

DESCRIPTION  
OF A  
PLANISPHERIC ASTROLABE,

CONSTRUCTED FOR  
SHÁH SULTÁN HUSAIN SAFAWÍ,  
KING OF PERSIA,

AND NOW PRESERVED IN THE BRITISH MUSEUM;  
COMPRISING AN ACCOUNT OF THE ASTROLABE GENERALLY,

WITH  
NOTES ILLUSTRATIVE AND EXPLANATORY:

TO WHICH ARE ADDED,  
CONCISE NOTICES OF TWELVE OTHER ASTROLABES, EASTERN AND EUROPEAN, HITHERTO UNDESCRIBED

BY  
WILLIAM H. MORLEY.



WILLIAMS AND NORGATE, 14, HENRIETTA STREET, COVENT GARDEN, LONDON;  
20, SOUTH FREDERICK STREET, EDINBURGH.  
BENJ. DUPRAT, PARIS. F. A. BROCKHAUS, LEIPSIG.

MDCCCLVI.

وَهُوَ الَّذِي جَعَلَ لَكُمُ النُّجُومَ لِتَهْتَدُوا بِهَا فِي ظُلُمَاتِ الْبَرِّ وَالْبَحْرِ

"It is He who hath ordained the stars for you, that ye may be directed thereby in the darkness of the land and of the sea."

KURAN, Surat vi. v. 97.

[One hundred copies printed.]

## P R E F A T O R Y N O T E.

WHEN I first saw the beautiful Astrolabe hereinafter described, it struck me that, as its engraved surfaces were all plane, its several parts might be readily and exactly reproduced by the Anastatic method of printing: I therefore made an application to the Trustees of the British Museum, and obtained their permission to have a set of impressions taken from the original instrument. After this, I consulted with Mr. Rudolph Appel, of No. 43, Gerrard Street, Soho, the ingenious Inventor and Patentee of the Anastatic process. The experiment was made, and the Plates at the end of this volume are the result. Those who may have the opportunity of comparing these Plates with the original will find that they exhibit an exact reproduction of each individual line and mark, even to the accidental scratches that have been caused by use; and every admirer of Oriental Caligraphy and Ornament will at once admit that the characteristic elegance of the inscriptions and embellishments could not have been so accurately rendered by the burin of the most skilful engraver. There is a certain indescribable something that enables a connoisseur in these matters to detect at a glance an European copy of the work of an Eastern artist: actual tracing cannot conceal the Western element, and the utmost dexterity of handling is insufficient to give the true Oriental stamp. The great obstacle to publications of a similar nature to the present has been, hitherto, the enormous outlay inseparable from the tedious processes of engraving or lithography,<sup>1</sup> which, after all, as I have just remarked, give but an unsatisfactory result. Under the circumstances, I have therefore thought that it might be neither uninteresting nor useless to describe the *modus operandi* adopted in this instance, since it is rapid, easy, and comparatively inexpensive. It is as follows:—The engraved surfaces having been first charged with a peculiar kind of transfer ink, prepared by Mr. Appel, impressions were pulled on thin hard paper by means of an ordinary copper-plate press. From these impressions, whilst fresh, counterproofs or sets-off were taken on India paper by passing them through a similar press with a tight pinch. These sets-off were then transferred to zinc plates, prepared anastatically, and from the latter the final impressions were printed. The double transfer was necessary because of the right reading of the written characters: had the engravings been merely ornamental, and their reversal unimportant, the *first* impressions might have been immediately transferred to the zinc. I can confidently assert, from some considerable experience in such matters, that by no other means could so perfect a representation of the original have been produced. The final impressions offer something more than what is usually called a fac-simile; indeed, by the help of a lathe, a piece of wood, and a few sheets of pasteboard, a possessor of this volume may manufacture for himself an exact double of the original instrument.

The vignette on the title-page affords a specimen of a different but not less interesting method of applying the Anastatic process. The silver medal, of which the reverse is here accurately represented, is the most remarkable of the Oriental coins collected by Mr. Marsden, and now deposited in

<sup>1</sup> That is, *drawing* on stone. The minuteness of the lines in the engraved surfaces of the present instrument, coupled with the viscid nature of lithographic printing ink, would prevent their reproduction by *transfer* to the stone. The greater limpidity of the ink used in the Anastatic process renders perfection in the transfer easily attainable.



the British Museum. He thus describes it—"This splendid ornament of the collection must, from its extraordinary weight and size, be considered rather as a medal than a coin, although the inscriptions on both sides are the same as we find them on the ordinary currency. The object in striking pieces of such a description, we can have no doubt, was that of presentation by the Monarch to distinguished personages (with as much propriety, at least, as our snuff-boxes); and this royal gift may have been brought to Europe by some Ambassador from our Court to that of Persia in the beginning of the last century. Of its actual history I am quite ignorant, further than my having purchased it, with several other Oriental coins, of Mr. Trattle, in the year 1808. So far as I am aware it is unique. The coin, or medal, described by Adler, (*Mus. Cuf. Borg.* p. 92. Tab. viii.), but of which he has omitted to mention the weight, cannot be supposed to stand in any comparison with this, being, as he says, one of those intended to be scattered amongst the people, and afterwards worn in the bosom, which is not at all applicable to a piece weighing between ten and eleven ounces. It has, however, been much exceeded in India, where, during the magnificent reign of *Aurungzêb*, gold medals of a still larger size were conferred in like manner, and some of them have found their way into European cabinets."<sup>1</sup> The obverse alone of this medal, containing the king's title, has been engraved in Mr. Marsden's work. The reverse here represented bears the symbol adopted by the Muhammadans of the Shî'ah sect, and which is found on the coins of all the Safawî kings of Persia. It is as follows—*لا اله الا الله محمد رسول الله علي ولي الله*, *There is no God but God; Muhammad is the Prophet of God; Ali is the friend of God*. The manner in which this vignette has been produced also deserves mention, as being a cheap and easy means of multiplying accurate representations of Eastern coins, not attainable with a like completeness by the more expensive process of engraving. A cast, in gutta percha, was first taken from the medal itself. To the surface of this cast, Anastatic drawing-ink was carefully applied with a dabber, and an impression taken therefrom by means of a small Stanhope press, on thin hard paper slightly dampened. The impression thus procured was sharpened in its edges with a fine steel pen dipped in the same ink, then transferred to a zinc plate, and finally printed off.

I must add a few words as to what follows—The work has swollen by degrees until that which I had originally intended as a mere description of a single instrument may now perhaps have some pretension to be considered as a monograph of the Planispheric Astrolabe. I can scarcely hope to have attained so much, but I believe that I have resumed all that has appeared on the subject, and have added something from original sources. Many, no doubt, will accuse me of having bestowed too much labour on what they will deem to be almost if not wholly unworthy of notice, and at the best will class my work amongst what are called "learned trifles." If so, I shall not complain, for learned trifles, however apparently trifling, are never devoid of utility; and the importance of a strict attention to particular details in the history, whether of nations or of sciences, is felt and acknowledged by all who look deeper than the surface. Should I have afforded materials even for a page in a future history of Astronomical Science, I shall not have wasted my time.

In conclusion of this note I offer my sincerest thanks to Mr. Augustus Franks, of the British

<sup>1</sup> Numismata Orientalia illustrata. The Oriental coins, ancient and modern, of his Collection, described and historically illustrated by W. Marsden. 2 Vols. 4to. London, 1823—25. Part II. p. 466, and Plate XXX. No. DLVI. I am not aware that any of the gold medals of Aurangzib, mentioned by Marsden, are extant, although

casts of them are to be found in the British Museum, in Mr. Bland's collection, and, I believe, at Glasgow. The inscriptions upon them are very inferior, both in point of elegance and execution, to those on the medal struck by Shâh Hûsain.

Museum, for his kind co-operation in the preparation and superintendence of the impression of the Plates: to Mr. Charles Rieu, of the British Museum, who has given me the advantage of his advice and assistance during the progress of my work, and who has obligingly revised the final proofs: and last, but not least, to a gentleman whom I am not at liberty to name, but whose European reputation as a Mathematician and for profound knowledge of the history of Astronomy, induced me, though a stranger, to apply to him, and who, with the utmost kindness, at once acceded to my request that he would read the sheets before they were sent to the press.

W. H. M.

15, SERLE STREET, LINCOLN'S INN.  
January, 1856.



DESCRIPTION  
OF A  
PERSIAN ASTROLABE  
CONSTRUCTED FOR  
SHÁH HUSAIN SAFAWÍ.

THE Astrolabe which is the subject of the following remarks was constructed for Sháh Husain, king of Persia, in A.H. 1124 (A.D. 1712), and although not remarkable for its antiquity, is for many reasons worthy of especial notice. Independently of the interest which attaches to it as having belonged to the last actual monarch of a powerful line of kings who occupy an important position in the history of Asia, it deserves the attention of the astronomer, as illustrating the state of science in Persia in comparatively modern times; as shewing the degree of perfection attained by the Persians in the manufacture of astronomical instruments; and as being perhaps the most beautiful specimen of the Astrolabe ever constructed, or at least now extant, either in Asia or Europe. The artist will admire it as a striking example of the beauty of eastern ornamentation, and of the peculiar felicity with which the Arabic character adapts itself to the purposes of decorative art: an adaptation only partially known in the more angular, though perhaps not less elegant forms of the inscriptions on the walls of the Alhambra.<sup>1</sup> To the Orientalist it requires no recommendation: he will appreciate it as an historical relic, as a curiosity of science, as an example of skilful mechanism, and as a work of art.

Sháh Husain was the eleventh and last independent sovereign of the descendants of Shaikh Safí ad-Dín of Ardabíl. He succeeded his father, Sháh Sulaimán, in A.H. 1106 (A.D. 1694), and, after an inglorious reign, resigned his crown in favour of Mahmúd, the Afghán usurper, in A.H. 1135 (A.D. 1722). On the day after his abdication he was compelled, together with all the Persian nobility, to do public homage at Isfahán to the new sovereign, in the palace he had so lately called his own. He was then consigned to what was virtually an imprisonment in a small palace, where he was confined for seven years; when, on the occasion of some disturbances which threatened the security of the Afghán rule, he was put to death. Thus ended the power of the Safawíyah kings, who had governed Persia for 231 lunar years.<sup>2</sup>

<sup>1</sup> The magnificent works of Murphy and Owen Jones on the antiquities of the Arabs in Spain and the Alhambra are too costly to form part of many libraries. A beautiful volume, exhibiting one of the numerous useful applications of photography, has, however, been recently published in Paris, at a price which will not interfere with its more extensive circulation. It contains nineteen specimens of Moorish ornamental sculpture from the Alhambra. The pictures are from the camera of the MM. Bisson: it is needless to add a word as to the beauty of their execution. This volume is entitled, "Choix d'ornemens Arabes de l'Alhambra offrant dans leur ensemble une Synthèse de l'ornementation Mauresque en Espagne au XIII<sup>e</sup> siècle." In folio, Paris, 1854.

<sup>2</sup> Tahmásp II., son of Sháh Husain, struck coin in his own name, and struggled ineffectually for a few years to re-establish the monarchy. He was nominally restored by Nádir Sháh, who deposed and imprisoned him in A.H. 1135 (A.D. 1722), and was nominally succeeded by his infant son (طفل شیر خواره) 'Abbás III., who died, or was murdered, or imprisoned, in A.H. 1148 (A.D. 1735), when Nádir Sháh assumed the sovereignty of Persia. Husain Mirzá, who is stated to have been born in prison six months before the assassination of his father Tahmásp II., in A.H. 1151 (A.D. 1738), but as to whose parentage there seems some doubt, was set up as king of Persia, under

the name of Husain II., by 'Alí Mardán Khán and some other nobles, about the time when Karím Khán Zand began the foundation of his power: he reigned nominally for seven months, when he was deposed and blinded. Husain II. had two sons, Tahmásp Mirzá, and Muhammad Mirzá. Tahmásp Mirzá died of small-pox in his childhood. Muhammad Mirzá was the last of the Safawíyah to whom the title of king was given. In A.H. 1200 (A.D. 1785) Muhammad Khán, son of Muhammad Husain Bég Astarábádí, sent to him at Tabs, begging him to proceed to Tihrán and assert his authority. Some rúpís were even struck in his name as king, bearing the following inscription:— *بزرگ سکه از الطاف سرمد* . . . *شاه والا کهر سلطان محمد*; in the margin, the names of the Panj Tan, i.e. Muhammad, Fátimah, 'Alí, Hasan, and Husain; and on the reverse *ضرب دار السلطنة طهران*. Muhammad Mirzá, however, declined the invitation, believing it to be a snare, and stated that his desire was to remain in obscurity, and that he had given up all pretensions to the sovereign power. It was in this very year, A.H. 1200 (A.D. 1785), that Ághá Muhammad Khán made Tihrán the seat of his empire, and struck money with the legend *بنام علي ابن ابي طالب*. See the *Fawá'id-i Safawíyah*: MS. of the Royal Asiatic Society, No. cxlv. in my Descriptive Catalogue.



It would be superfluous here to enter at all into the history of Arabian Astronomy. The science has remained stationary for some centuries in the East. Shāh Husain's Astrolabe shews that no improvement in the ordinary instruments of observation had been made between the time of Ulugh Bég<sup>1</sup> and the beginning of the last century; and more modern experience teaches us that the Oriental nations are even now as far in arrear of the Europeans in astronomical science as the latter were behind the Arabs in the Augustan age of the Khilāfat. We must not forget, however, that in the days of the Heptarchy and the Anglo-Saxon Kings, the Arabian philosophers had added and were adding to the scientific knowledge of the Greeks; that they were occupied in preserving for us, by translation into their own copious and polished tongue, writings of the Grecian sages, which would else have been irretrievably lost; and moreover, that by independent study and observation, they actually anticipated us by hundreds of years in several important discoveries afterwards attributed to European astronomers.<sup>2</sup> The perfection to which the Arabs brought the construction of astronomical instruments at this early period is not the least remarkable feature in the history of the science in Arabia, for excellence in this respect is one of the surest tests of progress. The honorary title of Usturlābī **اسطرلابي**, borne by many of the Arabian astronomers in Al-Māmūn's time<sup>3</sup>, shews that mechanical skill in the fabrication of instruments, conducive in the highest degree to accurate observation, was even then duly appreciated.

Before proceeding to the description of Shāh Husain's Astrolabe, it will be advisable, in the first place, to mention the sources to which I have had recourse in order to gain information on the subject; and secondly, to give as complete an account of the Astrolabe generally, and of its component parts, as I have been able to gather from such sources.

The Astrolabe, though exhibiting some varieties in its construction, which will be hereafter adverted to, is essentially the same wherever its use has obtained. Much valuable illustration as regards the Eastern Astrolabe may therefore be found by examining the instruments formerly constructed by European artificers, and the treatises on the subject composed by European authors. Such being the case, I have not confined my investigations to the labours of the Asiatics, but have taken my materials, wherever they were available, from European as well as from Oriental works.

The following is a list of the Arabic and Persian treatises on the Astrolabe that I have had the opportunity of consulting:—

A. Tazkirah Zawī al-Albāb fī Istifā al-'Amal bil-Usturlāb **تذكرة ذوي الالباب في استيفاء العمل بالاسطرلاب**, by Az-Zubair Ben Ja'far Ben az-Zubair. This Arabic work gives an excellent account of the Astrolabe and its different parts, together with their distinctive appellations: the projections and divisions are described with the greatest accuracy and minuteness of detail. British Museum Addit. MSS. No. 9603. I. Transcribed in A.H. 1008 (A.D. 1599).

B. Maksad at-Tālib wa Muntaha al-Matālib **مقصد الطالب ومنتهى المطالب**, by 'Abd ar-Rahīm Ben Muhammad Sharif ash-Sharif. A treatise in Arabic, containing a very full description of the Astrolabe, and of its several parts, with their technical names. Although treating principally of the Northern Astrolabe, many interesting details as to the Southern kind are introduced.<sup>4</sup> British Museum Addit. MSS. No. 7489. Transcribed in A.H. 1165 (A.D. 1751).

C. Risālah dar Usturlāb-i Shamālī wa Janūbī **رساله در اسطرلاب شمالي وجنوبي**. A treatise in Persian, by an anonymous author, on the Northern and Southern Astrolabes. This work is confined to the description of the instrument, and does not touch upon its uses: so far, however, it is very complete, entering fully into the methods of construction and delineation of the projections of the sphere, &c., and giving several technical terms not to be found elsewhere. As its title imports, it treats of the Southern as well as of the Northern Astrolabe. The author, who was evidently a thorough master of his subject, and was most probably a maker of the instrument, has illustrated his treatise with diagrams, which, though somewhat inaccurately drawn in the present manuscript, are very necessary for the proper understanding of the text. In the chapter on placing the names of the fixed stars on the 'Ankabūt, and immediately before a table constructed for that purpose, the author informs us that his work was composed

<sup>1</sup> Ulugh Bég, son of Shāh Rukh, and grandson of Tímūr Lang, was born in A.H. 796 (A.D. 1393), and was murdered in A.H. 853 (A.D. 1449). He may be considered as the last of the Eastern astronomers. Ulugh Bég's Catalogue of stars was edited and translated by Hyde, and published under the title of *Tabulae Long. ac Lat. Stellarum fixarum ex observatione Ulugh Beighi*, 4to. Oxon. 1665. It was reprinted by Francis Baily, in conjunction with those of Ptolemy, Tycho Brahé, and Hevelius, in the 13th volume of the *Memoirs of the Royal Astronomical Society*.

<sup>2</sup> It was long supposed that the Arabs were merely the depositaries of science, and that they contributed little to its advancement; but the learned labours of the MM. Sédillot, father and son, have proved to demonstration that they made valuable additions to the knowledge possessed by the Greeks. See *Traité des instruments astronomiques des Arabes composé par Aboul Hhassan Ali, traduit de l'Arabe par J. J. Sédillot*. 2 Tomes 4to. Paris, 1834-35. Also the following works by M. L. A. Sédillot, *Mémoire sur les instruments astronomiques des Arabes*, in the *Mémoires présentés par divers savants à l'Académie royale des inscriptions*. Prém. série

Tome i. 4to. Paris, 1844, p. 2, *et seq.* *Matériaux pour servir à l'histoire comparée des sciences mathématiques chez les Grecs et chez les Orientaux*. 2 Tomes. Paris, 1845-49. *Prolégomènes des tables astronomiques d'Ouloug-Beg*. Texte Persan. 8vo. Paris, 1847. *Introduction passim*. Ib. *Traduction et Commentaire*. 8vo. Paris, 1853; in the Preface entitled, *Lettre à M. de Humboldt sur les travaux de l'école Arabe*, (also published separately, 8vo. Paris, 1853), and in the *Notes passim*. *Histoire des Arabes*. 12mo. Paris, 1854. The sixth book of the last-named work contains an able résumé of the state of science in Arabia, and of the principal discoveries of the Arabs in Astronomy, Mathematics, and Geography.

<sup>3</sup> See Caussin, *Le Livre de la grande table Hakémité*; in the *Notices et Extraits des MSS.*, Tome vii., p. 54, note 1, the authorities there cited, and p. 66. Al-Māmūn was proclaimed Khalīfah in A.H. 198 (A.D. 813), and died in A.H. 218 (A.D. 833).

<sup>4</sup> The distinction between the Northern, Southern, and other Astrolabes will be explained hereafter.

in the Yazdajirdī year 864<sup>1</sup> (A.D. 1494); and from the use of this æra it may be inferred that he was either a Persian, or an Indian Pārsī. The latter is the more probable supposition, since we find him in one place alluding to the difference of the time of the 'Asr, as observed by the followers of Abū Hanīfah and Ash-Shāfi'ī; a distinction which would every day present itself to an Indian, but which would neither attract the attention or be considered worthy of notice by a Persian, and consequently a Shī'ah. This treatise is the best on the subject that I have met with; and, taken in conjunction with the two last mentioned works, leaves scarcely any thing to be desired. East-India House, No. 1514, I. Transcribed in A.H. 1056 (A.D. 1646).

D. An Arabic Treatise on the Astrolabe, by Muhammad Ben 'Alī Ben Yahya Ben an-Nattāh. It contains a short but methodical account of the instrument. British Museum Addit. MSS. No. 9602, I. No date of transcription, but evidently a MS. of considerable antiquity.

E. A short Treatise in Arabic, by Abū al-Hasan 'Alī Ben Ibrāhīm Ben Muhammad, commonly called Ibn ash-Shātīr. This author was a native of Damascus, and published some astronomical tables under the patronage of the Mamlūk Sultāns: he acquired a vast reputation, and subsequent astronomers relied greatly on his works in the composition of their tables: he died in A.H. 781 (A.D. 1379).<sup>2</sup> Of this treatise there are two copies in the British Museum, viz. Addit. MSS. No. 9598, I.; and Addit. MSS. No. 9600, V.

F. Kitāb al-'Amal bil-Usturlāb **كتاب العمل بالاسطرلاب**. This is a concise Arabic Treatise on the Northern Astrolabe by Ibn as-Samh. British Museum Addit. MSS. No. 9602, II.

G. Kitāb fī al-'Amal bil-Usturlāb **كتاب في العمل بالاسطرلاب**. A short Arabic work, by Abū al-Kāsim as-Saffār. British Museum Addit. MSS. No. 9600, VIII.

H. An Arabic Tract on the Astrolabe, by 'Abd Allah Ben Muhammad Ben Sa'd Ben Muhammad al-Tujībī. British Museum Addit. MSS. No. 9603, V.

I. Risālah fī 'Ilm al-Usturlāb **رسالة في علم الاسطرلاب**. An Arabic Treatise on the Astrolabe, by Abū al-Hasan Kūshyār Ben Layān Ben Bāshahrī al-Jīlī.<sup>3</sup> The introductory portion contains a short account of the component parts of the Astrolabe. British Museum Addit. MSS. No. 7490, XI.

K. Irshād **ارشاد**. A Treatise, in Persian, on the Astrolabe, by Nāsir ad-Dīn Ahmad Ben Muhammad Shīrāzī. The first book presents a very concise account of the instrument, the body of the work being devoted to the explanation of its uses. British Museum Addit. MSS. No. 7703.

L. The chapter on the Astrolabe in the excellent Persian Encyclopædia, the Nafāis al-Funūn **نفايس الفنون**, by Muhammad Ben Mahmūd al-Āmulī. This chapter, though comprised in a few pages, is well worthy of notice. East-India House, No. 743. British Museum Addit. MSS. Nos. 16827 and 16828.

To these I may add the well-known treatise by Māshā Allah, which, however, has not come down to us in the original. The author flourished in the time of the Khalīfah al-Mansūr,<sup>4</sup> and lived till the reign of al-Māmūn. Abū al-Faraj states that he was a Jew<sup>5</sup>; and Hamd Allah al-Musta'fī mentions incidentally that he was of Egyptian origin. I have had access to a MS. in Latin, purporting to contain the work of Māshā Allah, and preserved in the library of the British Museum.<sup>7</sup> It is fairly written, though disfigured by a multitude of contractions, and is illustrated by diagrams: its date is about the middle of the thirteenth century of our æra, and it is entitled *Prohemium in Astrolabium Messehallath*. A Latin translation of Māshā

<sup>1</sup> و ما در ائیل سال هشتصد و شصت و چهارم یزدجردی تقویم چهل کواکب از کواکبی که در اسطرلاب وضع کنند با عروض و ابعاد آنها (از) معدل النهار و درجات مبرأ آنها. And then follows the table alluded to. The Yazdajirdī æra, so called after Yazdajird III., the last of the Sāsānian kings of Persia, commenced on the 16th of June, A.D. 632. The year consisted of 365 days only. See Gravius, *Epochæ celebrioris*, 4to. Lond. 1650, p. 24, and the comparative table at the end. Hyde, *Veterum Persarum religionis Historia*, 4to. Oxon. 1760, p. 202. Prinsep's *Useful Tables*, Part II. 8vo. Calcutta, 1836, p. 12. L. A. Sédillot, *Prolégomènes*, &c. Trad. pp. 18 and 233, note 13. See also a dictionary of the technical terms used in the sciences of the Musalmans, entitled *Kitāb Kashshāf Istilāhāt al-Funūn* 'Abd al-Haq and Gholām Kādir, and Dr. A. Sprenger, and now in course of publication under the superintendence of the Asiatic Society of Bengal. 4to. Calcutta, 1853, sub voc. تاریخ, p. 500. The last-named work is an excellent compilation from the best authorities, and will form, when complete, an indispensable supplement to all the existing Arabic and Persian dictionaries, which are lamentably deficient as regards the scientific terms used by the Muhammadans.

<sup>2</sup> Nicoll. Cat. Bibl. Bodl. Cod. Orient. p. 246. L. A. Sédillot, *Prolégomènes*, &c., Texte, Introduction, p. cli., and the authorities there cited.

<sup>3</sup> In the Catalogue of the Arabic MSS. in the British Museum the author of this

work is called Abū al-Hasan Kūshyār Ben Amān Ben Shahrī al-Jīlī; but in another place, Addit. MSS. No. 7490, I. he is termed Ben Labān Ben Bāshahrī al-Jīlī. Fluegel reads Ben Labān al-Jīlī, Haj. Khalf., Tom. V. pp. 405 and 475. In the MS. 7490, I., however, the word Labān is apparently Layān; and in another copy of the same work, MS. No. 1514, II. of the East-India Company's Library, referred to hereafter, it is clearly so written. In the last-mentioned MS. he is called al-Jabālī instead of al-Jīlī, the word being distinctly so written and pointed الجبلي. Casiri gives his name Kūshyār Ben Labān al-Munajjam al-Jabalī. Bibl. Arab. Hisp. Escur., Tom. I. p. 400, c. 2.

<sup>4</sup> Al-Mansūr, the second of the 'Abbāsides, succeeded to the Khilāfat in A.H. 136 (A.D. 753), and died in A.H. 158 (A.D. 774).

<sup>5</sup> ماشاء الله اليهودي كان في زمن المنصور وعاش الي ايام المامون وكان فاضلا اوحد زمانه Abul-Pharajii, *Historia Dynastiarum*. Edidit Pocockius, 4to. Oxon. 1663, p. 248.

<sup>6</sup> و ارباب جدول بقول ماشاء الله مصري وديكر علمي مصرکه اکنون درین ملك بدان عمل میکنند. Nuzhat al-Kulūb, MS. in my own possession. Hamd Allah Ben Atūbak Abū Bakr Ben Hamd Allah al-Musta'fī al-Kazwīnī composed the *Nuzhat al-Kulūb*, as he himself tells us, in A.H. 740 (A.D. 1339). He died in A.H. 750 (A.D. 1349).

<sup>7</sup> Old Royal MSS. No. 126, XVII. M. L. A. Sédillot enumerates no less than five copies of Māshā Allah's treatise in Latin preserved in the Bibliothèque Impériale at Paris. They are numbered respectively 7194, 7195, 7280, 7295, and 7298. *Mémoire*, &c., p. 156, note 6.



Allah's treatise was added by Orontius Fineus to his edition of Reisch's *Margarita Philosophica*<sup>1</sup>, which was afterwards translated into Italian by Gallucci.<sup>2</sup> I have not succeeded in procuring the publication of Orontius Fineus; but on comparing the text of the Latin MS. with Gallucci's Italian version, I find that they agree tolerably one with the other, though the former contains some additional matter. Whether the additions are interpolated, or formed part of the original work, it is of course now impossible to determine.

The account of the Astrolabe given by Chardin<sup>3</sup>, and that contained in M. L. A. Sédillot's *Memoir on the Astronomical instruments of the Arabs*, quoted above, are entitled to the first place after the native authorities. The former acquired his information on the spot, from the Persian constructors of Astrolabes themselves, and his notice of the instrument bears testimony to the extensive observation and accuracy of description, so conspicuous throughout the relation of his travels. The *Memoir* by M. Sédillot is extremely valuable, as being almost entirely taken from Oriental sources. His principal authority is Abū al-Hasan 'Alī, who wrote about A.H. 627 (A.D. 1229)<sup>4</sup>, and a portion of whose works had already been translated and published by M. Sédillot's father.<sup>5</sup> In the part which relates to the Astrolabe there is an interesting account of no less than three Northern instruments till then undescribed. The most important of these was brought from Egypt by the late M. Marcel, but was afterwards unfortunately lost. Luckily, however, drawings had been made from the original; and these drawings were engraved in the *Description de l'Égypte*<sup>6</sup>, and are reproduced in lithography, with a translation of the inscriptions, in the plates annexed to the *Memoir*.<sup>7</sup> This Astrolabe is inscribed in the Kúfic character, and the date of its construction is conjectured to be about the thirteenth century of our æra, but it is probably later. M. Sédillot informs us that M. Marcel had intended to give a detailed explanation of it in the last volume of the *Description de l'Égypte*, which was never completed. He himself has now well supplied the deficiency. The other undescribed instruments are: one in the Imperial library at Paris, constructed for the son of the Khalifah al-Muktafi Billah, about the year 905 of our æra, and consequently the earliest Eastern Astrolabe with which we are acquainted<sup>8</sup>; and another, belonging to M. le Baron Larrey, made in A.H. 615 (A.D. 1218). M. Sédillot has also added an abstract of a notice by Dr. Dorn of St. Petersburg of an Astrolabe found in the citadel at Aleppo. Dr. Dorn states his opinion that this instrument was constructed in Sicily about the twelfth century of our æra; but there seems nothing to shew why it should be assigned to that country or period.

M. Fraehn has also published a short notice of a Kúfic Astrolabe of the thirteenth century of our æra, which once belonged to the celebrated astronomer Regiomontanus<sup>9</sup>, and is now in the library at Nuremberg.<sup>10</sup>

Lastly, a description of a Persian Astrolabe found at Hirát by Major Pottinger, written by J. Middleton, Esquire, Principal of the Government College at Agra, in 1841, was inserted in the *Journal of the Asiatic Society of Bengal*.<sup>11</sup> This description is illustrated with five plates, which are valuable as furnishing additional materials; but the description itself, derived chiefly, as Mr. Middleton informs us, from two intelligent Pandits, is extremely inaccurate.

European works on the Astrolabe, as may be supposed, are very numerous<sup>12</sup>, but almost all of them are of uncommon occurrence, and many extremely rare. The treatise most generally known in this country is "The Conclusions of the Astrolabe," written by the immortal Geoffrey Chaucer for his son "Iytel Lowis." It was long held in great esteem; and in the edition of Chaucer's works published in A.D. 1598 it is said—"This booke, written to his sonne in the yeere of our Lord 1391, and in the 14. of K. Richard 2, standeth so good at this day, especially for the Horizon of Oxford, as in the opinion of the learned it cannot be amended."<sup>13</sup> Of the other treatises by European authors the best are those by Stoeffler<sup>14</sup>,

<sup>1</sup> *Margarita Philosophica* ab Orontio Fineo locupletata. 4to. Paris 1520, and Basil. 1525.

<sup>2</sup> *Margarita Filosofica* del R<sup>to</sup> P. F. G. Reisch. Tradotta nuovamente dalla lingua Latina nell' Italiana da G. P. Gallucci, e dal medesimo accresciuta di varie e bellissime cose. 4to. Venezia, 1599.

<sup>3</sup> *Voyages du Chevalier Chardin en Perse*. Nouvelle édition par L. Langlès. 10 Tomes. 8vo. Paris, 1811. Tome iv. p. 335 *et seq.*

<sup>4</sup> Delambre, *Histoire de l'Astronomie du moyen âge*. 4to. Paris, 1819, p. 185. L. A. Sédillot, *Prolégomènes*, &c., Texte, *Introd.*, p. lxxxv.

<sup>5</sup> See *supra*, p. 2, note 2.

<sup>6</sup> *Description de l'Égypte*; État Moderne, Planches, Tome ii. Vases, meubles, et instruments, Pl. HH.

<sup>7</sup> Sédillot, *Mémoire*, &c. Pl. 13—24.

<sup>8</sup> M. L. A. Sédillot mentions, that at the time he wrote (A.D. 1844) M. Jomard was occupied with the engraving of the plates of this Astrolabe, and that they would shortly appear in the great geographical work in preparation by the latter savant. In 1851 M. Leleux stated, that, two years previously, no less than twenty-nine plates were ready for publication. I believe that up to the present time no portion of M. Jomard's work has appeared, although a recent announcement in the Catalogue of M. Duprat, the Parisian bookseller, leads us to hope that the day of publication is not far removed. I transcribe the announcement—"Publication Nouvelle. Les monuments de la Géographie ou choix de Mappemondes, planisphères, atlas et cartes du moyen âge européennes et

orientales, tables cosmographiques, sphères terrestres et célestes, astrolabes et autres instruments d'observation, depuis les temps les plus reculés jusque vers la moitié du xvi<sup>e</sup> siècle, avant la réforme d'Ortelius, publiés en fac-simile, de la grandeur des originaux; Recueil accompagné d'explications et de recherches, et pouvant servir à éclairer l'histoire des découvertes et celle des progrès des sciences géographiques; par M. Jomard."

<sup>9</sup> Johann Muller, generally known by the name of Regiomontanus, was born at Unfind, near Koenigsberg (Regius-Mons), in the Duchy of Hildburghausen, a dependency of Franconia, in A.D. 1436, and died at Rome in A.D. 1476. *Biographie Universelle*. Delambre, *Astronomie du moyen âge*, pp. 289 and 365.

<sup>10</sup> *Antiquitatis Muhammedanæ monumenta varia*, explicuit C. M. Fraehn. 4to. Petrop. 1820, Particula ii. p. 73.

<sup>11</sup> *Journal of the Asiatic Society of Bengal*. Vol. x. pt. 2. p. 759—777.

<sup>12</sup> A list of these works will be found in the Appendix No. II., principally extracted from Lalande's *Bibliographie Astronomique*. 4to. Paris, 1803.

<sup>13</sup> The works of our antient and lerned English Poet, Geoffrey Chaucer, newly printed. Folio, London, 1598. The Arguments.

<sup>14</sup> Johann Stoeffler, Stoffer, or Stofferin, for he appears to be known by all these names, was born in A.D. 1472. He was professor of mathematics at Tübingen, and died in A.D. 1530. For some particulars of his life see the *Biographie Universelle*, and Delambre's *Histoire de l'Astronomie du moyen âge*, p. 373 *et seq.* But see also Mr. A. De Morgan's interesting account of the earliest printed Almanacs, in the *Companion*

Focard<sup>1</sup>, Danti<sup>2</sup>, and Ritter.<sup>3</sup> The reader will perceive that it is to these writers that I have most frequently made reference in the following pages.

Taking into consideration the long period during which the use of the Astrolabe prevailed in Europe, it is surprising that so few specimens of the instrument should have been handed down to us. It is perhaps still more extraordinary that Eastern Astrolabes are so seldom found, either in our public Museums or private collections, seeing that in most parts of Asia they are, even now, daily employed for a variety of purposes. Notwithstanding this scarcity, I have been able to examine no less than seven Eastern Astrolabes, besides that which I have undertaken to describe, together with two of European workmanship. Three of the former are Arabic, two Persian, and two Hindú. The most ancient of the Arabic instruments is dated in A.H. 669 (A.D. 1270—71), and belongs to Professor Wilson, who procured it at Benares: the inscriptions are for the most part in the Kúfic character. The surfaces of the main body of this Astrolabe are very much defaced, and the Kúfic inscriptions in several places obliterated: it has been re-engraved in part by some Hindú possessor, and bears a table of the names of Indian cities, with their longitudes and latitudes, written in the Dévanagari character, evidently added long after the date of its construction. This Astrolabe is very interesting, as presenting some peculiarities hitherto undescribed. Of the remaining Arabic instruments, which are comparatively modern, one is preserved in the Museum of the East-India House, and the other in the British Museum: both are inscribed in Kúfic. One of the Persian Astrolabes is in the collection of the East-India Company: it is inscribed in an indifferent Naskh hand, and dated A.H. 1076 (A.D. 1665); the other is the property of W. S. W. Vaux, Esquire: the inscriptions are in Nasta'lik, and it bears the date A.H. 1228 (A.D. 1813). The Hindú instruments are preserved, the one in the Museum at the East-India House, and the other in that of the Royal Asiatic Society. The two European Astrolabes are of English origin, and form part of our national collection: they are both of the fourteenth century of our æra, and one is very remarkable both for its size and style of ornament.<sup>4</sup> The engraved copies of the drawings, made from M. Marcel's Kúfic Astrolabe, together with their reproduction in lithography by M. L. A. Sédillot, already alluded to, and the plates at the end of Ritter's *Astrolabium*, may be here pointed out as being almost equivalent to original instruments for all purposes of comparison. The plates which accompany Mr. Middleton's description of Major Pottinger's Astrolabe may be classed with them, so far as they extend, being evidently accurate copies of the original: they are, moreover, deserving of attention, since they offer inscriptions very similar to those on the Astrolabe of Sháh Husain.

Such are the materials I have had at my command. I now pass to the general account of the Astrolabe, which I think will be found necessary, both to avoid obscurity, and for the proper understanding of the particular description which follows. I have composed this account from a careful examination of the various authorities, and of the instruments and drawings above mentioned, and I have incorporated in it all such varieties of construction as have come under my notice. The description will be found to apply to European as well as to Asiatic Astrolabes, and in order to facilitate comparison between them I have inserted within brackets the European equivalents of the different technical terms used by the Arabian and Persian astronomers: it must, however, be understood as intended to refer especially to instruments constructed by Muhammadans.

The origin of the word Astrolabe has been attributed to various sources, and many Oriental writers have speculated upon it in a strain of grave absurdity scarcely surpassed in the fantastical theories of that numerous class of our own etymologists, who, even at the present day, persist in founding their arguments on mere verbal resemblances. The more judicious of the Eastern authors admit that the word is of Greek extraction, but their explanations are always erroneous. The derivation is clearly from ἀστρον and λαβη, Th. λαμβάνω. The Astrolabe is sometimes called in the East the Waz'ah al-Kurah *وضعة الكرة*, position of the sphere, which term has been corrupted by European authors into Walzagora, but it is almost universally named the Usturláb *استرلاب* Astrolabe. The fables of its invention by Abraham, Solomon, Enoch, or by a certain person named Láb, are unworthy of notice;

to the Almanac for the year 1846. pp. 27—29. Stoeffler's treatise on the Astrolabe had a wider reputation than any other European work on the subject: it is entitled, "Elucidatio fabricæ usûsque Astrolabii à Joanne Stofferino Justingensi nuper ingeniosè concinnata atque in lucem edita." There are several editions: the first, in folio, Oppenheim, 1513, the second, in folio, Oppenheim, 1524; the third, also in folio, was published by Peter Jordan, and is entitled, *Cœlestium rerum disciplinæ Johannis Stoefflerini*, Moguntiae, 1535; and the fourth in 8vo., Paris, 1585. To this last named edition is added the *Astrolabii declaratio* of Jacobus Kœbellius. Lalande says that Stoeffler's treatise was translated into French by Jean-Pierre de Mesmes, and published in 8vo. at Paris. *Bibliographie Astronomique*, p. 36. I have quoted from the second edition. Folio, Oppenheim, 1524.

<sup>1</sup> Paraphrase de d'Astrolabe, par Jacques Focard. 4to. Lyon, 1546. A second edition was published at the same place—Paraphrase de l'Astrolabe reunie et corrigée par Jacques Bassentin Ecossois, avec vne Amplification de l'Usage de l'Astrolabe par lui-même ajoutée. 8vo. Lyon, 1555. It is from this last that I have quoted.

<sup>2</sup> Trattato dell' Vso et della Fabbrica dell' Astrolabio, di F. Egnatio Danti. 4to. Fiorenza, 1569. Another edition appeared at the same place in 1578, entitled "Primo Volume dell' Vso et Fabbrica dell' Astrolabio."

<sup>3</sup> *Astrolabium oder Nützlicher Bericht von dem Astrolabio*, wie es soll aufgerissen und gebraucht werden, beschrieben durch M. Franciscum Ritter. 4to. Nürnberg, N. D.

<sup>4</sup> In the First Appendix to the following pages I have given a short account of all the Astrolabes above enumerated.



since the Astrolabe of the Arabs is clearly a modification of the instruments so long erroneously attributed to Ptolemy of Alexandria. The solid sphere<sup>1</sup>, or Astrolabium Sphaericum<sup>2</sup>, described by Ptolemy in the Eighth Book of the Almagest, was known before his time; and though it was a moot point for a considerable period, there is now no doubt but that the Planisphere, generally called after his name, and on which the construction of the Planispheric Astrolabe of the Arabian astronomers is based, was in reality the invention of Hipparchus, to whom the honour of having invented the stereographic projection of a sphere, or most convenient perspective representation of its concavity on a diametral plane, incontestably belongs. That the treatise entitled Planisphaerium ascribed to Ptolemy, and published with his works, was known to the Arabs is proved beyond a doubt, since the original Greek is no longer extant, and it has been handed down to us through the medium of an Arabic translation.<sup>3</sup>

The uses of the Astrolabe were manifold, but it was principally employed for taking observations of the sun, moon, and stars; for measuring the heights of mountains and buildings, and distances generally; for ascertaining latitudes; for the determination of time; for the construction of horoscopes; and for divers other operations connected with the sciences of Astronomy and Judicial Astrology. In Muhammadan Asia one of its chief uses was, and is still, the ascertainment of the exact position of Makkah as regards the place of the observer.

We have no record of the precise time when Astrolabes were first employed by the astronomers of Arabia, but, as I have already mentioned, a high degree of perfection had been attained by the Arabs in constructing them in what are truly and emphatically called the dark ages of Europe. This perfection presupposes a familiar use of the instrument for a considerable period. Ulugh Bég completed his celebrated tables in A.H. 853 (A.D. 1449).<sup>4</sup> Since then, science has declined, or, at best, stood still, in the East; and from then until now cloudless skies and Oriental indolence have there preserved to the Astrolabe its time-honoured pre-eminence amongst astronomical instruments<sup>5</sup>; the only change being, that it has passed from the hands of the man of science into those of the ignorant and superstitious interpreter of the stars. Judicial Astrology always prevailed, and still maintains its place throughout Asia; and the fate of an empire has often hung suspended from the 'Alákah of an Astrolabe. The greatest and the smallest undertakings are regulated by the aspect of the heavens; and the propitious moment for fighting a decisive battle or paying a morning visit is held to this day to be dependent on a fortunate conjunction of the planets.<sup>6</sup>

There seems but little doubt that the Astrolabe first became known in Europe in consequence of its introduction into Spain by the Arabian conquerors: it does not appear, however, to have been in general use until about the beginning of the fourteenth century of our æra. In the middle of that century it must have been commonly employed, for there is an amount of accuracy in the construction of the two English Astrolabes of that date in the British Museum which proves that the artificers who made them were perfectly familiar with the instrument. The large number of works on the subject which issued from the earliest presses, and followed each other in rapid succession for two hundred years after the invention of printing, attest the universal prevalence of the Astrolabe during that period. The instrument described by Stoeffler seems to have been pre-eminent in the sixteenth century, and Blundeville, writing about A.D. 1594, speaks of it as the Astrolabe "of Stoefflerus, which for these hundred yeares, or thereabouts, hath bene had in most price and estimation, as an instrument containing all the vses, or at least the most part of all other Mathematicall Instruments."<sup>7</sup>

The European astronomers adopted the Astrolabe as they found it in the hands of the Arabs. Indeed, Astrolabes actually constructed in Arabia are shewn to have been in common use in Europe as late as the end of the sixteenth century of our æra, by the fact that Danti adds the Arabic to the Latin names in his table of the fixed stars, expressly for the convenience of those who employed Arabian instruments.<sup>8</sup> Not only did the Astrolabe itself thus become naturalised in Europe, but even the Arabic

<sup>1</sup> Regiomontanus, Epitoma Joannis de Montereio in almagestum ptolomei. Fol. Ven. 1496. Liber viii.

<sup>2</sup> Stoeffler so calls it. Elucidatio fabricæ usûsque Astrolabii. Fol. 30 v.

<sup>3</sup> Delambre, Astronomie théorique et pratique. 3 Tomes 4to. Paris, 1814. Tome iii. p. 674. Ib. Histoire de l'Astronomie ancienne. 2 Tomes 4to. Paris, 1817. Tome i. p. 290; Tome ii. pp. 185 and 453 *et seq.* Delambre has given a detailed account of the Planisphere of Ptolemy in the latter volume, p. 433 *et seq.* L. A. Sédillot, Mémoire, &c., p. 22. Géographie d'Aboulféda traduite de l'Arabe par M. Reinaud. 2 Tomes 4to. Paris, 1848 (unfinished). Tome i., Introduction, §. iii. p. ccixii.

<sup>4</sup> Delambre, Histoire de l'Astronomie du moyen âge, p. 205. L. A. Sédillot, Prolegomènes, &c. Texte, Introd., p. cxxxi. This was about a century and a half before Kepler's discoveries. The latter was born in A.D. 1571, and died in A.D. 1630.

<sup>5</sup> Lane's translation of the Thousand and One Nights. 3 Vols. 8vo. London, 1839—1841. Vol. I. p. 428, note 57.

<sup>6</sup> The constant and popular use of the Astrolabe in the East on the most trivial occasions is amusingly illustrated by the well-known story in the Arabian Nights of the barber, who, being sent for to assist at the toilet of an impatient lover, drives the latter half crazy by pulling out an Astrolabe and taking the altitude of the sun, in order to ascertain the fact that "the shaving of hair is now an excellent operation." Lane's translation of the Thousand and One Nights. Vol. i. p. 374.<sup>2</sup> And see Chardin, Voyages, &c., Tome iv. p. 320; Malcolm's History of Persia, 2 Vols. 4to. London, 1815. Vol. ii. p. 576, *et seq.*; and Reinaud's Description des monumens Musulmans du cabinet de M. le Duc de Blacas d'Aulps. 2 Tomes. Paris, 1828. Tome ii. p. 367, *et seq.*

<sup>7</sup> M. Blundeville his exercises containing eight treatises. 2d. Edit. 4to. London, 1613, p. 595.

<sup>8</sup> — "Aggiugnendovi i nomi Arabi per comodità di quelli che hanno l'Astrolabio fatto in Arabia con le stelle scritte con nomi Arabeschi." Primo Volume, &c., p. 161.

nomenclature of its component parts was retained by the European astronomers. De Roias, so long ago as the middle of the sixteenth century of our æra, made an effort to abolish these foreign terms; but notwithstanding his endeavours to "exterminate" the "barbarous" epithets so offensive to his classical taste<sup>1</sup>, they were still employed by his less fastidious successors; and many of them remain to the present day a lasting memorial of the debt that modern astronomy owes to the fostering and improving care of the enlightened Arabs. The Astrolabe continued to be universally employed in Europe for a lengthened period; and though it had undergone some modifications and improvements, the last century had commenced before it was completely superseded by instruments more perfectly contrived for similar purposes.

