundials were widely distributed within the Late Antique and Early Byzantine period. The Byzantine Sundial-Calendar can be classified as a vertical disc dial, and functions as an altitude dial, since the shadow casted by the gnomon on the back of the turnable vane depends on the altitude of the Sun that is of the height of the Sun above the horizon. Its design probably corresponds to the type described by Vitruvius as “pros pan clima”, that is for every latitude, since it can be used for a wide range of different latitudes [Wright, 2000].

This type of portable sundials evolves a vane A, a plane piece embodying gnomon and scale. This stands normal to a disc B, fitted by its pin which passes through the central hole in the disc. The component C is used for the suspension of the instrument, in order for this to hang in a vertical plane [Wright, 2000].

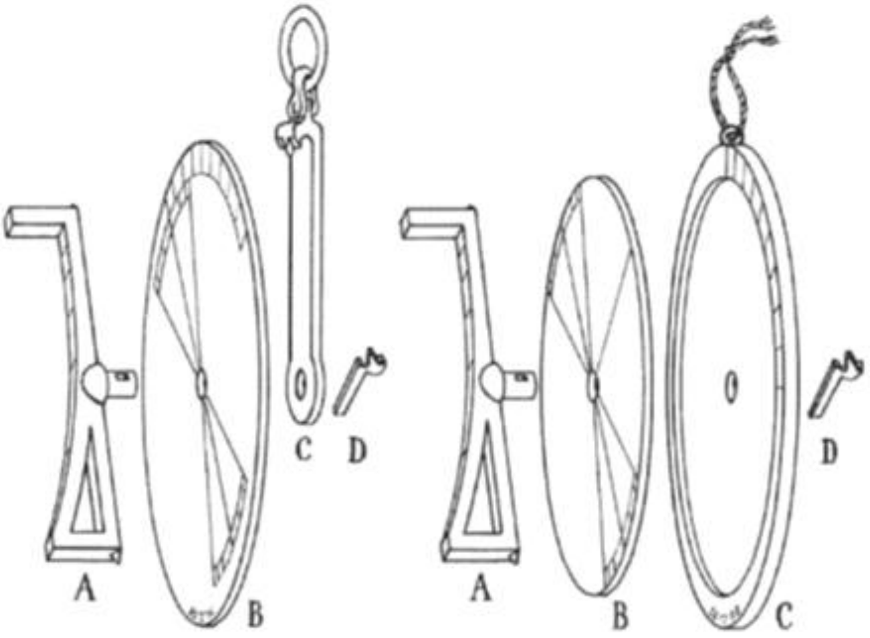

Fig 19: The two forms of the type of the portable sundial appearing on the front face of the Byzantine Sundial-Calendar. The Byzantine Sundial-Calendar belongs to type presented on the left of the figure [by Wright, 2000].

Two separate adjustments are made by the user: The vane is adjusted against the disc, using the double sector-scale laid out on the disc, which is marked out in calendar months, according to the declination of the Sun. The disc is also adjusted against the component C for latitude, by the use of the quadrant scale found on the outer rim of the dial plate. The angle of elevation of the vane equals to the corresponding of the Sun's at noon, for the specific day and place of the observer. The sundial is suspended and turned until the shadow of the gnomon is cast along the scale of the vain for determining the temporal hour. of the day

In the case of the Byzantine Sundial-Calendar the user determines or estimates its latitude, sets the pointer of the arm of the instrument on the correct value of the latitude by reading the outer scale on the front face of the instrument, and then sets the vane on the correct month by the help of the two annuli giving the names of the months of the year. Then, he holds the instrument in a vertical plane, and turns it until the shadow of the gnomon falls on the temporal hour scale, determining the local hour.

The scale on the vane is divided into 6 parts subtending equal temporal hours at the tip of the gnomon. The vane has its upper end, the gnomon, towards South when the disc faces to the East. After noon,the instrument is rotated around a vertical axis, in order for the gnomon to cast its shadow on the scale of the vane [Wright, 2000].