Astrolabes, as constructed by the Muhammadans, may be divided into two principal classes, viz. the Kuri كروي, *Spherical*<sup>2</sup>, and the Musattah مسطح, *Superficial*, or Planispheric.<sup>3</sup> The latter class is again divided into various sorts. With the Spherical Astrolabe we have, in this place, nothing to do; the reader who may be curious in the matter will, however, find an ample account of it, derived from Abû al-Hasan, in M. Sédillot's Memoir already quoted.<sup>4</sup> In like manner we may dismiss in a few words the greater part of the different kinds of Planispheric instruments, seeing that but two, or at most three, were in common use, and that the Arabian astronomical writers themselves scarcely do more than mention the remainder by name. The two kinds most generally employed are the Shamali شمالي, *Northern*, and the Janubi جنوبي, *Southern*, which are so called in consequence of the stars and projections of the sphere inscribed thereon having particular relation to the Northern or Southern hemisphere respectively. A third, the Saratani سرطاني, which takes its name from the position of the sign Saratan سرطان, *Cancer*, is by most writers either passed over, or only incidentally mentioned, but receives some attention from Az-Zubair: this kind of Astrolabe was both Northern and Southern, and combined the properties and uses of each. M. L. A. Sédillot enumerates, from Abû al-Hasan, the following different sorts of instruments that are both Northern and Southern<sup>5</sup>:—the Tablî طبلی, the Ásí آسی, the Sadafi صدافي, the Shakáiki شكاقي, the Burjadani برجسداني, the Bisáti بساطي, the Thauri ثوري, the Jámusi جاموسي, and the Sulahfi سلحفی, more correctly termed the Sulahfai سلحفائي by the author of the Maksad at-Tálib. Most of these seem to be named after some real or imaginary resemblance to natural objects, as the Tablî, from Tabl طبل, a drum; Ásí, from Ás آس, myrtle; Sulahfai, from Sulahfa سلحفاة, a tortoise. This is sufficiently obvious if we compare the diagrams given by Abû al-Hasan in illustration of several of these Astrolabes.<sup>6</sup> Abû al-Hasan adds some other kinds to the above, as the Zauraki زورقي, *ship-like*; the Kámil كامل, *perfect*; the Safihah az-Zarkalah الصفیحة الزرقالة, the tablet of Az-Zarkalah, known to Europeans as the Shafiah of Arzachel<sup>7</sup>, and ably described by M. L. A. Sédillot<sup>8</sup>; the Shakáziyah شكازیة; the Khattî خطی, *linear*, which is the baculus or staff of Nasir ad-Dín Túsi<sup>9</sup>; and three other sorts, which have no distinctive names, but in which the zones are not dependent on the projection; in one the twelve signs are ranged in a straight line passing through the pole; in a second they are tangent or adjacent to the parallel of the commencement of Cancer; and in the third they are arranged in the form of a helix. In the Maksad at-Tálib I find the additional names of the Kurawí كروي, *Globular* (which is not spherical, as its name would seem to imply, but especially ranged in the Musattah class), and the Zát al-Kursi ذات الكرسي, *possessed of the throne*.<sup>11</sup> Az-Zubair adds one called the Afáki آفاقي, *appertaining to horizons*, the invention of which is ascribed to one Hanash, and which seems to be the same with the tablet called As-Safihah al-Afákiyah الصفیحة الأفاقیة, *tablet of the horizons*, and described hereafter.<sup>12</sup>

The European astronomers do not appear to have employed any other than the Northern Astrolabe.

Astrolabes are also subject to another kind of division, governed by the number of Almucantars, or circles parallel with the

<sup>1</sup> — "Voculas enim nescio quas, uti Nadir, Cenith, Alidagda, Azimuth, Almadarath, Almucantarath et similia, à media ipsa Barbaria deducta, à nostro libro depulimus, atque exterminavimus. In his autem quæ latinis nominibus carebant à Græcis, sed quæ à probatissimis autoribus recepta sunt, mutasti sumus." D. Joh. De Roias, Commentariorum in Astrolabium Libri sex. 4to. Lutetiae, 1550. Dedicatio, fol. b. ii.

<sup>2</sup> M. Sédillot, quoting Abû al-Hasan 'Alî, calls the Spherical Astrolabe the Akri, في وضع الاسطرلاب الكروي. Mémoire, &c., p. 142, note 1.

<sup>3</sup> Abû al-Hasan 'Alî, according to M. L. A. Sédillot, speaks also of a cylindrical and a conical Astrolabe, في ذكر عمل الاسطرلاب الاسطوانی وفي ذكر نيز من تسطح الاسطرلاب. Mémoire, &c., p. 142, *et seq.* At p. 148 M. Sédillot gives also a short description, taken from Abû al-Hasan, of the Shámilah شاملة, a species of spherical, or rather hemispherical, Astrolabe, which I do not find mentioned elsewhere.

<sup>4</sup> Mémoire, &c., p. 181, *et seq.*

<sup>5</sup> See Sédillot, Mémoire, &c., Pl. 25—27.

<sup>6</sup> Az-Zarkáhiyah الزرقالیه.

<sup>7</sup> Ibráhim Ben Yahya an-Nakásh Abû Ishák, known as Ibn Zarkál of Cordova, and

commonly called by the European writers Arzachel, was living in Spain in A.D. 1180: he was distinguished for his astronomical observations, and is celebrated as being the author of the Tolotan tables. Delambre Histoire de l'Astronomie du moyen âge, pp. 6. 172. 174—176. 286. Casiri, Bibliotheca Arabico-Hispana Escorialensis, Tom. ii. p. 148. L. A. Sédillot, Prolegomènes, &c. Texte, Introd. p. lxxx.

<sup>8</sup> Mémoire, &c., p. 183, *et seq.*

<sup>9</sup> Nasir ad-Dín Muhammad Ben al-Hasan at-Túsi was the author of the well-known Ílkánian tables, and presided over the observatory at Marághah. He died in A.H. 672 (A.D. 1273). Hajji Khalifah, Tom. i. p. 205. Delambre, op. cit. p. 199. L. A. Sédillot, Prolegomènes, &c. Texte, Introd. p. xcvi. Abul-Faraj, loc. cit. p. 548. Jourdain, Mémoire sur l'Observatoire de Méragah et sur quelques instruments employés pour y observer, suivi d'une notice sur la vie et les ouvrages de Nassiroddin. Paris, 1810.

<sup>11</sup> Zát al-Kursi is the Arabic name of the constellation Andromeda.

<sup>12</sup> ومن انواع الاسطرلاب المسطح نوع يسمى الأفاقی واطنه الذي يعزى الى حنش رحمه الله وسمي بذلك لاشتغاله على الأفاق الإستوائية والمائلة. It is possible, if not probable, that several of the so-called different kinds of Astrolabe above enumerated are merely various sorts of tablets used with the ordinary planispheric instrument.



horizon, that are inscribed, between the horizon and the zenith, on the tablets. Arabic and Persian instruments are usually divided, and designated as follows:—The *Támm* تامم, complete, perfect, or solipartite Astrolabe, in which there are 90 circles or almucantars, each corresponding to a degree; the *Nisfi* نصفی, bipartite, which comprises 45 circles, each equivalent to 2 degrees; the *Thulthi* ثلثی, tripartite, containing 30 circles, each equal to 3 degrees; the *Khumsí* خمسی, quinquepartite, with 18 circles; and the *Sudsi* سدسی, sexpartite, with 15 circles, each respectively marking the degrees by five and five, and six and six. Násir ad-Dín Ahmad Shírází adds the *Tusí* تسعی, novempartite, and the *Ushrí* عشري, decempartite, Astrolabes, which would of course be inscribed respectively with 9 or 10 Almucantars, but they are not spoken of by other authors. Chaucer mentions only three kinds of Astrolabe according to this method of division.<sup>1</sup> Chardin distinguishes but four sorts, viz. the *Támm*, the *Nisfi*, the *Thulthi*, and the *Sudsi*, and these no doubt are those most commonly met with: he adds that the *Támm* Astrolabe is usually nine or ten inches in diameter, and is never made larger: the smallest instruments that he saw were no wider than two inches.<sup>2</sup>

The component parts of the Astrolabe may, for the purposes of description, be conveniently arranged in the following order—

1. The apparatus for suspending the instrument when in use.
2. The *Kursí*.
3. The Face of the Astrolabe.
4. The Tablets.
5. The Spider, or reticulated tablet.
6. The Indices, or pointers appertaining to the face.
7. The Back of the Astrolabe.
8. The Index which traverses on the back.
9. The parts and contrivances by which the different portions of the Astrolabe are fastened together when the instrument is in working order. Of these I shall treat in succession.

1. The suspensory apparatus consists of three distinct portions, viz. the *Ilákah* علاقة, cord; the *Halkah* حلقة, ring, (the Ring, Alphantia, Abalantica, Alanthica, Armilla suspensoria, seu rotunda); and the *Urwah* عروة, handle, sometimes called the *Habs* حبس, prison, (the Turet, Alhabos, Ansa, Armilla reflexa). The *Ilákah* is the cord from which hangs the entire instrument when in use. The *Halkah* A (Plate xviii. fig. 1) is a ring to which the *Ilákah* is attached, and which passes through the *Urwah*. The *Urwah*, or *Habs* B, receives the *Halkah*: its upper part is circular; the lower portion ends in two flattened extremities: these last embrace the upper part of the *Kursí* CDE, and are joined by means of a fixed rivet passing through a hole in the top of the *Kursí*, allowing the latter to swing freely, but without shake, from side to side between the extremities of the *Urwah*.<sup>4</sup>

2. The *Kursí* كرسي, throne, CDE, to which the *Urwah* is fastened, is a projection from the superior portion of the *Hajrah* and *Umm*, which form the main body of the instrument, and with which it is connected. The *Kursí* is often made in one piece with the *Hajrah* and *Umm*, and thus becomes an integral part of the main body of the instrument (*Corpus Astrolabii*). This method of construction is mentioned by the anonymous Persian author<sup>5</sup>; and I may add, that the *Kursí* is in one piece with the *Hajrah* in all the Astrolabes that have fallen under my notice. In some European instruments, however, it was entirely separate from the *Hajrah* and *Umm*, and was firmly fastened to the former by means of screws<sup>6</sup>: in such cases it was called the *Armillæ fixa*, and reckoned as part of the apparatus for suspension. Ibn as-Samh omits to speak of the *Kursí* altogether, and tells us that the *Urwah* is attached immediately to the *Hajrah* by means of a rivet passing through a hole in the latter.<sup>7</sup>

3. The Face of the Astrolabe (*Antica*, *Facies Astrolabii*) is the upper surface of the circular plane which forms the main body of the instrument, and comprises the *Hajrah* حجرة, side, sometimes called the *Kiffah* كفة, rim, or the *Tauk* طوق, ring, collar (the Brinckes, the Bordure, Alnogiza, Limbus, Margo, Margilabrum), and the *Umm* أم, mother (the Moder, the Wombe, Mater). The *Hajrah* and *Umm* are sometimes constructed separately, and afterwards fastened together, and they are so found in the Astrolabes of Professor Wilson and Mr. Vaux; but they are more commonly made out of one piece, and formed in a lathe.<sup>8</sup> In most instances, as I have mentioned above, the *Hajrah*, *Umm*, and *Kursí* were all three cast in one block; but according to the anonymous Persian author the separate method of construction was preferable.<sup>9</sup> The *Hajrah*, DEFGH (Plate xviii. fig. 1), is the Limb of the Astrolabe, and forms the

<sup>1</sup> —“These almicantars been compounded by two and two, albeit so that on diuers Astrolabes, some almicantars been deuised by one, and some by two, and some by three, after the quantitie of the Astrolabe.” The Conclusions, &c., fol. 263.

<sup>2</sup> Chardin, loc. cit. p. 337. The inch mentioned by Chardin is of course the Ponce which prevailed under the old French régime; it is equal to 1·06578 English inches.

<sup>3</sup> Some European writers say that the *Habs* is the cavity (foramen concavum) occurring in certain Astrolabes, and in which the *Halkah* (armilla) moves. See Stoeffler, *Elucidatio fabricæ usque Astrolabii*, fol. 31 r., and Koebellius, *Astrolabii declaratio*. Second Edit., fol. 5 v.

<sup>4</sup> Stoeffler gives the *Urwah* another form (see Plate xviii. fig. 2); but the above construction is followed in all the instruments I have examined, with but one exception. See Plate xviii. fig. 3, and Appendix, No. I. B.

<sup>5</sup> See *infra*, note 9.

<sup>6</sup> See Stoeffler, *Elucidatio*, &c., fol. 30 r., and Koebellius, *Astrolabii declaratio*. Second Edit. fol. 6 r. I have copied their drawings in Plate xviii. fig. 2.

<sup>7</sup> وفي خط الجنوب الذي في الطوق المذكور ثقب في وسط الخط قد احكم امره وثقبه وادخل في ذلك الثقب محور يبري فيه واثبت ذلك المحور في عروة وادخل في تلك العروة حلقة يعلق به &c.

<sup>8</sup> Az-Zubair says, المصنوع الصفيحة الكبرى الجامعة فاما الامة فهو اسم موضوع يطلق على مجموع الصفيحة الكبرى الجامعة للصفيحة والمجرة المصققة بها والمجرة هو اللقطة الغليظة المستديرة المتوازية للسطح العريضة الصفيحة بجميع الصفيحات المصققة بالصفيحة المذكورة وتسمى الطوق وقد تكون هذه الحلقة والصفيحة من جسم واحد في بعض الاسطرلابات قد احكم خيطه وقد تلصق احداها بالآخر ومنها يبرز الكرسي الذي فيه العروة والعلاقة التي يعلق بها الاسطرلاب لاذن الارتفاع وعلي ظهر الامة خطوط ودوائر واشكال &c.

<sup>9</sup> The anonymous Persian author says, وتدوير درغایت استوا وتدوير بارسازد بر وجهی که هیچ جانب آن اقل از جانب دیگر نباشد وطوقی درغایت تدویر بران ترکیب کنند بر وجهی که یک محیط حلقه بیرون طوق بر محیط صفيحه منطبق بود و آن طوق را حجرة خوانند و آن صفيحه را ام پس بر یک طرف حجرة و ام زيادتی ترکیب کنند و آن را كرسي گویند و بعضی از صنایع حجرة و ام و كرسي هه با یکدیگر بریزند لیکن اول درست تر باشد

margin of the *Umm* and the outer circumference of the face of the instrument. At the top, or at the lower part of the inner circumference of the *Hajrah*, there is either a small cavity, or an excrescence *L*, by which the tablets are retained in their places when lying in the *Umm*. This excrescence is called the *Mumsikah* مسكة, holder.<sup>1</sup> In Professor Wilson's Astrolabe the *Mumsikah* is a small pin projecting from the surface of the *Umm* near the lower portion of its circumference: the tablets having holes pierced in them for its reception. The surface of the *Hajrah* is divided into 360 equal parts, beginning from the middle of the *Kursí*, and proceeding from left to right. In European instruments the *Hajrah* is also generally divided into 24 parts, representing the equal hours of the day and night. The *Umm* IKLM is usually a circular concavity sunk in the face of the Astrolabe<sup>2</sup>, bounded by the *Hajrah*, and serving to contain the tablets and the spider. Through the centre of the *Umm* at *N* there is invariably pierced a hole called the *Mahan* محن, for the admission of the *Kutb* or pin, by means of which the separate parts of the Astrolabe are fastened together. The inscriptions on the face of the *Umm* vary in different Astrolabes. In general there is either a stereographic projection of the sphere on the plane of the equinoctial, the eye of the observer being supposed to be placed at the south pole of the world; or a table of the names of cities, with their longitudes and latitudes: sometimes it is left uninscribed. When an Astrolabe is constructed to be used at one place or station only the *Hajrah* and the *Umm* are in one plane.<sup>3</sup> A single projection of the sphere is engraved upon the surface of the *Umm*; and this being sufficient, a series of tablets is not required, and consequently the depression of the *Umm* becomes unnecessary.<sup>4</sup> The Arabic instrument, No. I., of the East-India House, and the *Hindú* Astrolabe of the Royal Asiatic Society, are each made for but one latitude, and the *Umm* and the *Hajrah* in both are in one plane. If the *Umm* bear the projection of the sphere, and be completely inscribed, it will present the lines and circles severally mentioned in the description of the tablets next following.

4. The *Safáih* صفائح, plural of *Saffihah* صفيحة, thin plate or tablet (Shafiahs, Saphiahs, Tympana, Tabulae regionum) vary in number in different instruments. Every tablet is made carefully of even thickness, and so constructed that its outside edge may coincide everywhere with the inner circumference of the *Hajrah*. At the top or lower part of each tablet there is either a small protuberance (*Portiuncula*, *Denticulus*), or a notch *N* (Plate xviii. fig. 4), which fits into, or upon, the cavity or excrescence in the circumference of the *Hajrah* already described.<sup>5</sup> In Professor Wilson's Astrolabe a hole is bored in each tablet for the reception of the *Mumsikah*, as before mentioned. The notch fitting on to the excrescence in the *Hajrah* appears to have been the most usual method of keeping the tablets in position in Eastern Astrolabes. In M. Marcol's Astrolabe, however, some of the tablets have notches, and some protuberances, proving, amongst other evident reasons, that they belonged to different instruments, and that the said Astrolabe was in fact a composite one. In the *Kúfic* instrument in the British Museum the tablets are furnished with the protuberance at the top, and there is a cavity for their reception at the summit of the *Hajrah*. This latter plan is also adhered to in the European Astrolabes in our national collection, and in the *Hindú* instrument in the Museum of the East-India House, in which, however, the denticle and cavity are at the bottom of the plates and *Hajrah*. The *Mahan*, as in the *Umm*, is pierced through the centre of every tablet at *C*, for the reception of the *Kutb*. The lines and circles usually inscribed on either side of each tablet are as follows—1. The two diameters, perpendicular and horizontal, *SCN*, *ECW*, which pass through the centre of the tablet, and cut each other at right angles. The perpendicular diameter *SCN* is called the *Khatt* Wasat as-Samá خط نصف النهار Nisf an-Nahár, line of the midst of heaven<sup>6</sup> (Linea medii coeli), and the *Khatt* Nisf an-Nahár خط نصف النهار Tewazalzene, Linea meridionalis, Linea medii diei sive meridiei: this latter appellation is however more strictly employed to signify the portion of this line *SM* (Plate xviii. fig. 5) which is above the horizon, and is called by Chaucer the South line, or the Line meridionall; the lower

<sup>1</sup> M. L. A. Sédillot, quoting a Persian MS. in the Bibliothèque Impériale (No. 1157) calls the cavity the *Mumsikah* (See *Mémoire*, &c. p. 156, note 6); but my anonymous Persian author refers that term to the excrescence, speaking of it as the *Mumsikah-i Thábitah*, a fixed holder. در حجرة زيادتی ترکیب کنند تا چون صفائح در حجرة وضع کنند بواسطه حرکت عنکبوت متغير نشود و آن زيادتی را مسكة ثابتة خوانند. The term might be, however, applicable to either.

<sup>2</sup> That is if it be made in one piece with the *Hajrah*, if not, it is a tablet encircled by a rim or projecting border.

<sup>3</sup> In this case the Latin writers call it *Unius latitudinis aut elevationis polaris Astrolabium*.

<sup>4</sup> It may here be mentioned that there were some other kinds of Astrolabe having only one projection of the sphere, but which served for all latitudes. Some, if not all of these, are known as the *Planisphere* of De Roias, the *Astrolabium Catholicum* of Gemma Frisius, and the *Mathematical Jewel* of Blagrave. See De Roias, Op. cit. Gemma Frisius, *De Astrolabo Catholico*, 8vo. Lovanii, 1555. Blundeville his exercises, &c. p. 595. Adrianus Metius, *Primum Mobile*, 4to. Amstelod. 1631. Tom. ii. entitled *Astrolabium*. Danti, *Trattato dell' uso*, &c. p. 139, *et seq.*

<sup>5</sup> M. L. A. Sédillot, quoting the Persian MS. of the Bibliothèque Impériale (No. 1157), calls this protuberance (appendix) the *Mék* ميع, nail. See *Mémoire*, &c. p. 156, note 6. But Násir ad-Dín Ahmad Shírází applies that term to the *Mumsikah* in the *Umm* and نكردند و نكردند.

<sup>6</sup> The anonymous Persian author is the only one who speaks of the notch. و صفائح را همه در يك موضع رخته سازند چنانكه اسفل خط وسط السما بر منتصف آن رخته بود و بر محاذاة آن در حجرة زيادتی تركيب کنند &c. the conclusion of the passage is given in note 1 *supra*.

<sup>7</sup> The word *Khatt* خط, line, when used in describing the sphere, signifies the intersection of the plane of any great circle with that of the horizon or any circle parallel therewith. For example, 'Abd al-'Alí Barjandí, in his Commentary on the *Prolomena* to Ulugh Bég's Astronomical Tables, defines the *Khatt* Nisf an-Nahár, or meridian line, to be the section common to the plane of the circle of the meridian and that of the horizon, either rational or sensible. خط نصف النهار فصل مشترك میان سطح دائرة نصف النهار و سطح افق حقیقی و فصل مشترك را میان سطح نصف النهار و سطح افق حقیقی. It must be understood, however, that the word *Khatt* does not mean the line of intersection as such, but that it is merely an accidental name of a circle of the projected sphere, where the projection of such circle happens to be also the intersection of its plane with the circle of projection. The European authors used the word *Line* in the same sense.

<sup>8</sup> The Circle of the midst of the apparent heaven is defined by 'Abd al-'Alí Barjandí as a great circle passing through the poles of the ecliptic and those of the horizon. و دائرة عطية که بقطب افق و قطب منطقة البروج گذرد آنرا دائرة اقليم رويت و وسط سما رويت گویند بجهت آنکه منتصف نصفین منطقة البروج است.



portion *M N* being termed the Khatt Nisf al-Lail *خط نصف الليل*, *line of midnight* (North line, Line of the Midnight, Cathalzewi, *Linea mediæ noctis*): this lower portion is also called the Khatt Watad al-Arz *خط وتد الارض*, *line of the pivot of the earth* (Angulus terræ), and the Khatt az-Zawál *خط الزوال*, *line of the going down (of the sun)*. The horizontal diameter, *E C W* (Plate xviii. fig. 4), is denominated the Khatt al-Istiwa' *خط الاستواء*, *straight, or level line*, or the Ufk al-Istiwa' *افق الاستواء*, *right, or straight horizon* (Horizon rectus). This line is also named the Khatt al-I'tidál *خط الاعتدال*, *line of equality*, i.e. the line of the equinoxes, and very generally the Khatt Wasat al-Mashrik wa al-Maghrib *خط وسط المشرق والمغرب*, *line of the midst of the East and the West* (*Linea ortus et occasus*); the right-hand half *C W* being called the Khatt al-Maghrib *خط المغرب*, *line of the West* (West line, Line occidentalis, Almagrip); and the portion *E C* on the left of the centre, the Khatt al-Mashrik *خط المشرق*, *line of the East* (East line, Line orientalis, Almasrech). The perpendicular diameter represents the Solstitial Colure and the Meridian: the horizontal, the Colure of the Equinoxes, and the line of intersection of the planes of the equinoctial, and of the prime vertical with that of the horizon. The point *C*, where the diameters intersect, is the North pole in a Northern Astrolabe, and the South in a Southern instrument. 2. The three circles. The first, *A B D F*, is the Tropic of Capricorn, and is called the Madár Rás al-Jadí *مدار رأس الجدي*, *circle of the head of Capricorn*; it is also named Al-Munkalab ash-Shatawí *المنقلب الشتوي*, *the winter place of turning*. The second, *G H I K*, is the Equinoctial, and is termed the Madár Awwal al-Hamal wa Awwal al-Mizán *مدار أول الحمل وأول الميزان*, *circle of the beginning of Aries and the beginning of Libra*; the Madár Rás al-Hamal *مدار رأس الحمل*, *circle of the head of Aries*; the Mu'addal al-Lail wa an-Nahár *معدل الليل والنهار*, *place of equalization of the night and day*, or simply the Mu'addal an-Nihár; and the Dáirah al-I'tidál *دائرة الاعتدال*, *circle of equality*. The third, *L M N' O*, is the Tropic of Cancer, and is called the Madár Rás as-Saratán *مدار رأس السرطان*, *circle of the head of Cancer*; it is also termed Al-Munkalab as-Saifi *المنقلب الصيفي*, *the summer place of turning*. In a Northern Astrolabe the Tropic of Capricorn is outside, near the circumference of the tablet, and the Tropic of Cancer is the inmost of the three circles; but in a Southern Astrolabe this order is reversed. 3. The Mukantarát *مقنطرات*, *bridges* (Almucantars, Almicanteras, Circuli progressionum sive altitudinum, Coronæ) *A M A'*, *a a a* (Plate xviii. fig. 5). These are the circles parallel with the horizon, or parallels of altitude. The first *A M A'*, which passes through the points at which the equinoctial cuts the straight horizon, is called the Ufk *افق*, *horizon*, or the Ufk al-Mashrik wa al-Maghrib *افق المشرق والمغرب*, *horizon of the East and West* (Horizon obliquus). It is the true or astronomical horizon which separates the upper from the lower hemisphere, so that all that is above it is visible at the place for which the tablet is constructed, and all below it hidden. The portion that is above it, both in reality and on the tablet, is called Fawk al-Arz *فوق الارض*, *above the earth*; that which is under is termed Taht al-Arz *تحت الارض*, *below the earth*. The half of this first Almucantar *A M*, on the left hand of the perpendicular diameter, is called the Ufk al-Mashrik *افق المشرق*, *horizon of the East*, and that on the right of the same line *M A'*, the Ufk al-Maghrib *افق المغرب*, *horizon of the West*. The points of intersection of the first Almucantar with the equinoctial and the straight horizon are termed respectively the Nuktah al-Mashrik *نقطة المشرق*, *East point*, and Nuktah al-Maghrib *نقطة المغرب*, *West point*; or the Mashrik al-I'tidál *مشرق الاعتدال*, *East of the equinoctial*, and Maghrib al-I'tidál *مغرب الاعتدال*, *West of the equinoctial*: that is to say the equinoctial points. The centre of the Almucantars within the last circle, numbered 90, is the Zenith, and is called the Samt ar-Rás *سمت الرأس*, *direction of the head*, or the Kutb al-Ufk *قطب الافق*, *pole of the horizon* (the Signet, Punctus verticalis). From the Ufk to the Samt ar-Rás the division is into 90 degrees: in a solipartite, Tamm, or perfect Astrolabe, there is a separate circle for each degree; in a bipartite, or Nisfi, one for every two, &c., as has been already pointed out. All the Almucantars that are within the circle of the Ufk, or horizon, and between it and the Samt ar-Ras, or Zenith, are called the Mukantarát al-Itifá' *مقنطرات الارتفاع*, *Almucantars of altitude*. In the Maksad at-Tálib, and the work of the anonymous Persian author other Almucantars are mentioned as the Mukantarát al-Inhitát *مقنطرات الانخفاض*, *Almucantars of declination*; these are placed below the Ufk, or horizon. The Almucantar which is equal in latitude to the place for which the tablet is constructed is a straight line, parallel with the straight horizon: the remainder are traced in the same manner as the Almucantars of altitude, the centres being below instead of above the earth. The author of the Maksad at-Tálib says that these Almucantars of declination are very rarely introduced. I have never met with them except in a species of tablet called the Saffihah-i 'Arz-i Tamám-i Mail-i Kullí, which will be described in the sequel. The latitude for which the tablet is constructed, expressed in degrees and minutes, is usually written immediately below the Ufk, or oblique horizon *A M A'* on the right hand, or western side of the meridian line: on the left, or eastern side, in a corresponding position, is marked the duration of the longest day at such place in hours and minutes. The hours of the longest day are not always inserted, and the names of divers cities of the same, or nearly the same, latitude as that for which the tablet is constructed are very frequently added at *c c c c*. In a Southern Astrolabe the Almucantars are traced in a similar manner to those in the Northern, but the method of their construction

<sup>1</sup> It must be remarked that I have used the words right and left throughout this description with reference to the right and left hands of the spectator, as is usual when speaking of a picture. The contrary would, however, have been more strictly correct. Chaucer says, "The East side of the Astrolabe is cleped the right side, and the West side is cleped the left side. Forget not this little Lewis, put the ring of thine

Astrolabe upon the thombe of thy right hand, and then wolle his right side be toward thy left side, and his left side wolle be toward thy right side. Take this rule generally, as well on the backe, as on the wombe side." The Conclusions, &c., fol. 262.

<sup>2</sup> See *supra*, p. 9, note 7.

is reversed. 4. The Sumút *سموت*, *ways, directions* (Azimuths, Circuli verticales, Circuli altitudinum sive rectitudinum) *B B'*, *b b b b* (Plate xix. fig. 9). These are the vertical circles and are sometimes traced in the portion of the tablet above the earth, sometimes in that below it, *B B'*, *b b b b* (Plate xix. fig. 10), and occasionally drawn both above and below *B B'*, *b b b b* (Plate xix. fig. 11); they all pass through the Zenith *Z* and the Nadir *N*, which is called the Samt al-Kadam *سمت القدم*, or Samt ar-Rijl *سمت الرجل*, *direction of the foot*, and necessarily cut the Almucantars. The circle *B B'*, which passes through the east and west points (or equinoxes) at the intersection of the straight and oblique horizons and the equinoctial, is termed Awwal as-Sumút *أول السموت*, *the first of the Azimuths*, or the Dáirah al-Mashrik wa al-Maghrib *دائرة المشرق والمغرب*, *circle of the east and the west*: it is the prime vertical. Every tenth Azimuth is usually traced, viz. the first, the tenth, the twentieth, and so on. Sometimes, however, only every fifteenth, or even every thirtieth circle is marked. When the Azimuths are numbered by tens the numbers generally proceed from the points of intersection above mentioned, both ways; i.e. both towards the circumference, and the centre of the tablet, terminating at the Khatt Wasat as-Samá, or perpendicular diameter. Sometimes, however, according to the anonymous Persian author, the numbers are made to begin from each side of the perpendicular diameter at the top and centre of the tablet, and to end at the two points of intersection. The Azimuths are the same in a Southern and Northern Astrolabe, but the method of construction is reversed, and the Nadir takes the place of the Zenith. 5. The arcs of the Unequal or Temporal hours, *U, u u u* (Plate xix. fig. 9). As-Sá'át al-Mu'awwajah *الساعات المعوجة*, *the crooked hours*, or As-Sá'át az-Zamáníyah *الساعات الزمانية*, *the temporal hours* (Heures of the planettes, <sup>1</sup> Horæ inequales sive temporales, <sup>2</sup> Nototalgab), are each the twelfth part of the day and of the night. These arcs are numbered beginning from the west of the oblique horizon, the numbers being written between the equinoctial and the tropic of Capricorn, and usually contiguous with the former circle. 6. The arcs of the equal hours *F, f f f* (Plate xviii. fig. 5), As-Sá'át al-Mustawiyah *الساعات المستوية*, or As-Sá'át al-Mu'tadilah *الساعات المعتدلة*, *the equal hours* (Heures of the clock, Horæ equales), which are each the twenty-fourth part of the period of time comprised between one sunrise and that next following. These arcs are generally traced below the earth, intersect those of the unequal hours where they cut the equinoctial circle, and are numbered beginning from the west; sometimes, however, they commence, and are numbered as well from the east as from the west, ending at the meridian line (Plate xix. fig. 11 *F, f f f f*). The numbers of the equal hours are always written close to the inner circumference of the tropic of Capricorn. The arcs of the equal hours are often marked with dots, so that they may be readily distinguished from those of the temporal hours. I find them so marked in the Astrolabe No. II. of the East-India House. The anonymous Persian author moreover mentions, and it is also so stated by the author of the Maksad at-Tálib, that some artificers trace the arcs of the equal hours above the earth, in which case the numbers commence from the East. 7. The Khatt ash-Shafak wa al-Fajr *خط الشفق والفجر*, *line of the twilight and of the dawn* (*Linea auroræ sive crepusculina*), the time of morning and evening prayer, *A B* (Plate xviii. fig. 7); the Khatt az-Zuhr *خط الظهر*, *line of a little time after midday*, the time of midday prayer, *D*; and the Khatt al-'Asr *خط العصر*, *line of the afternoon*, the time of afternoon prayer, *C*; are frequently traced on the tablets. These are usually designated by dotted lines, and in such case the Khatt az-Zawál, or lower portion of the meridian *E*, is similarly marked. The anonymous Persian writer is the only one of my eastern authorities that alludes to these lines, and even he omits to mention the Khatt az-Zuhr<sup>3</sup>; they are, however, all found in the Kúfic Astrolabe of M. Marcel, in that of the British Museum, and in No. I. of the East-India House: M. Larrey's Astrolabe has the lines of the Zuhr and the 'Asr, but omits the Khatt ash-Shafak wa al-Fajr. The anonymous Persian author says that the line of the 'Asr is sometimes traced in the division of the tablet above, and sometimes in that below the earth; he also points out the distinction between the 'Asr as observed by the followers of Ash-Sháfi'í and Abú Hanifah<sup>4</sup>, and states that against the line of the 'Asr of Ash-Sháfi'í should be written Awwal al-'Asr *أول العصر*, *beginning of the 'Asr*, and against that of Abú Hanifah Akhar al-'Asr *آخر العصر*, *end of the 'Asr*. He adds that occasionally these lines are inscribed on the back of the Astrolabe. The crepuscular line is usually introduced into European Astrolabes, but the Zuhr and 'Asr are omitted as being obviously of no practical utility to Káfirs. 8. Lastly, the usual inscription found on the tablets is sometimes completed by the addition of the arcs of the twelve celestial houses<sup>5</sup> (Plate xviii. fig. 8). These are, however, more often left out than inserted.

<sup>1</sup> Gemma Frisius thus explains the reason of this term—"Verum Planetarise dicuntur ideo, quia à veteribus Astronomis creditum est septem Planetas ex ordine istis horis dominari, ea scilicet conditione ut prima diei hora illi cedat planetæ à quo dies denominatur." &c. De Astrolabo Catholico, fol. 56 v. And see Stoeffler, Elucidatio, &c. fol. 35, 43, and the Theatro del Mvndo y de el Tiempo compvesto por Ioan Paulo Galvicio, Saloense, Traducido de lengua Latina en Castellana por Miguel Perez. Folio, Granada, 1606; fol. 110. r.

<sup>2</sup> Blundeville says that the unequal hours "are called temporall, because the ancient observers of time were wont to make diuers clockes and Horologies to shew these unequal and temporall houres."—A plaine Treatise of the first principles of Cosmographie, and specially of the Spheare, in M. Blundeville his exercises, p. 370.

<sup>3</sup> Abú al-Hasan describes the construction of the lines of the 'Asr and Shafak wa al-Fajr, but does not allude to that of the Zuhr. Mémoire, &c. p. 162.

<sup>4</sup> According to Ash-Sháfi'í the 'Asr begins at the moment when the gnomon of the sun-dial projects a shadow equal to its own length: according to Abú Hanifah the shadow must be twice the length of the gnomon before the 'Asr commences. And see D'Oshson, Tableau général de l'Empire Othoman. Tome ii. p. 101, 8vo. Paris, 1778.

<sup>5</sup> For an account of the twelve celestial houses see Gemma Frisius, De Astrolabo Catholico, fol. 82 v. Darius, Ad Astrorum iudicia facilis introductio. 4to. Lugd. 1557, p. 29, et seq. Christ. Clavii Astrolabium, 4to. Romæ, 1593, p. 488, et seq. Stoeffler, Elucidatio, &c. fol. 8, 58. Delambre, Histoire de l'Astronomie du moyen âge, pp. 45, 496. And see also M. L. A. Sédillot's translation of the Prolegomena of Ulugh Bég, p. 195.



Occasionally some of the lines and circles enumerated above are omitted, and sometimes other inscriptions are substituted on the faces of some of the tablets; or they are variously arranged. Of these tablets the most usual seems to be that called *As-Saffihah al-Áfakiyah* *الصفحة الأفقية*, the *tablet of the horizons* (Plate xx. fig. 16), on which are traced the two diameters; the three circles; a number of oblique horizons *a a*, *b b*, *c c*, *d d* (or rather half horizons on the eastern side), varying according to the size of the tablet, and of different latitudes<sup>1</sup>; and the degrees of the inclination of the ecliptic *SSSS*, *NNNN*. This tablet is mentioned in the *Maksad at-Tálib*, and the *Nafáis al-Funún*, and by the anonymous Persian author. It exists in Sháh Husain's Astrolabe in its most extended form, and a more particular description of it as there found will be given in its proper place. I have also met with it in Mr. Vaux' Astrolabe, in No. II. of the East-India House, and in the Hindú instrument in the same collection. The anonymous Persian author speaks of another tablet, which he calls the *Saffihah-i 'Arz-i Tamám-i Mail-i Kullí* *صفحة عرض تمام میل کلی*, the *tablet of the latitude of the complement of the total obliquity* (the obliquity of the ecliptic)<sup>2</sup>: he describes it as containing an oblique horizon of sixty-six and a half degrees of latitude<sup>3</sup>, coinciding with the circumference of the zodiac or ecliptic, when the head of Capricorn is placed on the meridian line; all the Almucantars both of altitude and declination; and the Azimuths both above and below the horizon.<sup>4</sup> The signs of the zodiac are divided into degrees, and from each other, by the Azimuths. I have given a drawing of this projection at Plate xix. fig. 14. It is found in all the three last-mentioned Astrolabes, and in each instance, is traced on the tablet which bears on its other side the *Saffihah al-Áfakiyah*. These two last-mentioned *Saffihahs* appear to have been used as models for the construction of the ordinary tablets. They are both represented in the plates of Major Pottinger's Astrolabe. Dr. Dorn also speaks of a tablet constructed for sixty-six degrees of latitude, which is perhaps the *Saffihah-i 'Arz-i Tamám-i Mail-i Kullí*. Another additional inscription, differing from those ordinarily employed, is sometimes found on one of the tablets; it consists of a projection of the sphere for places without latitude; i.e. situated on the equator. No. VII. of the plate in the *Description de l'Égypte*, apparently representing the Umm of M. Marcel's Astrolabe, is inscribed with the Almucantars arranged for a place without latitude; but, besides these, and the diameters and circles, it has nothing whatever traced or written upon it. Dr. Dorn likewise mentions a projection constructed for the island of Sarandib (Ceylon), "which has no latitude, since it is on the equinoctial line," and occupying the reverse of the tablet, on which is the projection for a latitude of 66°, alluded to above. I have met with no less than three projections for places on the equator, and as they present some variants I have inserted drawings of them in Plate xx. Fig. 17 is from No. II. of the East-India House. It contains the two diameters and the three circles: above the straight horizon are the Almucantars marked and numbered by sixes, from six to ninety, the first Almucantar coinciding with the straight horizon, since to an inhabitant on the equator the pole has no elevation; and the Azimuths marked by tens but not numbered, the first Azimuth, or prime vertical, being of course the equinoctial. Immediately under the horizon on either side are the words *المشرق لا عرض له*, the *East—no latitude*, and *المغرب لا عرض له*, the *West—no latitude*. Below the horizon, between the tropics of Capricorn and Cancer, are traced the arcs of the hours, which are always equal

<sup>1</sup> The smallest number is eight in each quadrant, i.e. thirty-two in all; and the largest, according both to the *Maksad at-Tálib* and the anonymous Persian author, is sixty-four, the latter adding that that is the entire latitude of the habitable world: *چنانچه مجموع شصت و چهار اقل شود که تمام عرض مبروره است*. Idrisi allows sixty-four degrees of latitude, reckoning from the equator, for the habitable portion of the globe. See Jaubert, *Géographie d'Edrisi traduite de l'Arabe*. Tome i. p. 2. 4to. Paris, 1836. A most able dissertation on the geographical doctrines of the Arabs will be found in the third section of M. Reinaud's translation of *Abú al-Fadá. Géographie d'Aboulféda*, traduite de l'Arabe par M. Reinaud. Tome i. p. clxxiv. et seq. 4to. Paris, 1848. And see also the *Mémoire sur les systèmes géographiques des Grecs et des Arabes*, par L. A. Sédillot. 4to. Paris, 1842; and the *Géographie du moyen âge étudiée par Joachim Lelewel*. 4 Tomes 8vo., avec un atlas. Breslau, 1851-52. This last named work, though somewhat deficient in arrangement, includes almost every thing that has been written on the geographical science of the Arabs.

<sup>2</sup> The term *Mail-i Kullí* *میل کلی*, *total obliquity*, or *Al-mail al-A'zam* *المیل الأعظم*, the *greatest obliquity*, signifies the greatest distance between the equinoctial and the ecliptic, measured upon the solstitial colure. It appears to have been so called not only because it is the sun's greatest declination or obliquity of the ecliptic, but also to distinguish it from the *Mail-i Awwal* *میل اول*, the *first obliquity*, and the *Mail-i Thání* *میل ثانی*, the *second obliquity*. 'Abd al-'Alí Barjandi, in his *Commentary on the Prolegomena of Ulugh Bég*, defines the *Mail-i Awwal* as the arc of a circle of declination comprised between a definite portion or point of the ecliptic and the equinoctial in the nearest direction; the *Mail-i Thání* as the arc of a circle of latitude comprised between the aforesaid point and the equinoctial in the nearest direction; and the *Mail-i Kullí* as the arc of the circle passing through the four poles (i.e. of the world and of the zodiac—the solstitial colure) comprised between the ecliptic and the equinoctial in the nearest direction. *وقسمي از دایره میل سه مابین جزء مقروض از منطقة البروج*

و معدّل النهار باشد از جانب ارب آن را میل اول آن جزء مکنند و قسمي از دایره عرض مابین جزء مقروض مذکور و معدّل النهار از جانب ارب آن را میل ثانی آن جزء مکنند و قسمي را از مارّه باقطاب اربعه مابین منطقة البروج و معدّل النهار از جانب ارب میل کلی مکنند. The first and second obliquities, when referable to the same point of the ecliptic, form the two sides of a spherical triangle, having for its base an arc of the equinoctial, and for its apex the given point of the ecliptic: both obliquities have the same maximum, viz. the *Mail-i Kullí*, or total obliquity.

<sup>3</sup> *Abú al-Fadá* places the end of the world, towards the north, at 66½ degrees of latitude. Reinaud, *Géographie d'Aboulféda*, traduite de l'Arabe. Tome i. p. clxxvii. I may add, that in the *Nuzhat al-Kulúb*, *Hamd Allah al-Mustanfi al-Kazwini* estimates the total width of the habitable part of the globe at 90 degrees, and the degrees of north latitude from the equator at 66 degrees and 25 minutes. In the *Nafáis al-Funún* the number of degrees north of the equator is stated to be sixty-six.

<sup>4</sup> The following is the account given by the Persian author: *اما صفحه عرض تمام میل کلی بران وجه باشد که بر یکی از صفائح افق شصت و شش درجه و نیم رسم کنند و علامت شصت عمل آنکه چون راس جدی بر خط وسط السماء نهند محیط منطقة البروج بران افق منطبق بود پس چنانچه در ابواب متقدمه مذکور شد مقتضای ارتفاع و انحطاط و دوائر سموت هم در فوق الارض و هم در تحت الارض رسم کنند و فایده این صفحه بسیار است چنانچه در کتب اعیال اسطرلاب مذکور است. In the *Maksad at-Tálib* a similar tablet is described as comprising the three circles and the two diameters, the zodiacal circle touching the two tropics, and divided as usual, together with the places of the fixed stars. The author says that this tablet is called the *Saffihah Mifáin al-'Ankabút* *صفحة میزان العنكبوت*, the *tablet of the measure of the 'Ankabút*. *و قد یقسم علی صفحه الاخری من الاثاقية المدارات الثلاث و القطرین المذكورین و دائرة البروج مابین لذار الانقلابین مقسومة كما اسلفنا و قد یقسم مواضع الکواکب ایضا و تستی بصفحة میزان العنكبوت.**

by day and night to an inhabitant on the equator where the pole coincides with the horizon; they are numbered outside the equinoctial from one to twelve, commencing from the west point of the horizon. The concentric semicircles which appear on the lower half of this tablet appear to be Almucantars projected on the supposition that the observer is stationed at the pole, so that the pole and zenith coincide and the equinoctial becomes the horizon.<sup>1</sup> These circles are numbered commencing first from the outer tropic by sixes, from six to 24, at which point is the equinoctial, and thence again from six to 78; the last two numbers, 84 and 90, and one circle which would complete the 90 degrees being unwritten, in consequence of the interference of the central hole or Mahan. Fig. 18 represents a similar projection as found in Mr. Vaux' Astrolabe. In the portion above the straight horizon the inscriptions are exactly similar to those last described, except that the Azimuths are marked by thirties: they are not numbered. Below the straight horizon the Almucantars are traced as before, but they are numbered six and six, up to forty-two, when the numbers stop: reckoning from the equinoctial there would be fifteen circles if it were not for the interference of the Mahan. The radii from the centre of the lower half on this tablet are very irregularly traced, as indeed are all the circles and lines, but since the numbers which are written, somewhat capriciously, against and upon the radii proceed by tens from ten to 90, beginning from the east and west points of the straight horizon, and ending on either side of the perpendicular diameter, I believe that they are the Azimuths, the first of which, supposing the observer to be stationed at the pole, would be the line of the east and west. Fig. 19 is a projection for a place without latitude, copied from the Hindú Astrolabe in the Museum of the East-India House. It contains the two diameters; the three circles; the Almucantars inscribed and numbered by tens, commencing from the east and west above the straight horizon; the Azimuths both above and below the horizon, shewing the Nadir as well as the Zenith, where the equinoctial, which is the prime vertical, is intersected by the Azimuths, numbered by thirties only below the horizon; and the lines of the hours, numbered from the east and west respectively, from one to six. Immediately under the horizon, on the left side of the perpendicular diameter at *a*, are the words *अक्षा मुन*, the *complete latitude*, and on the right at *b* *होरा १२*, *hours twelve*. Fig. 20 is the reverse of the tablet last mentioned, and contains an inscription differing in arrangement from any that I have seen elsewhere. It is a projection of the sphere for a latitude of 72°, and comprises the two diameters; the three circles; the Almucantars numbered by tens, the numbers commencing at the top of the meridian line under the circle of the oblique horizon. Outside this horizon are the arcs of the unequal hours, numbered from one to six both ways, commencing from either end of the straight horizon, and traced above as well as below the latter; and the arcs of the equal hours, distinguished by being dotted, traced both above and beneath the straight horizon, and numbered from one to twenty-two, beginning from the west below the latter. At the foot of the tablet at *a* are the words *अक्षा ७२*, *latitude seventy-two degrees*, and at *b* *होरा २३*, *hours twenty-three*.

The lines and circles usually found upon the tablets are sometimes so disposed as to combine two ordinary projections of the sphere. I have not seen this arrangement mentioned by any author, but it occurs both in Sháh Husain's Astrolabe and in that belonging to Professor Wilson. The double projection in the former instrument (Plate xix. fig. 12) will be particularly described in the following pages. It will be sufficient here to state that it comprises the ordinary diameters and circles drawn entire, and serving in common for both projections, the relative position of the diameters being, however, reversed, together with the Almucantars, the Azimuths, and the arcs of the unequal hours, all of which are only partially traced; and that both projections are constructed for the same latitude as is shewn by the horizons. In Professor Wilson's Astrolabe one tablet bears a double projection on either side, nearly similar to the above, but exhibiting some slight differences. In these the diameters occupy their usual positions, and, together with the circles, are common to both projections as before, but the Almucantars and the arcs of the unequal hours are all perfectly inscribed throughout: the prime verticals are the only Azimuths traced, and they are drawn both above and beneath the horizons. Each projection on each side of this tablet is constructed for a separate latitude, as is denoted by Dévanagari numerals placed under the eastern halves of the several oblique horizons: such numerals being the only written characters that appear upon the tablet. At fig. 12\* of Plate xix. I have given a drawing of one side of this tablet, where the projections are constructed for the respective latitudes of 30° and 24°: the other side is precisely similar, except that the constructions are for the latitudes 32° and 27°. It may be remarked that in the plates to M. L. A. Sédillot's *Mémoire*, fig. 88, plate 27, there is a diagram very nearly resembling the inscriptions above described: the learned author presents it as an example of the *Así* *آسی* Astrolabe, which he mentions as one of the

<sup>1</sup> The combination of these two projections on the surface of one tablet is not without reason, seeing that they are both projections of a right sphere; for although the latter kind is not now often so called, it was not unusual so to term it in former days. "It may be said to be right," says Master Blundeville, "in two manner of wayes, first, when the Horizon passeth through both the poles of the world, cutting the equinoctial with right angles, in which sphere they that dwell have their zenith in the equinoctial, which passeth right over their heads, to whom the dayes and nights are always equal. Secondly, they are said to have a right horizon, and to dwell in a right sphere, to

whom one of the poles of the world is their zenith, and their horizon is all one with the equinoctial, cutting the axletree of the world in the very midst with right angles; and because the horizon and the equinoctial are parallels, this kind of sphere is called a parallel sphere," &c. *Cosmographie*, in M. Blundeville his exercises, p. 313. Plerius Valerianus also says—"Recta etiam nonnulli vocant, vbi polus vertici nostro immet perpendiculariter, et equinoctialis est horizontalis loco." *Compendium in spheram per Plerium Valerianum Bellunensem*; added to the *Sphæra* of Sacrobosco. 12mo. Coloniae, 1601, p. 179.



class of instruments that are both Northern and Southern<sup>1</sup>, but he gives no account of it whatever. I have copied his diagram at fig. 13 of Plate xix.