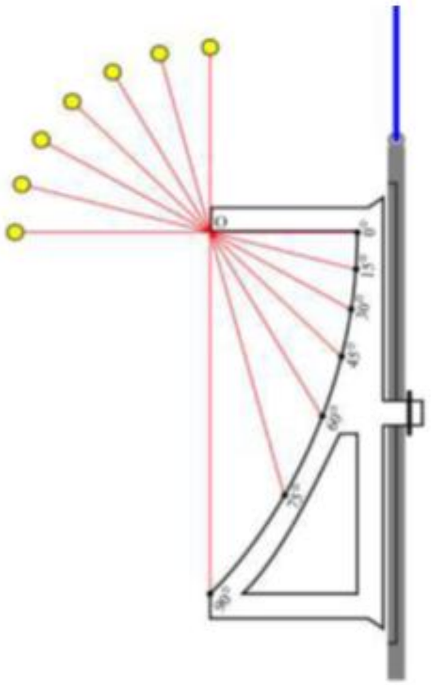

Fig 20: The gmomon assembly (vane and gnomon) of the type of the portable sundial met on the front face of the Byzantine Sundial-Calendar [by Ling, 2015].

The first temporal hour, the first hour of the day after sunrise, corresponds to the angle of 15^0 between the sunray falling at the tip of the gnomon and casting its shadow on the vane, while the angle of 90^0 corresponds to the sixth temporal hour, the hour when the Sun is at noon. The letter O designates upper edge of the gnomon [King, 2015]. We give two examples of such type of portable sundials “pros pan clima”.

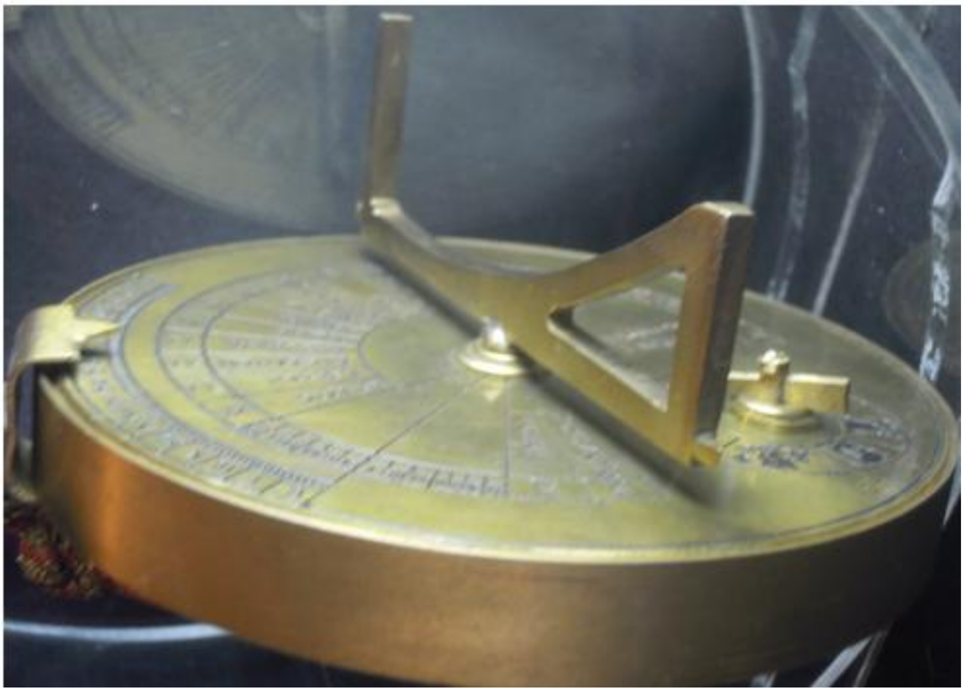

Fig 21: The Byzantine Sundial-Calendar in horizontal view showing the turnable vane, and the dial plate (reconstruction and photo courtesy by Dionyssios Kriaris).

Fig 22: The Roman portable Sundial in vertical view in vertical view showing the shape of the vane with gnomon and other similar characteristics of the dial plate to the Byzantine Sundial-Calendar (reconstruction and photo courtesy by Dionyssios Kriaris).

Fig 23: The Memphis portable Sundial in vertical view showing the shape of the vane with gnomon and other similar characteristics of the dial to the Byzantine Sundial-Calendar (reconstruction and photo courtesy by Dionyssios Kriaris).

4. Descendants of the Byzantine Sundial-Calendar

Al-Biruni's version of the astronomical gear device follows a similar gear design and philosophy, proving the long-termed lineage of such astronomical computing devices, as well as the wide influence of the Greco-Roman tradition in science and technology on the Arabic-Islamic civilization. Al-Biruni is considered to belong among the most important polymaths of all ages, a multifaceted talent, who wrote extensively on astronomy, mathematical geography, mathematics, astrological aspects and transits, astronomical instruments, chronology, comets, religion, history and linguistics, as well as medicine, geology, minerals and gems, and engineering [Hill, 1985; Sarton, 1927]. Among his works, the one entitled as “Book on the Full Comprehensiveness of the Possible Methods for Constructing the Astrolabe” contains detailed instructions for constructing the astrolabe, chapters on conic sections, on the construction of a sophisticated type of compass, as well as the gear calendar, which he calls “The Box of the Moon” [Hill, 1985].

Al-Biruni gives detailed instructions for the construction and for the functioning of the gear assembly, which are almost identical to these encountered in the Byzantine Sundial-Calendar. In his construction the output for displaying the Moon dial gives a synodic month of 28 days, a tropical year of 365.24 days, while the Moon wheel displays two successive synodical months of 29 and 30 days for each month, correspondingly. The face of this cylindrical device contains an alidade, which can be moved forward one step at a day, thus changing the positions of the Sun and of the Moon on the Zodiac, as well as the phases of the Moon. The instrument of Al-Biruni did not contain a rachet, as in the case of the Byzantine Sundial-Calendar. It is also possible for having the device in reverse, since by turning the pointer of the Sun at a particular angle on the Zodiac, the phase of the Moon at a particular day could have been found [Hill, 1985].