Lastly, to these additional tablets may be added the Safihah at-Tasyîr صفحة التسيير, on which, according to M. L. A. Sédillot, are traced the great circles that pass through the two poles of the prime vertical, or first Azimuth, and each of the degrees of the equator.<sup>2</sup> A drawing of this tablet will be found at fig. 15 of Plate xix.

None of the additional tablets above mentioned seem to have been used in Europe, but in some Western Astrolabes one tablet was engraved with a map of the world in polar projection, having the north pole for its centre, and extending to the tropic of Capricorn.<sup>3</sup> This map was certainly an European innovation, and Focard's quaint exordium to his description of its uses may lead us to suppose that he was the first to introduce it into the Astrolabe.<sup>4</sup>

5. The 'Ankabût عنكبوت, spider, also called the Shabakah شبكة, net (The rete, Alhancabuth, Aranea, Rete, Vellum) is the reticulated tablet (Plate xx. figs. 21, 22, 23, 24) which lies and revolves upon the surface of the other tablets, than which it is thicker and firmer. In forming the reticulation of this tablet the portions cut out, and those left intact, vary in different instruments; but a small circular portion at the centre, the outer circumference *E F M* (Plate xx. fig. 21), and the ecliptic with the signs of the zodiac *A B C D*, called by the Arabian astronomers the Mintakah al-Burj منطقة البرج, girdle of the signs of the zodiac (Circle of the Signes, Circle of Beastes, Mirach, Simiophoros, Signifer, Circulus obliquus vel inflexus) almost always remain untouched; a small part of the outer circumference only being removed, at its summit, so that the zodiacal circle, the outer edge of which is the ecliptic, may at that point be close to the Hajrah, and the sign thereon inscribed in apposition with it. The signs of the eastern zodiac correspond exactly with our own, and are named by the Muhammadans as follows: Hamal حمل, the ram; Thaur ثور, the bull; Jauzá جوزا, the sign Gemini, called also Tauaman توامان, the twins; Saratan سرطان, the crab; Asad اسد, the lion; Sunbulah سنبله, the ear of corn, the sign Virgo, also termed 'Azrá عذرا, the Virgin; Mizán ميزان, the balance; 'Akrah عقرب, the scorpion; Kaus قوس, the bow, the sign Sagittarius, sometimes termed Rami رامي, the archer; Jādī جدی, the kid, the sign Capricorn; Dalw دلو, the bucket, also called Sākib al-Māء ساكب الماء, the sign Aquarius; Hūt حوت, the fish. Each sign in the zodiacal circle is divided into thirty parts, which are marked separately in a Tamm, or complete Astrolabe: in a Nisfi, or bipartite, each mark comprises two divisions: in a Thulthi, or tripartite, three, and so on. A number of pointers are also always left projecting from, and forming part of, the reticulation, on each of which pointers, save one, are inscribed the names of some of the most conspicuous amongst the fixed stars: to these pointers I shall presently recur. In a Northern Astrolabe the outer circumference represents the Tropic of Capricorn, that sign being placed at the summit of the zodiacal circle, and, as part of the circumference of the tropic is there intentionally removed, in apposition with the Hajrah at *A*. In a Southern Astrolabe the outer circumference is the Tropic of Cancer, the position of the ecliptic is reversed, and the sign Cancer occupies the place of Capricorn in a Northern instrument, i.e. touching the Hajrah. In a Northern Astrolabe the fixed stars which lie between the ecliptic and the centre of the instrument are northern, and such as are between the zodiac and the outer tropic are southern.<sup>5</sup> In a Southern Astrolabe the reverse of this is the case. Sometimes a bar, or support, *G H* (Plate xx. figs. 22, 23, 24) crosses the middle of the 'Ankabût at the heads of Aries and Libra, serving to connect the reticulation of the 'Ankabût, and extending on either side to the outer circumference: this is called the 'Amūd rās al-Hamal wa al-Mizān عمود راس الحمل والميزان, pillar (or prop) of the head of Aries and Libra. Other supports are also frequently added. In some Astrolabes the equinoctial circle, the inmost tropic, viz. that of Cancer or Capricorn, according as the instrument is Northern or Southern, and the perpendicular and horizontal diameters are marked on the 'Ankabût, coinciding exactly, where not cut away, with the same circles and lines in the Umm, or on the tablets (Plate xx. fig. 22). Occasionally in Asiatic, and very generally in European instruments, the whole or portions of the

<sup>1</sup> Mémoire, &c. p. 182.

<sup>2</sup> Ib. p. 162.

<sup>3</sup> — "Dens la mere est vne table nommee Speculum cosmographicum, Mape, ou Miroir du monde: seruant pour les parties Septentrionales, Meridionales, Orientales, et Occidentales, d'Europe, Afrique, Asie, et Amerique." Paraphrase de l'Astrolabe, p. 29. And see Ritter, Astrolabium, oder Nützlicher Bericht von dem Astrolabio, p. 69, et seq. and Pl. 4. Petrus Apianus, or Bienewitz, who was born in A.D. 1495, and died in 1552, and who was professor of Mathematics and Astronomy at Ingoldstadt in Bavaria, describes the Speculum Cosmographicum as a separate instrument, and not as in connection with the Astrolabe. Cosmographia, sive descriptio orbis, Petri Apiani per Gemmam Frisium aucta, 4to. Antuerpie, 1550, fol. 27 r. Regner Gemma Frisius was born in A.D. 1503, and died in 1558, he published several editions of the work of Apianus, with Comments, and it seems that we owe all the geographical portion of the Cosmographia to the editor and commentator.

<sup>4</sup> — "Reste à present la declaration du Miroer du Monde, et de ces vtilitez. Et pource, que au commencement de notre euvre, en la page 30 l'ay promis de donner

la raison, pourquoy ay mis le Miroer du Monde. Pour satisfaire donq à ma promesse, je vseray du Prouerbe commun, qui est, Que d'une pierre faire deux coups, est habilité. Et comme par l'Astrolabe, on ha la connoissance du Ciel, par le Miroer, ou Mape monde, on aura celle de la Terre, et de ces parties: et ce certes ay fait, à fin que en vn traité tu ayes l'intelligence de tout le Monde." Paraphrase de l'Astrolabe, p. 126.

<sup>5</sup> That is if reckoned by their latitude, as is usual in Eastern astronomical tables; but if by their declination, then of course the signs and stars between the equinoctial and the centre of the Astrolabe are northern, and those outside the equinoctial are southern. The Arabian astronomers usually mean the latitude of a star when they employ the terms northern and southern, with relation to the stars in the 'Ankabût; sometimes however, these terms refer to the equinoctial. The author of the Maksad at-Talib classifies stars and signs according to their declination. والشبابة من الكواكب هي التي تدور ابدا داخل مدار راس الحمل والجنوبية هي التي تدور خارج مدار راس الحمل والشبابة من البروج ستة و هي الحمل و الثور و الجوزا و السرطان و الاسد و السنبلة و هي دائرة داخل مدار اول الحمل و الجنوبية منها الستة الباقية, but this is unusual.

equinoctial circle are left entire. In Muhammadan instruments the portion sometimes remaining is that which is beneath and between the end of Aries and the beginning of Virgo.<sup>1</sup> I have never seen any other part left; and both our English instruments agree with them in this respect. In the Hindú Astrolabe of the Royal Asiatic Society, however, the whole of the equinoctial *I K L* (Plate xx. fig. 23) remains untouched. In one instance, No. I. of the East-India House (Plate xx. fig. 24), the outer tropic, that of Capricorn, has been completely removed, and the 'Ankabût is formed solely of the zodiacal circle *G M H*, the lower part of the equinoctial *I K L*, and the 'Amūd rās al-Hamal wa al-Mizān *G H* within the zodiac: from these proceed the pointers of the fixed stars.

At the lower portion of the 'Ankabût there is generally a small knob *M* (Plate xx. figs. 21, 22) projecting from its upper surface: this is called the Mudîr مدبر, one who turns round, or the Muhrik محرك, mover,<sup>2</sup> and serves to turn the 'Ankabût about its centre. It is usually placed upon the outer tropic, but its situation is somewhat varied: in the Hindú Astrolabe of the Royal Asiatic Society (Plate xx. fig. 23), and the two English instruments, the Mudîr does not exist: in the Hindú Astrolabe of the East-India House it is on the right-hand side of the circumference, opposite the head of Libra: in one instance, the Kúfic instrument in the British Museum, there are no less than four Mudîrs, one below as usual, another at the top at the beginning of the sign Capricorn, and the remaining two at either end of the 'Amūd rās al-Hamal wa al-Mizān. No. I. of the East-India House has the Mudîr at the top *M* (Plate xx. fig. 24). In Professor Wilson's Astrolabe it is at the left end of a segment of the equinoctial under the sign Aries. The form of the reticulation, and of the pointers of the stars, is varied in different instruments; and the Persian author mentions, by way of example of the latter, that the pointers of the two vultures (Aquila and Lyra) are sometimes formed like the head or the beak of a bird, and that of the hand of Al-Jauzá (Orion) like the forefinger of a hand, the remaining fingers being clenched. These varieties in shape are left to the taste of the artificer, which is unrestricted if he comply with the rule of leaving the requisite fixed points, and cutting away only so much of the remainder as is consistent with coherence and stability.<sup>3</sup>

6. The pointers or indices appertaining to the face of the Astrolabe are differently described by the Asiatic and European writers; and the latter even differ one from another. They appear, however, to be of two kinds: the one being separate and moveable, revolving round the centre, and traversing the face of the instrument, over the 'Ankabût; and the other consisting of various pointers fixed to, and inherent in, the 'Ankabût itself. The separate moveable index does not seem to have been used in the East; but such an index is distinctly mentioned by several of the European writers. We find it in two forms, either extending across the entire face of the Astrolabe, and cutting the centre, or merely proceeding from the centre to the circumference as a radius, like the hand of a clock. In the former case it is sometimes called the Almuri, and must not be confounded with the Murî at the head of Capricorn or Cancer, which is a fixed pointer in the 'Ankabût placed at the head of such signs respectively, according as the instrument is Northern or Southern, and will be described presently: it is mentioned and figured by Stoeffler, Focard, and Danti.<sup>4</sup> Of the latter form we have a description and drawing in Ritter's treatise.<sup>5</sup> Focard describes, besides an Ostensor similar to that of Stoeffler, no less than two other separate facial indices, which he calls the Ostensor, Index, or Règle, and the Petite Roue (Plate xxi. figs. 32, 33); but he expressly states that they are employed only with reference to the map tablet.<sup>6</sup> Neither of these authors speak of the Murî at the head of Capricorn or Cancer. Koebelius, on

<sup>1</sup> The Persian author gives directions for leaving this portion of the equinoctial.

<sup>2</sup> Mudîr is the ordinary name, but the Persian author calls it the Muhrik. و بعضی از صنایع خرق آن بر وجهی کنند که اشکال غریب ازان حاصل آید و شطایاه کواکب بصور مختلفه سازند چنانچه شطایه نسرین بر صورت سرمخی یا منقاری سازند و شطایه ید الجوزاء بر صورت سبابه دسی که باقی اصابع آن مقهوش (مقبوض) باشد و علی هذا القیاس و این تعلق بقطاعات صانع دارد چه غرض آنست که منطقه البروج و کواکب از خرق عنکبوت منهدم نشود دیگر بهر نوع که خواهند خرق آن جایز است. I have not met with an Eastern Astrolabe in which the artist has allowed his inventive genius to overcome his religious prejudices by introducing the forms of animals. In the European instruments, however, this species of ornament is freely resorted to. Stoeffler mentions the practice—"Nonnulli denticulos, stellas per eorum acumina designantes, uel in modum folii uel rostri auis, uel alterius rei conuenientis nomini stellae protrahunt, subtile enim ingenium in huiusmodi figuratiombus admodum prodesse potest." Elucidatio, &c. fol. 20. verso. The English Astrolabes in the British Museum offer examples of this species of ornament. See Appendix, No. I., *H* and *I*.

<sup>3</sup> Stoeffler says—"Regula, Ostensor, Index, aut Almuri Arabico sermone in Astrolabii anteriori parte currens," &c. Elucidatio fabricae usque Astrolabii, fol. 21. v. He also calls it the "Ostensor faciei." Ib. fol. 29. v. And again speaks of it as follows: "Demum accidit regula percurrens faciem totius instrumenti, hanc Arabes Almuri aut Almeri nominant: Latini Calculatorem, Ostensorem, aut Indicem. Indicem enim ostendit et supputat horas, gradus equinoctialis et zodiaci," &c. Ib. fol. 32. r.

Focard has the following passage:—"L'autre partie moins principale contenue à la partie interieure, ou face, est nommée Index, ou Ostensor, qui est vne Règle, la droite ligne de laquelle montre le leuer et coucher tant du soleil, que des estoiles." Paraphrase de l'Astrolabe, p. 29. Danti says—"Sopra la detta Rete è posto un Regolo, che dal centro passa sino alla Circonferenza dell'Astrolabio, il quale dalli Arabi è chiamato Almuri, che in nostra lingua tanto uale quanto è dire Dimostratore." And again in another place—"Sopraponendo poi il detto Dimostratore, ò Almuri alla Rete, auertisci di non serrare il chiodo con la vite," &c. Trattato, &c. Prima parte, p. 36, and quinta parte, p. 28. And see Plate xxi. figs. 29 and 31, the first being the Ostensor as figured by Stoeffler and Focard, the second the Dimostratore of Danti.

<sup>4</sup> Ritter, after describing the construction of the 'Ankabût, adds—"Du sollt auch auf dieses Netz oder Spinnenweb, eine bewegliche Regel einheften oder einschrauben, welche du zwar in die Grad der Abweichungen, von dem Æquinoctial Circle, abtheilen magst, inmassen du dann schon ziwor auch bey No. 2. genugsamlich unterrichtet worden bist." Astrolabium oder Nuetzlicher Bericht von dem Astrolabio, &c. p. 124. I have reproduced Ritter's drawing at Plate xxi. fig. 34.

<sup>5</sup> — "La premiere, et plus inferieure, est le Miroir, ou Mape monde, laquelle doit estre appliquee à la concavité de l'Astrolabe, comme les autres tables: et par dessus toutes icelles, quand on sen veut servir: et sur icelui Miroir l'Aranea: sur l'Aranea, la petite roue: à laquelle sont marquees les 24 heures avec la ligne de midi, et par dessus tout, l'index ou regle, en laquelle sont marquez les degrez de la Latitude Meridionale ou Septentrionale." Paraphrase de l'Astrolabe, p. 159, 160. Petrus Apianus gives a similar account in his description of the Speculum Cosmographicum as a separate instrument—"Adsumt etiam tres rotulae mobiles, quarum prima, sine inferior, Speculum



the other hand, refers to the latter only, and is silent as to the separate facial index.<sup>1</sup> Chaucer alone of the European writers describes the moveable facial index, which he calls the Labell, and which, from his account, seems to have extended across the face of his Astrolabe; together with the Muri of Capricorn or Cancer.<sup>2</sup> I might easily multiply references shewing that a separate facial index of some sort was usual in Western Astrolabes, but the passages adduced in the notes will be sufficient. Moreover, in the small English Astrolabe in the British Museum such an index is actually extant: I annex a drawing of it at fig. 35 of Plate xxi, from which it will be seen that it coincides in form with the Almuri of Stoeffler, Focard, and Danti. I do not find anywhere a separate facial index alluded to by the Eastern authors who use the word Muri *مري*, *index*, as applying exclusively to the fixed pointers in the 'Ankabút, and more especially to the Muri at the head of Capricorn or Cancer. It is true that Máshá Allah wrote in the East; and in the MS. of his treatise on the Astrolabe in the British Museum an index is mentioned as traversing on the surface of the 'Ankabút, and called the Novella,<sup>3</sup> a drawing being added similar in form to the facial index given by Ritter (Plate xxi. fig. 36). This Novella is spoken of as distinct from the Muri of the head of Capricorn, the latter being separately mentioned<sup>4</sup> and figured in a diagram, with the words Almuri, Calculator, Ostensor graduum, Divisor, written over it (Plate xxi. fig. 37). It must be remarked, however, that in the translation of Máshá Allah, annexed to Galucci's version of the Margarita Philosophica, the Muri of Capricorn is the only one mentioned,<sup>5</sup> and the moveable index, or Novella, is nowhere alluded to. The Novella was therefore probably an European invention: it has no Arabic name; and the word Novella itself may imply that it was an improvement. The mention of it, however, in our copy of Máshá Allah, proves that it was known as early as the middle of the thirteenth century. Five of the Eastern Astrolabes that I have seen have the 'Izadah (Alidada), or usual index on the back, and the central pivot, on which the parts of the instrument are placed and fastened together; of both of which more hereafter. In all of these Astrolabes it is utterly impossible that a separate facial index could have existed; for even by compression, not the smallest space can be produced so as to admit of the introduction of any thing between the 'Ankabút and the wedge which crowns and confines the whole, as will be described in the sequel: the 'Ankabúts and the 'Izadahs are moveable, without shake in any direction, and the insertion of the least additional thickness would interfere with their rotation.<sup>6</sup>

In the Kúfic Astrolabe, brought from Egypt by M. Marcel, there are, according to the statement of M. Sédillot, two 'Izadahs, one on the face of the instrument over the 'Ankabút, similar in form to the usual dorsal 'Izadah, and another in its customary position on the back.<sup>7</sup> If this were so the facial 'Izadah would be, so far as I know, a solitary instance;<sup>8</sup> but I think from an examination of the plates, all that remains of this Astrolabe,<sup>9</sup> it by no means appears that there were two 'Izadahs, but rather the contrary. Plate xiii. fig. 47 in the Memoir presents a perspective view of the entire instrument; the face is uppermost, and an 'Izadah is represented over the 'Ankabút (Plate xxi. fig. 38). Plate xiv. fig. 49 (Plate xxi. fig. 39) is a side elevation of the same instrument with an 'Izadah, which M. Sédillot maintains is *dorsal*, but which, according to my idea, is identical with that represented in the perspective view: the position of the 'Izadah, which appears with the small end of the Kutb or pivot projecting through it, with its wedge, as represented in fig. 47, whilst on the other side of the main body of the instrument is the head of the pivot, would seem sufficient to shew that the 'Izadah in this figure was lying on the face of the instrument; besides, between it and the main body there are certain lines which can represent

Orbis, (quod Mappam vocant) representat. Altera fert zodiacum, et ob similitudinem, rete siue aranea nominatur, apud Arabes autem Alhancabut. Tertia verò et ultima volubilis rotula parua, habet 24 diuisiones horarum, cum Indice Meridiei. Est insuper Index, qui voluellum vel Alhidada dicitur, supra centrum infixus, qui omnes rotulas supradictas continet, et constringit, ne faciliè à centro decedant." Cosmographia, p. 63.

<sup>1</sup> "Et circa initium in eodem zodiaco est relictus quidam denticulus, qui Arabicè almuri dicitur, Latine uero ostensor: quia ipse est qui ostendit gradus in limbo descriptos." Astrolabii declaratio, fol. 4. v.

<sup>2</sup> "Then hast thou a Labell, that is shapen like a rule, save that it is straight and hath no plates on either end, but with the small poynt of the foresaide Labell shalt calcule the equacions in the bordure of thine Astrolabe, as by thine almurie."—"Thine Almurie is cleped, the denticle of Capricorne, or els the calculere, this same Almurie set fixe in the hed of Capricorne, and it serueth of many a necessarie conclusion in equacion of thinges, as shall be shewed." The Conclusions, &c. fol. 263. v.

<sup>3</sup> "Facies etiam aliam regulam quæ novella dicitur ut hic patet quæ sit divisa per notas super divisionem linee meridionalis tabule latitudinis tuæ regionis per almucatharath et hæc curret super faciem rethis." Old Royall MSS. No. 126, xvii.

<sup>4</sup> "Et sit super capud Capricorni almuri graduum, i.e. Ostensor graduum quem quidam Latinorum ut in quodam loco dixi modo calculatorem dicunt." And again in the recapitulation of the parts of the Astrolabe at the commencement of the second part of the treatise, after the description of the 'Ankabút, we find—"Postea est almuri quod ostensor dicitur latine verticulus scilicet extra circulum capricorni in alhancabuz relictus." Old Royall MSS. No. 126, xvii.

<sup>5</sup> "Il qual lembo deve essere più largo del cerchio del Capricorno, sopra quella

quantità della larghezza, nella quale si può descrivere l'Almuri dei gradi, il quale è un denticello, che uscisse dal capo del Capricorno sopra dal lembo predetto, la grossezza del qual lembo è sopra la quantità della rete." Margarita Filosofica, p. 1034.

<sup>6</sup> The five Astrolabes alluded to in the text are—the Kúfic one in the British Museum; the three, two Arabic and one Hindú, in the East-India House; and the Hindú instrument in the Museum of the Royal Asiatic Society. In Sháh Husain's Astrolabe the 'Izadah on the back is wanting, and, not knowing its thickness, no conclusion can be arrived at from the mere length of the pivot. In the Astrolabe belonging to Mr. Vaux, the place of the wedge is supplied by a nut which, of course, by being withdrawn a thread or more on the screw cut on the pivot would allow of the addition of an extra index: the exact portion of the pivot used as an axis of rotation is obviously indeterminate.

<sup>7</sup> Mémoire, &c. p. 166.

<sup>8</sup> M. Sédillot in a note relative to this 'Izadah says—"Dans la plupart des astrolabes arabes, cette alidade est remplacée par un simple indicateur (appelé *almuri*), qui sert seulement à marquer les degrés inscrits sur le limbe." Mémoire, &c. p. 166, note 4. If he mean here the Muri Rás al-Jadí, he is undoubtedly right: if not, as he refers to no authority for his statement, I must venture to differ in opinion from him until some actual example be instanced, or satisfactory evidence be adduced, of the existence of any separate index whatever on the face of Eastern Astrolabes.

<sup>9</sup> The figures 47, 49, 51, and 52 in the Memoir are copies of Nos. 1, 2, 3, and 4 in the engravings in the Description de l'Égypte, (loc. cit. Pl. HH) but they are not quite accurate. The drawings which I have given at Plate xxi. figs. 38, 39, 40, 41, are traced from the latter work, but even these do not clearly shew the mechanical adaptation of the parts.

nothing but a section of the 'Ankabút with its Mudir at the bottom. Figs. 51 and 52 (Plate xxi. figs. 40, 41) are respectively merely a plan and elevation of the 'Izadah, here called *facial* by M. Sédillot. I think myself there can be little doubt that there never was but one 'Izadah in the original instrument from which the drawings were made, and that such 'Izadah was erroneously placed on the face instead of in its proper position on the back of the Astrolabe, and so represented in the drawings. Even, however, if there were two 'Izadahs, their existence would prove nothing, since, as we have already seen, the Astrolabe of M. Marcel, as placed in the hands of the draughtsman, was composed of parts belonging to different instruments; and if the tablets, as is self-evident, belonged to two distinct Astrolabes, why may not the two 'Izadahs also.<sup>1</sup> Under the circumstances, then, I think it may fairly be concluded that the separate moveable facial index was either never admitted, or, at least, extremely unusual in Oriental Astrolabes.<sup>2</sup> I now pass on to the fixed pointers on the 'Ankabút, to which I have already adverted. They are all in the same plane with, and form a portion of, the substance of the 'Ankabút itself. The first of them, A (Plate xx. fig. 21) is a small sharp spike projecting from the summit of the 'Ankabút at the point of the Zodiacal circle which touches the Hajrah, in consequence of a portion of the outer tropic being removed, as above stated. In a Northern Astrolabe this spike is placed at the beginning of the Sign Capricorn and the end of Sagittarius and is usually called simply the Muri, or the Muri Rás al-Jadí *مري راس الجدي*, *Muri*, or *index of the head of Capricorn*; it points to the inner circumference of the Hajrah, and serves, as the 'Ankabút is turned, to mark off the divisions inscribed thereon. Muhammad an-Nattáh says that it is placed at the head of Capricorn in preference to the other signs, on account of the proximity of Capricorn to the Hajrah.<sup>3</sup> Ibn as-Samh and Az-Zubair term this Muri, the Muri al-Ajzá *مري الاجزاء*, *index of the divisions*. In the Southern Astrolabe this fixed Index has the name of the Muri Rás as-Saratán *مري راس السرطان*, *index of the head of Cancer*, that sign, as already explained, taking in such case the position occupied by Capricorn in a Northern instrument. No other facial index is mentioned by any of the Arabic and Persian authors I have consulted<sup>4</sup> except the Muris of the stars, which I now proceed to describe. These latter, distinguished by numerals in the diagrams (Plate xx. figs. 21, 22, 23, 24), consist of a number of pointers projecting from, and being in one piece with, the net-work of the 'Ankabút, and are called simply Shazáyá *شطايا*, plural of Shazíyah *شطية*, *spinter*, (denticulus), or Shazáyá al-Kawákib *شطايا الكواكب*, *Shazíyahs of the stars*. Az-Zubair and Muhammad an-Nattáh add the appellation of Ibar al-Kawákib *ابر الكواكب*, *needles of the stars*, and Az-Zubair also terms them Muriyát al-Kawákib *مرييات الكواكب*, *Muris of the stars*. On each of these Shazíyahs or Muris is inscribed the name of a fixed star, and each one is called accordingly the Shazíyah or Muri of the star, the name of which it bears.

7. The Zahr al-Usturláb *ظهر الاسطرلاب*, the *back of the Astrolabe* (Postica, Dorsum) is the under surface of the Hajrah and Umm, that is, of the main body of the instrument. It is in one plane. The inscriptions on the back in different Astrolabes vary materially. In every instance, however, we find the two diameters *A B*, *E W* (Plate xxi. fig. 25) as on the Umm or the Tablets. The perpendicular diameter *A B*, which is produced through, and bisects the back of, the Kursí *A A'*, is called as before the Khatt Wasat as-Samá, or Khatt Nisf an-Nahar: it is also sometimes termed the Khatt al-'Ilakah *خط العلاقة*, *line of the 'Ilakah*, from its being in the same line of direction with the suspensory cord. The horizontal diameter is similar to that on the face of the Astrolabe, and has the like names; its whole length being denominated the Khatt al-Mashrik wa al-Maghrib; its Western half the Khatt al-Maghrib, and its Eastern the Khatt al-Mashrik. The quadrants formed by the intersection of these diameters are termed according to their position; that above on the left *A C E* is the Rub' ash-Sharkí al-Janúbí *ربع الشري الجنوبي*, *Eastern Southern quadrant*; and that on the right *A C W* the Rub' al-Gharbí al-Janúbí *ربع الغربي الجنوبي*, *Western Southern quadrant*; the lower quadrants *E C B*, *W C B* are called respectively Ash-Sharkí ash-Shamáli *الشرقي الشمالي*, *Eastern Northern*; and Al-Gharbí ash-Shamáli *الغربي الشمالي*, *Western Northern*. The upper quadrant on the left hand is also denominated the Rub' al-'Irtifá' *ربع الارتفاع*, *quadrant of altitude*. Generally speaking, the back has traced upon it several concentric circular bands, which are usually inscribed, and occur in the order, as follows: the degrees of Altitude in the upper quadrants *E A*, *W A* of the outer circle up to 90: the arcs of the shadow *B E*, *B W* measured in Akdám *اقدام*, *feet*, and Asábil' *اصابع*, *fingers*, in the lower quadrants of the same circle: the degrees of the Zodiac, thirty to

<sup>1</sup> It may be here remarked, that it is necessary to examine carefully, and to receive with suspicion, the separate and accessorial portions of instruments like the Astrolabe, unless the use and application of such portions be perfectly known. Adjuncts may be made, and parts be adapted, by ignorant possessors, in a manner totally foreign to the original construction and purpose of the instrument.

<sup>2</sup> Delambre, whilst mentioning Stoeffler's description of the Astrolabe, gets rid of all difficulty as to these indices in a very expeditious and somewhat amusing manner. He says, "L'ostenseur, la règle, l'index, l'almuri, tout cela est la même chose; c'est l'alidade." Histoire de l'Astronomie du moyen âge, p. 375.

<sup>3</sup> و جعل في راس الجدي دون سائر البروج لقربه من المحرقة.

<sup>4</sup> The following are the passages descriptive of the only facial index mentioned by the Arabic and Persian authorities: الفصل: هو الزيادة البارزة الموضوعة في الفصل: A وفيها مري الاجزاء و هو الزيادة البارزة الموضوعة في الفصل: B و الثاني عند المشترك بين آخر القوس و اول الجدي و يدور ابدا ماسا لدبر المحرقة

راس الجدي الخارج من دائرته في الشمالي يسمى مري راس الجدي لأنه يدور ملتصقا لاجزاء المحرقة و يرى تلك الاجزاء و في الجنوبي تسمى مري راس السرطان C و بر سر جدي در اسطرلاب شمالي و بر سر سرطان در اسطرلاب جنوبي شطيه باقي كذا رند و انرا مري راس الجدي يا راس السرطان كويند D و في راس الجدي منها طرف حاد يقال المري به و انما سمي هذا الاسم لأنه يريك اجزاء المحرقة و جعل في راس الجدي دون سائر البروج لقربه من و في راس E. Ibn Ash-Shatir omits to mention any facial index whatever. F في راس الجدي شي نات من الصفيحة ممكّم يقال له مري الاجزاء G و الزيادة التي عند راس الجدي تسمى المري H المري هي الزيادة التي في راس الجدي I مري الاخر هي التي في راس الجدي K مري جدي ان انزوني است از سر جدي و ييوسسته با اجزاي محمّرة كردد و ازوي جدا نشود L و بر سر جدي زيادتي باشد كه در برابر اجزاء محمّرة كردد و انرا مري راس الجدي خوانند



each Sign: the names of the Signs: the days of the year for each month: and the names of the months. Oriental artificers often omit all these circular bands, except the outer, and sometimes trace the remainder only in the lower half of the back of the Astrolabe, *i.e.* below the horizontal diameter. The two quadrants above such diameter are, in Eastern Astrolabes, generally inscribed with a series of sines and arcs used for various purposes. One of these quadrants, most frequently that on the left of the perpendicular diameter, *i.e.* the Rub' ash-Sharkí al-Janúbí, almost invariably presents the series of sines found in the species of quadrant called the Rub' ad-Dastúr ربع الدستور, *quadrant of the canon*.<sup>1</sup> The arc *E A* which bounds it is the arc of altitude, divided into 90 degrees; the perpendicular boundary line or radius *A C* is the whole sine; the horizontal radius *C E* completing the outer limits of the quadrant, being the cosine. Each of these extreme radii is divided into 60 equal parts. The sines are both Mabsút مبسوط, *extended*, which are parallel with the cosine, and Mankús منكوس, *inverted*, parallel with the whole sine. In large instruments the sines are drawn from each degree of the arc of altitude both ways, *i.e.* perpendicular to each extreme radius of the quadrant, the sines both Mabsút and Mankús being of course each 90 in number, and dividing either radius into 90 unequal parts, in which case the quadrant is termed nonagesimal; but in small instruments this is impracticable, since towards the extremities of the arc the divisions become so minute as to be undistinguishable. In small instruments, therefore, the parallels are drawn, not from the degrees of the arc, but from the 60 divisions of the extreme radii, and the quadrant is then called sexagesimal. The Kúfic Astrolabe in the British Museum (Plate xxi. fig. 26), and the instruments belonging to Mr. Vaux (Plate xxi. fig. 28) and the Royal Asiatic Society, exhibit specimens of sexagesimal quadrants in which both the sines and cosines are traced, cutting each other at right angles. Occasionally the two kinds of quadrants are found united, the Rub' ad-Dastúr being nonagesimal as regards one extreme radius, and sexagesimal as regards the other. The parallels are sometimes only drawn horizontally, and proceed either from the degrees of the arc, or the divisions of the whole sine according to the size of the instrument. An example of the former or nonagesimal arrangement of the cosines of altitude is offered in the Astrolabe of Sháh Husain (Plate xvii. and the quadrant *A C E*, Plate xxi. fig. 25), and also in that of Major Pottinger: the sexagesimal order of the horizontal parallels, drawn alone, is found in that of M. Marcel, in No. II. of the East-India House (Plate xxi. fig. 27), and in the Hindú instrument in the same collection. In Professor Wilson's Astrolabe both the upper quadrants are inscribed with the horizontal parallels, which are sexagesimally arranged on the left of the perpendicular diameter, and nonagesimally on the right. The sexagesimal quadrant is, however, on close examination, evidently palimpsest: the vestiges of a former inscription being perceivable in some places, whilst the present engraved lines are clearly of modern workmanship. These vestiges, so far as they can be made out, seem to shew that both the upper quadrants were originally occupied by a series of ninety horizontal parallels, proceeding from and uniting the several degrees marked upon their respective arcs; but this is not quite certain, and even in the right hand quadrant the nonagesimal cosines of altitude are in a great measure obliterated. A small arc of a radius of 24° is often traced from the centre of the Rub' ad-Dastúr (Plate xxi. fig. 28): it is called the Arc of the Obliquity of the Ecliptic. The other upper quadrant *A C W* (Plate xxi. fig. 25), generally that on the right of the perpendicular diameter, that is to say the Rub' al-Gharbí al-Janúbí, usually contains, in Eastern Astrolabes, an arc of altitude *W A*, and a series of arcs, parallel with the arc of altitude, and representing the parallels of the signs of the Zodiac; each sign being subdivided, when there is sufficient space, by other intermediate arcs. Occasionally the parallels of the signs occupy the entire interior of this quadrant (Plate xxi. fig. 27); but sometimes, as in the Astrolabes of Sháh Husain and Major Pottinger, and the Hindú instrument in the East-India House, the arc of the Obliquity of the Ecliptic *F C G* (Plate xxi. fig. 25) is drawn from its centre, and the parallels are traced between the latter and the boundary arc. Usually the names of the signs of the zodiac are written at either end of the arcs of their parallels, *D F G H* (Plate xxi. fig. 25); but sometimes they are designated by numerals (Plate xxi. fig. 27), 0 standing for Aries, 1 for Taurus, and so on to 11, which signifies Pisces. On this quadrant we most often find traced the arcs of the unequal hours (Plate xxi. figs. 26, 27), and sometimes those of the meridians at different latitudes *f f f f* (Plate xxi. fig. 25), and of the altitude of the sun at different places *g h i k*, &c., when it traverses the azimuthal circle of the Kiblah<sup>2</sup> for the commencement of the signs at such places. This circle, or Azimuth of the Kiblah, as it is termed, is the vertical circle which passes through the zenith of Makkah, and that of the place of the observer. The meridian arcs *f f f f*, and azimuthal circles of the Kiblah *g h i k*, &c., are inscribed in the Rub' al-Gharbí al-Janúbí in both Sháh Husain's and Major Pottinger's Astrolabes. The arcs of the equal and unequal hours appear to have been almost invariably placed in these upper quadrants in European instruments.

The lower quadants of the circular space, included within the band or bands above mentioned, are in nearly every instance occupied by the square of the two shadows (Scalæ Altimetræ) *N O P R Q*, viz. the horizontal *P O*, *P R*, and the vertical *N O*, *Q R*, which are called respectively the Mabsút مبسوط, *extended*, or Mustawí مستوي, *level* (Umbra versa), and Mankús منكوس or Ma'kús معكوس,

<sup>1</sup> This quadrant and its uses will be found described by M. L. A. Sédillot. Mémoire, &c., p. 82 *et seq.*  
<sup>2</sup> The Kiblah كبة of the Muhammadans is the Ka'bah كعبة or Square Temple at

Makkah, towards which, in whatever quarter of the world they may be, they turn themselves when about to pray.

*inverted* (Umbra recta); in Eastern Astrolabes these shadows are generally measured in one quadrant by Akdám اقدام *feet*, and in the other by Asábi اصابع *fingers*. In the Zill al-Akdám ظل الاقدام *shadow of feet*, the lines on which it is measured in the square, whether vertical or horizontal, are divided into seven spaces: in the Zill al-Asábi ظل الاصابع *shadow of fingers*, the lines have twelve divisions. In some cases a third kind of measurement is employed, the lines being divided into sixty parts; this is called the Zill as-Sittíni ظل الستيني *sexagintal shadow*. In some Astrolabes other circles are added to those above mentioned, or substituted for them. In European instruments we often find tables for the Dominical letter, the Golden number, &c.<sup>1</sup> In the Astrolabes of Sháh Husain and Major Pottinger astrological tables of the Muthallathát مثنثات *triplicities* (Triplicitas); the Hudúd حدود *terms, limits* (Terminus, Finis, End, Bound); the Wajúh وجوه *faces* (Facies) of the Planets placed in apposition with the signs of the Zodiac; and of the Manázil منازل *mansions*, or Lunar Mansions, are introduced into the lower quadrants. The Lunar Mansions are also found on the back of No. II. of the East-India House. I have not met with these tables in any other instrument, but it appears from Focard that the practice of inscribing them on the backs of Astrolabes was not peculiar to the East.<sup>2</sup> The matters to which they relate demand some little explanation. Since the main features of the science of Judicial Astrology, as practised formerly in Asia, and as it there obtains at the present day are absolutely identical, I have not thought it requisite to consult many Eastern authorities, but have contented myself with the examination of a few treatises by the most approved authors.<sup>3</sup> A reference to the writings of the European Astrologers will shew that I might perhaps have spared myself even this trouble, as their science was derived from the East, and its principles remained unchanged in their hands.<sup>4</sup> The Astrological tables found on Astrolabes relate entirely, at least so far as I have met with them, to some of the chief divisions of the signs of the Zodiac and of the Planets; and thus the necessity of entering into much unprofitable detail is avoided, and few words will suffice.

A Muthallathah مثنثة *triangle, combination of three* (Triplicitas, Triplicity), is a certain division of the signs of the Zodiac according to the four elements and supposed nature of the signs. The Muthallathát مثنثات *triplicities*, are therefore four in number, and are respectively termed by the Arabs Náriyah نارية *fiery*, Arziyah ارضية *earthy*, Hawáiyah هوائية *airy*, and Máíiyah مائية *watery*; the Persians call these triplicities Átishí آتشی, Kháki خاكي, Hawái هوایی, and Abí آبى, words which have the same significance as the Arabic names. The first, or Fiery Triplicity consists of Aries, Leo, and Sagittarius; the second, or Earthy, of Taurus, Virgo, and Capricorn; the third, or Airy, of Gemini, Libra, and Aquarius; and the fourth, or Watery, of Cancer, Scorpio, and Pisces. The five planets have dominion severally in each of these Triplicities, sometimes ruling by day, sometimes by night, and sometimes governing both by day and night. They are called Lords of the Triplicities. In the Fiery Triplicity the Sun and Jupiter are Lords by day and night respectively, interchanging their functions alternately; Saturn is their companion (شريكهما) and has dominion both by day and night.<sup>5</sup> In the Earthy Triplicity Venus and the Moon are Lords by day or night, and their companion in both is Mars. In the Airy Triplicity the Lords of the day and night are Saturn and Mercury: Jupiter governs both by day and night. In the Watery Triplicity Venus and Mars rule severally by day and night, and the Moon has common dominion.<sup>6</sup> Hamd Allah al-Mastaufi, in the Nuzhat al-Kulub, gives the following table of the Lords of the Triplicities, shewing their respective dominions in each at one view—

Lords of the Triplicities.	Fiery.	Earthy.	Airy.	Watery.
By day.	☉ ♌ ♐	♋ ♍ ♎	♊ ♏ ♒	♑ ♓ ♛
By night.	♎ ☉ ♐	♋ ♍ ♎	♊ ♏ ♒	♑ ♓ ♛

<sup>1</sup>—"Oltre dens lesdites lignes, ou arcs, sont trois petits cercles, Au premier, sont les lettres dominicales. Le second montre le ciecle du soleil: Le troizieme le nombre d'or. Et conuient commencer à conter iceux nombre à vne petit croix, l'an que l'Astrolabe aura esté fait, et en allant vers la main senestre, suiuant l'ordre des anneex, trouueras ce que demanderas." Focard, Paraphrase de l'Astrolabe, p. 18.  
<sup>2</sup>—"En aucuns Astrolabes y ha des cercles par lesquels l'on void les faces, triplicitez, et termes des sept planettes, marquees de leurs caracteres. \* \* \* \* Semblablement les 28 mansions de la lune." Paraphrase de l'Astrolabe, p. 19—20.  
<sup>3</sup> The Eastern works that I have examined are as follows—I. Kitáb Mukhtasar al Madkhal كتاب مختصر المدخل. This is an abridgment of the Madkhal fi 'Ilm an-Nujúm مدخل في علم النجوم by Ja'far Ben Muhammad Ben 'Umr Al-Balkhí, known by the name of Abú Ma'shar (Albumazar) al-Munajjim, who died in A.H. 272 (A.D. 885). See Háj. Khalf. Tom. V. p. 475. Nicoll. Bibl. Bodl. Codd. Orr. Cat. p. 238. II. An Astrological treatise in four Books, by Abú al-Hasan Kúshyár (See *supra*, p. 3, note 3.) I have had access to two copies of this treatise, one in the British Museum, Additional MSS. No. 7490. 1, the other in the Library of the East-India House, No. 1541. 2. In the former it is entitled Kitáb Majmil Kúshyár كتاب المجمل, in the latter Kitáb al-Majmil fi Akhám an-Nujúm في كتاب المجمل كوشيار.

احكام النجوم. Casiri mentions the work, giving the first words, which agree with those in the above MSS., under the title of Al-Madkhal fi Siná'at Akhám an-Nujúm المدخل في صناعة احكام النجوم. Bibl. Arab. Hisp. Tom. I. p. 400, c. 2. It is evidently the same work as that described by Hájji Khalfah, in conjunction with the Madkhal by Abú Ma'shar (loc. cit. p. 475). Hájji Khalfah states that Kúshyár composed his quadrupartite treatise in A.H. 357 (A.D. 967); but he gives a different commencement from that found in the MSS. above mentioned, and in Casiri. III. The Nuzhat al-Kubáb. IV. The Nafáis al-Funún.  
<sup>4</sup> See Ad Astrorum Judicia faciliis Introductio Claudio Darioto Pomarcensi auctore. 4to. Lugd. 1557. Astrologia restaurata; or, Astrologie restored: being an Introduction to the General and Chief part of the Language of the Stars. In four Books. By William Ramesey, Gent. Folio. London. 1653.  
<sup>5</sup> According to Ramesey Saturn was sometimes omitted, but he was added, "that by his cold nature he may temperate the excess of heat." Astrol. Rest. Lib. 2. chap. xii., p. 70.  
<sup>6</sup> Ramesey says that Mars, "both night and day, hath assigned to him chief dominion of the Watery Triplicity; certainly the reason why Mars was assigned chief rule of the Water was to cool his courage and abate his heat; for we see he is more powerful to work his mischievous pranks in *Leo* than in *Cancer*." Ib.



A Hadd حد, *limit* (Terminus, Finis, Term, End, Bound), is a certain number of degrees in which in each sign of the Zodiac every one of the planets has a priority. These divisions, or allotments of degrees, are called Hudūd حدود, *limits*, because the planets have their proportions so assigned to them, that at the end of so many degrees the limits of another planet commence; as, for example, from the first degree of Aries to the sixth is the term of Jupiter; from the sixth to the fourteenth the term of Venus, and so on. The Wajh وجه, *face* (Facies, Face), of a planet is the third part of a sign, and therefore consists of ten degrees.<sup>1</sup> The Wujūh وجوه, *faces*, of the planets are among the essential dignities thereof, and they have severally special dominion therein. I have thought it unnecessary to enumerate here the Terms and Faces of the planets, as they will be found in the particular description of Shāh Husain's Astrolabe which follows. The Manāzil منازل, plural of Manzil منزل, *a mansion*, are certain divisions of the Moon's orbit founded upon the successive positions taken up by that star in passing through each sign of the Zodiac in its monthly revolution. They seem to have existed from time immemorial in China and in India.<sup>2</sup> In China they were employed for astronomical purposes; and since, in India and elsewhere, they have always been used solely for astrological combinations and the forming of various prognostics, M. Biot concludes that they originated with the Chinese. Be this as it may, there is little doubt but that they passed from India into Arabia about the time of the Khalīfah al-Mansūr,<sup>3</sup> and eventually from the latter country into Europe, where they are proved to have been known as early as A.D. 961.<sup>4</sup> The duration of their use in Europe appears to be uncertain; but they are marked in the Catalan Atlas, which was constructed in the latter half of the fourteenth century of our æra, and is preserved in the Bibliothèque Impériale at Paris.<sup>5</sup> In the East the Lunar Mansions are employed to the present day, and occupy an important place in the astrological system prevalent throughout Asia.<sup>6</sup>

8. The Index which traverses the back of the Astrolabe, is called the 'Izādah عَضَادَة, *door post* (Alhidada, Dioptra, Mediclinium, Radius, Regula, Verticulum, Traguado, Alidade). The 'Izādah is a necessary appendage to every Astrolabe: it is a flat narrow rule, extending across the whole diameter of the back of the instrument, so as to touch with either end the outer circumference, whereon the degrees of the Hajrah are inscribed, and rotating round its centre. In the Persian MS., and the Maksad at-Tālib, it is stated that the 'Izādah is of two kinds, viz. Tāmm تَام, *perfect*, and Muharraf or Munharif مُحَرَّف or مُخَرَّف, *inverted*. The Tāmm is bisected in its length and breadth respectively by two lines drawn at right angles to each other, the point of intersection being the centre of the 'Izādah. The line of longitudinal bisection, which always exists in both sorts of 'Izādah, is called by the European writers the Linea Fidei, or Fiducia.<sup>7</sup> I have never met with a Tāmm 'Izādah. In the Muharraf (Plate xxi. figs. 38, 40, 43, 44, 45) one half of the breadth of the 'Izādah is removed along its whole length, leaving only a small circular portion near the centre, sufficient for the passage of the Kutb, or pivot on which it turns, and which will be presently noticed: sometimes this excision of the breadth of the 'Izādah is made in opposite directions, or by interchange (بَرَسْبِيل تَبَادُل), i. e. one half of its breadth is removed from one half of its length, and the opposite half of its breadth from the other, so that the 'Izādah is divided as it were into two arms, extending from the opposite semicircles of the portion left about the centre of the instrument, leaving the line of longitudinal bisection of the 'Izādah intact (Plate xxi. fig. 42).<sup>8</sup> At either end of the 'Izādah is a flat rectangular plate. These plates are fixed parallel with each other, at equal distances from the centre of the 'Izādah, and at right angles to its plane of rotation. They are termed Libnatān لِبْنَتَان, *the two tiles* (Tabellæ, Pinnæ, Pinnulæ) (Plate xxi. figs. 38—45), each one being called a Libnah لِبْنَة. In the Maksad at-Tālib the Libnatān are also termed Daffatān دَفَاتَان, *the two boards of a book*, and Az-Zubair gives them the additional name of Hadafān هَدَفَان, *the two archers' butts*. Through each of these Libnahs is bored a small aperture, or Thukbah ثُقْبَة, *hole*, the one exactly opposite the other, the two together being denominated the Thukbatān al-Irtifā' ثُقْبَتَانِ الارتفاع, *the two holes of altitude* (Plate xxi. figs. 38, 42). In some instances each Libnah is pierced with two holes (Plate xxi. fig. 43), one very minute, and another, the upper of the two, somewhat larger; of these the lesser holes are employed for taking observations of the sun in the daytime, the larger for observing the stars at night. Some workmen, according to the anonymous Persian author, are satisfied with the two first-mentioned holes, and make a notch at the top of each Libnah, in which, at the time of taking the altitude of a star, a small tube is fixed, the hollow part of the said tube being over against the two holes.<sup>9</sup> The notches are found in

<sup>1</sup> Colebrooke, in his Memoir on the Indian and Arabian divisions of the Zodiac, has pointed out the identity of the Wajh with the πρόσωπον of the Greeks, and the near correspondence between the Wujūh and the Drēshkānas of the Hindūs, the Decani of the Roman authors, and the Δεκανοί of the Grecian writers. See Asiatick Researches, Vol. ix., pp. 373, 374, and the authorities there quoted.