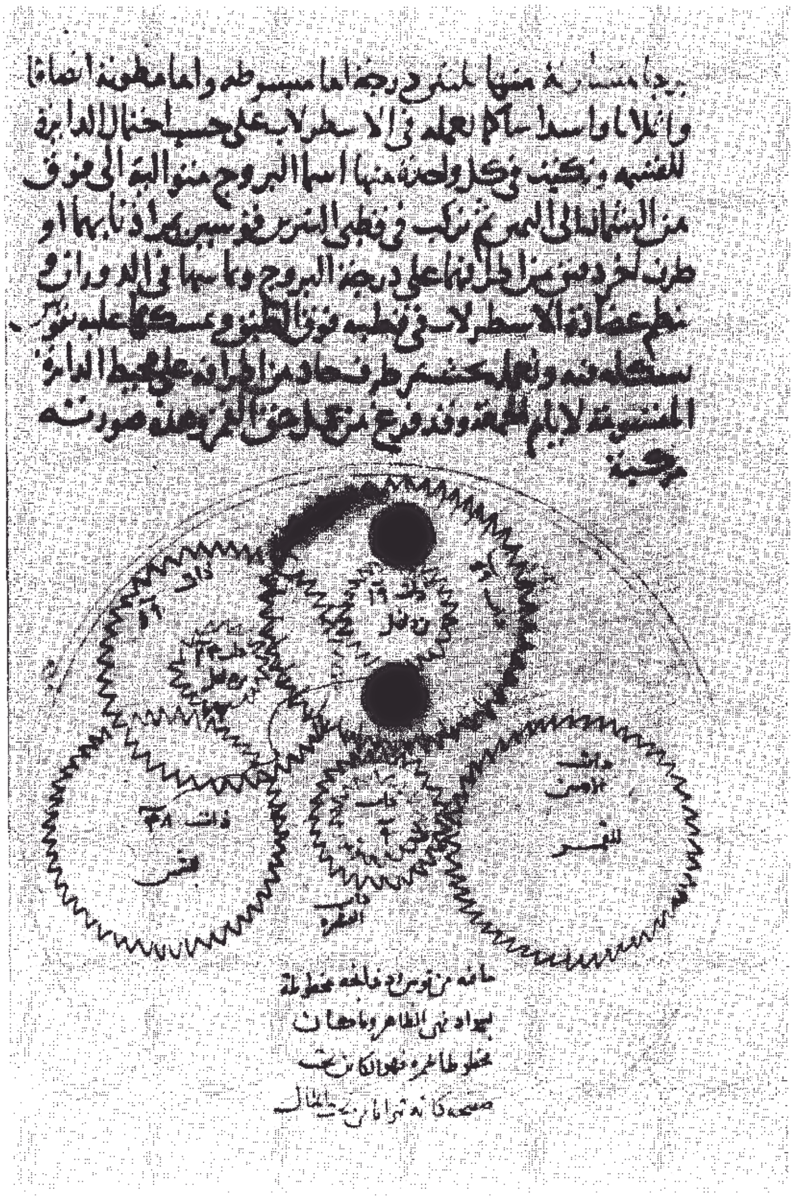

Fig 24: The calendrical device described in Al-Biruni's “Book on the Full Comprehensiveness of the Possible Methods for Constructing the Astrolabe”, here displaying the structure of the gear mechanism [Hill, 1985].

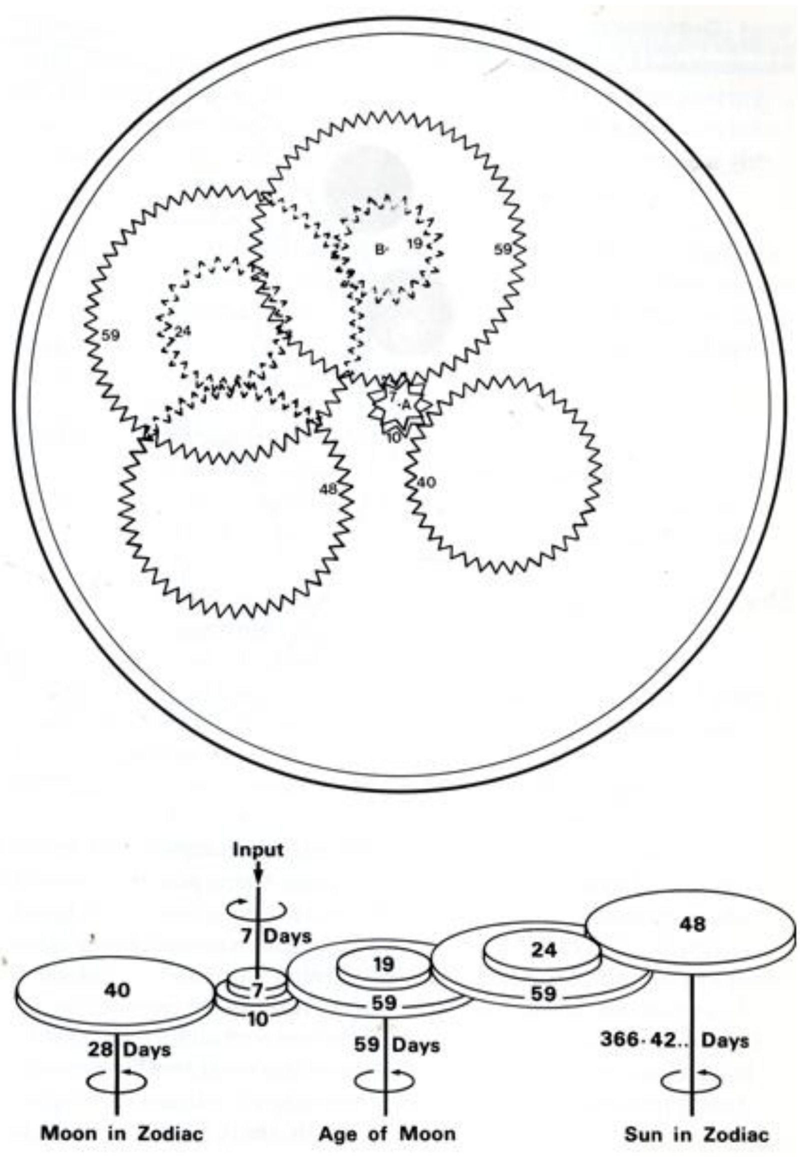

Fig 25: The calendrical gearing described by Al-Biruni, and its schematic diagram (in modern form) [by Field & Wright, 1985b].

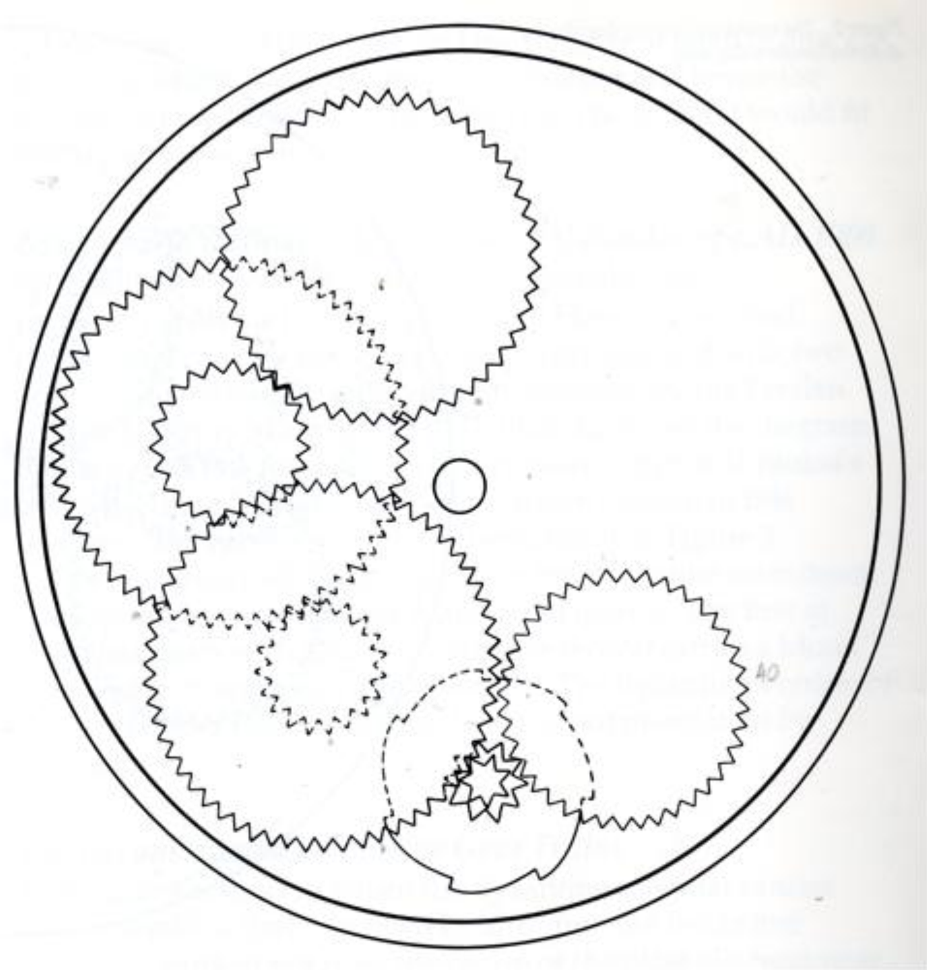

Fig 26: The calendrical gear mechanism described by Al-Biruni implemented in the case of the Byzantine Sundial-Calendar by the use of the same gear ratios [by Field & Wright, 1985b].