<sup>2</sup> See Colebrooke, on the Indian and Arabian divisions of the Zodiac in the Asiatick Researches, Vol. ix. p. 323; Biot's Articles in the Journal des Savants for the years 1839 and 1840, and especially in the month of January 1845; and Reinaud's Mémoire sur l'Inde, p. 355 et seq. See also L. A. Sédillot's Matériaux, &c., p. 426 et seq., and the same author's translation of the Prolegomena of Ulugh Bég, p. 287.

<sup>3</sup> But see L. A. Sédillot's translation of the Prolegomena of Ulugh Bég, p. 288.

<sup>4</sup> Reinaud, Mémoire sur l'Inde, pp. 355, 359.

<sup>5</sup> A description of this curious geographical monument, accompanied by facsimiles,

has been given by M. M. Buchon and Tastu. Notice d'un Atlas en langue Cataban in the Notices et extraits des MSS. de la Bibliothèque du roi. Tome xiv. 2<sup>e</sup> partie, pp. 1—152; and see Lelewel, Géographie du Moyen âge. Tome iii. pp. 37—67.

<sup>6</sup> Full information on the interesting subject of the Lunar Mansions will be found in the works quoted in the preceding notes. See also Hyde, Tabulæ Ulugh Beighi. 4to. Oxon. 1665. Comment p. 5. Ideler, Untersuchungen über den Ursprung und die Bedeutung der Sternnamen. 8vo. Berlin, 1809, pp. 120, 148, and 287. Hamd Allah al-Masta'fi al-Kazwini's Nuzhat al-Kulūb مقدمه باب دوم.

<sup>7</sup> Stoeffler, Elucidatio, &c. fol. 28 v. Koebelin, Astrolabii Declaratio, fol. 5 v. Focard, Paraphrase, &c., p. 28.

<sup>8</sup> Fig. 42 is taken from No. I. of the East-India House.

<sup>9</sup> The anonymous Persian author is the only one who mentions the notches and در اصطاف هر وجهی که معاذی يك ازان دو لبه دو ثقبه باریك كند بهمت (اخذ) ارتفاع آنتاب بر وجهی که معاذی

the Astrolabe No. II. of the East-India House, but there are two holes below them in each Libnah (Plate xxi. fig. 43). In the Hindū Astrolabe of the Royal Asiatic Society, the lower holes alone are present, the place of the upper ones being supplied by a brass tube passing through, and soldered into, each Libnah (Plate xxi. fig. 44). In Mr. Vaux' Astrolabe the Libnahs have three holes in each, the largest being in the middle, and the smallest, which is exceedingly minute, at the top (Plate xxi. fig. 45). The ends of the 'Izādah are sharp pointed, and are termed the Shaziyatān al-Irtifā' شَظِيَّتَانِ الارتفاع, *the two Shaziyahs of altitude*: they point to the divisions marked on the inner circumference of the back of the Hajrah. The anonymous Persian author mentions that the unequal hours are sometimes traced on the 'Izādah; and this is also stated by Māshā Allah. The former adds, in another place, that it is occasionally engraved with scales of sines and arcs,<sup>1</sup> and gives some instructions as to the method of division. The Astrolabe, No. II. of the East-India House, offers a specimen of a divided 'Izādah (Plate xxi. fig. 43).

9. The apparatus for fastening the various parts of the Astrolabe together comprises three pieces, viz. 1. the Kutb كُتْب, *pivot* (The Exiltre, the Pin, Alchitot, Architob, Clavus, Vectis teres sive rotundus, Axis, Cavilla), sometimes called the Mihwar محور, *axis*, or the Wataq وَتَد, *stake*. 2. The Faras فَرَس, *horse* (The Horse, Alpherath, Apheratz, Alferaz, Equus, Caballus, Cuneus). 3. The Fals فَلْس, *a small coin* (Alphelath). The Kutb resembles a nail with a large head. At the smaller end it is either pierced through with a long narrow aperture (Plate xxi. figs. 44, 46, 50),<sup>2</sup> called by the European writers the Stabulum, or has the worm of a screw cut upon it (Plate xxi. figs. 47, 52),<sup>3</sup> for the reception of the Faras. The Faras is usually a small flat wedge, fitting tightly into the aperture at the end of the Kutb. This wedge has received its name from being sometimes shaped, more or less, in the form of a horse (Plate xxi. figs. 48, 49, 50, 51);<sup>4</sup> or it is a nut in which a female screw is cut, adapted to the screw at the end of the Kutb (Plate xxi. figs. 47, 52).<sup>5</sup> The Fals is a small ring fitting loosely on the Kutb, in order to prevent the Faras from injuring the surface of the 'Ankabūt (Plate xxi. fig. 53): it is sometimes in one piece with the latter, or permanently fastened thereupon. The mode in which these several parts are applied to the Astrolabe is as follows:—A hole, called the Mahan مَحْن, *'* of the size of the stem of the Kutb, is first pierced through the 'Izādah, the main body of the instrument, the tablets, and the 'Ankabūt, and these are successively deposited upon the Kutb, the head of which is placed downwards, in the order above mentioned, the tablet constructed for the place of observation being laid on the top of the other tablets, and under the 'Ankabūt; the Fals is then dropped on to the protruding end of the Kutb, over the 'Ankabūt, and lastly, the Faras is inserted into the aperture of the Kutb, and pushed home,<sup>6</sup> or screwed on over all, though not so tightly but that the 'Ankabūt and the 'Izādah may rotate upon their axes. The Astrolabe being suspended from the 'Ilākāh is ready for use.

After this general account of the Astrolabe, I trust that the following particular description will be readily intelligible. In order to avoid disfiguring the impressions taken from the original instrument, I have abstained from adding to them any extraneous marks: all the essential parts, however, are repeated in the plates of diagrams at the end; and it is hoped that the reader, by referring to them at the same time with the original impressions, will be able at once to perceive the parts of the latter to which the text refers. We know nothing of the history of our Astrolabe beyond what is borne upon the face of it, and the fact that it formed part of the collection of Sir Hans Sloane, who died in January A.D. 1753. As the instrument itself was made in the latter half of A.D. 1712, its stay in Persia was but short. By what means it arrived in this country it is difficult to conjecture, but it is scarcely doubtful that it was lost or stolen during the troubles that arose in Persia immediately after Shāh Husain's abdication. Was it perchance carried away by the Jesuit Father Krusinski, who was in Isfahān during the siege by the Afghāns? Jonas Hanway, the English traveller, returned to England in the month of October A.D. 1750,<sup>7</sup> so that, though unlikely, it is just possible that he might have procured the Astrolabe in Persia, and have disposed of it to Sir Hans Sloane. If this had been the case, however, it is highly improbable that Sir Hans should not have noticed his acquisition of the instrument from so remarkable a source, and no notice of any kind is added to the entry in the catalogue of his collection. The face of the tablet in the Astrolabe which is constructed for the Latitude of Isfahān, bears such evident marks of frequent

باشند و در فوق این دو ثقبه دو ثقبه اوسع سازند بهمت (اخذ) ارتفاع كوكب و بعضي بر همان دو ثقبه اولي اختصار كند و دو سر لبه را رسته كند (مكند؟) تا بوقت احد (اخذ؟) ارتفاع كوكب انبوه درميان دو لبه درين دو رخنه محكم كند بر وجهي که تجويف انبوه بر مكاذا و في كل لبه انة Maksad at-Tālib. The tube, however, is spoken of in the Maksad at-Tālib. ثقبتهين باشد ثقبه او ثقبتهان هما ثقبتهان الارتفاع و في بعضها ثقبه عليها نصب انبوه M. Jourdain speaks of a similar application of a tube (انبوه) in his Mémoire sur l'observatoire de Meraghah, p. 27.

<sup>1</sup> و بعضي جيب و قوس را هر دو بر عضاده نقش كند.  
<sup>2</sup> Fig. 44 is from the Hindū Astrolabe in the Royal Asiatic Society; Fig. 46 from that of Shāh Husain; and Fig. 50 from No. II. of the East-India House.

<sup>3</sup> Fig. 47 is from Stoeffler's drawing; Fig. 52 is from Mr. Vaux' Astrolabe.

<sup>4</sup> Fig. 48 is from M. Marcel's Astrolabe; Fig. 49 from No. I. of the East-India House;

Fig. 50 from No. II. in the same collection; and Fig. 51 from the drawing in the MS. of Māshā Allah in the British Museum.

<sup>5</sup> Fig. 47 is from Stoeffler; Fig. 52 from Mr. Vaux' Astrolabe.

<sup>6</sup> Nafāis at-Funūn.

<sup>7</sup> I have not met with this word in any of the native treatises, but have adopted it from M. Sédillot.

<sup>8</sup> In the Hindū Astrolabe of the Royal Asiatic Society the tube between the Libnahs of the 'Izādah does not admit of the head of the Kutb passing it; the latter is accordingly adjusted with its point or smaller end towards the back of the instrument, and the Faras is pushed into its receptacle over the 'Izādah. See Plate xxi. fig. 44.

<sup>9</sup> A historical account of the British Trade over the Caspian sea, with a Journal of travels, by Jonas Hanway. 4 Vols. 4to. London, 1753. Vol. ii. p. 348.



use, that there can be no question of its having been constantly referred to at that city during the troublous ten years that elapsed between its construction and the fall of Sháh Husain. It was most likely one of the very instruments employed by the Astrologers on the occasion of the phenomenon that appeared in the air at Isfahán in the summer of A.D. 1721. "The Clouds being at that time very thick," says Father Krusinski, an eye-witness, "the Sun appeared through them of a blood colour, which lasted near two months. The Astrologers of Persia being consulted upon it, declared that it was an Omen of a great effusion of blood."<sup>1</sup> Most fearfully was this prediction fulfilled, in the unspeakable horrors of the siege of Isfahán, and the subsequent massacre of its defenceless citizens by the sanguinary usurper Mahmúd.

Sháh Husain's Astrolabe is a northern instrument, and is *Támm* تامم, complete, or soli-partite, being the only one of that nature with which we are acquainted. As it now stands it comprises the suspensory apparatus entire, with the exception of the 'Ilákah; the main body of the instrument; seven tablets; the 'Ankabút; and the Kutb. The 'Izádah, the Fals, and the Faras are wanting. The whole is constructed of gold-coloured brass, and is in excellent preservation.

PLATE I. represents the Face of the Astrolabe, with the apparatus for suspension, the 'Ilákah only being wanting. *A* (Plate xviii. fig. 1) is the Halkah, and *B* the 'Urwah. The Kursí *C D E* is cast in one piece with the Hajrah *F G H*, and the Umm *I K L M*. The inscription on the Kursí is as follows—

هو

بموجب فرمان قضا جريان سلطان سلاطين زمان سيد خواقين دوران پشت و پناه اهل ايمان ولي نعمت عالم و عالمان مدار سپهر دولت و عدالت قطب فلک اعظم عظمت و جلالت اختر درخشان اوج كيتي ستاني مهر تابان وسط السماء جهانباني شاه سلطان حسين صفوي موسوي حسيني مد الله تعالي ظل معدننه علي روس الانام مدي الليالي و الايام اين اسطرلاب تام صورت الحجام يافت في شهر شعبان 1124

"He is (God)

"In conformity with the mandate, flowing like fate, of the Sultán of the Sultáns of the world, the Lord of the Emperors of the age, the Protector and Asylum of the people of the faith, the Benefactor of the universe and of mankind, the Centre of the Sphere of power and justice, the Pole of the supreme heaven of magnificence and grandeur, the Flashing Star of the Apogee of World Conquest, the resplendent Sun of the midst of the heavens of World Government, Sháh Sultán Husain Safawí Musawí Husainí,—May the Almighty God extend the shadow of his equity over the heads of mortals so long as night and day shall endure; this Astrolabe, complete (*Támm*) in form, was finished in Sha'bán 1124." (August–September A.D. 1712).

In the original the words Sháh Sultán Husain شاه سلطان حسين are inlaid in silver.

The titles Safawí, Musawí, and Husainí were assumed by the Safawiyah Sháhs of Persia as indicative of their descent. The first was derived from the name of Shaikh Safi ad-Dín, the founder of the family; the second from that of Músa, the second son of the sixth Imám Ja'far, who is held to be the seventh Imám, according to the Persian Shí'ahs;<sup>2</sup> and the third from that of Husain, the son of 'Alí Ben Abú Tálíb and Fátimah, the daughter of the Prophet.<sup>3</sup>

It will be remarked, that in this inscription many of the words in the Sháh's titles, such as Sphere, Pole, &c., have reference to the uses of the instrument on which it is written. This choice of terms, appropriate to their situation, is observable in most of the inscriptions on Arabic and Persian Astrolabes. The face of the Hajrah *F G H* is divided into 360 degrees, arranged and numbered five and five, commencing at *I* on the right hand of the centre of the Kursí, and continuing from left to right. The numbers are written at length, Panj پنج, five; Dah ده, ten; Panzdah پانزده, fifteen, &c., to Sisad wa Shast سیصد و شصت, three hundred and sixty.<sup>4</sup> Every degree is subdivided into four parts, each of which of course comprises fifteen minutes. At *L* is the Mumsikah for retaining the tablets in their places. The Umm *I K L M* is sunk into the face of the instrument to the depth of  $\frac{11}{16}$ ths of an inch.<sup>5</sup> On its surface are traced thirteen concentric circles, divided into parts by lines radiating from the centre. Of the twelve circular bands included within these circles, the outer, which is shaded, contains the names of cities, the second their Longitudes, the third their Latitudes, the fourth their Inhiráfs, the fifth their distances from Makkah, and the sixth their Jihats: each of these are inclosed between the radii that are on either side of the name of the city to which they refer. The six inner bands are a repetition of the outer, as to subject, in the same order, the seventh

<sup>1</sup> The History of the late revolutions of Persia, taken from the Memoirs of Father Krusinski, Procurator of the Jesuits at Ispahan. 2 Vols. 8vo. London, 1733. Vol. i. p. 273; and see Jonas Hanway, op. cit. Vol. iii. p. 92.

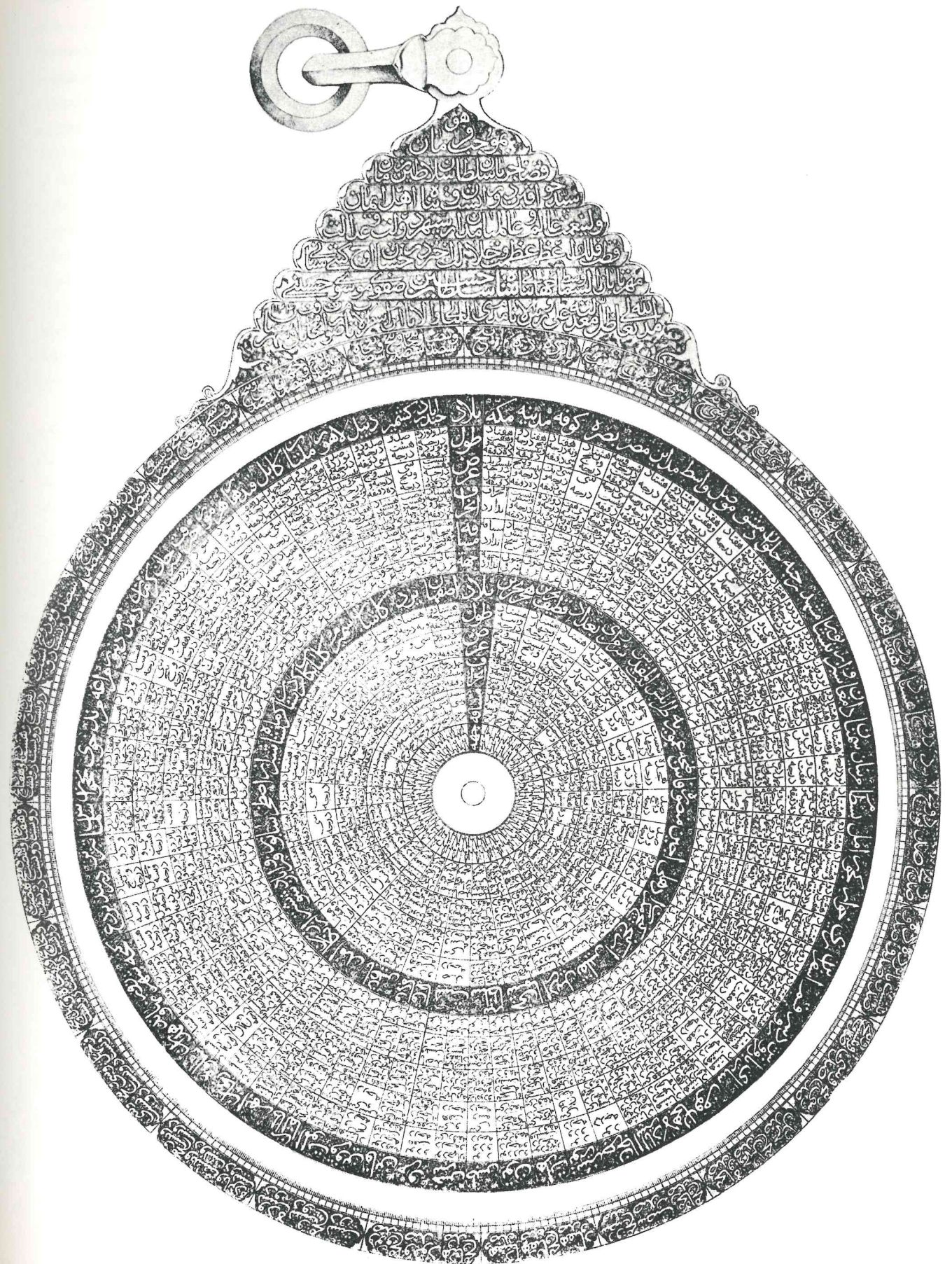
<sup>2</sup> In opposition to the doctrine of the Fátimides and other Isma'ilís, who maintained the succession of Isma'il, the eldest son of Ja'far and of his children, a doctrine, however, long since exploded. Von Hammer, Geschichte der Assassinen. 8vo. Stuttgart, 1818, p. 31. Asch-Schahrastáni's Religions partheien und Philosophen-Schulen, aus dem Arabischen übersetzt von Theodor Haarbrücker. 2 Vols. 8vo. Halle, 1850-51. Vol. i.

p. 219. Histoire des Berbères, par Ibn-Khaldoun, traduite de l'Arabe par M. le Baron de Slane. 8vo. Alger, 1852-54. Tome ii. pp. 501, 504 et seq.

<sup>3</sup> Reineaud's Description des Monumens, &c. Tome i. p. 371, note 2.

<sup>4</sup> I may here mention, once for all, that every number throughout the entire instrument is written at length in words, numerals not being employed in a single instance.

<sup>5</sup> From the nature of the Anastatic plates it was found impossible to represent to the eye this depression of the Umm after the transfer had been made. This defect, however, is the only one that is worthy of notice throughout the Plates, and is wholly unimportant.



Reduced from 15 $\frac{1}{8}$  inches diameter



band, which is shaded, containing the names of additional cities. On the perpendicular shaded radius, in the spaces marked respectively *a, b, c, d, e, f*, are the words Bilād بلاد, Cities, Túl طول, Longitude, 'Arz عرض, Latitude, Inhiráf انحراف, Inclination, Masáfat مسافت, Distance, and Jihat جهت, Side, indicating the contents of each of the circular bands. The first three of these terms require no explanation, except the remark that the Longitude, as is most usual with the Arabian geographers, is reckoned from the Fortunate Islands:<sup>1</sup> the Latitude, as with us, is computed from the Equator. The last three have especial reference to Makkah, the accurate position of which city, with regard to his own place of sojourn, being, as is well known, of vital importance to every Muhammadan. The Inhiráf is an arc of the horizon, intercepted between the meridian of any place, and a vertical circle passing through the zenith of such place and that of Makkah, such circle being called the Azimuth of the Kiblah;<sup>2</sup> and it is equal to the angle at the zenith of such place, formed by the said meridian and vertical circle, which is measured by the forementioned arc. This angle is the Angulus positionis of our older geographers.<sup>3</sup> The Masáfat is the distance in a straight line, as the crow flies, between any place and Makkah; i.e. it is the arc of a great circle intercepted between the zenith of such place and that of Makkah in the nearest direction;<sup>4</sup> the distance is computed in Farsangs, Miles, or Barids, برید, poste (Veredus).<sup>5</sup> The Jihat is the direction of the Azimuth of the Kiblah with reference to any place and the four cardinal points; and it denotes the quarter of the horizon of such place in which Makkah is situated. It is obvious that if the Inhiráf, the Masáfat, and the Jihat, are known at any place, the position of Makkah, with regard to such place, is completely defined. If the place be of the same Latitude as Makkah, there is no Inhiráf; if of the same Longitude, the Inhiráf is 90°: in either case the Masáfat and Jihat are sufficient to determine the position of Makkah.

The following table is a translation of that in the Umm of Sháh Husain's Astrolabe. I have taken the cities as they occur, commencing with the outer circular band, and from the right of the shaded perpendicular space; then descending from left to right, and turning upwards towards the left; and afterwards proceeding with the seventh band in a similar direction. The order I have adopted is that of the degrees of the Hajrah; for although the contrary direction would seem more natural to a Semitic scribe, yet it is most likely to be that originally intended, since, by this arrangement, Makkah occupies the first and most honoured place in the series.<sup>6</sup> The numbers of the degrees, &c., are written in the original in words at full length. The Masáfat is expressed in Farsangs. The Longitudes and Latitudes differ materially in many instances from those given by other Eastern geographers;<sup>7</sup> and the table generally seems to have been constructed with some degree of carelessness: I have, however, translated it as I have found it, with the exception of a few suggestions in the notes, where the errors seem obvious and of magnitude. As might be expected, the mistakes are more frequent the further we go from Isfahán. As regards those places that are situated in Persia, and within a moderate distance of the seat of sovereignty, the admeasurements, tested by our own standards, appear to be accurate; and, indeed,

<sup>1</sup> The first meridian chosen by Ptolemy passed through the Fortunate Islands. In the Khiláfat of Al-Mámún the Arabs borrowed the Greek method of geographical measurement, and some adopted Ptolemy's first meridian: others, however, and Abú al-Fadá amongst their number, fixed upon other points of departure for the Longitude. For an interesting account of the various meridians employed by the Arabs see Reinoud's Géographie d'Aboulféda, Tome i. p. ccxxxii. *et seq.*, and the Mémoire géographique, historique et scientifique sur l'Inde, by the same author, printed in the Mémoires de l'Académie des inscriptions, Tome xviii. 2<sup>e</sup> partie, and published separately. 4to. Paris, 1849, p. 367 *et seq.* See also Lelewel Géographie du moyen âge: Prolegomènes, p. xxvi. *et seq.*

<sup>2</sup> 'Abd al-'Alí Barjandí gives the following definitions respecting the Azimuth of the Kiblah. The point where a vertical circle, passing through the zenith of Makkah and that of the place of observation, cuts the horizon, is called the Nuktah-i Samt-i Kiblah, *Point of the Azimuth of the Kiblah*; the section common to the plane of such vertical circle, and that of the sensible horizon of the place of observation, is the Khatt-i Samt-i Kiblah, *Line of the Azimuth of the Kiblah*, (see *supra* p. 9, note 7); the arc of the said horizon intercepted between the point of the Azimuth and the East or West equinoctial point, whichever may be nearest, is the Kaus-i Samt-i Kiblah, *Arc of the Azimuth of the Kiblah*; and the arc of the said horizon intercepted between the point of the Azimuth and the North or South point, whichever may be nearest, is the Inhiráf-i Samt-i Kiblah, *Inclination of the Azimuth of the Kiblah*, the two lastmentioned arcs being of course complementary to each other. I subjoin the text: چون دائره عظيمه اخراج كند كه بسبت راس مكه منطبق و راس بلد مفروض كند و تقاطع اين دايه با افق بلد آن تقاطعي كه درجهت مكه بود نقطه بود نقطه سمت قبله و فصل مشترك درميان سطح افق حسي و سطح اين دايه خط سمت قبله بود و قوسي از افق بلد كه ميان نقطه سمت قبله و نقطه مشرق اعتدال يا مغرب اعتدال هر کدام كه اقرب بود قوس سمت قبله بود و قوسي هم از افق بلد ما بين نقطه سمت قبله و نقطه شمال يا جنوب هر کدام كه اقرب باشد انحراف سمت قبله بود و بالجهله هر يك از قوس سمت قبله و قوس انحراف تمام آن ديكر باشد تا ربع دور (مقدار قوس انحراف) In the Nuzhat al-Kulûb of Hamd Allah al-Musta'fi al-Karwini, the method of determining the Azimuth of the Kiblah, and the measure of the arc of its inclination (مقدار قوس انحراف)

by means of the Indian circle, is fully detailed. See مقاله اول قسم سيوم متاع. And see also J. J. Sédillot, *Traité des instruments astronomiques des Arabes*, Tome i. p. 319 *et seq.* L. A. Sédillot, *Mémoire*, &c., p. 99. Ib. *Prolegomènes*, &c., p. 11. Ib. *Traduction*, p. 120.

<sup>3</sup> Petri Apiani *Cosmographia*, fol. 51 v. Fournier, *Hydrographie*. Folio, Paris, 1643, p. 611. <sup>4</sup> 'Abd al-'Alí Barjandí, after describing the method of measuring the distance between two stars, states that the same process is applicable to cities, و بعد بين البلدین كه ازین عمل حاصل آید قوسي بود از (دائره) عظيمه بر محيط نلك اعظم كه بسبت راس هر دو بلد كند. He goes on to explain that one degree of the celestial arc is equal to 22 Farsangs and  $\frac{1}{2}$ th, according to the opinions of the ancients, and 19 Farsangs, less  $\frac{1}{2}$ th, according to the moderns; every Farsang containing 12,000 cubits, and each cubit being equal to 24 fingers. See on the measurement of a degree of the meridian, and on the geodetic measures of the Arabs generally; Gravius, *Chorasmiae Descriptio ex Tabulis Abulfedæ*. 4to. London, 1650. Pref. Sig. a a 2. De Guignes, in the first volume of the *Notices et extraits des MSS.* p. 48 *et seq.* The extracts from Arabic authors in Tychoen's, Takieddin Almakrizi *Tractatus de legalibus Arabum ponderibus et mensuris*; 12mo Rostochii, 1800. Reinoud, *Géographie d'Aboulféda*, Tome i. p. cclxiii. *et seq.*, and Tome ii. p. 16 *et seq.* Lelewel, *Géographie du moyen âge*, Tome i. pp. 16, 100, 165.

<sup>5</sup> For the method of determining the Masáfat and its measurement by Farsangs, Miles, or Poste, see J. J. Sédillot, *Op. cit.*, Tome i. p. 324.

<sup>6</sup> Abú al-Fadá has even taken Makkah and Madínah out of their proper situations in order to make them lead the van. "Aboulféda," says M. Reinoud, "ne s'est pas contenté de commencer ses descriptions par l'Arabie, berceau de la religion Musulmane; il a retiré la Mekke et Médine de leur véritable place, pour les mettre en tête des tables." *Géographie d'Aboulféda*, Tome ii. p. 114, note i.

<sup>7</sup> It must be observed, however, that they agree remarkably with those given in the *Tables of Ulugh Bég*. The latter will be found in the *Atlas* to Lelewel's *Géographie du moyen âge*, p. 10, and very accurately given in the *Notes et éclaircissements* to M. L. A. Sédillot's translation of the *Prolegomena of Ulugh Bég*, p. 257 *et seq.*



wherever they agree with each other, it may be questioned whether our geographical knowledge of Persia be sufficiently extensive to entitle us to refuse the statements of a scientific Persian on the authority of a European map-maker.<sup>1</sup>

## OUTER CIRCLE.

Cities.	Longitude.	Latitude.	Inhiráf.	Distance.	Jihat.
1. Makkah, مكة . . . . .	77 10	21 40	none	none	none.
2. Madínah, مدينة . . . . .	75 20	25 10	26 2	86	South-East.
3. Kúfah, كوفه . . . . .	79 30	31 30	12 31	223	South-West.
4. Basrah, بصره . . . . .	85 —	30 —	37 59	230	South-West.
5. Misr, مصر . . . . .	63 20	30 20	58 38	335	South-East.
6. Madáin, مدائن . . . . .	80 —	33 10	16 2	261	South-West.
7. Wásit, واسط . . . . .	81 30	32 20	20 54	251	South-West.
8. Mausil, موصل . . . . .	77 —	34 30	— 42	285	South-East.
9. Dimashk, دمشق . . . . .	70 —	33 15	30 31	293	South-East.
10. Hulwán, حلوان . . . . .	82 15	34 —	21 16	291	South-West.
11. Rahbah, رحبه . . . . .	74 35	34 10	10 59	282	South-East.
12. Mashhad, مشهد . . . . .	92 30	37 —	45 6	451	South-West.
13. Nishábúr, نیشابور . . . . .	92 30	36 21	46 25	440	South-West.
14. Sabzawár, سبزوار . . . . .	91 30	36 5	44 12	422	South-West.
15. Dámghán, دامغان . . . . .	88 55	36 20	38 5	382	South-West.
16. Samnán, سمنان . . . . .	88 —	36 —	36 17	381	South-West.
17. Mazínán, مازنیان . . . . .	90 30	37 —	40 41	426	South-West.
18. Bistám, بسطام . . . . .	89 30	36 10	39 53	400	South-West.
19. Amul, امل . . . . .	88 20	36 15	36 43	389	South-West.
20. Kajúr, کجور . . . . .	86 50	36 25	32 19	377	South-West.
21. Khuwár, خوار . . . . .	87 10	35 40	34 38	366	South-West.
22. Rai, ري . . . . .	86 20	35 —	37 26	356	South-West.
23. Asfaráin, اسفراین . . . . .	91 50	36 25	44 50	433	South-West.
24. Kum, قم . . . . .	85 40	34 45	31 55	339	South-West.
25. Rúdisar, رودسر . . . . .	85 10	37 —	26 32	373	South-West.
26. Bárfurúsh, بارفروش . . . . .	87 50	36 50	34 17	394	South-West.
27. Sári, ساري . . . . .	88 —	37 —	34 28	399	South-West.
28. Fúman, فومن . . . . .	84 40	37 20	24 36	376	South-West.
29. Láhián, لاهیجان . . . . .	84 —	37 15	22 40	370	South-West.
30. Astarábád, استرآباد . . . . .	89 35	36 50	38 48	416	South-West.
31. Jurján, جرجان . . . . .	90 —	36 50	39 48	418	South-West.
32. Túrshíz, تورشیز . . . . .	92 —	35 —	48 15	416	South-West.
33. Hirát, هرات . . . . .	94 20	34 30	54 5	439	South-West.
34. Tún, تون . . . . .	92 30	34 30	50 20	416	South-West.
35. Tabas, طبس . . . . .	92 —	33 —	52 55	385	South-West.
36. Sarakhs, سرخس . . . . .	94 30	37 —	49 12	476	South-West.
37. Marw, مرو . . . . .	97 —	37 40	52 30	520	South-West.
38. Káin, قاین . . . . .	93 20	33 40	54 1	414	South-West.
39. Kazwín, قزوین . . . . .	85 —	36 —	27 34	352	South-West.
40. Alamút, الموت . . . . .	85 37	36 21	28 53	364	South-West.
41. Tálakán, طالقان . . . . .	85 45	36 10	29 33	362	South-West.
42. Abhar, ابهر . . . . .	84 30	36 45	24 53	363	South-West.

<sup>1</sup> The following opinion of a competent judge, with regard to our maps and map-makers, and those who rely on them, is worthy of remark:—"Indeed, the carelessness, not to say the want of common honesty, with which some maps are got up and sent out among the public, is a crying evil; but—and we regret to say it—so small is the amount of knowledge possessed by people in general of this department of science, that if not

one map in ten be good for any thing, there is not one person in a thousand capable of detecting the errors, or discovering the discrepancies of the maps they purchase." *Manual of Geographical Science: Chartography* by J. R. Jackson. 8vo. London, 1852, p. 74.

Cities.	Longitude.	Latitude.	Inhiráf.	Distance.	Jihat.
43. Zanján, زنجان . . . . .	83 40	36 30	22 37	352	South-West.
44. Sâwah, ساوه . . . . .	85 —	35 —	29 16	333	South-West.
45. Hamadán, همدان . . . . .	83 —	35 10	22 17	320	South-West.
46. Naháwand, نهاوند . . . . .	83 15	34 20	24 29	305	South-West.
47. Shahrazúr, شهرزور . . . . .	82 20	32 30	24 14	261	South-West.
48. Ganjah, گنجه . . . . .	83 —	41 20	15 49	450	South-West.
49. Barda', بردع . . . . .	83 —	40 30	16 28	432	South-West.
50. Darband, دربند . . . . .	85 —	43 —	19 29	495	South-West.
51. Tabriz, تبریز . . . . .	82 —	38 —	15 40	367	South-West.
52. Salamás, سلماس . . . . .	79 15	37 40	7 —	357	South-West.
53. Nakhjawán, نخجوان . . . . .	81 15	38 40	12 49	385	South-West.
54. Khuwai, خوی . . . . .	79 40	37 40	8 23	358	South-West.
55. Marand, مرند . . . . .	80 45	37 50	11 50	365	South-West.
56. Marághah, مراغه . . . . .	82 —	37 20	16 17	360	South-West.
57. Dínawar, دینور . . . . .	83 —	35 —	22 31	317	South-West.
58. Damdam, دمدم . . . . .	79 45	37 —	9 1	344	South-West.
59. Kirmán, کرمان . . . . .	92 30	29 50	62 56	356	South-West.
60. Sírján, سیرجان . . . . .	90 20	29 30	59 35	315	South-West.
61. Jíraft, جیرفت . . . . .	93 —	27 30	71 24	344	South-West.
62. Hurmúz, هرموز . . . . .	92 —	25 —	74 —	274	South-West.
63. Kandahár, قندهار . . . . .	107 40	33 —	75 —	356 <sup>1</sup>	South-West.
64. Kábul, کابل . . . . .	104 40	34 7	69 57	604 <sup>2</sup>	South-West.
65. Multán, ملتان . . . . .	107 35	29 40	80 48	632 <sup>3</sup>	South-West.
66. Láhúr, لاهور . . . . .	119 <sup>4</sup> 20	31 50	78 26	674 <sup>2</sup>	South-West.
67. Daibul, دیبل . . . . .	102 30	25 10	86 41	521	South-West.
68. Kashmir, کشمیر . . . . .	108 —	35 —	68 44	605 <sup>2</sup>	South-West.
69. Haidarábád, حیدرآباد . . . . .	119 19	28 4	89 44	857	North-West.

## INNER CIRCLE.

70. Hajr; Bahrain, هجر بحرین . . . . .	83 —	25 15	57 23	143	South-West.
71. Katíf; Bahrain, قطیف بحرین . . . . .	84 —	25 —	63 24	157	South-West.
72. Baghdád, بغداد . . . . .	80 —	33 25	12 46	266	South-West.
73. Surra man Raa, سرمن رای . . . . .	79 —	34 —	7 56	276	South-West.
74. Bait al-Mukaddas, بیت المقدس The holy house (Jerusalem) . . . . .	66 30	31 50	45 43	309	South-East.
75. Taráblus, طرابلس . . . . .	45 —	32 —	78 17	674 <sup>2</sup>	South-East.
76. 'Ammúriyah, عمورية . . . . .	64 —	43 —	31 23	533	South-East.
77. Fás; Tanjah, فاس طنجه . . . . .	17 —	22 <sup>5</sup> —	78 24	1212	South-East.
78. Mansúrah, منصوره . . . . .	105 —	27 40	82 50	576	South-West.
79. Ujjain, اُجین . . . . .	102 —	24 30	77 57 <sup>6</sup>	510	South-West.
80. Dihlí, دهلي . . . . .	114 18	28 16	87 34	763	South-West.
81. Kich; Makrán, کچ مکران . . . . .	99 —	28 —	77 7	461	South-West.
82. Urganj, ارکنج . . . . .	93 45	42 35	38 44	557	South-West.
83. Tiflis, تفلیس . . . . .	83 —	43 —	4 41 <sup>7</sup>	486	South-West.

<sup>1</sup> This must be a mistake for 656.

<sup>2</sup> In all these Masáfát's شمسد is put, evidently erroneously, for شمسد, six hundred.

<sup>3</sup> From the actual place of Láhúr, and the Masáfát stated above, this appears to be an error for 109. Ulugh Bég gives 109. 20', and the Longitude is so set down in Mr. Vaux' Astrolabe and the Hindú instrument in the East-India House. In No. II. of the latter collection the Longitude is, however, as in the text.

<sup>4</sup> Where there are two names conjoined, the second is added to denote the country or province in which the city designated by the first is situated.

<sup>5</sup> Probably an error for 32, which will agree better with the actual position of Fás, and with the Inhiráf and distance as given in the text.

<sup>6</sup> According to any calculation the Inhiráf of Ujjain must be greater than that of Dihlí. It will be observed that the Inhiráf of the latter is stated almost as much too large as that of Ujjain is too little.

<sup>7</sup> This Inhiráf of Tiflis must be wrong, according to the Latitudes and Longitudes above given, by about ten degrees.



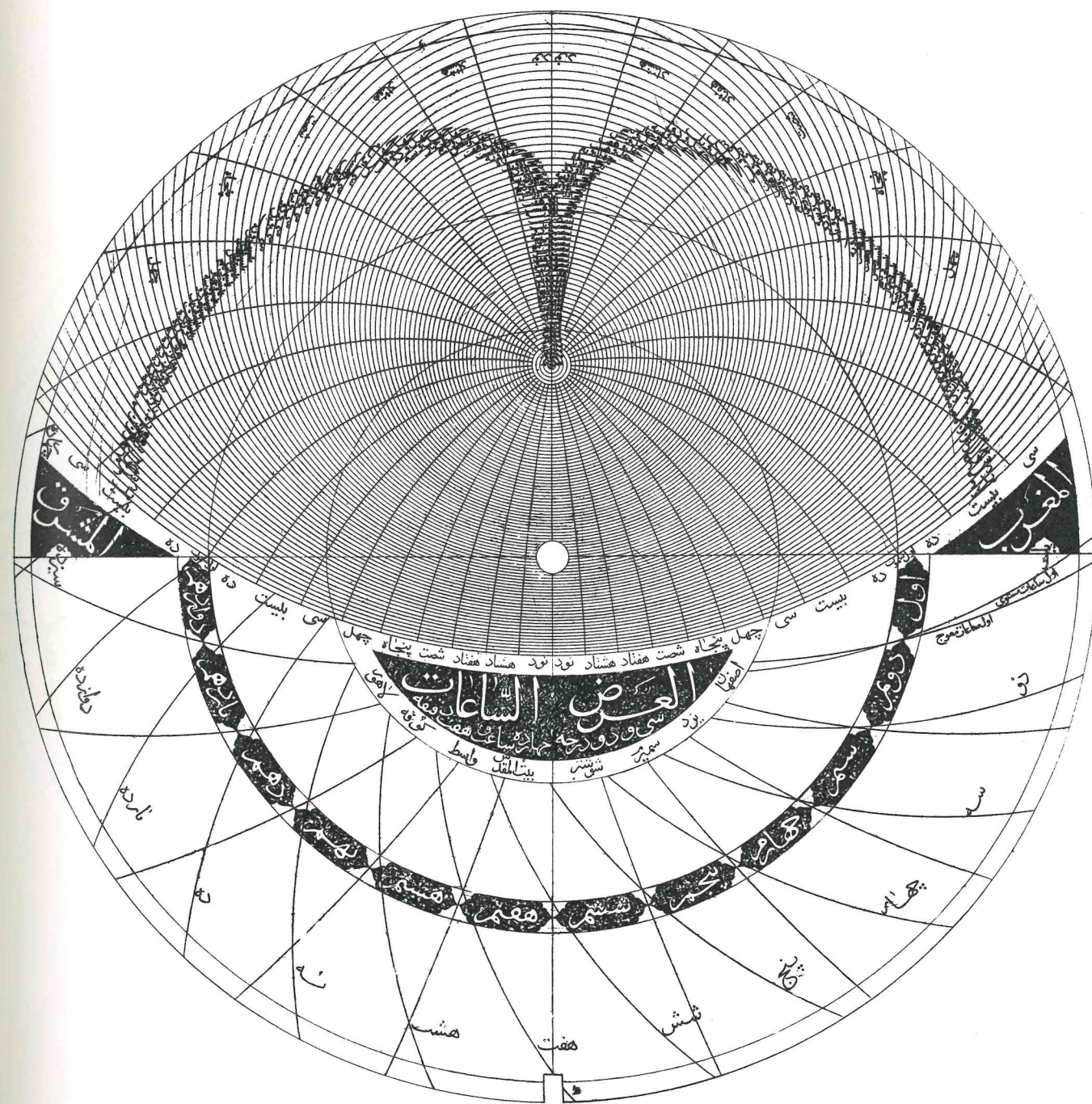
Cities.	Longitude.	Latitude.	Inhiráf.	Distance.	Jihat.
84. Ardabíl, اردبیل . . . . .	82 30	38 —	17 16	377	South-West.
85. Shamákhí, شمشاخى . . . . .	84 30	40 50	20 9	447	South-West.
86. Sultaníyah, سلطانیه . . . . .	84 6	37 30	22 40	376	South-West.
87. Bust, بست . . . . .	100 —	33 —	66 30	514	South-West.
88. Márúchák, ماروجاى . . . . .	97 —	36 30	54 42	505	South-West.
89. Bádgíh, بادغیس . . . . .	94 30	35 20	52 34	453	South-West.
90. Amud, اُمُد . . . . .	73 40	38 —	11 29	367	South-East.
91. Arzangán, ارزنگان . . . . .	77 —	38 —	— 33	362	South-East.
92. Shústar, شوستر . . . . .	84 —	31 30	35 24	262	South-West.
93. Fírúzábád, فیروزآباد . . . . .	87 30	28 10	57 32	253	South-West.
94. Sábúr, سابور . . . . .	86 55	30 —	48 43	268	South-West.
95. Istakhr, اصطخر . . . . .	88 30	30 —	53 21	292	South-West.
96. Shíráz, شیراز . . . . .	88 —	29 36	53 23	279	South-West.
97. Kirmánsháh, کرمانشاه . . . . .	83 —	34 30	23 18	308	South-West.
98. Kurdistán, کردستان . . . . .	84 45	34 —	30 25	311	South-West.
99. Gulpáigán, گلپایگان . . . . .	85 30	34 15	32 21	323	South-West.
100. Sumairam, سمیرم . . . . .	85 40	32 10	37 51	288	South-West.
101. Káshán, کاشان . . . . .	84 —	34 —	34 31	324	South-West.
102. Yazd, یزد . . . . .	89 —	32 —	48 29	331	South-West.
103. Isfahán, اصفهان . . . . .	86 40	32 25	40 29	330	South-West.

The small circle at *N* is the Mahan, pierced through the centre of the Umm for the admission of the Kutb.