The Arabic Astrolabe-Calendar, signed by Muhammad b. Abi Bakr and dated in 1221/1222 AD, embodies another example of such a particular astronomical computing device [Field & Wright, 1985]. This early instrument is the oldest gear machine existing in complete shape, and can be regarded as the materialization of Al-Biruni's "Box of Moon". The close resemblance to the design of Al-Biruni is evident, but the gearing has been simplified in order to avoid wheels with odd number of teeth, since gears with even number of teeth can are marked out more easily.

The back face of the instrument contains the lunar phase volvelle. When the user turns the central pivot, probably by using the rete as a handle, the calendrical circles and the lunar phases begin to move [Price, 1959].

Fig 27: The Arabic Asatrolabe-Calendar of Muhammad b. Abi-Bakr of Isfahan, front and back face of the instrument [by de Solla Price, 1959].

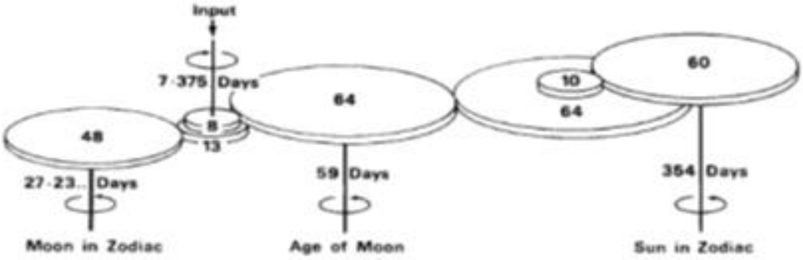

Fig 28: Calendrical gearing in the Astrolabe-Calendar of Muhammad b. Abi-Bakr of Isfahan [and its schematic diagram (in modern form) [by Field & Wight, 1985b].

Fig. 29: Calendrical gearing in the Astrolabe-Calendar of Muhammad b. Abi-Bakr of Isfahan [by Field & Wight, 1985b].

Conclusions

The Byzantine Portable Sundial and Calendar, dated to around the late 5th or 6th century CE, is the second-oldest astronomical gear mechanism known to survive, after the famous Antikythera Mechanism. The technical significance, the historical importance and the beauty of the Byzantine Portable Sundial and Calendar is obvious to the layman. The instrument embodies both the art and the science of time measurement, where simplicity can be considered as the ultimate sophistication, and could be also considered by its user as an astronomical mechanical toy, as well, beyond its practical use. The design of such time-keeping devices meets the criteria of ergonomic design, are of considerable horological value, artistic value, while also possessing a symbolic significance for their users, playing a major role in the material culture of those historical eras. In our epoch, and after the so far accumulated evidence and multidisciplinary research in the field of the history of technology, the appearance of the Antikythera Mechanism, and of the Byzantine Sundial and Calendar, as well as of the Arabic Astrolabe-Calendar, seems to belong in a natural way within a tradition of technological innovations, combined and cross-fertilized with a tradition which can be casted as the natural precursor of the sciences of Cybernetics, Automata Theory, and Informatics. The historical and cultural value of the Antikythera Mechanism, or of the Byzantine Sundial -Calendar seems to be of comparable importance with the other achievements of the Greek civilization, and add to our contemporary self-knowledge. In our epoch, we stand as global citizens living within a novel technological era, where information and its generation, transmission and manipulation, both as a commercial product and as a social and individual value plays a decisive role in our everyday experience.

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