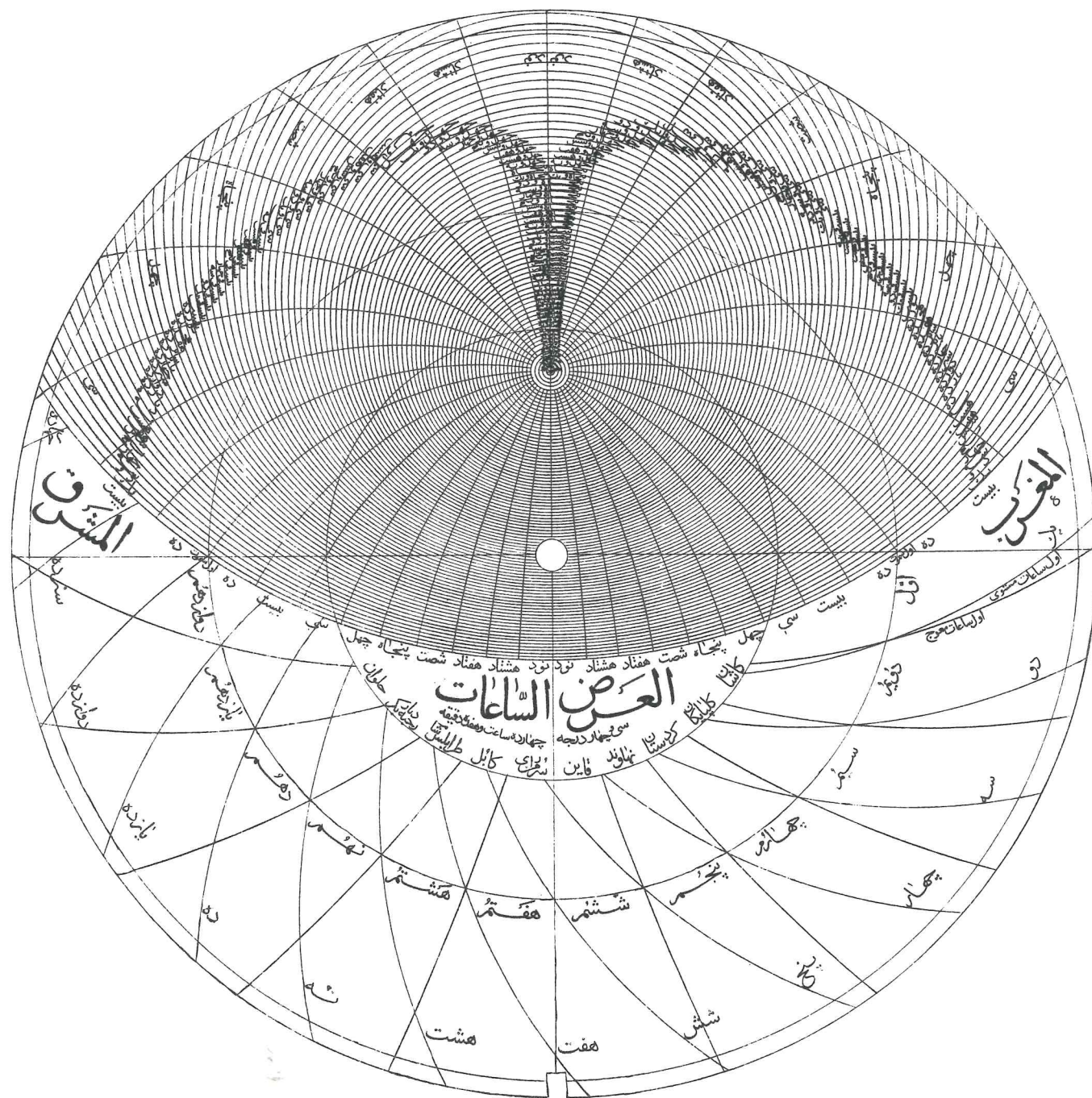
PLATE II. This is the obverse of the first tablet. The tablets, of course, have no particular order of rotation, since their use depends on the variable circumstance of the Latitude of the place of observation. I have, however, given to the present one the precedence over the rest, inasmuch as it bears the name of Isfahán, the seat of sovereignty in Sháh Husain's reign; and because, moreover, the scratches on its surface shew that it must constantly have occupied the first place under the 'Ankabút during the time that the Astrolabe was in the possession of its royal owner. The inscriptions are as follows: 1. The two diameters, *i.e.* the Khatt Wasat as-Samá, or meridian, *S N*, (Plate xviii. Fig. 4); and the Khatt Wasat al-Mashrik wa al-Maghrib, or line of the East and West, *E W*. 2. The three circles, viz. the Madár Rás al-Jadí, or Tropic of Capricorn, *A B D F*; the Madár Rás al-Hamal, or Equinoctial, *G H I K*; and the Madár Rás as-Saratán, or Tropic of Cancer, *L M N O*. 3. The Almucantars *A A' a a a* (Plate xviii. Fig. 5), commencing from the Ufk, or oblique horizon *A M A'*, and numbered progressively from one to ninety; the last and smallest circle 90, being the Zenith. Immediately under the oblique horizon *A M A'*, in the shaded space on the right hand at *W*, is the word *المغرب*, the West; and in the corresponding space, on the left hand, at *E*, *المشرق*, the East; on the right of the meridian line *S N* is written *العرض سی و دو درجه*, Latitude—thirty-two degrees, being the latitude for which the tablet is constructed; and on the left of the same line *الساعات چهارده ساعت و هفت دقیقه*, Hours—fourteen hours and seven minutes, being the duration of the longest day at such parallel of Latitude: these together form the crescent shaped shaded space under the centre of the oblique horizon: under these again just within the Tropic of Cancer at *c c c c* are the names of the following cities, which are 32°, or nearly so, of latitude, as may be seen by reference to the table in the Umm: Isfahán اصفهان, Yazd یزد, Sumairam سمیرم, Shústar شوستر, Bait al-Mukaddas (Jerusalem) بیت المقدس, Wásit واسط, Kúfah كوفه, and Láhúr لاهور. 4. The Azimuths, *BB' b b b* (Plate xix. Fig. 9), inscribed above the earth, and commencing from *B B'*, at which points of intersection of the two horizons, being the 'Itidálain, or equinoctial points, are the words *أَوَّلُ سَمَوَاتٍ*, the first of the Azimuths, or prime vertical. The Azimuths *b b b* are numbered by tens, proceeding along the outside of the oblique horizon and the inside of the outer tropic, from the points *B* and *B'* both ways, towards the centre and the circumference, and ending at the meridian line at *S* and *M*. The Azimuths all pass through the zenith *Z*. 5. The arcs of the unequal or temporal hours *U u u u* (Plate xix. Fig. 9), traced below the earth, and numbered from West to East in ordinal numbers in the shaded spaces outside the Equinoctial circle. At *U* are the words *أَوَّلُ سَاعَاتٍ مَعْرُوجَةٍ*, the first of the crooked hours. 6. The arcs of the equal hours *F f f f* (Plate xviii. Fig. 5), traced below the earth, and numbered from one to fourteen, commencing from the West. The numbers are placed near the inner circumference of the Tropic of Capricorn. At *F* are the words *أَوَّلُ سَاعَاتٍ مُسْتَوِيَةٍ*, the first of the equal hours.

The small circle *C* in the centre of the tablet (Plate xviii. Fig. 4), is the Mahan, or hole for the passage of the Kutb, and represents the North Pole: the interstice at the bottom of its outer circumference at *N* is the notch which fits on to the Mumsikah *L* (Plate xviii. Fig. 1).

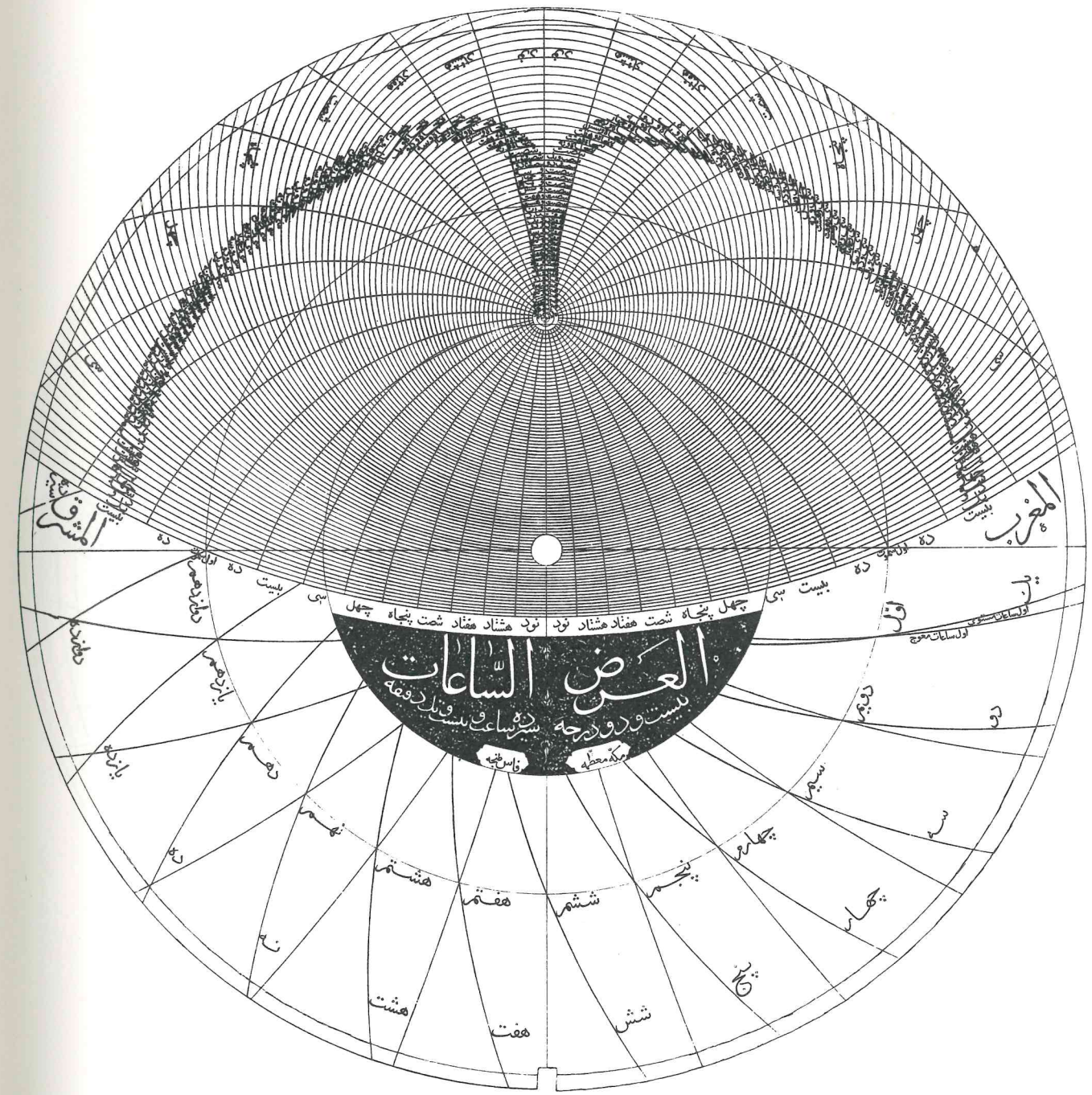
PLATE III. The reverse of the first tablet inscribed with—1. The two diameters. 2. The three circles. 3. The Almucantars, under which





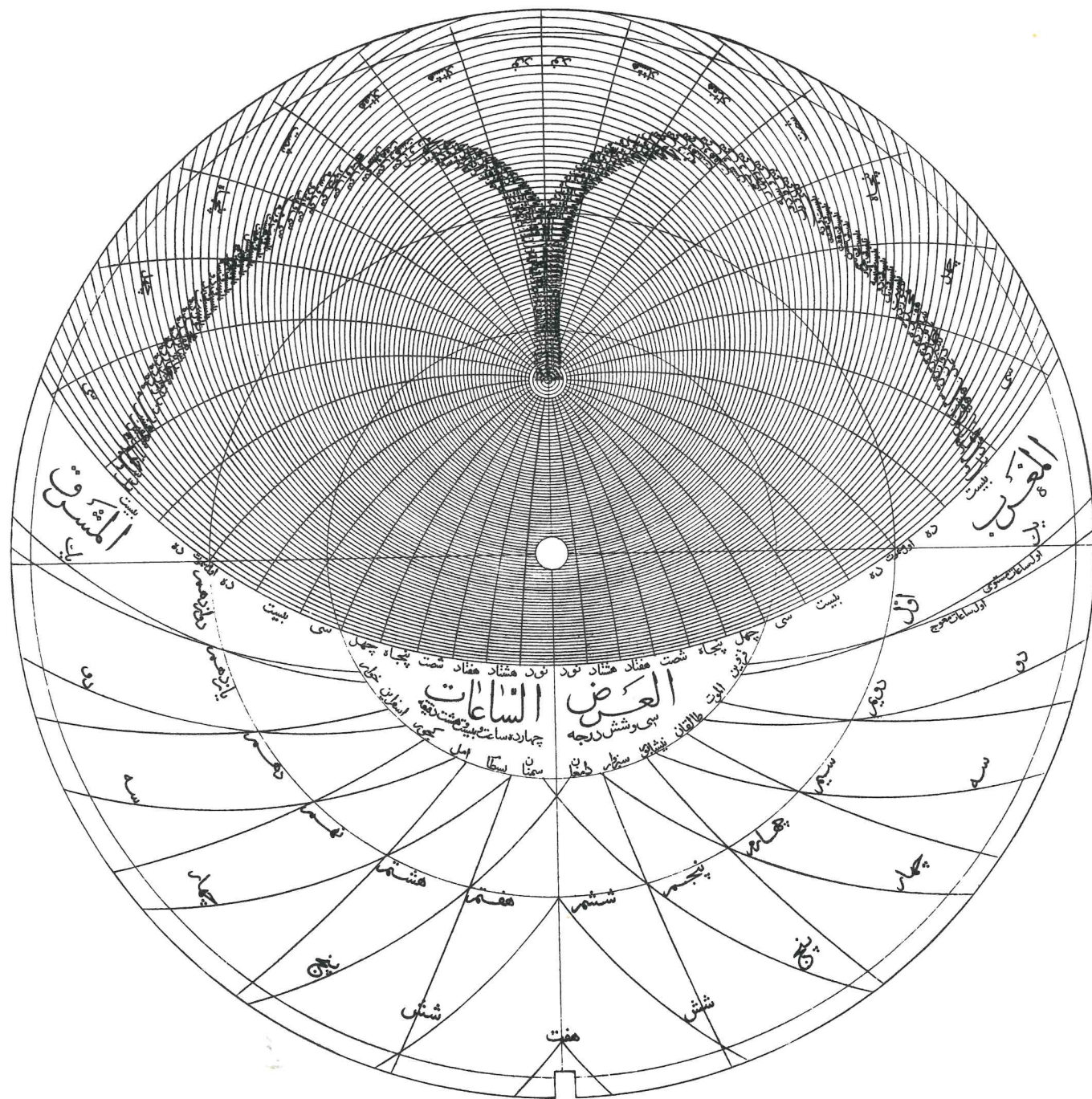


Reduced from 14 $\frac{3}{8}$  inches diameter

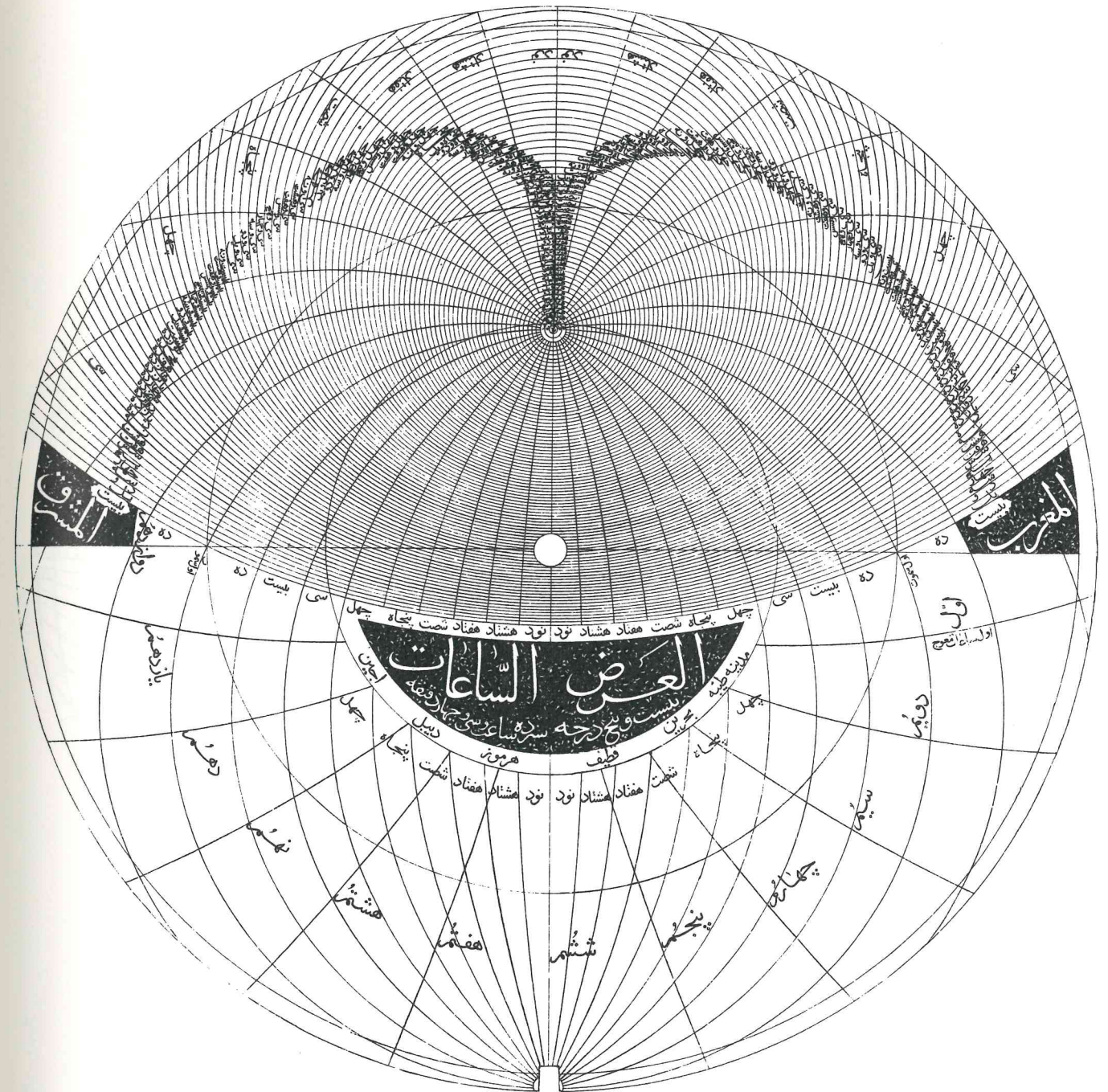


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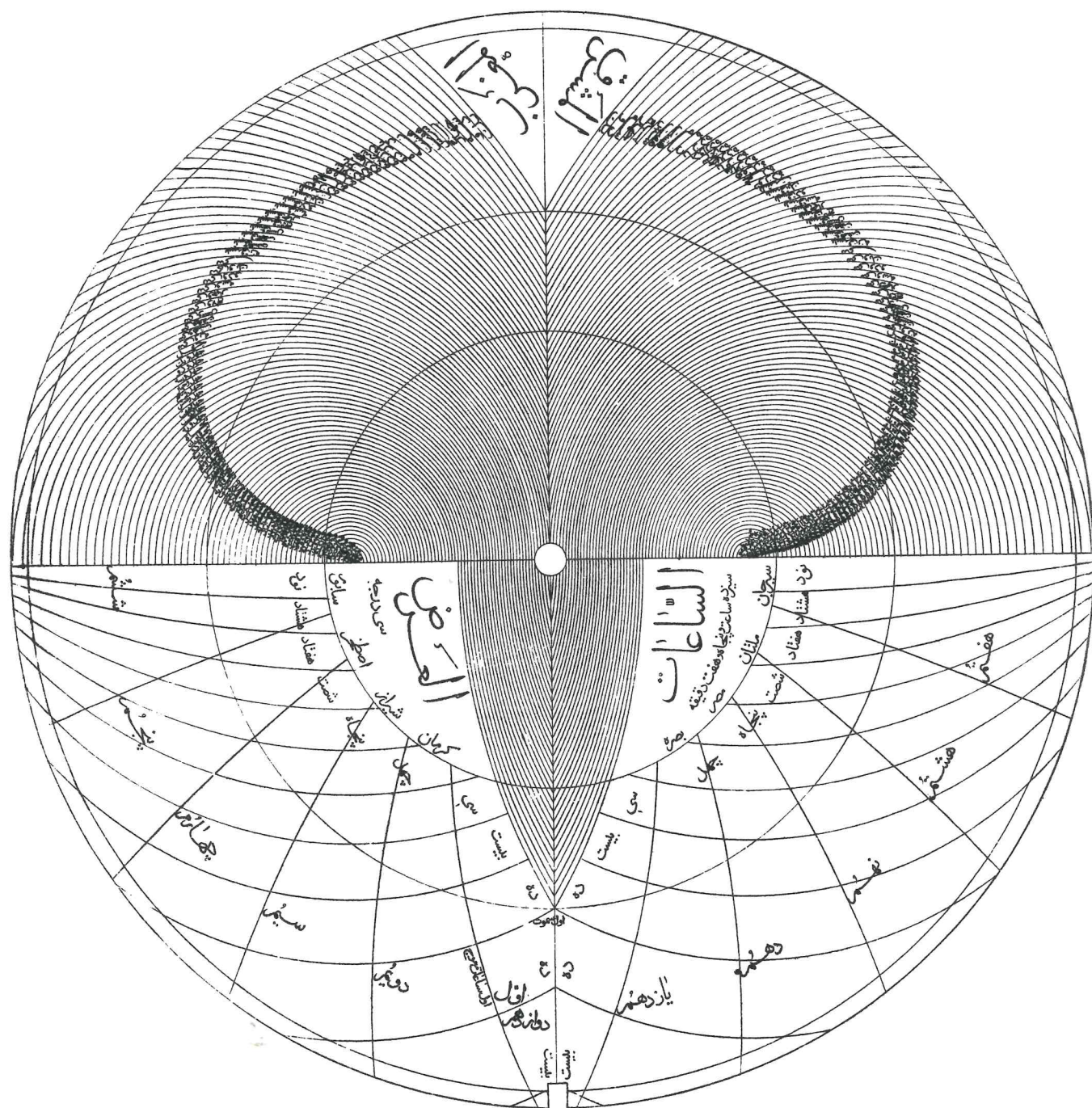


Reduced from  $14\frac{7}{16}$  inches diameter

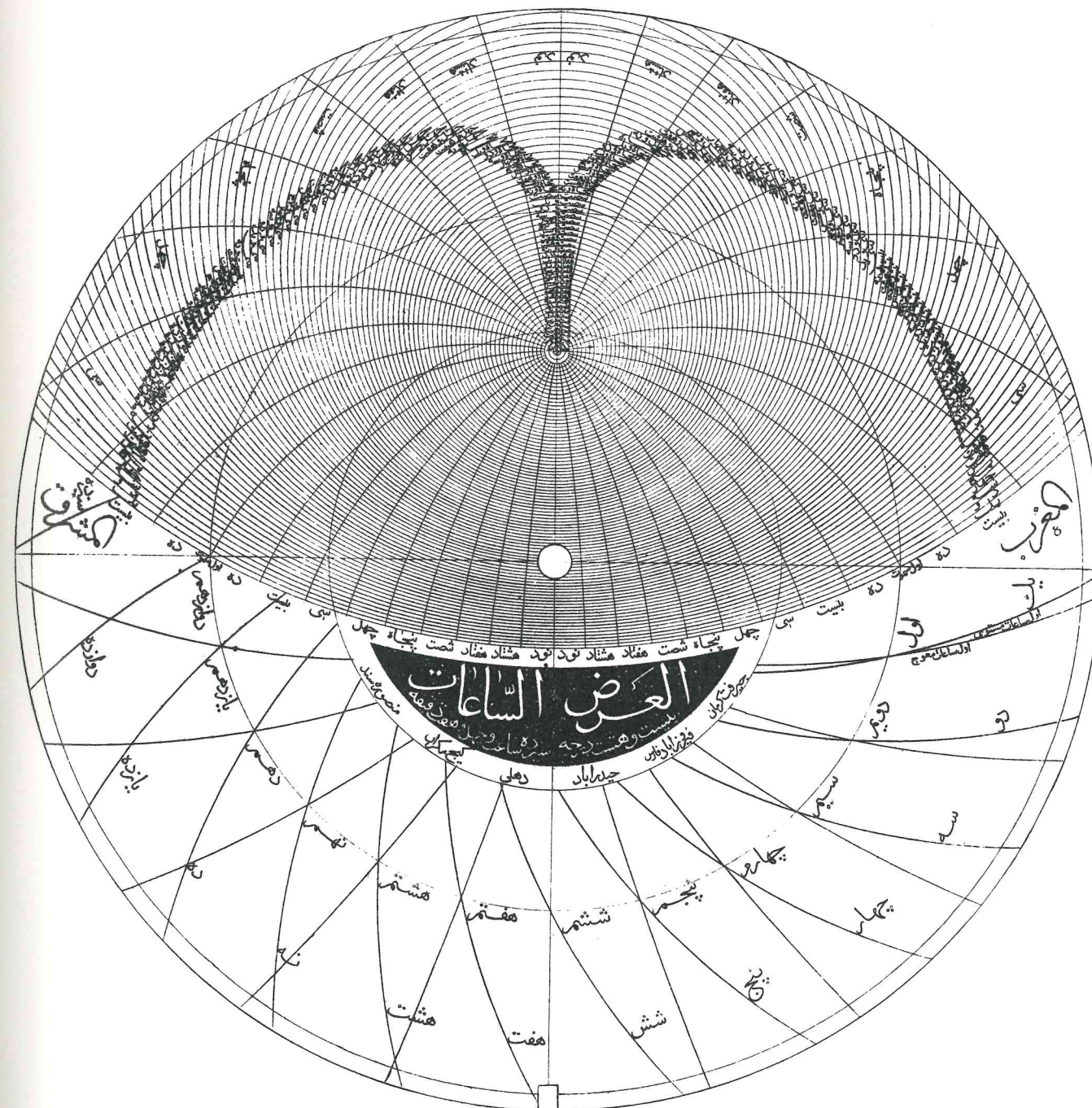


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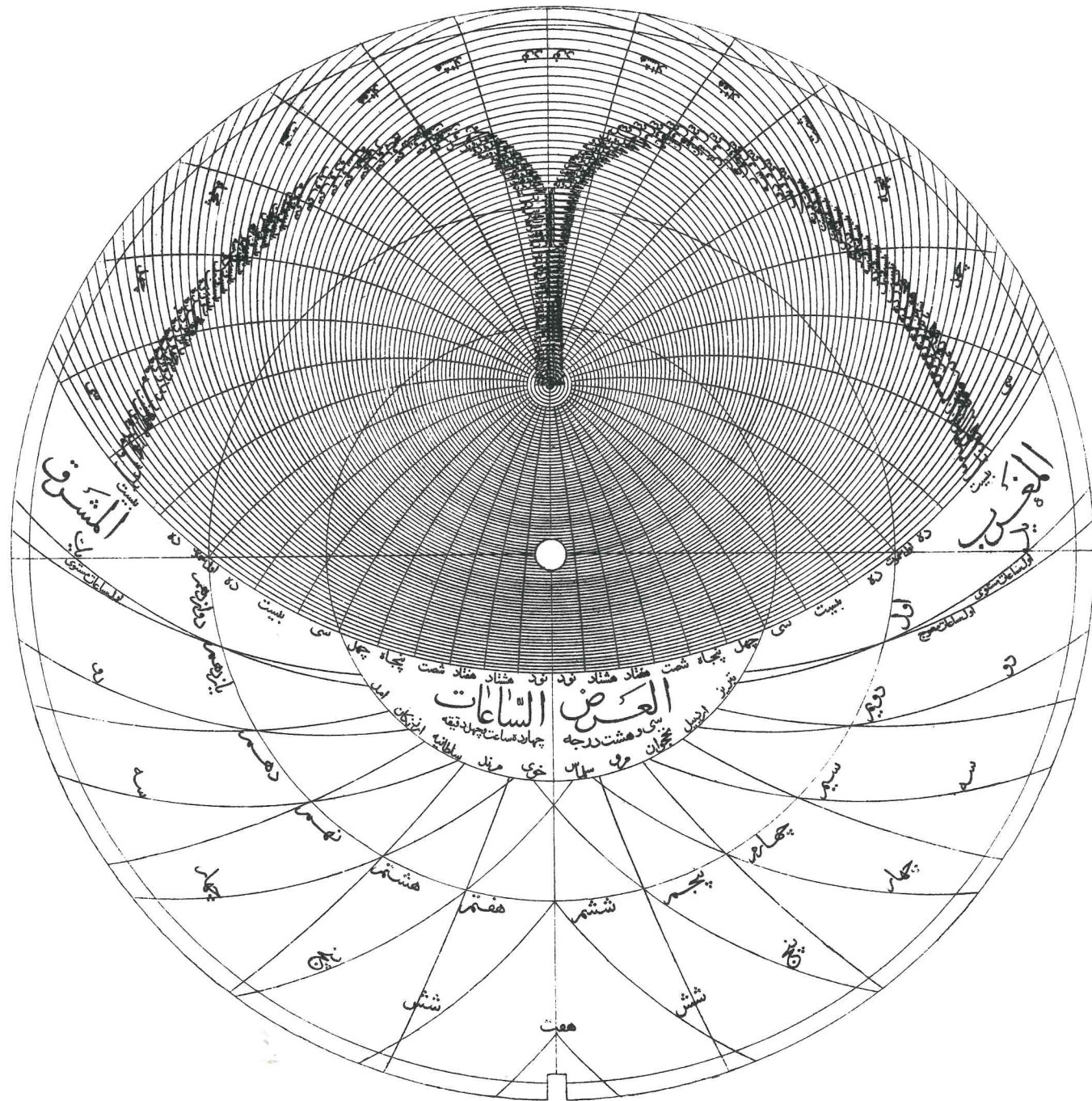


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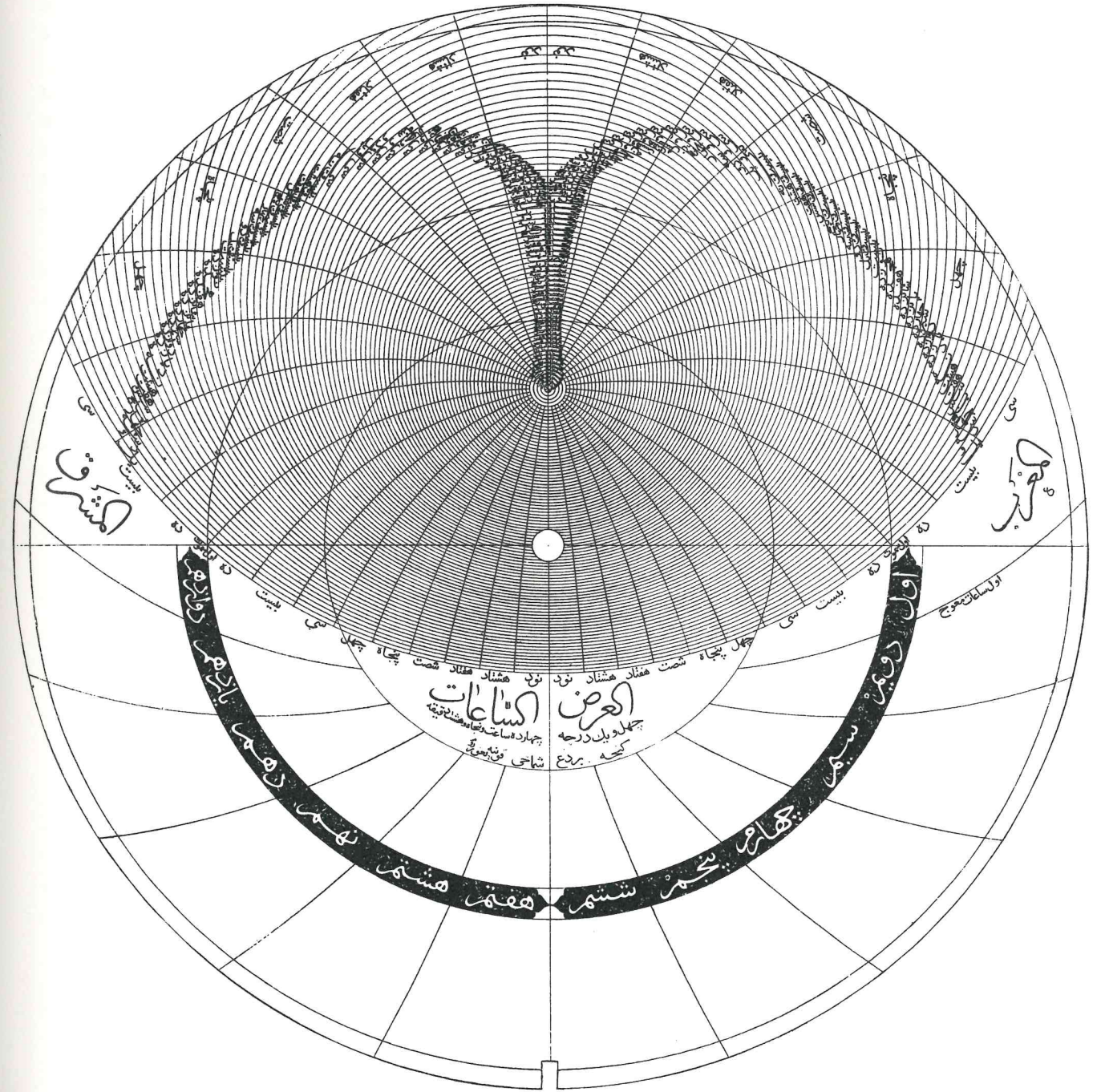


Reduced from 14 $\frac{3}{8}$  inches diameter





Reduced from 14 $\frac{3}{8}$  inches diameter



Reduced from 14 $\frac{3}{8}$  inches diameter



are written the Latitude for which the tablet is constructed, viz.  $34^{\circ}$ ; and the hours of the longest day—fourteen hours seventeen minutes, with the following names of cities, Káshán كاشان, Gulpáigán گلپایگان, Kurdistán كردستان, Niháwand نهاوند, Káin قاين, Surra man Raa سُرّ من راي, Kábul كابل, Taráblus; Shám (Tripoli; Syria) طرابلس شام, Rahbah; Diyárbakr ديار بكر, and Hulwán حلوان. 4. The Azimuths above the earth. 5. The arcs of the unequal hours. 6. The arcs of the equal hours from one to fourteen.

PLATE IV. The obverse of the second tablet. On its surface are traced, 1. The two diameters. 2. The three circles. 3. The Almucantars, under which is written the Latitude of  $22^{\circ}$ , the hours of the longest day—thirteen hours twenty-one minutes, and the names of the cities, Makkah the Great مكة معظمه, and Fás; Tanjah (Fez; Tangiers) فاس طنجه. 4. The Azimuths above the earth. 5. The arcs of the unequal hours. 6. The arcs of the equal hours, from one to thirteen.

PLATE V. The reverse of the second tablet, on which are, 1. The two diameters. 2. the three circles. 3. The Almucantars, with the Latitude  $36^{\circ}$ , the hours of the longest day—fourteen hours twenty-eight minutes, and the names Kazwín قزوین, Alamút الموت, Tálíkán طالقان, Nishábúr نیشابور, Sabzawár سبزوار, Dámghán دامغان, Samnán سمنان, Bistám بستم, Amul امل, Kajúr كجور, Asfaráin اسفراین, and Khuwár خوار. 4. The Azimuths above the earth. 5. The arcs of the unequal hours. 6. The arcs of the equal hours *ffff*, numbered both from the West and East (Plate xix. Fig. 11), from one to seven, the arcs of the last two hours meeting on either side of the Khatt Wasat as-Sama, but not cutting that line.

PLATE VI. The obverse of the third tablet, containing, 1. The two diameters. 2. The three circles. 3. The Almucantars, with an horizon for a Latitude of  $25^{\circ}$ , the hours of the longest day—thirteen hours and thirty-four minutes, and the names Madínah the Good مدينه طيبه, Bahrain بحرين, Katíf قطيف, Hurmúz هرموز, Daibul دبيل, and Ujjain اجين. 4. The Azimuths, traced both above and below the earth *B b b b* (Plate xix. Fig. 11), and cutting both the zenith and the nadir. 5. The arcs of the unequal hours.

PLATE VII. The reverse of the third tablet, bearing the double projection to which I have already alluded. It presents, as before stated, the diameters and circles drawn entire, and serving for both projections, together with a separate set of Almucantars, Azimuths, and horary arcs for each. The latter are only partially traced, either for the purpose of avoiding a confusion of lines, or perhaps for the sake of what may be called the pattern of the inscription. As the tablet stands in the Umm, the ordinary position of the diameters is reversed, the straight horizon being perpendicular. The North and South, and the East and West points of the diameters are interchangeable. If the tablet be turned round from right to left, so that *C* (Plate xix. Fig. 12) be at the summit, *CH* will be the meridian line, and *AD* the straight horizon: at *E* is the word المشرق, *the East*, in its usual place. The Almucantars *a a a*, only traced above the straight horizon on the left or Eastern side, and below it on the right or Western, proceed and are numbered on the left of the meridian line from one to ninety, the zenith. Immediately under the portion of the first Almucantar, or oblique horizon, to the right of the meridian line, is written the Latitude  $30^{\circ}$ , and the names of the cities, Kirmán كرمان, Shíráz شیراز, Istakhr اصطخر, and Sábúr سابور, at *c c c c*. The Azimuths *B, b b b b* are inscribed below the earth, on the right or Western side, and are numbered both ways from the prime vertical *B*. The arcs of the unequal hours *U, u u u u* are also traced below the earth on the same side, and are numbered from the West, from the first to the sixth, the first hour being denoted by the usual words at *U*. If the tablet be turned in the contrary direction, so that *H* may occupy the top place, we find an exactly similar inscription, but reversed. At *W* is the word المغرب, *the West*: the Almucantars *a' a' a' a'* are drawn above the straight horizon on the right, and below it on the left of the meridian line; and the hours of the longest day—thirteen hours fifty-seven minutes, are written under the oblique horizon on the left of the same line, together with the names of the cities, Sírján سیرجان, Multán ملتان, Misr مصر, and Basrah بصره, at *c' c' c' c'*. The Azimuths are traced and numbered as before, but on the Eastern side of the perpendicular diameter *B, b' b' b' b'*, *B* being still the first Azimuth. The arcs of the unequal hours are drawn on the left of the same diameter, and numbered from the seventh to the twelfth.

PLATE VIII. The obverse of the fourth tablet, on which we find, 1. The two diameters. 2. The three circles. 3. The Almucantars with the Latitude  $28^{\circ}$ , and the hours of the longest day—thirteen hours forty-seven minutes, together with the names, Jíraft; Kirmán منصورة سند, Fírúzábád; Fárs فيروزاباد فارس, Haidarábád دهلي, Kích; Makrán مکران, and Mansúrah; Sind منصوره سند. 4. The Azimuths above the earth. 5. The arcs of the unequal hours. 6. The arcs of the equal hours, from one to thirteen.

PLATE IX. The reverse of the fourth tablet, comprising, 1. The two diameters. 2. The three circles. 3. The Almucantars, with an horizon of  $38^{\circ}$ , the hours of the longest day—fourteen hours forty minutes, and the names of Tabríz تبریز, Ardabíl اردبیل, Nakhjawán نخجوان, Marw مرو, Salamás سلماس, Khuwai خوي, Marand مرند, Sultáníyah سلطانیه, Arzankán ارزنگان, and Amad امد. 4. The Azimuths above the earth. 5. The arcs of the unequal hours. 6. The arcs of the equal hours, from one to seven, commencing and numbered both from the West and the East..

PLATE X. The obverse of the fifth tablet, comprising, 1. The two diameters. 2. The three circles. 3. The Almucantars, under the first of which is the Latitude  $41^{\circ}$ , the hours of the longest day—fourteen hours fifty-eight minutes, and the names of the cities, Ganjah كنج, Barda' بردع, Shamákhí شمخى, and Kúníyah, on the frontier of Rúm قونیه ثغور روم. 4. The Azimuths above the earth. 5. The arcs of the unequal hours.



PLATE XI. The reverse of the fifth tablet, on which are traced, 1. The two diameters. 2. The three circles. 3. The Almucantars for an horizon of Latitude 43°, with the hours of the longest day—fifteen hours twelve minutes, and the names of Tiflis تيفليس, Darband دربند, 'Amuriyah of the Turks اُمُورِيَّةُ التُّرُكِ, and Urganj اُرْغَنْج. 4. The arcs of the unequal hours. 5. The equal hours, from one to fifteen. The Azimuths are omitted in this projection.

PLATE XII. The obverse of the sixth tablet, with—1. The two diameters. 2. The three circles. 3. The Almucantars, under which is written the Latitude 35°, the hours of the longest day—fourteen hours twenty-two minutes, and the names of the cities as follows, Hamadán همدان, Sāwah ساوه, Rai ري, Kum قم, Túrshíz تورشيز, Bádghis بادغيس, Hirát هرات, Tún تون, Kirmánsháh كِرمانشاه, Dinawar دینوار, Mausil موصل, and Kashmír کشمیر. 4. The Azimuths above the earth. 5. The arcs of the unequal hours. 6. The arcs of the equal hours, from one to fourteen.

PLATE XIII. The reverse of the sixth tablet, on which are found, 1. The two diameters. 2. The three circles. 3. The Almucantars for an horizon of 33° of Latitude, with the hours of the longest day—fourteen hours twelve minutes, and the names Kandahár قندهار, Sistán سیستان, Shahrazúr شهرزور, Tabas طَبَس, Baghdád بغداد, Madāin مداین, Dimashk دمشق, and Bust بست. 4. The Azimuths traced below the earth *B b b b* (Plate xix. Fig. 10). 5. The arcs of the unequal hours.

PLATE XIV. The obverse of the seventh tablet, whereon we find, 1. The two diameters. 2. The three circles. 3. The Almucantars for an horizon of Latitude 37°, with the hours of the longest day—fourteen hours thirty-four minutes, and the names of the cities, Mashhad مشهد, Mazínán مزینان, Sarakhs سرخس, Astarábád استراباد, Jurján جرجان, Mārúhák ماروجاق, Bárfurúsh بارفروش, Rúdisar رودسر, Sári ساری, Fúman فومن, Láhiján لاهیجان, Damdam دمدم, Marághah مراغه, Zanján زنجان, and Abhar ابهر. 4. The Azimuths traced above the earth. 5. The arcs of the unequal hours.

PLATE XV. The reverse of the seventh tablet. This is the Safihah al-Áfakiyah الصَفِيحَةُ الْاَفَاقِيَّةُ, the tablet of the horizons. It is divided by the two diameters, and contains the three circles. About the diameters are traced a number of half horizons on the Eastern side, each cutting the equinoctial points, the diameters becoming by turns the Meridian Line, and that of the East and West. These half horizons commence at *A* (Plate xx. Fig. 16), immediately above the horizontal diameter, and to the right of the centre of the tablet as it stands; the first is of 6°, and they proceed by intervals of four and four upwards on the tablet to 66°, which last is just within the Tropic of Cancer. The intermediate half horizons commence and proceed in similar order from *B*, *C*, and *D*; those beginning at *B* being the horizons at intervals of four and four from 7° to 63°, at *C* from 8° to 64°, and at *D* from 9° to 65°. Thus every horizon from 6° to 66° is found on the tablet, each several arc being numbered at either end near the centre and the circumference of the tablet. The degrees of the obliquity of the Ecliptic from 1 to 23½ are inscribed on either side of the diameters proceeding from the Equinoctial circle to the Tropics of Cancer and Capricorn respectively; the former being those of the Northern, and the latter the Southern obliquity. These are severally denoted by the words ميل كُلي شمالي, total Northern obliquity, which are written at *NNNN*, and ميل كُلي جنوبي, total Southern obliquity at *SSSS*.

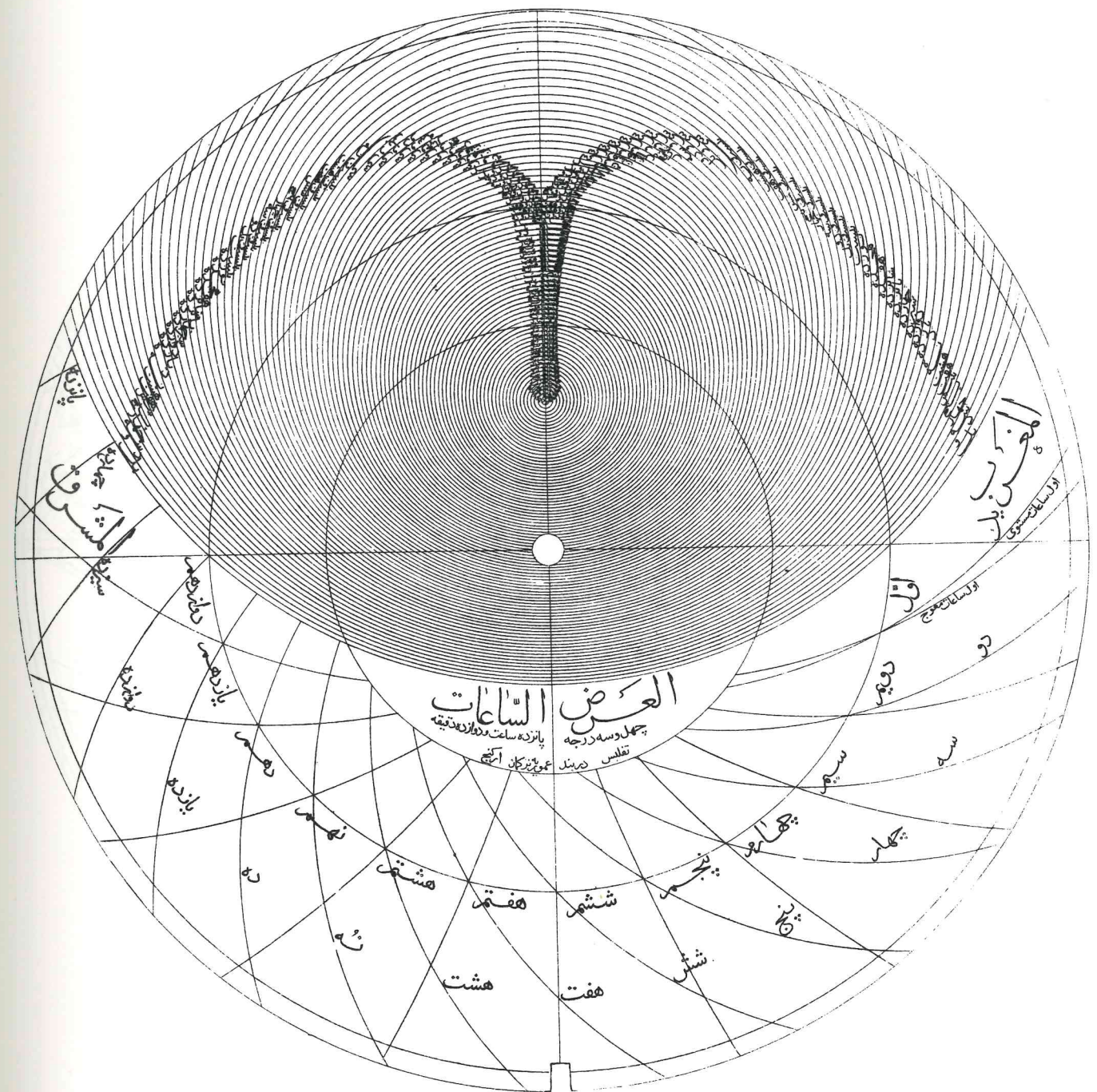
PLATE XVI. The 'Ankabút. The reticulation of this 'Ankabút is peculiarly elegant in form and delicate in workmanship; there is no 'Amúd to break the flowing of the lines, and the Shaziyahs of the stars are so contrived as not to interfere with the symmetry of the general design, but rather to add to its beauty. The Zodiacal circle *A B C D* (Plate xx. Fig. 21) is the only one left on the 'Ankabút. The signs of the Zodiac are inscribed thereon in the usual order, Capricorn being placed at the summit; and each sign is divided into thirty degrees, proceeding from right to left, and numbered by threes. At *A* is the Murí Rás al-Jadí. At the lowest portion of the outer rim, which is the Tropic of Capricorn, is the Mudir *M*. The Shaziyahs of the stars as they stand are as follows: they are numbered in the diagram, beginning from the top of the net work, and proceeding from right to left.

Within the Zodiacal circle—1. Rukbah-i Hawwá رُكْبَةُ حَوَّاءِ, the knee of the Snake Catcher ( $\mu$  Serpentis?).<sup>1</sup> 2. Marfak-i Hawwá مَرْفَقُ حَوَّاءِ, the elbow of the Snake Catcher ( $\lambda$  Serpentarii). 3. Rás-i Hawwá رَاسُ حَوَّاءِ, the head of the Snake Catcher (Ras alangue, Ras alhague,  $\alpha$  Serpentarii). 4. Zanab-i 'Ukáb ذَنْبُ عَقَابِ, the tail of the Eagle ( $\zeta$  Aquilæ). 5. This Shaziyah has been accidentally broken. 6. 'Unuk-i Hayyah عُنُقُ حَيَّةِ, the neck of the Serpent ( $\alpha$  Serpentis). 7. Mankib-i Játhí مَنْكِبُ جَاثِي, the shoulder of the Kneeler ( $\beta$  Herculis). 8. Rás-i Játhí رَاسُ جَاثِي, the head of the Kneeler (Ras algethi,  $\alpha$  Herculis). 9. Minkár-i Dajájah مَنْقَارُ دَجَاجَةِ, the beak of the Hen ( $\beta$  Cygni). 10. Nasr-i Táir نَسْرُ طَائِرِ, the flying Vulture (Althayr, Atair,  $\alpha$  Aquilæ). 11. Zanab-i Dulfín ذَنْبُ دَلْفِينِ, the tail of the Dolphin ( $\epsilon$  Delphini). 12. Fam-i Faras فَمُ فَرَسِ, the mouth of the Horse ( $\epsilon$  Pegasi). 13. Simák-i Rámih سِمَاكُ رَاْمِحِ, the supporter of the Spear-bearer (Alramech, Arcturus,  $\alpha$  Bootis). 14. Nayyir-i Fakkah نَيَّيرُ فَكَّةِ, the luminary of Fakkah (Munir, Malfecare, Elpheta, Alpheta,  $\alpha$  Coronæ Borealis). 15. Tarf-i 'Asá طَرَفُ عَصَا, the end of the staff ( $\mu$  or  $\beta$  Bootis?).<sup>2</sup> 16. Nasr-i Wáki نَسْرُ وَاكِعِ, the falling Vulture (Vega, Wega,  $\alpha$  Lyrae).

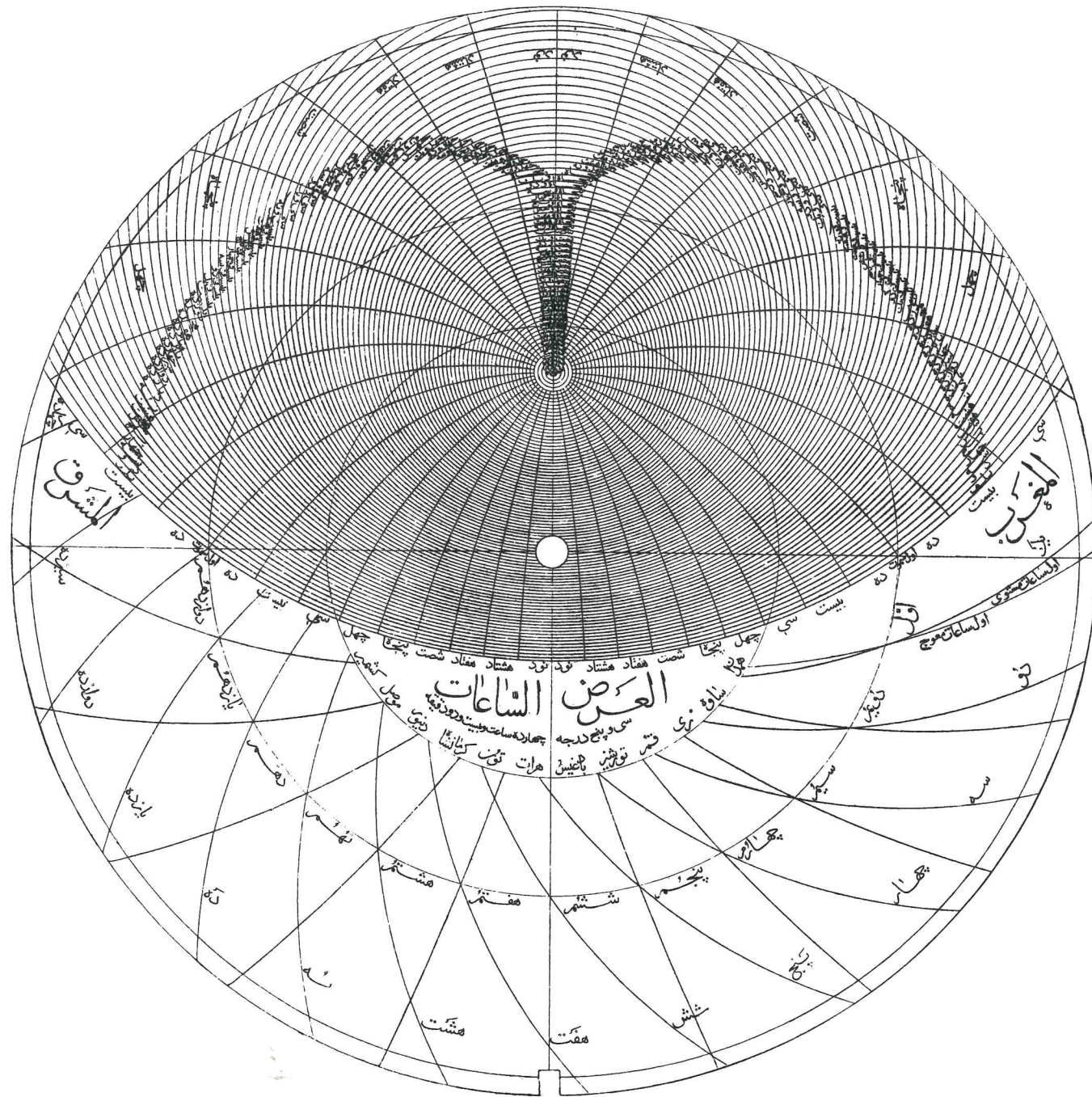
<sup>1</sup> I do not find this star mentioned either by Hyde, Tabulæ &c.; Von Hammer, Ueber die Sternbilder der Araber, in the Fundgruben des Orients, Vols. II. and III.; Ideler, Untersuchungen ueber den Ursprung und die Bedeutung der Sternnamen, 8vo., Berlin, 1809; Dorn, in the Transactions of the Royal Asiatic Society, Vol. II., 2d Part;

or L. A. Sédillot, Mémoire, &c. In this and other instances where the names are new to me I have added a ?, and have conjectured the star from its position on the 'Ankabút as compared with Argelander's Neue Uranometrie, Fol. obl., Berlin, 1843.

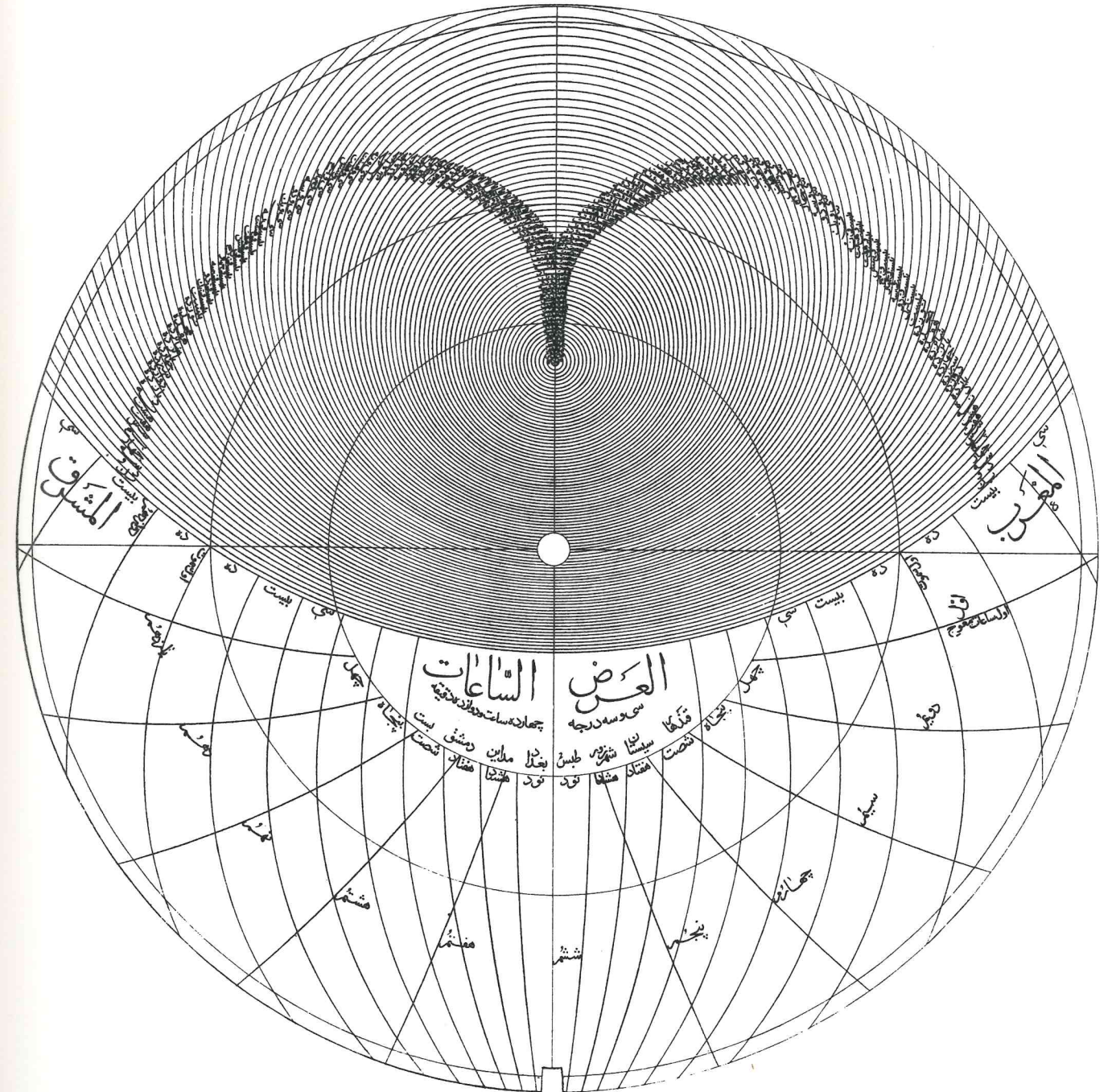
<sup>2</sup> The word 'Asá means a staff, and also an instrument used in taking altitudes.





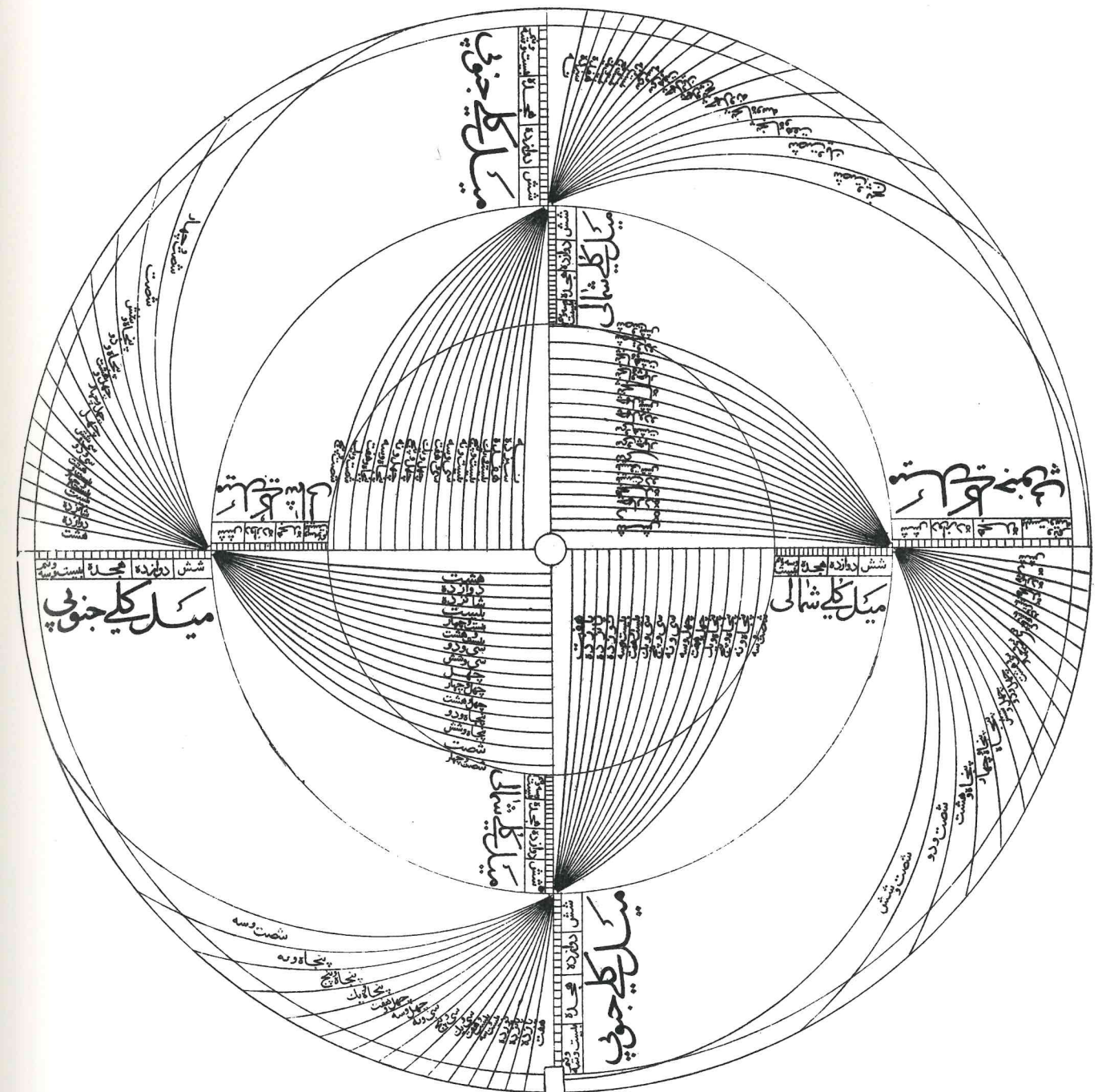
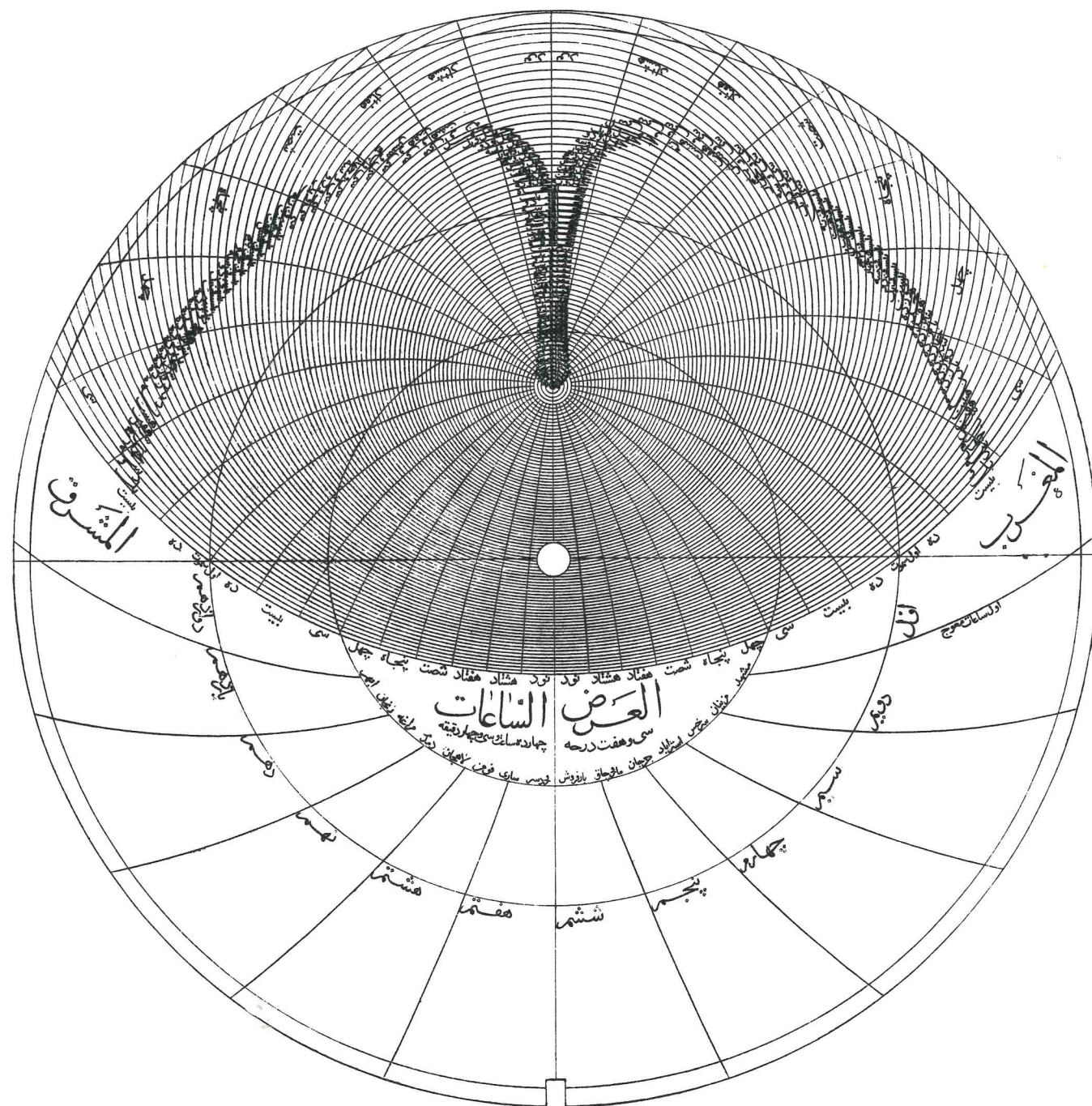


Reduced from 14 $\frac{3}{8}$  inches diameter

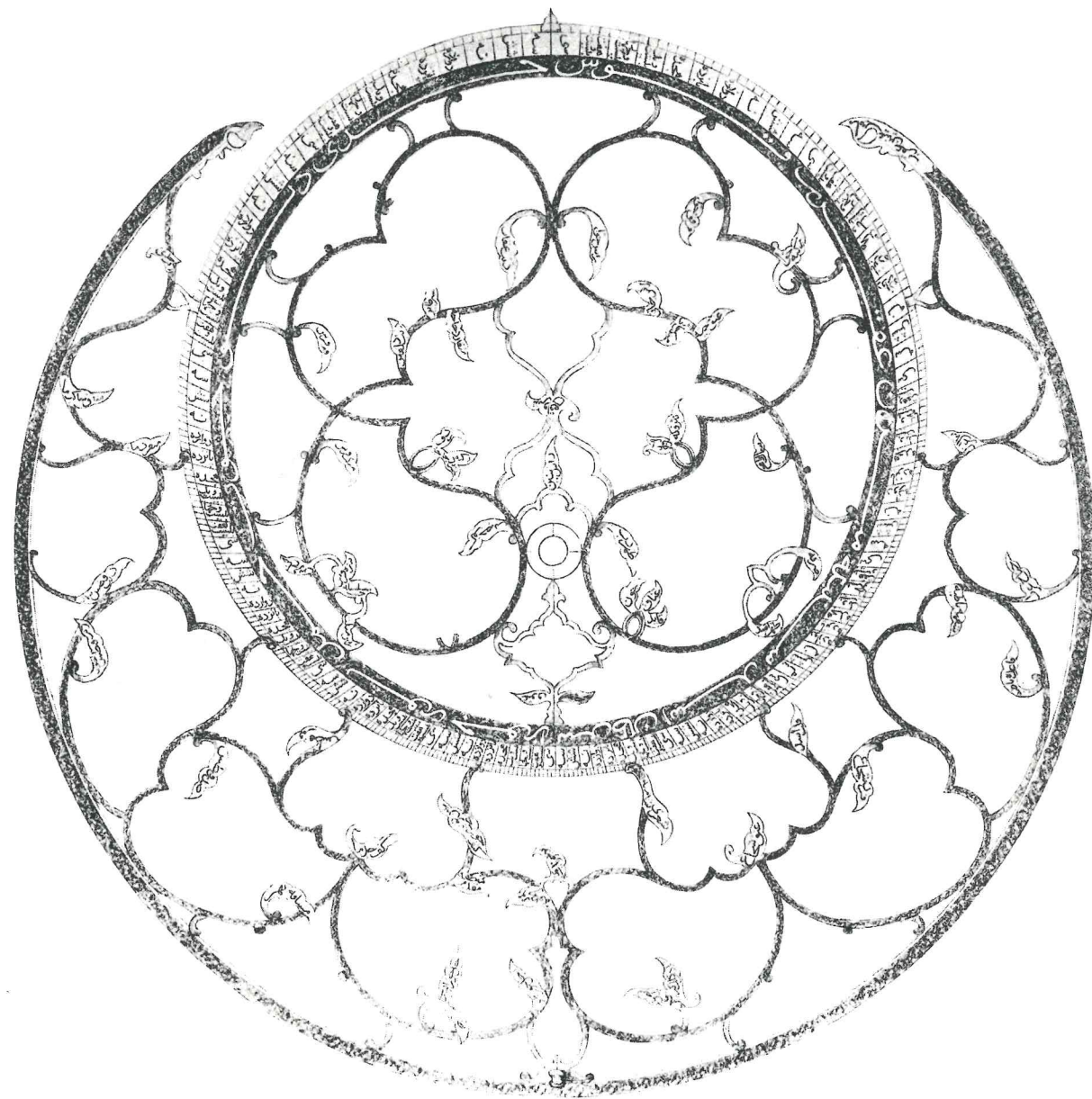


Reduced from 14 $\frac{3}{8}$  inches diameter







Reduced from 14 $\frac{5}{16}$  inches diameter

17. Rás-i Tinnín راس تينين, the head of the Dragon (Etanin,  $\gamma$  Draconis). 18. Rukbah-i Dajájah ركبہ دجاجہ, the elbow of the Hen ( $\omega$  Cygni). 19. 'Áshirah-i Dajájah عاشرہ دجاجہ, the outer feather of the Hen ( $\pi$  Cygni?). 20. Ridf ردف, the Follower (Aried, Arrioph,  $\alpha$  Cygni). 21. Mankib-i Faras منكب فرس, the shoulder of the Horse (Scheat alpheratz,  $\beta$  Pegasi). 22. Sarfah صرفہ, the Change ( $\beta$  Leonis). 23. Zahr-i Asad ظهر اسد, the back of the Lion ( $\delta$  Leonis). 24. Zahr-i Dubb ظهر دب, the back of the Bear (Dubhe, Edub,  $\alpha$  Ursæ Majoris). 25. Jaun جون, the White, (Alioth,  $\epsilon$  Ursæ Majoris). 26. 'Anák عناق, the Goat (Halcór,  $\zeta$  Ursæ Majoris). 27. Káid قائد, the Governor (Benenatz, Benetnasch,  $\eta$  Ursæ Majoris). 28. Kaff-i Khazib كفت حبيب, the stained Hand ( $\beta$  Cassiopeæ). 29 and 30. These Shazíyahs are unfortunately broken. 31. Rás-i Muthallath راس مثلث, the head of the Triangle ( $\alpha$  Trianguli). 32. Janb-i Musalsalah جنب مسلسلة, the side of the chained Woman (Mirach, Mirath, Mirar, Miraz,  $\beta$  Andromedæ). 33. Surrah-i Faras سرّہ فرس, the navel of the Horse (Alpherath,  $\delta$  Pegasi and  $\alpha$  Andromedæ). 34. Janáh-i Faras جناح فرس, the wing of the Horse (Algenib,  $\gamma$  Pegasi). 35. 'Ayyúk عيوق, the Kid (Capella,  $\alpha$  Aurigæ).

Outside the Zodiac—36. Má bain-i 'Ainain-i 'Akrah ما بين عينين عقرب, between the eyes of the Scorpion. I do not find any star in Scorpions named the 'Ain عين; this Shazíyah may perhaps point to  $\delta$  Scorpí, or to the intervening space between  $\beta$  and  $\delta$ . 37. Simák-i 'A'azal سمالك اعزل, the sustainer of the unarmed Man (Azimech, Spica Virginis,  $\alpha$  Virginis). 38. Janáh-i Ghuráb جناح غراب, the wing of the Crow (Algorab,  $\gamma$  Corvi). 39. Shafahah-i Batiyah شفه باطيه, the lip of the Cup ( $\delta$  Crateris). 40. Ká'idah-i Batiyah قاعدة باطيه, the base of the Cup ( $\beta$  Crateris). 41. Fard-i Shujá' فرد شجاع, the solitary one of the Serpent (Alphard, Cor Hydræ,  $\alpha$  Hydræ). 42. Kalb-i Asad قلب اسد, the heart of the Lion (Kalb Eleced, Regulus,  $\alpha$  Leonis). 43. 'Unuk-i Shujá' عنق شجاع, the neck of the Serpent ( $\delta$  Hydræ?). 44. Shi'ra-i Shamiyah شعريه شاميه, the Syrian Dogstar (Algomeisa, Procyon,  $\alpha$  Canis minoris). 45. Uzn-i Kalb-i Akbar اذن كلب اكبر, the ear of the greater Dog ( $\gamma$  Canis majoris). 46. Shi'ra-i Yamaniyah شعريه يمانيه, the Dogstar of Yaman (Alhabor', Sirius,  $\alpha$  Canis majoris). 47. Yad-i Jauzá-i Yumna يد جوزاء يمني, the right hand of Jauzá (Bed Algeuze,  $\alpha$  Orionis). 48. Muakhkhir-i Mintakah موخر منطقه, the hinder part of the Girdle ( $\zeta$  Orionis). 49. Rijl-i Jauzá-i Yumna رجل جوزاء يمني, the right foot of Jauzá ( $\alpha$  Orionis). 50. 'Ain-i Thaur عين ثور, the eye of the Bull (Aldebaran,  $\alpha$  Tauri). 51. Kitf-i Jauzá-i Yusra كتف جوزاء يسري, the left shoulder of Jauzá (Bellatrix,  $\gamma$  Orionis). 52. Mukaddam-i Mintakah مقدم منطقه, the fore part of the Girdle ( $\delta$  Orionis). 53. Rijl-i Jauzá-i Yusra رجل جوزاء يسري, the left foot of Jauzá (Rigel, Rigel Algeuze,  $\beta$  Orionis). 54. Batn-i Arnab بطن ارنب, the belly of the Hare ( $\alpha$  Leporis). 55. Kaff-i Jazmá كف جذماء, the amputated Hand (Menkar,  $\alpha$  Ceti). 56. Masáfah-i Nahr مسافه نهر, the interval of the River ( $\delta$ ,  $\epsilon$ ,  $\eta$ , or  $\zeta$  Eridani). 57. Fam-i Kítas فم قيطس, the mouth of the Whale ( $\gamma$  Ceti). 58. Sadr-i Kítas صدر قيطس, the breast of the Whale ( $\pi$  Ceti). 59. Zanab-i Kítas-i Janúbí ذنب قيطس جنوبي, the Southern tail of the Whale ( $\beta$  Ceti). 60. Zanab-i Kítas-i Shamálí ذنب قيطس شمالي, the Northern tail of the Whale (Deneb kaitoz,  $\epsilon$  Ceti). 61. Munfarid-i Má مفرد ماء, the solitary one of the Water ( $\lambda$  Aquarii). 62. Sák-i Sákib-i Má ساق ساكب ماء, the leg of the Waterpouer (Scheat,  $\delta$  Aquarii). 63. Zanab-i Jadí ذنب جدى, the tail of the Kid (Deneb Algedi,  $\delta$  Capricorni).

PLATE XVII. This is the back of the Astrolabe. The lines  $A B, E, W$  (Plate xxi. Fig. 25) are the two diameters.  $A B$ , the Khatt Wasat as-Samá, being produced through the Kursí to  $A'$ , and forming the Khatt al-'Ilákah. The small circle  $C$ , in the centre of the back, is the Mahan through which the Kutb passes.  $E A C$ , the upper of the four quadrants, formed by the two diameters  $A B, E W$ , is the Rub' al-Irtifá', or quadrant of Altitude. The band  $E A$ , forming its outer circumference and being the back of the Hajrah in the fourth of its whole extent, is the arc of Altitude, and is divided into ninety degrees, marked separately, but arranged and numbered by fives, commencing from  $E$ . Each degree is subdivided into four parts, severally comprising fifteen minutes. The interior of this quadrant is inscribed with a series of Mabsút sines, *i. e.* parallel with the cosine  $E C$ , proceeding from each degree of the arc of Altitude, and consequently dividing the whole sine  $A C$  into ninety unequal parts. The quadrant is therefore nonagesimal. The upper quadrant  $A C W$ , to the right of the perpendicular diameter, is the Rub' al-Gharbí al-Janúbí. The band at its outer circumference  $W A$  is divided into degrees and minutes, as in the outer arc of the Rub' al-Irtifá'. The surface of this quadrant is inscribed with the arcs of the parallels of the signs of the Zodiac, each sign being divided into six parts, and the names of the signs being written at either end of the parallels in the shaded spaces  $F D, H G$ , to the right of the upper half of the Khatt Wasat as-Samá, and above the Western portion of the horizontal diameter. The arcs  $f f f f f f$  which cut the parallels of the signs are those of mid-day at the Latitudes  $30^\circ, 32^\circ, 34^\circ, 36^\circ, 38^\circ$ , and  $40^\circ$ , the numbers being written at the top of the second band  $I K$  and over against each arc between  $I$  and  $L$ . On this second band in the shaded space  $L M$  are written the words *دوائر نصف النهار در عرضهاى كه مرقوم است*, the circles of Mid-day in the Latitudes that are

<sup>1</sup> This star is sometimes called Alyát الية, the Tail, whence this name.

<sup>2</sup> The Banát an-Na'ah بنات النعش, the daughters of the Bier, from which this name is derived, is a term which comprehends  $\alpha, \beta, \gamma, \delta, \epsilon, \zeta$ , and  $\eta$  Ursæ Majoris, and  $\alpha, \delta, \epsilon, \gamma, \beta, \eta$  and  $\zeta$  Ursæ Minoris.

<sup>3</sup> This star is sometimes called Mizár ميزار, or Izár ازار, the Trousers or Janb-i Marát جنب مرات, the side of the Woman, whence these corrupted names.

<sup>4</sup> This is clearly the Tam al-Kás الكاس of M. Sédillot, or as he conjectures the Fam al-Kás فم الكاس, the mouth of the cup.

<sup>5</sup> M. Sédillot gives this star as  $\alpha$  Crateris, but from its position it seems to be  $\beta$ .

<sup>6</sup> Sédillot makes the Fard and the 'Unuk of Hydra both the  $\alpha$ ; and see Hyde, Comment. p. 62.

<sup>7</sup> This star is sometimes called Shi'ra al-'Abúr الشعريه العبور, whence this name.

<sup>8</sup> The five stars in Taurus (the Hyades), but especially  $\alpha$ , are called Dabarán دبران, whence this name.

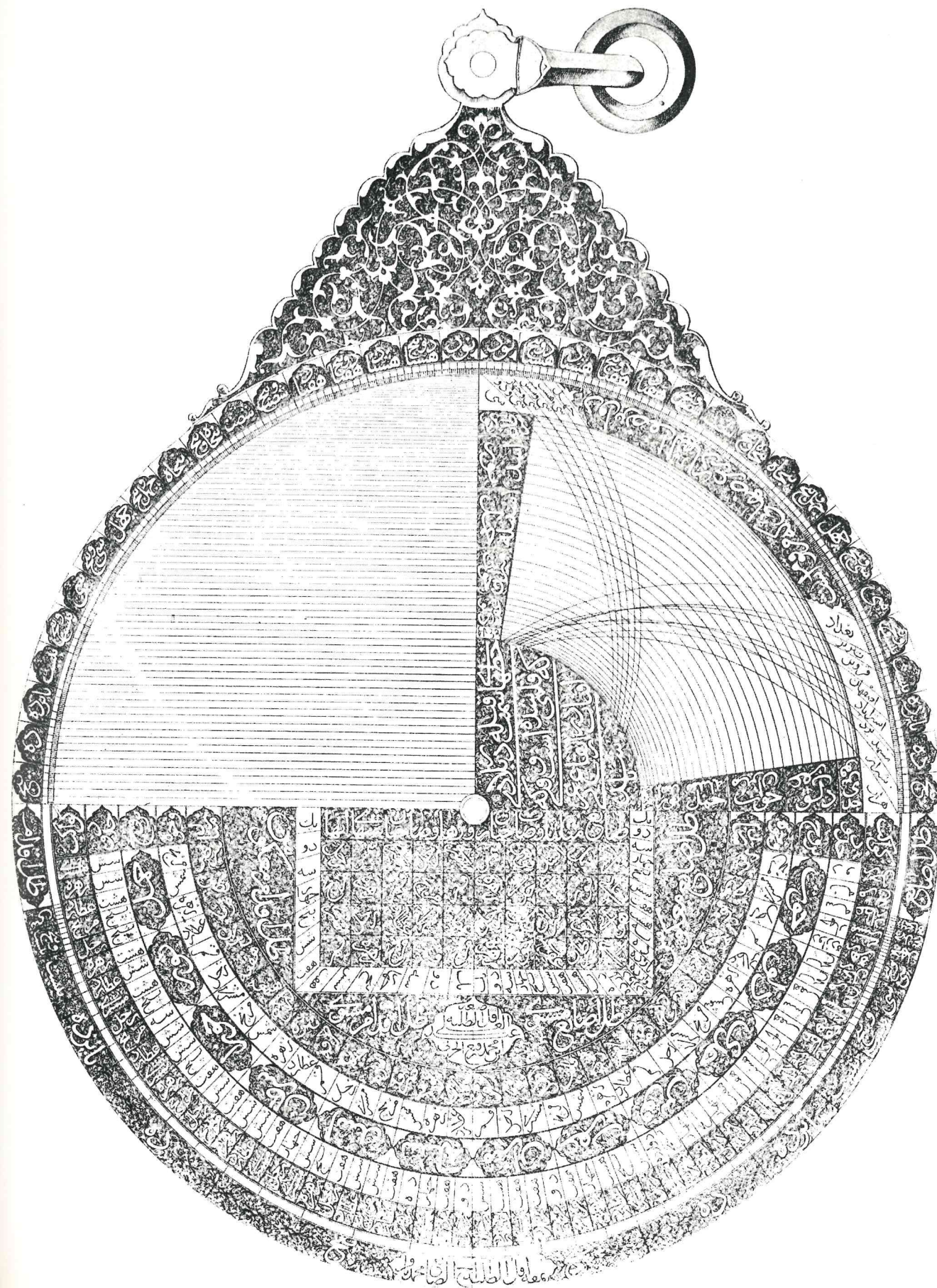
<sup>9</sup> Sed quare. See on the Sadr-i Kítas; Hyde, Comment. p. 49; and M. L. A. Sédillot, Mémoire, &c. p. 139, note 2.



written. The other arcs which cut the parallels of the signs are those of the Azimuth of the Kiblah, i.e. of the altitude of the Sun when it passes over the Azimuthal circle of the Kiblah, at the following places—Baghdád, Tabríz, Kazwín, Isfahán, Astarábád, Yazd, Mashhad, Shíráz, and Hirát. The names of these cities are respectively written under the end of each arc where it touches the outer band of the quadrant, at *g h i k l m n o p*. The small arc *F G*, the inmost of this quadrant, is that of the obliquity of the Ecliptic. In the shaded space *F C G*, bounded by it, are the words خطهای سمت قبله در بلادی که قلمی شده است وقتی که آفتاب در ارتفاع غربی باشد, the lines of the Azimuth of the Kiblah, at the cities the names of which are written, at the time when the Sun is in Western altitude. The lower quadrant on the left, the Rub' ash-Sharkí ash-Shamáli *B C E*, has on its first or outer band *B E*, which is the back of the Hajrah in that fourth of its circumference, the arc of the shadow of Feet, the degrees being marked separately, but arranged and numbered by fives, from five to thirty, and commencing from *B*. In the shaded space *g*, where this arc is bounded by the Eastern half of the horizontal diameter, are the words ظل اقدم, the shadow of Feet. The lower quadrant on the right, the Rub' al-Gharbí ash-Shamáli *B C W*, has marked upon its outer band, the back of that fourth of the Hajrah, the degrees of the shadow of Fingers, arranged and numbered by fives as before, from five to fifty, and commencing from *B*. In the shaded space *r* are the words ظل اصابع, shadow of fingers. The remainder of the bands in the lower quadrants are concentric with the boundary arcs of the shadow, and are semicircular, that is, continuous throughout both quadrants. They commence respectively from *a, b, c*, and *d*, and contain various astrological tables. The band *c c'*, the fourth from the outer circumference, is the principal of these, and has inscribed upon it the signs of the zodiac in the usual order, beginning with Aries immediately under *c*. At *c* and *c'* is the word Burúj, signs of the Zodiac, indicating the nature of the contents of the band. The second band, *a a'*, is entitled at either end Kawákib, كواكب, stars, and contains the names of the five planets arranged, five to each sign, in the order of their Terms or Limits: the order in which the planets occur, with reference to each sign, will be found designated by the usual conventional marks in the diagram. The third band has written upon it, at *b* and *b'*, the word Hudúd, حدود, limits, bounds, and comprises the numbers of the degrees of each sign, allotted as the Limits or Terms of the planets inscribed in the last-mentioned band; these numbers will be found expressed in figures in the diagram. The fifth band, *d d'*, exhibits the Faces of the planets, as is pointed out by the word Wujúh, وجوه, faces, written at *d* and *d'*: the planet, which has the priority in each Face, is indicated in the diagram by its appropriate mark. The sixth and inmost band has the word Manázil, منازل, mansions, written at *e* and *e'*, and contains the names of the twenty-eight Lunar Mansions, beginning from the left immediately under *e*. They are as follows—1. Sharatín, شرتین, the two signals, ( $\beta$  and  $\gamma$  Arietis). 2. Butáin, بطین, the little belly, ( $\delta$ ,  $\epsilon$ , and  $\epsilon_3$  Arietis). 3. Thurayyá, ثریا, the brilliant gem, (Pleiades). 4. Dabarán, دبران, the follower, (Hyades; particularly the brightest of them, Aldebaran,  $\alpha$  Tauri). 5. Hak'ah, هکعه, three bright stars in the head of Orion, ( $\lambda$ ,  $\phi_1$  and  $\phi_2$  Orionis). 6. Han'ah, هنة, a burnt mark in a camel's neck, ( $\gamma$  and  $\xi$  Geminorum). 7. Zirá', ذراع, the forearm, ( $\alpha$  and  $\beta$  Geminorum). 8. Nathrah, نثرة, the division between the mustachios and the nose in a lion, (Two small stars reckoned by the Arabs to be in the constellation Leo, but apparently  $\delta$  and  $\gamma$  Canceris).<sup>1</sup> 9. Tarfah, طرفه, a twinkle of the eye, ( $\xi$  Canceris, and  $\lambda$  Leonis). 10. Jabhah, جبهة, the forehead, ( $\alpha$ , [Regulus]  $\zeta$ ,  $\gamma$ , and  $\eta$  Leonis). 11. Zubrah, ذبرة, the hair of a lion's mane, ( $\delta$  and  $\theta$  Leonis). 12. Sarfah, صرفه, vicissitudes of fortune, ( $\beta$  Leonis). 13. 'Awwá, عواء, a barking dog, ( $\beta$ ,  $\eta$ ,  $\gamma$ ,  $\delta$ , and  $\epsilon$  Virginis).<sup>2</sup> 14. Simák, سمالك, the sustainer, (Spica Virginis,  $\alpha$  Virginis). 15. Ghafr, غفر, a sack, ( $\phi$ ,  $\iota$ , and  $\kappa$  Virginis). 16. Zubáná, زبانا, or, more correctly, Zubánayán, زبانیان, the two claws of a scorpion, ( $\alpha$  and  $\beta$  Libræ). 17. Iklíl, اكلیل, the crown, ( $\beta$ ,  $\delta$ , and  $\pi$  Scorpii). 18. Kalb, قلب, the heart, (Antares,  $\alpha$  Scorpii). 19. Shaulah, شولة, the tail of a scorpion, ( $\lambda$  and  $\nu$  Scorpii). 20. Na'áim, نعائم, the ostriches, ( $\gamma$ ,  $\delta$ ,  $\epsilon$ ,  $\zeta$ ,  $\eta$ ,  $\theta$ ,  $\iota$ ,  $\kappa$ ,  $\lambda$ ,  $\mu$ ,  $\nu$ , and  $\xi$  Sagittarii). 21. Baldah, بلدة, the city, (a starless space in the heavens between Na'áim and Zábih, the next following mansion: or perhaps Kiládah, قلادة, the necklace, formed by  $\xi$ ,  $\phi$ ,  $\pi$ ,  $d$ ,  $g$ , and  $\nu$  Sagittarii). 22. Zábih, ذابح, the Sacrificer, ( $\alpha$  and  $\beta$  Capricorni). 23. Bula', بلع, the glutton, ( $\mu$ ,  $\nu$ , and  $\epsilon$  Aquarii). 24. Su'úd, سعود, the fortunes, ( $\beta$  and  $\xi$  Aquarii). 25. Akhbiyah, اخبية, the tents, ( $\gamma$ ,  $\zeta$ ,  $\pi$ , and  $\eta$  Aquarii). 26. Mukaddam, مقدم, the foremost, ( $\alpha$  and  $\beta$  Pegasi). 27. Muakhkhir, موخر, the hindmost, ( $\gamma$  Pegasi, and  $\alpha$  Andromedæ). 28. Risha, رشا, the rope, ( $\beta$  Andromedæ). Within the semicircular space, inclosed by the band of the Lunar Mansions, and the horizontal diameter, is the square of the two shadows *N O P R Q*. In the first half, *N O P*, on the left of the perpendicular diameter, the degrees of the shadows are marked in feet, the division from *N* to *O* being the vertical shadow marked from one to seven, and designated by the words ظل اقدم معكوس, inverted shadow of feet, written in the shaded space *S*, and from *P* to *O*, the horizontal shadow similarly divided, and pointed out by the words ظل اقدم مستوی, level shadow of feet, inscribed in the space *T*. On the right hand of the perpendicular diameter we have, from *Q* to *R*, the vertical shadow measured in fingers, marked from one to twelve, and designated in the space *U* by the words ظل اصابع معكوس, inverted shadow of fingers, and from *P* to *R* the horizontal shadow similarly divided, and designated in the space *V* by the words ظل اصابع مستوی, level shadow of fingers. In the interior of the square of the shadows are five bands parallel with the horizontal diameter. The first of these bands, *XY*, has inscribed upon it the title of the rest, viz. طبائع مثلثات, the natures of the Triplicities, and the Lords of the days and the Lords of the nights thereof. The remaining

<sup>1</sup> Hamd Allah al-Musta'fi al-Kazwini says that they are in Cancer.

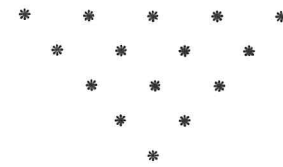
<sup>2</sup> Hamd Allah al-Musta'fi says that this mansion comprises four bright stars in the tail of the Lion, and that the Arabs call them dogs barking at the Lion.





four bands are each divided into ten equal parts. At  $s, t, u, v$ , the first divisions of each band, are written respectively the words Átishí **آتشي**, *fiery*, Kháki **خاكي**, *earthy*, Hawáii **هوائي**, *airy*, and Ábí **آبي**, *watery*, denoting the natures of the several Triplicities. The three divisions next in order in each band contain the names of the three signs forming the several respective Triplicities, and in the other six divisions in each band are inscribed the names of the planets having dominion by day and night in the Triplicities, over against which they are written. A reference to the diagram, where the signs and planets are indicated in their proper places by their usual conventional marks, will show at one glance the signs and planets as arranged in each Triplicity. In the clear space  $P$ , immediately under the centre of the square of the shadows, is the name of the constructor of the Astrolabe, recorded in the words **صنعه اقل الطلبة عبد العلي ابن محمد** *صنعه اقل الطلبة عبد العلي ابن محمد*, *constructed by the least of the students 'Abd al-'Alí, son of Muhammad Rafi' al-Juzi*.

Lastly, in the midst of the lower part of the outer circumference, or back of the Hajrah, in the clear space marked  $Z$  in the diagram, we find the name of the Caligraphist, and most probably the engraver of the beautiful specimens of writing and ornament with which this matchless astronomical instrument is covered. With modesty equal to that of his relative, the scientific maker, he inscribes at the foot of his work **نمقه اقل الطلبة اخ الصانع محمد باقر** *نمقه اقل الطلبة اخ الصانع محمد باقر*, *written by the least of the students, the brother of the constructor, Muhammad Bákir*.





A P P E N D I X, N°. I.

THE following is a short account of the various Astrolabes mentioned at page 5 of the text. The first on the list is interesting from its antiquity; few Muhammadan Astrolabes being of so early a date. The Hindú instruments are, I believe, the only ones of their kind that have been hitherto described, and the two English Astrolabes are especially remarkable on account of the extreme scarcity of early instruments of observation constructed in this country, and the beauty of their design and workmanship. In addition to these claims on our attention, the series will be found to exhibit several peculiarities and some projections of the sphere, which, until now, have remained entirely unknown to writers on the subject, or have only been imperfectly noticed.

I have classed the Eastern Astrolabes as Arabic, Persian, or Hindú, according as the inscriptions they present are in the Arabic, Persian, or Sanskrit languages, without reference to the places where they were constructed.

ARABIC.

A. A Sudsi, or Sexpartite Astrolabe, made of copper gilt, 3½ inches in diameter, procured by Professor Wilson at Benares. It is inscribed, partly in Kúfic,<sup>1</sup> and partly in Dévanágari characters, and was constructed in A. H. 669 (A.D. 1270-71). The suspensory apparatus is complete, the 'Ilákah alone being wanting. On the face of the Kursi is written, in Kúfic, سنة فصیح ملكشاهی, the year 193 Maliksháhí (Æra).<sup>2</sup> The degrees on the surface of the Hajrah, three hundred and sixty in number, are divided and arranged by fives, commencing from the top of the perpendicular diameter, proceeding from left to right, and designated by Kúfic letters numerically employed. The numbering exhibits the peculiarity that the letter 5, occupies by itself every alternate division, e.g. 5, 10, 5, 20, &c., to 5, 100; thence 5, 10, 5, &c., to 5, 200; thence 5, 10, &c., to 5, 300; and, lastly, thence 5, 10, &c., to 5, 60, i.e. 360° in all. Inscribed on the face of the Umm is the following table of the names of Indian cities with their Latitudes, written in the Dévanágari character.

<sup>1</sup> Kúfic inscriptions, as is well known, are always difficult to be read, on account of the peculiar nature of the character, and the systematic absence of the diacritical points, which alone, in many instances, serve to distinguish one Arabic letter from another; it is, indeed, frequently necessary to know what to expect before any clue can be gained to their decipherment. In this Astrolabe the inscriptions are more than usually obscure, as, in addition to the ordinary difficulties, they have been very much effaced by the injuries of time and use. At every unconnected point or protuberance in each letter, e.g. the top and bottom of an Alif, and the summits of the teeth of a Sin, there is, however, a wedge-shaped mark, apparently produced by percussion, which, having penetrated more deeply into the metal than the intervening lines cut with the graver, still remains in several places where the latter have become quite obliterated by friction: by means of these marks I have been enabled to reconstruct, as it were, the inscriptions with certainty.

<sup>2</sup> The Maliksháhí æra was instituted in Persia, in reformation of the Yazdajirdí (see *supra*, p. 3, note 1), by Sultán Jalál al-Daulah Malik Sháh Ben Alp Arslán, the third of

the Saljúkí kings. It is sometimes termed the Jalálí æra, from the title bestowed upon its founder by the Khalifah Al-Káim. There is some difference of opinion as to the precise period when this æra commenced, but according to that most generally received, it began on the 10th of Ramazán, A.H. 471 (15th March, A.D. 1079). The year was solar, and of 365 days, with an additional day whenever it appeared necessary to postpone the commencement of the following year, that it might occur on the day of the sun's passing the same degree of the ecliptic. See Gravius, Epochæ celebriores, p. 38, and the comparative table at the end. Hyde, Veterum Persarum religionis historia, p. 206. L'Art de vérifier les dates, Tome I. p. xli. 3me édit. Fol. Paris, 1783. Delambre, Histoire de l'Astronomie moderne, 2 Tomes, 4to. Paris, 1821. Tome i, pp. 75 *et seq.* Prinsep's Useful Tables, Part ii. p. 12. Vullers, Mirchond's Geschichte der Seldschuken, 8vo. Giessen, 1838, p. 105, note 8. L. A. Sédillot, Prolégomènes, &c. Texte p. 25, note 2. Ib. Traduction, p. 27, *et seq.*

	Degrees.	Minutes.
Dillí दिल्ली . . . . .	28	39
Ágrá आगरा . . . . .	26	43
Multán मुल्ता . . . . .	29	40
Kábul काबुल . . . . .	33	45
Ajmér अजमेर . . . . .	26	—
Ahmadábád अहमदाबाद . . . . .	23	—
Bijápúr बीजापुर . . . . .	16	20
Bháganagar भागनगर . . . . .	19	20
Siraunj सिरौज . . . . .	24	10
Buhránpur बुहानपुर . . . . .	20	40
Ujjén उज्जैन: . . . . .	22	20
Láhór लाहोर . . . . .	31	50

This table is evidently more modern than the Kúfic inscriptions. A small peg projects from the lower part of the face of the Umm, at a little distance from the Hajrah: it is the Mumsikah for retaining the tablets in their proper position. There are but two tablets in the Umm, but from the depth of the recess it would seem that there were originally at least two more. The first bears on one side a projection of the sphere constructed for a Latitude of 36°, and comprises the two diameters; the three circles; the Almucantars, traced and numbered six and six; and the arcs of the unequal and equal hours, the former being numbered, and the latter distinguished by being dotted. Under the first Almucantar, in their usual places, are the words "East" and "West," and, in the middle, the words "Latitude 36°," and "Hours 14 hrs. 30 min." The Azimuths are not traced. The other side of this tablet is precisely similar, except that it is constructed for a place of Latitude 37° and Hours 14 hrs. 33 min. All the characters on this tablet are Kúfic. The second tablet has a double projection of the sphere on either side, exhibiting the two diameters; the three circles; the Almucantars, traced six and six, the first, sixth, and eleventh being dotted; the first Azimuth, or prime vertical, drawn both above and below the earth; and the arcs of the unequal hours. The projections on one side are constructed for the respective Latitudes of 30° and 24°, and on the other for Latitudes 32° and 27°. In the projection for Latitude 32° the prime vertical is omitted. Dévanágari numerals, denoting these Latitudes, are placed under the eastern ends of the oblique horizons, or first Almucantars, and are the only written characters on this tablet. I have already described it in the text,<sup>1</sup> and have given a drawing of one side of the tablet at Fig. 12\* of Plate xix.

A hole is pierced through the lower part of each of the tablets to receive the Mumsikah. The 'Ankabút has no peculiarity, except that the Mudír is situated at the left end of a segment of the equinoctial, which has not been cut away in its lower portion. It presents the Zodiacal circle and the signs, each divided into six parts, the Tropic of Capricorn, and twenty-two Shazíyahs of the stars, besides the Murí Rás al-Jadí. The Shazíyahs of the stars bear the following names or abbreviations of names, written in the Kúfic character: they are much effaced. Within the Zodiac— 1. Al-Hawwá الحواء (Ras alangue, Ras alhague, α Serpentarii). 2 The inscription on this Shazíyah is obliterated, but from its position it should bear the name At-Táir الطائر<sup>2</sup> (Althayr, α Aquilæ). 3. Ar-rámih الرامح (Arcturus, α Bootis). 4. Al-'Anák العناني (Halcór, ζ Ursæ Majoris). 5. Al-Fakkah الفكّة (Munir, Malfecar, Alpheta, α Coronæ Borealis). 6. Al-Wáki' الواقع (Vega, α Lyræ). 7. Ar-Ridf الردف (Arided, α Cygni). 8. Kaff al-Khazib كَفّ الخَضِيب (β Cassiopeie). 9. Al-Faras الفرس (Scheat Alpheratz, β Pegasi). 10. Al-Kafzah القفزة, the leap (λ and μ Ursæ Majoris).<sup>3</sup> 11. Al-'Ayyúk العيُوق (Capella, α Aurigæ). Outside the Zodiac—12. Kalb al-'Akraab قلب العقرب, the heart of the Scorpion, (Antares, α Scorpii). 13. Al-A'azal الاعزل (Azimech, Spica Virginis, α Virginis). 14. F ash-Sh ف الش for Fard ash-Shujá' فرد الشجاع (Alphard, Cor Hydræ, α Hydræ). 15. Kalb al-Asad قلب الاسد (Regulus, α Leonis). 16. Ash-Shámíyah الشامية (Algemeisa, Procyon, α Canis Minoris). 17. Al-Yamáníyah اليمانية (Alhabor, Sirius, α Canis Majoris). 18. Yad al-Jauzá يد الجوزا (Bed Algeuze, α Orionis). 19. Ar-Rijl الرجل (Rigel, β Orionis). 20. 'Ain ath-Thaur عين الثور (Aldebaran, α Tauri). 21. Az-Zalím الظالم, the male Ostrich, (Fomalhaut,<sup>4</sup> α Piscis Australis). 22. Kítas قيطس (Deneb kaitoz, ι Ceti).

<sup>1</sup> *Supra*, p. 13. <sup>2</sup> I have omitted the translations of those star-names which have already been explained in the description of Shah Husain's Astrolabe. <sup>3</sup> Sed quare. This name is very doubtfully written. The three Kafzahs, or Kafazát az-Zibáa قفزات الظباء, the leaps of the wild bucks, are the six stars in the feet of the great Bear (ν and ξ, λ and μ, and ι and κ Ursæ Majoris). See Ideler, Untersuchungen &c., pp. 20 and 26. The Shazíyah in question seems from its position to be the same with that marked Rijl ad-Dubb رجل الدب, the foot of the Bear, in No. I. of the East-India House, and marked 10 in Fig. 24 of Plate xx. <sup>4</sup> This word is derived from the Arabic Fam al-Hút al-Janúbى الجنوبية, the mouth of the Southern fish, by which name this star is sometimes designated: it is common to Piscis Australis, and Aquarius.



The inscriptions on the back of this Astrolabe are all in Kúfic, and in addition to the difficulty and uncertainty inseparable from that species of writing, they are so worn away by use as to be almost illegible, and in several places quite obliterated.

On the back of the Kursí is written *اسكندر رومية* *سنة 640* (the year 640 of the Yazdajirdiyah<sup>1</sup> (Æra), 1582 of the Iskandar Rûmîyah<sup>2</sup> (Æra). The two upper quadrants bear on their outer circumferences the degrees of altitude, numbered from 5 to 90, commencing at either end of the horizontal diameter, the same method of numbering, viz. 5, 10, 5, 20, &c., being adopted as on the face of the Hajrah. The interiors of both quadrants seem to have been originally occupied, as I have mentioned in the text, by a nonagesimal series of cosines of altitude, produced through both quadrants, and uniting the corresponding degrees of their boundary arcs.<sup>3</sup> In the left hand quadrant, however, this arrangement has been superseded by a more modern sexagesimal division of the whole sine by horizontal parallels, each fourth parallel only being traced. In the quadrant on the right hand the nonagesimal form is distinctly perceivable, although in several parts the lines have quite disappeared. In the band which forms the outer circumference of the lower left hand quadrant and is the back of the Hajrah in that fourth of its circumference, are the words *سنة خسط هجرية*, *Constructed by Mahmûd Ben 'Alî Ben Yûsha' Al-'\*ri, in the year 669 Hijriyah* (Æra) (inc. 20th August, A.D. 1270). On the corresponding band which forms the back of the Hajrah in the lower quadrant on the right, are inscribed the degrees of the arc of the shadow of fingers by fives, marked as before 5, 10, 5, 20, and so on to 40, 5. At that point, under the horizontal diameter, are the words *ظل الاصابع*, *shadow of the fingers*.

Across the midst of the two lower quadrants is the following inscription—*برسم خزانة الصدر المعظم صاحب الاعظم المريد العالم العادل ملك الامرا خسرو الآفاق بهاء الدولة والدين شمس الاسلام والمسلمين غياث الملوك والخواصين الحسن بن علي التّديد اعز الله انصاره وضاعف جلالة* *For the Museum of the Honoured Prime Minister, the Supreme lord, the Assisted (by God), the Wise, the Just, the King of the Amirs, the Khusrú of the quarters of the World, the Splendour of the State, and of the Faith, the Sun of the Islám and of Muslims, the Succour of princes and lords, Al-Hasan Ben 'Alî Ash-Shadîd: may God glorify his friends, and double his dignity.* I have been unable to identify with certainty the personage above mentioned. The æras written upon the Astrolabe might lead us to suppose that he was either a Persian or a Syrian, but Abáká Khán reigned both in Persia and in Syria at the date of its construction, and his prime minister was the Khwájah Shams ad-Dín Muhammad: besides this the use of the æras is not in any way conclusive, since eastern astronomers frequently employ several to express one date, without reference to the countries in which they lived or wrote. The title, Sadr al-Mu'azzam, makes it almost certain that the owner of the instrument was a prime minister, and if in conjunction with this be put the title of Malik al-Umará, "King of the Amirs," a title conferred by the sovereigns of Egypt on their principal Náibs,<sup>4</sup> it may perhaps be safely inferred that he was the Sáhib Bahá ad-Dín Abú al-Hasan 'Alî Ben Muhammad Ben Salím Ben Hinna, who was the chief Wazír of the Sultan Bîbars, and who died in A.H. 677<sup>5</sup> (A.D. 1278).

The 'Izadah, Kutb, and Faras of this instrument are of modern workmanship. The Libnahs of the 'Izadah are each pierced with two holes, the larger being at the top; and the 'Izadah itself is marked with divisions corresponding with the modern sexagesimal arrangement of the cosines in the Rub' al-Irtifá', or left upper quadrant.

B. This Astrolabe, which I have called in the text No. I. of the East-India House, is a Thulthí instrument, constructed for only one Latitude, and is inscribed in an ornamental Kúfic character. It is made of brass, is 8½ inches in diameter, and evidently of modern date. The suspensory apparatus is complete, with the exception of the 'Ilákah. The 'Urwah is somewhat different in form from that usually found, comprising an extra piece or swivel, which enables the instrument to have a complete rotatory motion on a perpendicular axis. A drawing of the suspensory apparatus is given at Fig. 3 of Plate xviii. The Hajrah and Umm are in one plane, the entire body of the Astrolabe being composed of a single plate, about twice the thickness of the tablets in ordinary instruments of the same size. The face of the Hajrah is divided into 360 degrees, which are numbered throughout the circle by letters, one to each 5 degrees, commencing afresh 5, 10, 15, &c., at the end of each hundred. The Umm has marked upon it—The two diameters; the three circles; the Almucantars, traced and numbered three and three, the words East and West, and the Latitude 34° being written under the oblique horizon; the Azimuths drawn above the earth, but not numbered; the arcs of the unequal hours, numbered from one to twelve; together with the lines of twilight and dawn, of the Zuhr, the 'Asr, and the Zawál, all of which are marked by dotted lines. On the back of the Kursí are the words *الحمد لله*

<sup>1</sup> For the Yazdajirdi Æra, see *supra*, p. 3, note 1., and l'Art de Vérifier les Dates, Tome i. p. xli.

<sup>2</sup> This æra is also sometimes called simply the Rûmî *رومي*, *Grecian*, and more properly the Suryání *سورياني*, *Syrian*. It derives the first name from its being erroneously supposed to commence from the death of Alexander the Great (Iskandar Rûmî). It is most generally known with us as the Grecian Æra, or Æra of the Seleucides. It dates from the reign of Seleucus Nicator, 311 years and three, or, according to some authors, four months before Christ. The year was solar, and consisted of 365 days, with the addition of a day every fourth year. See Gravius, *Epochæ Celebriores*, p. 18, and in

the table at the end. Prinsep's *Useful Tables*, Part ii. p. 11. J. J. Sédillot, *Traité des instruments astronomiques des Arabes*, Tome i. p. 89. L. A. Sédillot, *Prolégomènes*, &c. Trad. p. 15. L'Art de Vérifier les Dates, Tome i. p. xvii.

<sup>3</sup> See *supra*, p. 18.

<sup>4</sup> See the *Histoire des Sultans Mamlouks de l'Égypte*, écrite en Arabe par Taki-éddin-Ahmed-Makrizi, traduite en Français par M. Quatremère. 4to. Paris, 1840. Tome i., 2<sup>me</sup> Partie, p. 94, note.

<sup>5</sup> Quatremère, *Histoire des Sultans Mamlouks*, Tome i., 2<sup>me</sup> Partie, p. 167.

for *الحمد لله*, *Praise be to God*. The inscriptions on the back of this Astrolabe are ranged in ten circular bands, two of which are excentric, the remainder having a common centre, which is that of the instrument. The first and outermost band is divided into degrees, arranged and numbered by fives, each quadrant containing 90 degrees, commencing above and below either end of the horizontal diameter. The second band contains the degrees of the signs of the Zodiac, marked five and five, thirty to each sign. The third band is the Zodiacal circle, the head of Cancer being at the summit. The fourth band is excentric, touching the Zodiac at the top, and bears a division for the 365 days of the Roman year, arranged and numbered by fives, thirty to each month; those months which have thirty-one days have an additional division added at the end. The fifth band, the second excentric, has inscribed upon it the names of the Roman months. The inner five bands are traversed by radii, proceeding from their common centre, and forming a table, the title of which is written between the perpendicular diameter, and the first radius to the right of it as follows—*جدول الظل والارتفاع*, *table of the shadow and altitude*. The outer band of these five bears upon it the Daraj al-Irtifá' *درج الارتفاع*, *degrees of altitude*; the second the Asábi' az-Zill *اصابع الظل*, *fingers of the shadow*, corresponding with each degree of altitude; the third the Dakáik *دقائق*, *minutes (thereof)*; the fourth the Akdám az-Zill *اقدام الظل*, *feet of the shadow*, corresponding with each degree of altitude; and the fifth and last the Dakáik *دقائق*, *minutes (thereof)*. These latter titles are placed between the second and third rays to the right, counting from the meridian line; the numbers proceed in the same direction, i.e. from left to right. The following is a transcription of the whole. The shadow measured is the Zill-i Mustawí, horizontal, or right shadow (Umbra recta).

Degrees of Altitude.	Fingers of Shadow.	Minutes thereof.	Feet of Shadow.	Minutes thereof.	Degrees of Latitude.	Fingers of Shadow.	Minutes thereof.	Feet of Shadow.	Minutes thereof.
1	687	36	351	54	33	18	28	10	15
2	383	39	190	55	34	17	47	9	53
3	228	59	127	13	35	17	8	9	31
4	171	36	95	20	36	16	31	9	10
5	137	9	76	12	37	15	55	8	51
6	114	10	93	25	38	15	21	8	32
7	97	44	54	18	39	14	49	8	14
8	85	23	47	26	40	14	18	7	57
9	77	46	42	5	41	13	48	7	40
10	68	3	37	48	42	13	19	7	24
11	61	44	34	18	43	12	52	7	9
12	56	27	31	22	44	12	25	6	54
13	51	59	48	13	45	12	0	6	40
14	48	9	26	45	46	11	35	6	26
15	44	47	24	53	47	11	11	6	13
16	41	51	22	15	48	10	48	6	0
17	39	15	21	48	49	10	26	5	48
18	36	56	20	31	50	10	4	5	35
19	34	51	19	22	51	9	43	5	24
20	32	58	18	16	52	9	22	5	12
21	31	16	17	22	53	9	2	5	1
22	29	42	16	30	54	8	43	4	51
23	28	16	15	42	55	8	25	4	40
24	26	57	14	58	56	8	5	4	29
25	25	44	14	18	57	7	47	4	19
26	24	36	13	40	58	7	30	4	10
27	23	33	13	5	59	7	12	4	0
28	22	34	12	32	60	6	56	3	51
29	21	38	12	1	61	6	39	3	42
30	20	47	11	33	62	6	23	3	33
31	19	58	11	5	63	6	6	3	23
32	19	12	10	40	64	5	51	3	15



Degrees of Altitude.	Fingers of Shadow.	Minutes thereof.	Feet of Shadow.	Minutes thereof.	Degrees of Altitude.	Fingers of Shadow.	Minutes thereof.	Feet of Shadow.	Minutes thereof.
65	5	36	3	7	78	2	33	1	25
66	5	21	2	58	79	2	20	1	18
67	5	6	2	50	80	2	7	1	10
68	4	51	2	42	81	1	54	1	3
69	4	36	2	33	82	1	41	0	56
70	4	22	2	25	83	1	28	0	49
71	4	8	2	17	84	1	16	0	42
72	3	54	2	10	85	1	3	0	35
73	3	40	2	2	86	0	50	0	28
74	3	26	1	54	87	0	38	0	21
75	3	13	1	47	88	0	25	0	14
76	2	59	1	39	89	0	13	0	7
77	2	46	1	32	90	0	0	0	0

The 'Ankabūt of this Astrolabe is represented at Fig. 24 of Plate xx. As has been already mentioned, the only portions not cut away are the Zodiacal circle, with the signs written thereon, each divided into 15 parts every one of which represents two degrees; the 'Amūd Rās al-Hamal wa al-Mizān *G H*; and a segment of the lower part of the equinoctial *I K L*; together with the Shaziyahs of the stars projecting from these, and the Murī Rās al-Jadī. The names of the stars are not inscribed, as is generally the case, on the Shaziyahs themselves, but at the foot or root of each. The pointers are numbered in the diagram, and contain the following names—

Within the Zodiac—1. Rās al-Hawwā *راس الحواء* (Ras al-hague,  $\alpha$  Serpentarii). 2. 'Unuk al-Hayyah *عنق الحية* ( $\alpha$  Serpentis). 3. At-Tāir *الطائر* (Althayr,  $\alpha$  Aquilæ). 4. Ad-Dulfin *الدلفين* ( $\delta$  Delphini). 5. As-Simāk ar-Rāmiḥ *السماك الرامح* (Alramech, Arcturus,  $\alpha$  Bootis). 6. Al-Fakkah *الفكة* (Munir, Alpheta, Malfecar,  $\alpha$  Coronæ Borealis). 7. Al-Wāki' *الواقع* (Vega,  $\alpha$  Lyræ). 8. Ar-Ridf *الردف* (Arided, Arrioph,  $\alpha$  Cygni). 9. Mankib al-Faras *منكب الفرس* (Scheat alpheratz,  $\beta$  Pegasi). 10. Rijl ad-Dubb *رجل الدب*, the foot of the Bear, ( $\lambda$  or  $\mu$  Ursæ Majoris). 11. Yad ad-Dubb *يد الدب*, the paw of the Bear, ( $\iota$  or  $\kappa$  Ursæ Majoris?). 12. Al-'Ayyūk *العيتوق* (Capella,  $\alpha$  Aurigæ). 13. Rās al-Ghūl *راس الغول*, the head of the Ghūl, (Algol,  $\beta$  Persei).

Outside the Zodiac—14. Al-Ghumaisā *الغيميسا*, the lesser Dog-star, (Algomeisa, Procyon,  $\alpha$  Canis Minoris). 15. Mankib al-Jauzá *منكب الجوزاء*, the shoulder of Jauzá, (Bed Algeuze,  $\alpha$  Orionis). 16. Ad-Dabarān *الدبران* (Aldebaran,  $\alpha$  Tauri).

The Mudīr of the 'Ankabut is under the Murī Rās al-Jadī, at the top of the Zodiac at *M*.

The 'Izādah of this Astrolabe is of the inverted kind in which the arms are interchanged, the half of the breadth of the 'Izādah being removed in each half of its length on the opposite sides of the longitudinal diameter, or Linea Fiduciæ; the Libnahs have but one hole in each. This 'Izādah will be found represented at Fig. 42 of Plate xxi., with the Kutb passing through its centre: a drawing of the Faras is given at Fig. 49 of the same Plate.

*C* Is a Thulthī or tripartite instrument in the British Museum, made of brass, measuring 6½ inches in diameter, and inscribed in an ornamental Kūfic character. The style of the workmanship and of the handwriting is very similar to that observable in the last-mentioned Astrolabe, and shows that it is of recent date.<sup>1</sup> It comprises three tablets. The suspensory apparatus is complete and unadorned, the 'Ilākah being, however, wanting. The face of the Hajrah is divided into 360 degrees, commencing on the left of the Khatt al-'Ilākah, and arranged and numbered five and five continuously. There is a cavity at the top of the Hajrah for the reception of the Mumsikahs, which in this instance are denticles at the summits of the tablets. In the Umm is a projection of the sphere for a Latitude of 66°: it has the two diameters; the three circles; the Almucantars traced six and six, the first coinciding with the zodiacal circle when Capricorn is at the top of the instrument; and the prime vertical traced above the earth. The inscriptions on the tablets are as follows, differing from each other only in Latitude:—the two diameters; the three circles; the Almucantars traced and numbered three and three, the 7th, 11th, 16th, and 21st, being dotted, and the second Almucantar only partially traced in order to leave room for the numbers of the Azimuths which are written along the oblique horizon; the words East and West, and the Latitudes, are written in their usual places under the horizon: the Azimuths, drawn and numbered ten and ten above the earth, the prime vertical being dotted; the arcs of the unequal hours; and the lines of the 'Asr, Zuhr,

<sup>1</sup> See *supra*, p. 20.

<sup>2</sup> Coupled with the remark of Danti, quoted at p. 6, note 8, and the use of the Roman months, it may be hazarded as a conjecture that this and the last-mentioned Astrolabe,

together with that of Marcel, were constructed for European use. The Kūfic inscriptions on the latter are evidently *not ancient*; and as the original instrument is lost, it is scarcely more than a surmise to state that it is as old as the thirteenth century of our æra.

and Zawāl, distinguished by being dotted, and by their respective names being written against them. The Latitudes are written as follows:—1. Obv. لكل موضع عرضه كذل *for every place the Latitude of which is 25° 30'*. Rev. لكل موضع عرضه كام *for every place the Latitude of which is 21° 40'*. 2. Obv. لكل بلد عرضه ل *for every city the Latitude of which is 30°*. Rev. لكل بلد عرضه لال *for every city the Latitude of which is 31° 30'*. 3. Obv. لعرض فاس *for the Latitude of Fās (Fez)*. Rev. لكل بلد عرضه له *for every city the Latitude of which is 35°*. Each tablet has a Mumsikah, or denticle, at its summit to fit into the cavity in the Hajrah. The 'Ankabūt has the Zodiac with the signs, each divided into five parts containing six degrees, and numbered by sixes, and the Murī Rās al-Jadī at the top; a segment of the lower part of the Equinoctial; the tropic of Capricorn; the 'Amūd Rās al-Hamal wa al-Mizān, and some other 'Amūds. It bears no less than four Mudīrs, one at the top, between the signs Sagittarius and Capricorn, one at each end of the horizontal 'Amūd, and the fourth in the centre of the segment of the Equinoctial. The Shaziyahs of the stars are inscribed as follows:—

Within the Zodiac—1. Rās al-Hawwā *راس الحواء* (Ras al-hague,  $\alpha$  Serpentarii). 2. 'Unuk al-Hayyah *عنق الحية* ( $\alpha$  Serpentis). 3. Tāir *طائر* (Althayr,  $\alpha$  Aquilæ). 4. Ka'b Faras *كعب فرس*, the ankle of the horse, ( $\kappa$  or  $\nu$  Pegasi). 5. Wāki' *واقع* (Vega,  $\alpha$  Lyræ). 6. Rāmiḥ *رامح* (Alramech, Arcturus,  $\alpha$  Bootis). 7. Fakkah *فكة* (Munir, Alpheta,  $\alpha$  Coronæ Borealis). 8. Ridf *ردف* (Arided, Arrioph,  $\alpha$  Cygni). 9. Mankib Faras *منكب فرس* (Scheat alpheratz,  $\beta$  Pegasi). 10. Rijl ad-Dubb *رجل الدب* ( $\lambda$  or  $\mu$  Ursæ Majoris). 11. 'Ayyuk *عيتوق* (Capella,  $\alpha$  Aurigæ). 12. Rās al-Ghūl *راس الغول* (Algol,  $\beta$  Persei).

Outside the Zodiac—13. Kalb al-'Akrab *قالب العقرب* (Antares,  $\alpha$  Scorpii). 14. Al-A'azal *الاعزل* (Azimech, Spica Virginis,  $\alpha$  Virginis). 15. Al-Ghurāb *الغراب* (Algorab,  $\gamma$  Corvi). 16. Shujā' *شجاع* (Alphard, Cor. Hydræ,  $\alpha$  Hydræ). 17. Ghumaisā *غيميسا* (Algomeisa, Procyon,  $\alpha$  Canis Minoris). 18. 'Abūr *عبر* (Alhabor, Sirius,  $\alpha$  Canis majoris). 19. Mankib *منكب* for Mankib al-Jauzá *منكب الجوزاء* (Bed Algeuze,  $\alpha$  Orionis). 20. Rijl al-Jauzá *رجل الجوزاء* (Rijel,  $\beta$  Orionis). 21. Dabarān *دبران* (Aldebaran,  $\alpha$  Tauri). 22. Batan Kītūs *بطن قيطوس*, the belly of the whale, (Batan kaitoz,  $\zeta$  Ceti). 23. Zanab Kītūs *ذنب قيطوس* (Deneb kaitoz,  $\iota$  Ceti). 24. Zanab al-Jad *ذنب الجدي* for Zanab al-Jadī *ذنب الجدي* (Deneb Algedi,  $\delta$  Capricorni).

The back of this Astrolabe exhibits three circular bands. The first and outermost band has written upon it, in its upper quadrants, a division into 90 degrees on either hand, arranged and numbered five and five, commencing from each end of the horizontal diameter; the lower half of this band is plain. The second band bears upon it the signs of the Zodiac, Cancer being at the top, each sign being divided into thirty degrees, arranged and numbered by fives. The third and inmost band has written upon it the names of the Roman months, each divided into days which are numbered five and five. Within these bands the upper quadrant on the left of the perpendicular diameter is occupied by the arcs of the unequal hours, that on the right by a sexagesimal series of sines and cosines: these quadrants will be found copied at Fig. 26 of Plate xxi. The square of the shadows fills up as usual the space between the horizontal diameter and the lower halves of the bands. This square is divided only in the European fashion, *i.e.* into twelve parts; the vertical shadow is denoted by the word *منكوس*, and the horizontal by *ميسوط*. There is also a line drawn diagonally from the centre of the instrument to each corner of the square. This line, called by the European writers Linea mediæ umbræ, I have never seen in any other Asiatic Astrolabe. The Libnahs of the 'Izādah have but one hole pierced through each. The Kutb is shaped as usual, and the Faras is a thin wedge slightly approaching the form of a horse.

#### PERSIAN.

*D*. Is a Persian Sudsī, or sexpartite Astrolabe, of Indian workmanship, preserved in the East-India Company's Museum. I have referred to this instrument in the preceding pages at No. II. of the East-India House. It is made of brass, is 4½ inches in diameter, and the inscriptions are in a clumsy but legible Naskh character. It comprises six tablets. The suspensory apparatus is complete with the exception of the 'Ilākah. The face of the Kursī, which is coarsely engraved with flowers and leaves, is traversed by the Khatt al-'Ilākah. The surface of the Hajrah is divided as usual into 360 degrees, arranged and numbered by sixes continuously, from 6, 18, 24, &c., to 354, 360. Within the Umm there is a table of the names of cities, with their Longitudes and Latitudes, arranged in a double series, as in Shāh Husāin's Astrolabe, but omitting the Inhirāfs, Masāfats, and Jihats. The Longitudes are reckoned from the Fortunate Islands. This table is as follows:—

OUTER CIRCLE.					
Cities.	Longitude.	Latitude.	Cities.	Longitude.	Latitude.
Hurmūz <i>هرموز</i>	92 —	26 50	Mashhad <i>مشهد</i>	92 30	37 —
Khutan <i>ختن</i>	107 —	42 —	Isfahān <i>اصفهان</i>	86 40	32 25
Kāshghar <i>كاشغر</i>	106 30	44 —	Yazd <i>يزد</i>	89 —	32 —
Samarkand <i>سمركند</i>	99 36	39 37	Shīrāz <i>شيراز</i>	88 —	29 36
Bukhārā <i>بخارا</i>	97 30	39 50	Basrah <i>بصرة</i>	84 —	30 —
Badakhshān <i>بدخشان</i>	104 24	37 10	Baghdād <i>بغداد</i>	80 30	33 25
Balkh <i>بلخ</i>	102 —	36 41	Kūfah <i>كوفه</i>	79 30	31 30



Cities.	Longitude.	Latitude.	Cities.	Longitude.	Latitude.
Bulkár بلقار . . . . .	90 —	49 30	Makkah-i Mu'azzamah مكة معظمه, Mak-		
Tabriz تبريز . . . . .	82 —	38 —	kah the Great . . . . .	77 10	21 40
Marághah مراغه . . . . .	82 18	37 20	Madínah-i Rasûl مدينة رسول, the city of		
Halab حلب . . . . .	72 10	35 50	the prophet . . . . .	75 20	25 —
Dimashk دمشق . . . . .	70 —	36 15	Misr مصر . . . . .	63 20	30 20
Bait al-Mukaddas بيت المقدس, the holy					
house (Jerusalem) . . . . .	66 31	31 50			

## INNER CIRCLE.

Bánáras بانارس . . . . .	117 20	26 55	Múltán مولتان . . . . .	107 35	29 40
Kanúj قنوج . . . . .	115 50	26 29	Kandahár قندهار . . . . .	107 40	33 —
Ajmir اجمير . . . . .	112 —	26 —	Tibbat تبت . . . . .	110 —	40 —
Agrah اكراه . . . . .	114 —	27 13	Kashmir كشمير . . . . .	108 —	35 —
Hazrat Dihlí حضرت دهلي . . . . .	113 35	28 15	Kábul كابل . . . . .	104 40	34 30
Laháhur لاهور . . . . .	119 20	31 50			

On four of the tablets in this Astrolabe the inscriptions are alike, varying only in the Latitudes for which they are constructed. These inscriptions are: the two diameters, the three circles, the Almucantars, traced and numbered six and six, the words East and West, and the Latitudes and hours of the longest days at the several places for which the projections are constructed, being written as usual under the first Almucantar; the Azimuths, the first or prime vertical being traced both above and below the Earth, the remainder only below, and numbered by tens from the prime vertical; and the arcs of the unequal hours, distinguished by dots, drawn from the West and East, and meeting at the perpendicular diameter. The Latitudes and hours marked on the eight faces of these four tablets are as follows:—1. Obv. Lat. 22°. Hours 13 hrs. 22 min. Rev. Lat. 24°. Hours 13 hrs. 31 min. 2. Obv. Lat. 24°. Hours 13 hrs. 46 min. Rev. Lat. 30°. Hours 13 hrs. 18 min. 3. Obv. Lat. 32°. Hours 14 hrs. 8 min. Rev. Lat. 36°. Hours 14 hrs. 32 min. 4. Obv. Lat. 38°. Hours 14 hrs. 42 min. Rev. Lat. 40°. Hours 14 hrs. 54 min. The fifth tablet has on one side a projection similar to the above, constructed for a Latitude of 35°, with the hours of the longest day, 14 hrs. 25 min.; on the other side of this tablet is the projection for the Equator, described above at page 12, and drawn at Fig. 17 of Plate xx. The remaining tablet bears on one surface the Safihah al-Áfakíyah; the horizons proceed by eights, and only every second horizon being marked, there are but thirty-two in all; the horizon of 66° is traced entire: the degrees of the obliquity of the Ecliptic are marked by sixes, from 6 to 24 on either side of the diameters, between the circles. This Safihah has been particularly described in the preceding pages. The other side of this sixth tablet bears the Safihah-i 'Arz-i Tamám-i Mail-i Kullí, of which I have already given a detailed account at p. 12. I have copied this Safihah at Fig. 14 of Plate xix.

The 'Ankabút of this Astrolabe is of the ordinary form, bearing the Zodiacal circle, the degrees of the signs being marked six and six, the tropic of Capricorn with the Murí Rás al-Jadí, and the 'Amúd Rás al-Hamal wa al-Mízán: the diameters and circles are traced on those portions of the reticulation that remain. A drawing of it will be found at Fig. 22 of Plate xx. The Shazíyahs of the stars are numbered in the diagram, and are inscribed as follows—

Within the Zodiac—1. Rás al-Játhí راس الجاثي (Ras algethi,  $\alpha$  Herculis). 2. Nasr-i Táir نسر طائر (Althayr,  $\alpha$  Aquilæ). 3. Fam al-Faras فم الفرس (Pegasi). 4. Nayyir al-Fakkah نير الفكاه (Munir, Malfecar, Elpheta,  $\alpha$  Coronæ Borealis). 5. Nasr-i Wáki' نسر واقع (Vega,  $\alpha$  Lyrae). 6. Simák ar-Rámih سمك الزامح (Alramech, Arcturus,  $\alpha$  Bootis). 7. Al-Káid القائد (Benenatz, Benetnasch,  $\eta$  Ursæ Majoris). 8. Ridf ردف (Arided, Arrioph,  $\alpha$  Cygni). 9. Kaff-i Kh كفف, for Kaff-i Khazib خضيب ( $\beta$  Cassiopeiae). 10. Surrah-i Faras سرده فرس (Alpherath,  $\delta$  Pegasi and  $\alpha$  Andromedæ). 11. Mankib منكب, for Mankib al-Faras منكب الفرس (Scheat Alpheratz,  $\beta$  Pegasi). 12. Janáh-i F جناح ف, for Janáh-i Faras جناح فرس (Algenib,  $\gamma$  Pegasi). 13. Sarfah صرفه ( $\beta$  Leonis). 14. Zahr al-Asad ظهر الاسد ( $\delta$  Leonis). 15. Janb-i Marat جنب امرأة, the side of the woman, (Mirach, Mirath,  $\beta$  Andromedæ).

Outside the Zodiac—16. Kalb al-'Akrah قلب العقرب (Antares,  $\alpha$  Scorpii). 17. Simák-i A'azal سماك اعزل (Azimech, Spica Virginis,  $\alpha$  Virginis). 18. Kalb al-Asad قلب الاسد (Kalb Eleced, Regulus,  $\alpha$  Leonis). 19. Fard ash-Shujá' فرد الشجاع (Alphard, Cor Hydræ,  $\alpha$  Hydræ). 20. Zanab-i Kalb-i Akbar ذنب كلب اكبر, the tail of the greater dog, ( $\epsilon$ ,  $\delta$  or  $\eta$  Canis Majoris?). 21. Shi'ra-i Yamání شعري يماني (Alhabor, Sirius,  $\alpha$  Canis Majoris). 22. 'Ain ath-Thaur عين الثور (Aldebaran,  $\alpha$  Tauri). 23. Yad al-Jauzá يد الجوزاء (Bed Algeuze,

<sup>1</sup> This name has evidently been erroneously engraved for Shi'ra-i Shámi, the names of the two dogstars having been carelessly interchanged.

$\alpha$  Orionis). 24. Shi'ra-i Shámi شعري شامي (Algemeisa, Procyon,  $\alpha$  Canis Minoris). 25. Rijl al-Jauzá al-Yusra اليسري الجوزاء (Rigel Algeuze,  $\beta$  Orionis). 26. Fam al-Kítas فم القيطس ( $\gamma$  Ceti). 27. Kaff al-Jazmá كف الجذماء (Menkar,  $\alpha$  Ceti). 28. Zanab-i Kítas ذنب قيطس ( $\beta$  Ceti). 29. Zafda' ضفدع, the frog, (Fomalhaut,  $\alpha$  Piscis Australis). The Mudír of the 'Ankabút is at M.

The upper quadrants on the back of this Astrolabe have each an arc of Altitude as usual, the degrees being arranged and numbered six and six. In the left hand quadrant there is a sexagesimal series of cosines of Altitude, each parallel being traced: in that on the right hand the parallels of the signs of the Zodiac are drawn, numbered from 0, which stands for Aries, to 11, Pisces; and the arcs of the unequal hours. A drawing of the interior spaces of these quadrants will be found at Fig. 27 of Plate xxi.

The two lower quadrants are bounded respectively by the arcs of the shadow measured in fingers on the left, and in feet on the right hand. Next to these are two continuous semicircular bands, one containing the names of the signs of the Zodiac, and the other of the twenty-eight lunar mansions. Within the inclosed space is the square of the shadows, with the ordinary divisions into feet and fingers, and the usual words pointing out the horizontal and vertical shadows. Inside the square, to the left of the perpendicular diameter, is written Zill-i Sullam-i Akdám ظل سلم اقدام, shadow of the ladder of feet, and to the right of the same line Zill-i Sullam-i Asábi' ظل سلم اصابع, shadow of the ladder of fingers. Lastly, in the same space, i.e. within the square, we find the name of the artificer, and the date of the construction of the Astrolabe recorded as follows, ١٠٧٦ سنة تته محمد صالح, made by Muhammad Sálíh, (at) Tattah, in the year (of the Híjrah) 1076 (A.D. 1665).

The 'Izádah, of which I have given a representation at Fig. 43 of Plate xxi, is marked with certain lines, arcs, and numbers, corresponding with those inscribed on the upper quadrants. It has also notches cut at the top of the pinnules for the reception of a tube as described above at p. 20. The Kutb and Faras of this Astrolabe are copied at Fig. 50 of the same Plate.

E. This Astrolabe is the property of W. S. W. Vaux, Esq.: it is a Sudsi or sexpartite instrument: it is made of brass, is 2½ inches in diameter, and comprises seven tablets: it bears the date A.H. 1228 (A.D. 1813). The suspensory apparatus is wanting. On the face of the Kursí are the words وسع كرسيه السموات والارض, His throne is extended over the heavens and the earth. This sentence, which is taken from the 256th verse of the second Súra of the Kurán, called the Verse of the Throne,<sup>3</sup> is applicable to its present position, as containing the word Kursí كرسي, throne.<sup>4</sup> The surface of the Hajrah is divided into 360 degrees, which are arranged and numbered by sixes from 6 to 90 in each quadrant of the circle, proceeding from left to right. On the surface of the Umm there is a radiating table of cities, with their Longitudes reckoned from the Fortunate Islands, and their Latitudes, forming a double series as follows:—

## OUTER SERIES.

Cities.	Longitude.	Latitude.	Cities.	Longitude.	Latitude.
Ardabil اردبيل . . . . .	82 7	38 3	Misr مصر . . . . .	63 20	30 20
Isfahán اصفهان . . . . .	86 40	32 25	Bait al-Mukaddas بيت المقدس, the holy		
Shíráz شیراز . . . . .	88 —	29 36	house (Jerusalem) . . . . .	66 30	31 50
Baghdád بغداد . . . . .	80 —	33 25	Madínah-i Munawwarah مدينة منورة, the		
Basrah بصره . . . . .	87 —	30 —	illuminated city . . . . .	75 20	25 15
Kúfah كوفه . . . . .	79 34	31 30	Makkah-i Mu'azzamah مكة معظمه		
Dimashk دمشق . . . . .	70 —	33 15	Makkah the Great . . . . .	77 10	21 40

<sup>1</sup> See p. 38, note 1.

<sup>2</sup> The engraver has misplaced this name, together with that next following, viz. No. 27. The two should have been interchanged.

<sup>3</sup> The Muhammadans consider the Verse of the Throne to be the most important in the Kurán; and the whole, or portions of it, are constantly found engraved on amulets, vases, cups, &c., which are thought, through its virtues, to secure good fortune to their possessors. M. Reinand has given a full and detailed description of this verse in his "Descriptions des Monumens, &c.," Tome II. p. 11, *et. seq.* The following is Sale's translation of the Verse of the Throne:—"God! There is no God but he; the living, the self-subsisting; neither slumber nor sleep seizeth him; to him belongeth whatsoever is in heaven and on earth. Who is he that can intercede with him, but through his good pleasure? He knoweth that which is past, and that which

is to come unto them, and they shall not comprehend any thing of his knowledge but so far as he pleaseth. His throne is extended over heaven and earth, and the preservation of both is no burthen unto him. He is the high, the mighty." The translator says justly, that this is "a magnificent description of the Divine majesty and providence," and modestly adds, "but it must not be supposed the translation comes up to the dignity of the original."

<sup>4</sup> The Kursí, as employed in this verse, is supposed by the Muhammadans to be God's Judgement seat, being placed under the 'Arsh عرش, which is his imperial throne. The Kursí, allegorically, signifies the Divine providence, which sustains and governs the heaven and the earth, and is infinitely above human conception. See D'Herbelot Bibl. Orient. *sub voce* Corsi. Sale's Korán in the notes. Reinand, loc. cit.



## INNER SERIES.

Cities.	Longitude.	Latitude.	Cities.	Longitude.	Latitude.
Guwáliyar کوالیر . . . . .	114 —	26 29	Dihli دهلي . . . . .	113 35	25 11
Bijápúr بیجاپور . . . . .	125 —	20 —	Tibbat تبت . . . . .	110 —	40 —
Ahmadábád احمدآباد . . . . .	108 40	20 15	Kashmír کشمیر . . . . .	108 —	35 —
Burhānpūr برهانپور . . . . .	109 —	20 34	Kābul کابل . . . . .	104 40	34 30
Kanūj کنوج . . . . .	115 50	26 35	Lāhūr لاہور . . . . .	109 20	31 50
Banāras بنارس . . . . .	117 20	28 16			

Four of the seven tablets in this Astrolabe offer the same arrangement of lines, arcs, and circles, differing only in the latitudes for which they are respectively constructed. They present the two diameters; the three circles; the Almucantars, traced and numbered by sixes, with the words East and West, and the Latitudes and Hours in their usual places, the latter, however, being sometimes omitted; the Azimuths, every fifteenth being traced, half of which, viz. the first, thirtieth, sixtieth, and ninetieth are drawn both above and below the horizon, and the remainder, viz. the fifteenth, forty-fifth, and the seventy-fifth only below the horizon; and the arcs of the unequal and equal hours. The Latitudes and Hours of the longest days of these tablets are as follows:—1. Obv. Lat. 21°. Arcs of the equal hours, numbered from one to thirteen. Rev. Lat. 24°. Arcs of the equal hours, similarly numbered. 2. Obv. There is no writing in this projection except the words East and West, the numbers of the Almucantars, and those of the Azimuths above the earth: the Latitude is about 24°, and there are thirteen arcs of the equal hours. Rev. Lat. 29°. Hours 13 hrs. 12 min. 3. Obv. Lat. 30°. Arcs of the equal hours, numbered from one to thirteen. Rev. Lat. 32°. Hours 14. 4. Obv. Lat. 34°. Arcs of equal hours, numbered from one to fourteen. Rev. Lat. 36°. Hours 14 hrs. 32 min. The fifth tablet bears inscriptions similar to the above, except that the Almucantars are traced ten and ten. The Obverse is constructed for Lat. 40°. Hours 15: the arcs of the equal hours proceed from the East and West, and meet at the perpendicular diameter. The Reverse bears like inscriptions, the arcs of the equal hours being thirteen in number, and proceeding from the West only. There are no-written characters in this projection, but it appears to be for about Lat. 25°. The sixth tablet, which has no writing whatever upon it, bears on one side a projection for a Latitude of about 42°; the Almucantars are traced six and six, and the arcs of the equal hours, which are the only ones drawn, proceed both from East and West. The other side bears a projection for an inhabitant on the equator, which I have already described at p. 13. I have given a drawing of it at Fig. 18 of Plate xx. The sixth and last tablet has on one side the Saffhah al-Áfákiyah, with 32 horizons, but no degrees of the obliquity of the Ecliptic, and without written characters. On the other side there is the Saffhah-i 'Arz-i Tamám-i Mail-i Kullí, of which an account has already been given. The 'Ankabút has the Zodiac with each sign divided into five parts, and the outer tropic with the Murí Rás al-Jadí. The three circles are traced where the body of the plate has not been removed. There are no names of fixed stars on the reticulated portion left. The back of this Astrolabe offers the usual arcs of Altitude in the upper quadrants. The quadrant on the left bears a sexagesimal series of sines and cosines, with the arcs of the obliquity of the ecliptic and of the sixth unequal hour. That on the right presents the arcs of the parallels of the signs of the Zodiac. A drawing of both will be found at Fig. 28 of Plate xxi. The lower quadrants comprise the arc of the shadow in fingers and feet, the division into fingers being on the left of the perpendicular diameter, contrary to the usual practice. Within the arc is the square of the shadows. On the left of the perpendicular diameter are the vertical and horizontal shadows of the fingers, designated respectively by the words ظلّ سلم اصابع معكوس, *inverted shadow of the ladder of fingers*, and ظلّ سلم اصابع مستوي, *level shadow of the ladder of fingers*. The horizontal and vertical shadows, divided into feet, and denoted by like words, with the substitution of اقدام, *feet*, for اصابع, *fingers*, are in the right hand compartment of the square. Round the outer edge of the main body of the instrument are the following verses, recording the date of the construction of the Astrolabe, and the names of its maker and his patron.

سپهر سلطنت سلطان محمد  
چو او صفرن شدادی دهر کی دید  
سطلای بتا در عصر اوست  
که مافوق است این از جام جمشید  
چو احمد صانعش پرسید سالش  
خدیو عصر گفت میزان خورشید

The sphere of sovereignty Sultan Muhammad,  
When did the world ever behold such a brave lion?  
Since how long has an Astrolabe existed in his time,

That this one should be superior to the mirror of Jamshid?<sup>1</sup>

When Ahmad its maker asked its year (of construction)

The Lord of the age said "The Balance of the Sun."

The last words میزان خورشید, *the Balance of the Sun*, form a chronogram, and the numerical values of the letters, according to the Abjad, being added together, make up the number 1228, the year of the Hijrah in which the Astrolabe was constructed (A.D. 1813.) The verses themselves are faulty in expression and obscure in their meaning,<sup>2</sup> and as the last line is not in conformity with prosody, it would seem that the author was more skilled in the making of Astrolabes than in the rules of versification. The character in which the verses are written is clear though inelegant, and there can be no doubt as to the correctness of the above reading.

I have not been able to ascertain who the Sultán Muhammad alluded to actually was. More than one of the chieftains who alternately rose to almost sovereign power in Afghanistan and Kashmir, about the year 1813, bore that name; amongst others, the celebrated Dúst Muhammad Khán, and Muhammad 'Azím Khán, eldest brother of Fath Khán the Wazír of Mahmúd Sháh Durrání, who was appointed Governor of Kashmir in A.D. 1811.<sup>3</sup> Drawings of the 'Izadah, the Kutb, and Faras of this Astrolabe, are given at Figs. 45 and 52 of Plate xxi.

## HINDÚ.

F. This is the Hindú Astrolabe in the Museum of the Royal Asiatic Society. It appears, from some letters and papers in the archives of the Society, that it originally belonged to a Mrs. Furlong. In November 1828 the late Sir Alexander Johnstone asked Lord John Campbell to procure an account of the instrument for publication, and two remarkable letters were, in consequence of Sir Alexander's application, received by the Secretary to the Society from a Mr. John Hart, of Glasgow. Mr. Hart in his first letter, says, "I have examined the Astrolabe, but as I am unacquaint with the Sanscrit character, I cannot hazard any opinion I might have of the instrument." He, nevertheless, in this and the second letter, offers some conjectures which are singularly accurate, considering his ignorance of the language and character of the inscriptions. This Astrolabe was deposited in the Museum of the Society in August 1829, and was about that time submitted to the late Dr. Rosen's inspection, who translated the inscriptions. It is made of brass, is 6½ inches in diameter, and is bipartite. The apparatus for suspension is complete, excepting the 'Ilákah. The Umm and the Hajrah are in one plane, the instrument being constructed for a single Latitude, and the inscriptions are plainly written in the Dévanágari character. The Kursí has a somewhat ornamental form, representing leaves and flowers, the interstices being pierced. The face of the Hajrah is divided into 360 parts, arranged and numbered six and six, the numbers commencing from 6 above and below either end of the horizontal diameter, and ending at 90 at both sides and extremities of the meridian line. The Umm presents the two diameters; the three circles; the Almucantars, two and two, arranged for a Latitude of 24°; the Azimuths drawn below the Earth, every sixth being traced and the prime vertical being produced above the Earth through the Zenith; and the arcs of the unequal hours. This projection bears no writing whatever. The 'Ankabút of this Astrolabe is copied at Fig. 23 of Plate xx. It bears the Zodiacal circle, the Equinoctial, and the tropic of Capricorn, together with several 'Amúds: the Mudír is absent. The signs of the Zodiac, each of which is divided into five parts containing six degrees, which are again subdivided into three each containing two degrees, are as follows:—Méshe मेष, *the Ram*; Vrisha वृष, *the Bull*; Mithuna मिथुन, *the Pair*; Karkata कर्कट, *the Crab*; Sinha सिंह, *the Lion*; Kanyá कन्या, *the Virgin*; Tulá तुला, *the Balance*; Vrischika वृश्चिक, *the Scorpion*; Dhanus धनुस्, *the Bow*; Makara मकर, *the Sea monster*; Kumbha कुम्भ, *the Urn*; Mína मीन, *the Fish*. At the summit of the Zodiacal circle is the denticle of Capricorn. The pointers of the stars in this 'Ankabút are twenty-three in number. There is considerable difficulty in identifying the stars to which the names on these pointers refer, orientalists not having bestowed the same attention to the names of the fixed stars prevailing amongst the astronomers of India as to those employed by the Arabians. Indeed, I believe that the Memoir, by Colebrooke, on the Nakshatras, or Lunar Mansions of the Hindús, to which I have already referred, is almost the only source from which information can be gained without consulting the original astronomical works. The explanations which follow are therefore necessarily somewhat incomplete, though the translations by Dr. Rosen, above alluded to, and the assistance kindly afforded me by Professor Wilson, will render them of authority so far as they extend. Wherever I have added a note of interrogation to the European designation of a star, it must be understood that such designation is offered merely as a conjecture, derived from the relative positions of the pointers in this instrument, compared with those of the Shazíyahs of the stars in the Muhammadan Astrolabes, described above, and the star maps of Argelander. In the case of the Lunar Mansions, I have found that these relative positions confirm the views of Colebrooke without exception.

<sup>1</sup> The mirror, cup, or globe of Jamshid, according to Eastern fabulists, represented the whole world, real and supernatural, whence it is also called the Jám-i Jahán Numá, جام جهان نما, *a mirror showing the Universe*. M. Reinaud has given a most interesting account of the magic cups, mirrors, and vases of the Muhammadans, in his *Description des Monuments*, &c., Tome ii. p. 337, *et seq.*

<sup>2</sup> It seems extremely unlikely, for instance, that the maker of the instrument should have asked his sovereign, even by poetical licence, to furnish him with a chronogram to express the date of his work. The contrary would have been more decorous and probable; yet the two last lines scarcely admit of any other translation.

<sup>3</sup> Burnes. *Travels into Bokhara*, 2d Edit. 3 Vols. 8vo. Lond. 1835. Vol. iii. p. 238.



Within the Zodiac—1. Sarpadhārisira सर्पधारिशिरः, the Snake-bearer's head; (Ras Alangue,  $\alpha$  Serpentarii?). 2. Sravana श्रवण, the Ear, the 23d Lunar Mansion; (Althayr,  $\alpha$  Aquilæ). 3. Swatī स्वाती, the Sword, (Arcturus,  $\alpha$  of Bootes). 4. Ashtāmukha अष्टामुख, the Eight-faced, (Pegasi?). 5. Mātrīmandala मातृमंडल, the Orbit of the Mother; (Munir, Alpheta,  $\alpha$  Coronæ Borealis?). 6. Abhijit अभिजित, an Expiatory Sacrifice, the 22d Lunar Mansion; (Wega,  $\alpha$  Lyrae). 7. Kurkutapu कुर्कुटपु, probably for Kukkutapuchehha, कुक्कुटपुच्छ, the Cock's tail (Aried, Arrioph,  $\alpha$  Cygni?). 8. Pūrvābhādrapada पूर्वभाद्रपद, the prior Cow-footed, or Lucky-footed one, the 26th Lunar Mansion; (Scheat alpheratz,  $\beta$  Pegasi). 9. Uttarābhādrapada उत्तरभाद्रपद, the subsequent Cow-footed, or Lucky-footed one, the 27th Lunar Mansion; (Alpherath,  $\delta$  Pegasi and  $\alpha$  Andromedæ?). 10. Matsyodara मत्स्योदर, the Fish's belly; (Mirach,  $\beta$  Andromedæ?). 11. Brahmahrida ब्रह्महृद, the Heart of Brahma; (Capella,  $\alpha$  Aurigæ?). 12. Chatashirah चतशिरः apparently for Chatu-shira चतुःशिरः the Four-headed one ( $\alpha$  Trianguli?).

Outside the Zodiac—13. Chitrā चित्रा, the Variegated one, the 14th Lunar Mansion; (Azimech, Spica Virginis,  $\alpha$  Virginis). 14. Maghā मघा, the 10th Lunar Mansion; (Regulus,  $\alpha$  Leonis). 15. Mahāpurusha महापुरुष, the Hero; (Alphard, Cor Hydræ,  $\alpha$  Hydræ). 16. Lubdhakabandhu लुब्धकबंधु, the Hunter's brother; (Algoeisa, Procyon,  $\alpha$  Canis Minoris?). 17. Stubbhaka लुब्धक, or qu. Lubdhaka लुब्धक, the Hunter; (Sirius,  $\alpha$  Canis Majoris). 18. Ādrā अर्द्रा, the Moist one, the 6th Lunar Mansion; (Bed Algeuze,  $\alpha$  Orionis). 19. Rōhinī रोहिणी, one of the daughters of Daksha, the 4th Lunar Mansion; (Aldebaran,  $\alpha$  Tauri). 20. Mithunavāmapada मिथुनवामपद, the left foot of the Pair; (Rigel,  $\beta$  Orionis?). 21. Naharī नहरि, ( $\pi$  Ceti?). 22. Samudrapakṣī समुद्रपक्षी, the Bird of the Sea; (Deneb kaitoz,  $\iota$  Ceti?). 23. Satajivā शतजीवा, or qu. Satamivā शतमिवा, qu. for Satajivā शतजीवा, the Hundred-lived one ( $\lambda$  Aquarii?).

The boundary arc of each quadrant on the back of this Astrolabe is divided into 90 degrees, ranged and numbered by sixes, commencing on each side of the horizontal, and ending at the top and bottom of the perpendicular diameter. The upper quadrant on the left bears a sexagesimal series of sines and cosines, a parallel being traced for every two divisions; it has also the arc of the obliquity of the Ecliptic. On the other upper quadrant are the arcs of the parallels of the signs of the Zodiac, arranged from either end of the boundary-arc and proceeding towards the centre. Sagittarius occupies the outermost place at the top of the meridian line, and Capricorn at the end of the horizontal diameter; the inmost parallels next the centre are those of Cancer and Gemini. Each sign is divided into five parts, and the arcs of the parallels therefore correspond with the Mabsūt sines drawn from the whole sine where such arcs touch the latter. Underneath the horizontal diameter is the square of the two shadows: the compartment on the left being occupied by the vertical and horizontal shadows of feet, the former denoted by the words सप्तगुलशंकोः विलोमछाया, the opposite shadow of a gnomon seven fingers long, and the latter by the words सप्तगुलशंकोः समछाया, the right shadow of a gnomon seven fingers long; and that on the right by the division of the same shadows into fingers, the vertical shadow being denoted by the words द्वादशगुलशंकोः विलोमछाया, the opposite shadow of a gnomon twelve fingers long, and the horizontal by the words द्वादशगुलशंकोः समछाया, the right shadow of a gnomon twelve fingers long. I have already noticed, at p. 21 and note 8 at the foot of the same page, the peculiarities observable in the 'Izādah, and the fastening apparatus of this Astrolabe. I therefore refer the reader to the account there given, and to the drawing at Fig. 44 of Plate xxi, merely adding that the divisions on the edge of the 'Izādah correspond with the arcs of the parallels of the signs of the Zodiac, and with the sexagesimal division of the whole sine and cosine.

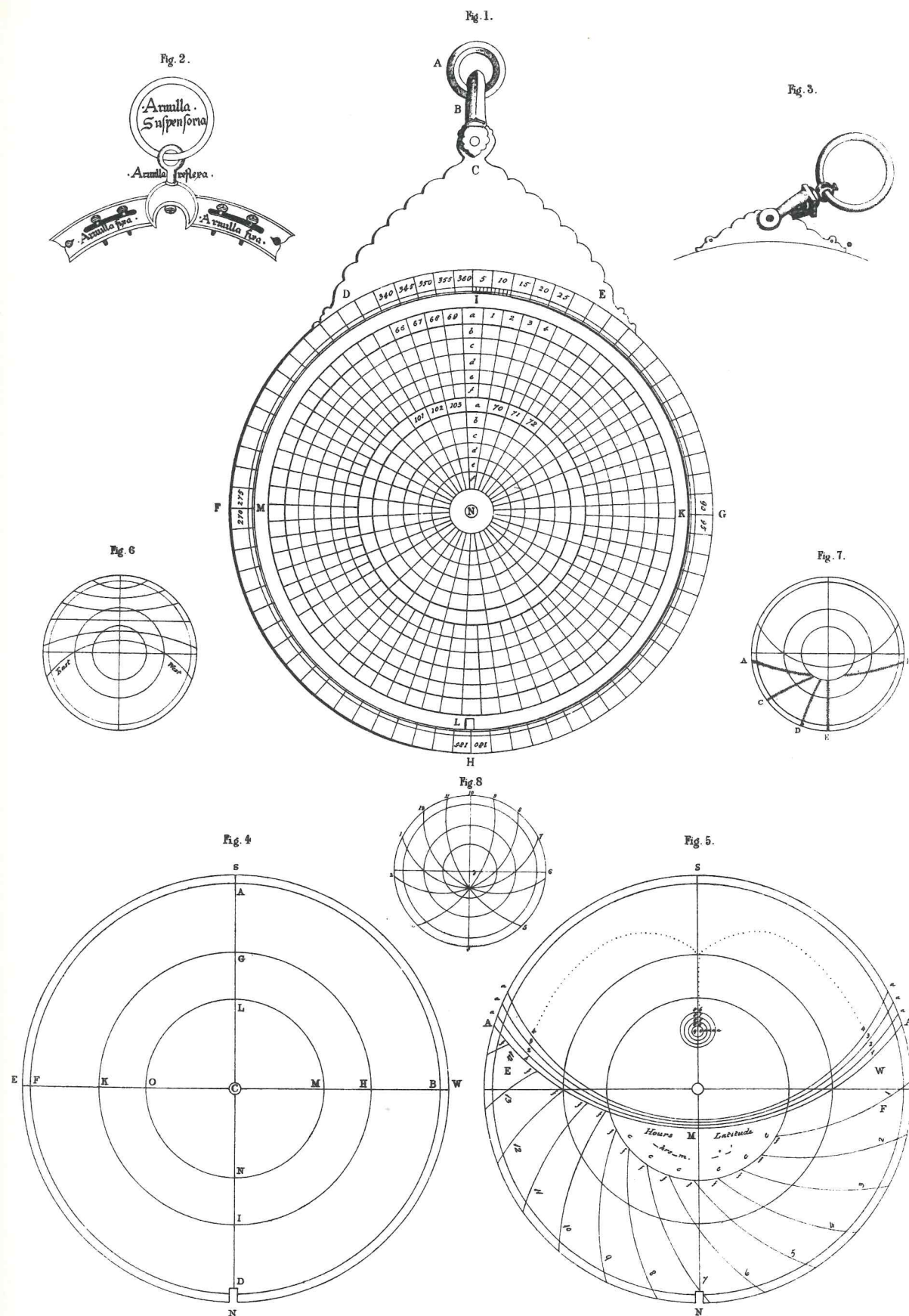
G. A small modern Hindū Astrolabe preserved in the Museum of the East-India House. It is a sexpartite instrument, made of brass, comprises seven tablets, and measures  $3\frac{1}{4}$  inches in diameter. The inscriptions, which are in the Dēvānāgarī character, are exceedingly ill-written, and the workmanship throughout is coarse and clumsy. The suspensory apparatus is complete, with the exception of the 'Ilākah. The face of the Hajrah is divided into 360 degrees, arranged and numbered by sixes, commencing from the top, proceeding from left to right, and beginning afresh from six at the completion of each ninety. In the Umm is the following table of the names of Cities, with their Latitudes and Longitudes. The latter are reckoned from the Fortunate Islands.<sup>2</sup>

Cities.	Latitude.	Longitude.	Cities.	Latitude.	Longitude.
Dālatabād दालतबाद . . . . .	20 —	111 —	Góyálúr (Gwalior) गोयालूर . . . . .	26 29	114 —
Jayanpur (qu. Jaipur) जयनपुर . . . . .	26 36	119 6	Ágrá आगरा . . . . .	26 43	115 —
Ayódhyā अयोध्या . . . . .	26 32	118 6	Dillí दिल्ली . . . . .	29 —	113 —
Badānu बदानु . . . . .	27 32	114 50	Lāher (Láhór) लाहेर . . . . .	31 50	109 20
Gólkundā गोलकुंडा . . . . .	18 4	115 19	Burhanpur बुरहानपुर . . . . .	21 21	110 —
Khawāit खवाइट . . . . .	22 —	109 —	Amadnagar (Ahmadnagar) अमदनगर . . . . .	19 —	115 —
Aladábād (qu. Alláhábád) अलदाबाद . . . . .	23 —	108 40	Thāneswar थानेश्वर . . . . .	30 10	112 30
Ujjevanī उज्जयनी . . . . .	23 30	110 50	Banóras बनोरस . . . . .	26 15	117 20

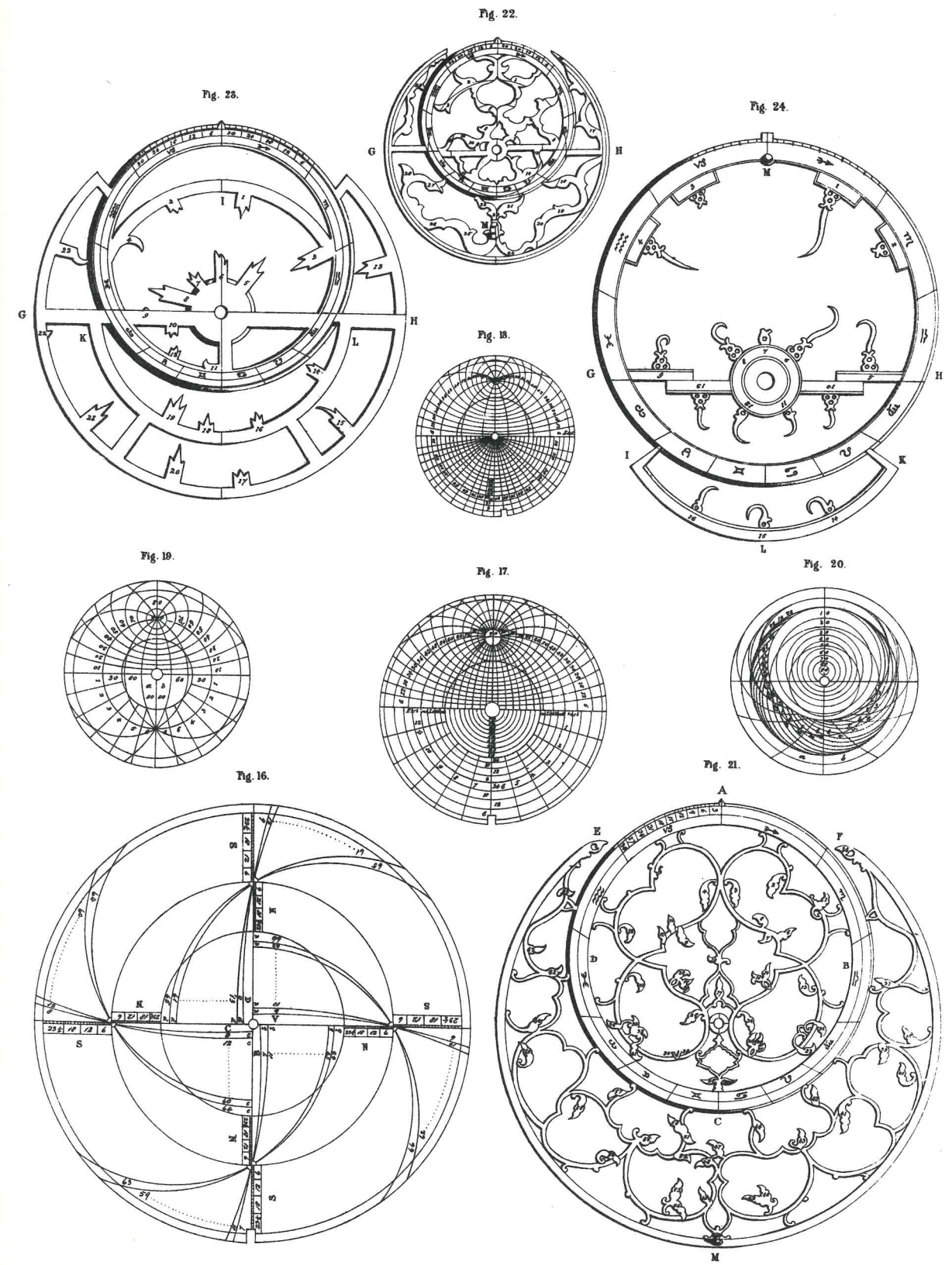
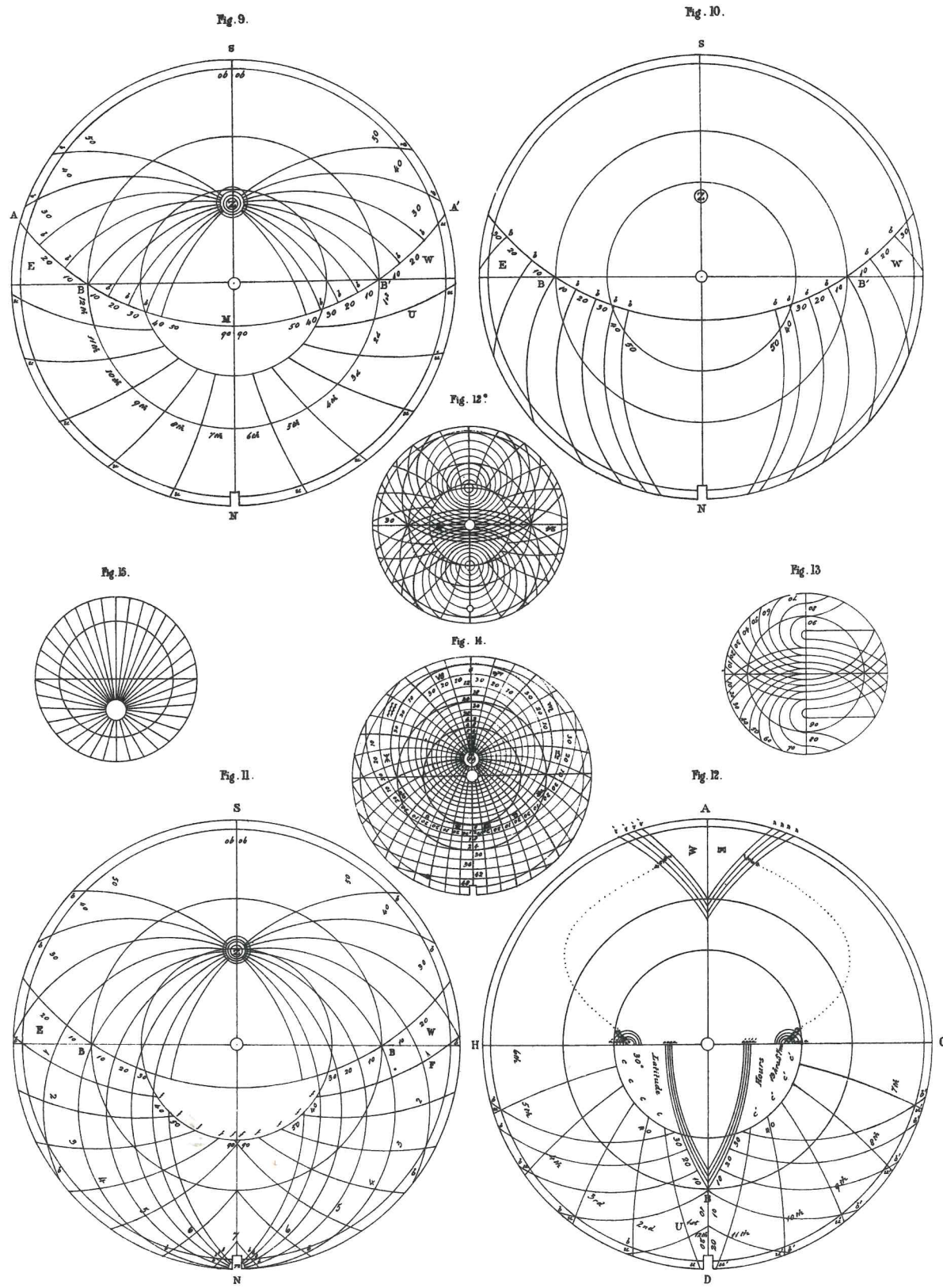
<sup>1</sup> In this and other cases, where no translation has been added, the names of the stars are not to be found in Professor Wilson's Dictionary.

<sup>2</sup> For information respecting the first meridian of the Hindús, see L. A. Sédiillot,

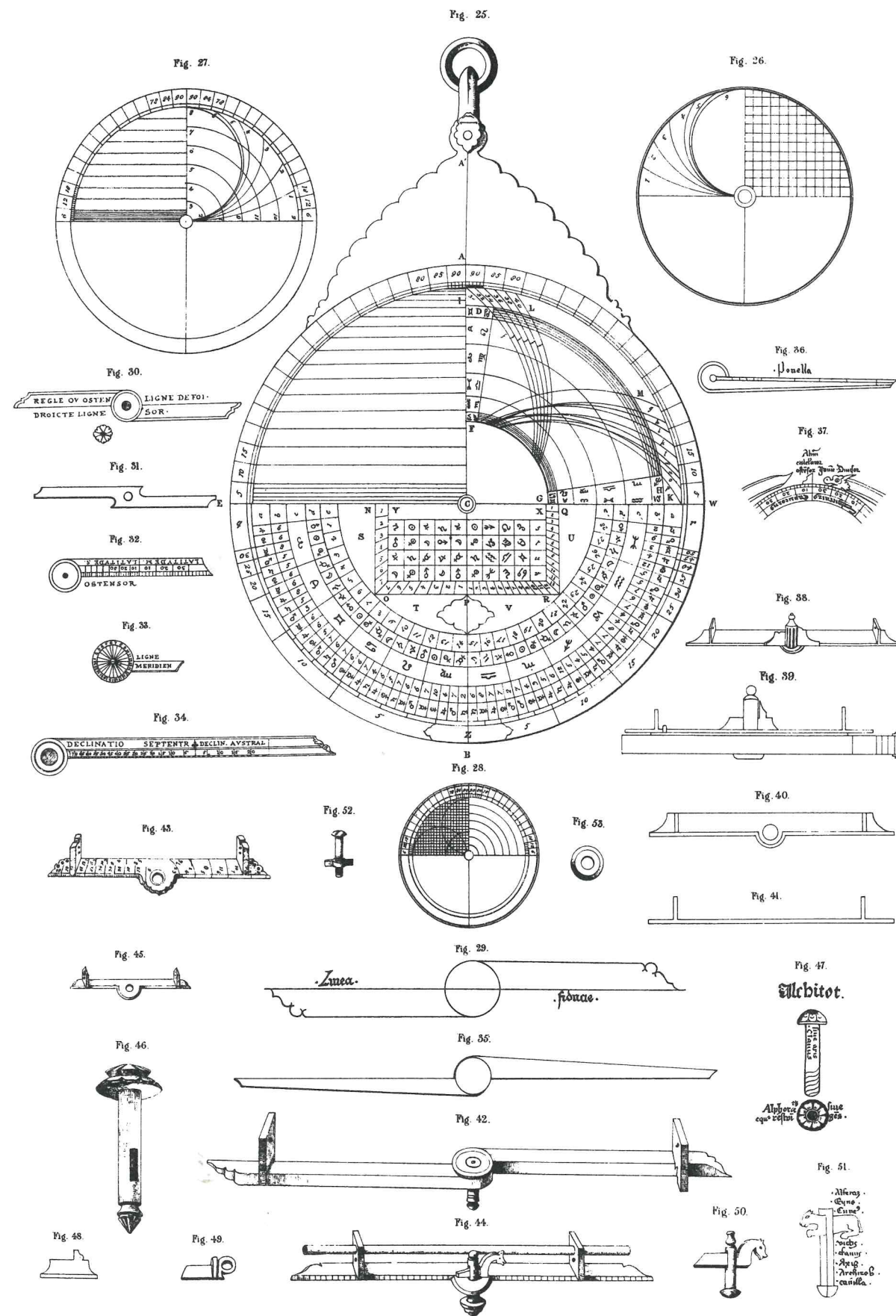
Mémoire sur les Systèmes &c., p. 9. et seq.; and Reinaud, Mémoire sur l'Inde, p. 368, et seq.











W. H. Murray, Facit.

The Mumsikah in this Astrolabe is a cavity, or rather hole, pierced right through the Hajrah at the bottom.

Five of the seven tablets exhibit the same lines, circles, and arcs, the inscriptions only varying in the Latitudes and the number of the hours of the longest days. They comprise the two diameters; the three circles; the Almucantars, drawn one to every six, and numbered six and six, the Latitude and number of hours of the longest day being written under the first as usual; the Azimuths above and below the Earth, the first and every thirtieth only being traced; and the arcs of the unequal and equal hours, the latter being distinguished from the former by being dotted. The Latitudes for which the ten projections on these tablets were constructed, together with the hours of the longest day at each, are as follows:—1. Obv. Lat. 17°. Hours 13. Rev. Lat. 18°. Hours 13. 2. Obv. Lat. 20°. Hours 13. Rev. Lat. 21°. Hours 13. 3. Obv. Lat. 23°. Hours 13. Rev. Lat. 24°. Hours 13. 4. Obv. Lat. 26°. Hours 13. Rev. Lat. 27°. Hours 13. 5. Obv. Lat. 29°. Hours 13. Rev. Lat. 32°. Hours 14. Of the two remaining tablets one bears on one side that of the series of horizons, of which it contains thirty-two, numbered at either end, together with the degrees of the obliquity of the Ecliptic, marked two and two, and numbered by sixes: the other side is occupied by the projection for the Lat. 66°, called by the Muhammadans, the Sahífah-i 'Arz-i Tamám-i Mail-i Kulli; it exhibits no difference from those already described, except that the signs of the Zodiac are denoted by the figures 1, 2, 3, &c., instead of by words. The seventh and last tablet has on one surface a projection for a place without Latitude, and, on the other, one constructed for a Latitude of 72°. I have already given an account of both these projections at p. 13, and drawings of them will be found at Figs. 19 and 20 of Plate xx.

All the tablets, except the last, have a protuberance or denticle at the lowest part of their outer circumference which fits into the hole bored through the Hajrah, as mentioned above.

The 'Ankabút of this instrument has the Zodiacal circle, with the signs, expressed by abbreviations only, but numbered from 0 aries to 11 Pisces, and divided into degrees six and six, the denticle of Capricorn being at the summit of the circle; together with the tropic of Capricorn. The pointers of the stars are most illegibly inscribed, and the obscurity is increased by the names they bear being in many cases abbreviated. The names, so far as they can be read, are as follows:—

Within the Zodiac—1. Dhanak धनक्? perhaps for Dhanuk धनुक्, a bow ( $\alpha$  Herculis? or  $\alpha$  Serpentarii?). 2. Sravana श्रवण, the Ear, the 23d Lunar Mansion (Althayr,  $\alpha$  Aquilæ). 3. Swát स्वात, for Swátí स्वाती, the Sword (Arcturus,  $\alpha$  Bootis). 4. A आ, qu. for Ashtámukha अष्टामुख, the Eight-faced ( $\epsilon$  Pegasi?). 5. A आ, qu. for Abhijit अभिजित्, an Expiatory Sacrifice, the 22d Lunar Mansion (Vega,  $\alpha$  Lyrae). 6. Ká का, qu. for Kurkutapu कुरुटपु, (Aried, Arrioph.  $\alpha$  Cygni).

Outside the Zodiac—7. Jyészthá ज्येष्ठा, the Pre-eminent one, the 18th Lunar Mansion (Antares,  $\alpha$  Scorpii). 8. Chitra चित्रा, the Variegated one, the 14th Lunar Mansion (Azimech, Spica Virginis,  $\alpha$  Virginis). 9. Kaphajnaphara कफजफर? (Algorab,  $\gamma$  Corvi?). 10. Maghá मघा, the 10th Lunar Mansion (Regulus,  $\alpha$  Leonis). 11. L ल, qu. for Lubdhakabandhu लुब्धकबन्धु, the Hunter's brother (Algemeisa, Procyon,  $\alpha$  Canis Minoris). 12. Ardrá अर्द्रा, the Moist one, the 6th Lunar Mansion (Bed Algeuze,  $\alpha$  Orionis). 13. R र, qu. for Róhini रोहिणी, one of the daughters of Daksha, the 4th Lunar Mansion (Aldebaran,  $\alpha$  Tauri). 14. Mithunapáda मिथुनपद, qu. for Mithunavámápad, the left foot of the Pair (Rigel,  $\beta$  Orionis?). 15. Nivana निवन? ( $\gamma$  Eridani?). 16. Musarí मुसरी? ( $\gamma$  Ceti?). 17. Puchhará पुच्छरा? ( $\epsilon$  Ceti?). 18. Makarapuchchha मकरपुच्छ, the tail of Capricorn (Deneb Algedi,  $\delta$  Capricorni). The Mudír of this 'Ankabút is, as I have already mentioned, situated at the right hand extremity of the support which joins the head of Libra with the Tropic of Capricorn. The three circles are traced upon the portions of this 'Ankabút which have not been removed.

The upper quadrants on the back of this Astrolabe have their boundary arcs divided as usual into 90 degrees, arranged and numbered six and six, the numbers commencing from the East and West points of the horizontal diameter. In the left hand quadrant there is a series of cosines of Altitude sexagesimally arranged, one line being drawn for each two divisions of the whole sine: the arc of the obliquity of the Ecliptic is traced on this quadrant, and the cosine which touches its upper extremity is divided transversely into twenty-eight parts; perpendiculars drawn through these divisions parallel with the whole sine, would of course divide the cosine sexagesimally, and thus complete the quadrant. The arc of the obliquity of the Ecliptic is produced through the upper right-hand quadrant, and between it and the boundary arc are the parallels of the Zodiac, the signs being expressed by numerals as in the corresponding quadrant in No. II. of the East-India House. It will be observed, however, that in the latter instance, as well as in Mr. Vaux' Astrolabe, and the Hindú instrument of the Asiatic Society, the parallels of the signs of the Zodiac extend from the boundary arc quite to the centre, whereas in the present instance, as in Shah Husain's and Major Pottinger's Astrolabes, they are drawn only within the space circumscribed by the boundary arc of the quadrant and the arc of the obliquity of the Ecliptic. The boundary arc of the lower quadrant on the left of the perpendicular diameter is divided into 15 portions, each representing six degrees, and numbered accordingly; the numbers commence from the bottom of the instrument. Within this arc, and parallel with it, are three bands, two of which are divided into parts corresponding with the

<sup>1</sup> The pointer occupying nearly the same position in the Hindú Astrolabe of the Royal Asiatic Society bears the name of Sarpadhárisira. This pointer seems to be identical with that assigned to Rás al-Játhí راس الجاثي, in the Muhammadan instruments.



divisions of the boundary arc or external band, and are inscribed with numerals. The three outer bands thus form a table radiating from the centre of the quadrant. The inmost band has written upon it the word Paramakránti परमक्रान्ति.<sup>1</sup> The following is a transcription of the table:—

External Band.	Degrees.	First Band.	Second Band.	External Band.	Degrees.	First Band.	Second Band.
6		146	49	54		1133	6
12		286	71	60		1206	20
18		426	5	66		1286	10
24		561	54	72		1341	53
30		692	22	78		1382	14
36		816	4	84		1406	46
42		931	54	90		1415	10
48		1037	49				

The lower quadrant on the right has nothing traced upon it but the square of the shadows, the vertical shadow being divided into seven, and the horizontal into twelve parts.

The 'Izadah of this instrument presents no peculiarity, with the exception that its ends, or Shaziyahs, project  $\frac{1}{4}$ th of an inch beyond the outer circumference of the Astrolabe: the pinnules are each pierced with but one hole, situated quite at the bottom. The Kutb is hollow, and has a female screw cut on its inner surface; the Faras is an ordinary male screw, with a flat head, and works into the Kutb. There is no Fals.

#### ENGLISH.

H. Is a large brass instrument, of English workmanship, measuring  $18\frac{1}{2}$  inches in diameter. Its date is apparently about A.D. 1340. It is bipartite, and contains three tablets. The suspensory apparatus is perfect, except the cord from which the instrument hangs when in use ('Ilakah), but the Ring (Halkah), and the Armilla reflexa ('Urwah), seem to be modern. The surface of the Bordure (Hajrah), which is remarkably narrow, is divided into 360 degrees, arranged and numbered by fives as usual. The Mumsikah is a cavity in the Bordure, immediately under the centre of the Armilla fixa (Kursi). In the Mother there is traced a projection of the sphere, comprising the two diameters; the three circles; the Almucantars, drawn two and two, the words "42 Gradus Roma" being written under the centre of the oblique horizon; the Azimuths above the Earth, every tenth being traced; and the arcs of the unequal hours. The inscriptions on the tablets are similar with that in the mother, differing only in their Latitudes and some other slight particulars, as follows:—

1. Obv. 48 Gradus. 30 Mt. Rev. 51 Gradus. 2. Obv. 53 Gradus. Rev. 54 Gradus. In this tablet the Almucantars are numbered by twos from the left of the oblique horizon to the Zenith; the arcs of the unequal hours are also numbered. 3. Obv. 55 Gradus. Rev. 52 Gradus Lundoniarum. In this tablet the Almucantars and the unequal hours are numbered as in the last, and in the projection for London the twelve celestial houses are added. Each of the tablets has a protuberance at its summit, fitting into the cavity in the Bordure. The Rete ('Ankabút) of this Astrolabe presents the Zodiacal circle with the signs, each divided into 15 parts of two degrees, numbered 6 and 6, the denticle of Capricorn (Murí Rás al-Jadí), the lower portion of the Equinoctial, the tropic of Capricorn, and the 'Amúd of Aries and Libra, with some other supports for the starpointers (Shaziyahs) and reticulation. The pattern of the latter, which is Gothic in form, is principally made up of trefoils and quatrefoils, from which proceed the pointers in the forms of grotesque animals. The pointers have written under them the names of the following stars:—

Within the Zodiac—1. Ied ( $\delta$  Serpentarii). 2. Alhave ( $\alpha$  Serpentarii). 3. Altair ( $\alpha$  Aquilæ). 4. Delfin ( $\epsilon$  Delphini). 5. Alramec ( $\alpha$  Bootis). 6. Alfeca ( $\alpha$  Coronæ Borealis). 7. Alvaca ( $\alpha$  Lyræ). 8. Alref ( $\alpha$  Cygni). 9. Raztaben ( $\gamma$  Draconis). 10. Benenaz ( $\eta$  Ursæ Majoris). 11. Alderaim ( $\alpha$  Cephei). 12. Bedalferaz ( $\beta$  Pegasi?). 13. Alferaz ( $\delta$  Pegasi and  $\alpha$  Andromedæ). 14. Cauda Leonis ( $\beta$  Leonis). 15. Conjuncte ( $\lambda$  and  $\mu$  Ursæ Majoris?). 16. Edub ( $\alpha$  Ursæ Majoris). 17. Mirac Andro, for Andromedæ ( $\beta$  Andromedæ). 18. Rigilalsabie ( $\delta$  Andromedæ?). 19. Caput Gemino, for Geminorum ( $\beta$  Geminorum?). 20. Alhaioc ( $\alpha$  Aurigæ). 21. Algemb ( $\alpha$  Persei). 22. Caput Ar. for Arietis ( $\alpha$  Arietis?).

Outside the Zodiac—23. Cor Scorpionis ( $\alpha$  Scorpui). 24. Achimec ( $\alpha$  Virginis). 25. Algorab ( $\gamma$  Corvi). 26. Cor Leonis ( $\alpha$  Leonis). 27. Alfard ( $\alpha$  Hydræ). 28. Markeb ( $\epsilon$  Argûs). 29. Algomeiza ( $\alpha$  Canis Minoris). 45. Bedelgeuze ( $\alpha$  Orionis). 46. Alhabor ( $\alpha$  Canis Majoris). 47. Rigil ( $\beta$  Orionis). 48. Aldebran ( $\alpha$  Tauri). 49. Augetenar ( $\gamma$  Eridani?). 50. Menkar ( $\alpha$  Ceti). 51. Batencaitoz ( $\zeta$  Ceti). 52. Denebcaitoz ( $\epsilon$  Ceti). 53. Scheac ( $\delta$  Aquarii?). 54. Denebalgedi ( $\delta$  Capricorni).

<sup>1</sup> I have not ventured to give a version of this word, as I am ignorant of the uses of the table. It is compounded of परम, *best, supreme*, and क्रान्ति, *progression, declination of a planet, the Ecliptic*.

<sup>2</sup> I have used the European term, but in the present instrument the Kursi is in one

piece with the Hajrah and Umm.

<sup>3</sup> This name is derived from the Arabic Rás ath-Thubán رأس الثعبان, *the head of the Dragon*.

There is no Mudír to this Ankabút.

The outer band on the back of this Astrolabe contains the signs of the Zodiac, Cancer being at the top, divided and subdivided each into 120 parts; thus the outer circumference of the instrument presents in each quadrant a division into 360 degrees. The next or second band is excentric, and bears the signs, Aries being at the summit, where that sign touches the outer band. The third band is concentric with the circumference of the instrument, and is also inscribed with the signs of the Zodiac, with Cancer at the top; within this is an excentric band, bearing the names of the Latin months and the number of days in each, together with the feasts and saints' days, and the days on which they fall, and their dominical letters. In the space included within these bands we find, first, about the centre of the instrument, a small circle, which contains a table for finding the dominical letter; and between that circle and the bands aforesaid, first, above the horizontal diameter, a table of the moveable feasts: secondly, below the same diameter, and on either side of it, the square of the shadows, divided both horizontally and vertically into twelve parts. The spaces left between the eccentric and concentric bands, within and without the square of the shadows, are occupied by ornamental designs, the character of which leaves no doubt as to the antiquity of the instrument.

The Alidade ('Izadah), and the apparatus for fastening the Astrolabe together, are wanting; but there is an Axis (Kutb), which is evidently of modern workmanship.

I. An English Astrolabe, made of brass, and dated A.D. 1342. It is a bipartite instrument, measuring  $8\frac{1}{2}$  inches in diameter, and comprising two tablets. The suspensory apparatus is perfect, the cord being alone wanting, and is beautifully engraved with gothic tracery. The face of the Bordure (Hajrah), is divided into 360 degrees, in the ordinary manner, and numbered five and five. The Mumsikah is a cavity at the top. The surface of the Mother (Umm) is smooth and unengraved. One of the tablets contains the two diameters; the three circles; the Almucantars, traced two and two; the Azimuths drawn above the Earth, every fifteenth being traced; and the arcs of the unequal hours. On one side of this tablet the Almucantars are numbered, the Lat. being marked  $52^\circ$  below the first: the horary arcs are also numbered; the other side offers no written character, but is for a Latitude of  $51^\circ$ . The second tablet has on one side the two diameters; the three circles; and the arcs of the celestial houses alone: on the other we find only the three circles. At the upper end of each tablet is a protuberance which fits into the hole in the Bordure. The Rete ('Ankabút) is simple but elegant, two of the pointers are in the form of grotesque animals, and the supports are beautifully engraved. It presents the circle of signs, each divided into 30 degrees arranged and numbered six and six, together with the denticle of Capricorn (Murí Rás al-Jadí); the lower part of the Equinoctial; the tropic of Capricorn, and the 'Amúd of Aries and Libra, with some other supporters.

At the top of a large quarterfoil, which forms part of the reticulation, and immediately under the denticle of Capricorn, is the name of the maker of the instrument, and the date of its construction, thus written:—Blakene me fecit Anno Do<sup>i</sup>. 1342. The pointers of the stars (Shaziyahs) are inscribed as follows:—

Within the Zodiac—1. Alhawe ( $\alpha$  Serpentarii). 2. Yed ( $\delta$  Serpentarii).<sup>1</sup> 3. Altair ( $\alpha$  Aquilæ). 4. Delfin ( $\epsilon$  Delphini). 5. Aleitl ( $\alpha$  Serpentis?). 6. Elfeta ( $\alpha$  Coronæ Borealis). 7. Wega ( $\alpha$  Lyræ). 8. Alrif ( $\alpha$  Cygni). 9. Alramek ( $\alpha$  Bootis). 10. Aldiraz ( $\alpha$  Cephei). 11. Alpheraz ( $\delta$  Pegasi and  $\alpha$  Andromedæ).<sup>2</sup> 12. Benenaz ( $\eta$  Ursæ Majoris). 13. Scecor ( $\beta$  Cassiopeie?). 14. Menchef ( $\beta$  Pegasi?).<sup>3</sup> 15. Deneber ( $\beta$  Leonis). 16. Alrica ( $\beta$  Ursæ Majoris?).<sup>4</sup> 17. Algon ( $\beta$  Persei?). 18. Eiuk ( $\alpha$  Pegasi?). 19. Egregez ( $\lambda$  or  $\mu$  Ursæ Majoris?).<sup>5</sup> 20. Alhayoc ( $\alpha$  Aurigæ).

Outside the Zodiac—21. Alchimek ( $\alpha$  Virginis). 22. Algorab ( $\gamma$  Corvi). 23. Corvus ( $\beta$  Crateris?). 24. Cor Leonis ( $\alpha$  Leonis). 25. Alturan ( $\delta$  Hydræ?). 26. Equis ( $\alpha$  Hydræ?). 27. Algomeiza ( $\alpha$  Canis Minoris). 28. Algeuze ( $\alpha$  Orionis). 29. Alhabor ( $\alpha$  Canis Majoris). 30. Rigil ( $\beta$  Orionis). 31. Aldebaran ( $\alpha$  Tauri). 32. Augetenar ( $\gamma$  Eridani?). 33. Menkar ( $\alpha$  Ceti). 34. Pantacaytoz ( $\pi$  Ceti?). 35. Batencaytoz ( $\zeta$  Ceti). 36. Denebcaytoz ( $\epsilon$  Ceti). 37. Libidened ( $\delta$  Capricorni).

There is no Mudír.

An Index, of which I have given a drawing at Fig. 35 of Plate xxi, traverses over the Rete. I have already alluded to this Index at page 16 of the text.

The outer band on the back of this Astrolabe is divided in each quadrant into  $90^\circ$ , arranged and numbered by tens, the numbers commencing on either side and at both ends of the horizontal diameter. The second band bears the signs of the Zodiac, Cancer being at the top, and each sign being divided into 30 degrees. The third band has written upon it the Latin names of the months, each month

<sup>1</sup> The names of Alhawe and Yed have been erroneously interchanged on their pointers.

<sup>2</sup> From the position of this pointer it answers to Mankib al-Faras ( $\beta$  Pegasi) of the Arabic instruments, called Bed al-Feraz, in the large English Astrolabe. The name is probably wrongly interchanged with No. 14.

<sup>3</sup> Menchef is probably a corruption of Mankib, and should have been inscribed on No. 11.

<sup>4</sup> The word Alrica may possibly be a corruption of Marák مرق, *the soft parts of the belly*. The name given to  $\beta$  Ursæ Majoris by the Arabs is Marák ad-Dubb al-Akbar

مرق الدب الأكبر. This pointer cannot, from its position, be that of the pole-star, but I may mention that the North-pole is sometimes called the Fás ar-Rahá قاس الرها, *the cleft of the millstone*, and that in the Alphonsine Tables the pole-star is termed Alrucaba. Both these latter names have some similarity with the word Alrica.

<sup>5</sup> The position of this Shaziyah seems to point to one of these stars:  $\delta$  Ursæ Majoris is called Maghras ad-Dubb al-Akbar مغرز الدب الأكبر *the seat of the great bear*: but unless the name be wrongly written, the pointer cannot be intended for that star. It occupies the same position as the Conjuncte, No. 15 of the larger English Astrolabe.



being divided into days. About the centre is a small circular table for finding the dominical letters; and between this table and the bands, in the space below the horizontal diameter, is the square of the shadows, divided into twelve parts. The Alidade ('Izādah) is counter-changed, as in that of No. I. of the East-India House, and has but one hole through each of the pinnules. The Axis (Kutb) is of the usual form. The Alpheratz (Faras) is wanting.

## APPENDIX, N<sup>o</sup>. II.

THE following list comprises the titles of all the treatises on the Astrolabe, written by European authors, that I have seen or been able to collect from the various Bibliographical works I have consulted.

### Works composed before the invention of printing—

SYNESIUS, Treatise on the Astrolabe, circa 400. BEDÆ VENERABILIS Libri de argumentis Lunæ, &c., signis cœlestibus et Astrolabo, 720. HERMANNI CONTRACTI Liber de Compositione Astrolabii, &c., 1050. ATHELARDI Liber de Astrolabio, 1130. JORDANI NEMORARI Demonstratio Astrolabii, 1200. PETRI DE APOÑO Astrolabium planum, 1300. NICEPHORI GREGORÆ Tractatus de Astrolabii fabrica, 1350. NICOLAI LINNENSIS Tractatus de Mundi Revolutione, de usu Astrolabii, &c., 1355. ISAAC ARGYRI Tractatus de apparatu Astrolabii, &c., 1368. CHAUCER, The Conclusions of the Astrolabie, 1391. JO. DE GEMUNDEN, Tractatus de compositione Astrolabii, 1400. PURBACH, Astrolabii Canones, 1450—61.

### Works printed in the fifteenth century—

ANDALONIS Opus Astrolabii. Ferrariæ, 1475. JO. ANGELI Opus Astrolabii plani. AUG. VINDEL. 4to. 1488. PROCLUS, De Astrolabio. Venet. 1491. NICEPHORUS, De Astrolabio; PROCLUS, De Astrolabio. Fol. Venet. 1498.

### Works printed in the sixteenth century—

STOFLEPINI Elucidatio fabricæ usûsque Astrolabii. Fol. Oppenheimii, 1513.<sup>1</sup> JO. MART. PROBLACION De usu Astrolabii Compendium. 4to. Paris. 1518. STOFLEPINI Elucidatio fabricæ usûsque Astrolabii. Fol. Oppenheimii, 1524. JO. FERNELII AMBIANATIS Monalosphærium, sive Astrolabii genus; generalis horarii structus et usus. Fol. Paris. 1526. JO. DE AQUILERA Canones Astrolabii. 4to. Viennæ, 1528. COLB Astrolabii instrumenti geometricique tabulæ. 4to. Coloniz, 1532. ORONTII FINEI Quadrans Astrolabicus. Fol. Paris. 1534. ORONTII FINEI Declaratio Astrolabii, &c. 4to. Basil. 1535. JAC. KOEBELII Astrolabii Declaratio, &c. 4to. Moguntiz, 1535. PETRI JORDANI Cœlestium rerum disciplinæ Johannis Stoefflerini. Fol. Moguntiz, 1535. JAC. KOEBELII Astrolabii Declaratio, &c. 8vo. Paris. 1552. ΝΙΚΟΛΑΟΥ, &c., i. e. NICOLAI SOPHIANI De Preparatione et usu Astrolabii annularis. 4to. Basil. 1545. JAQUINOT Usage de l'Astrolabe. 8vo. Paris, 1545. FOCARD, Paraphrase de l'Astrolabe. 4to. Lyon, 1546. JO. DE ROIAS, Commentariorum in Astrolabium. 4to. Paris. 1550. REINERI GEMMÆ Tractatus, &c., et de Astrolabo Catholico. 4to., Antwerpiz, 1550. GEMMÆ FRISII De Astrolabo Catholico. 8vo. Lovanii, 1555. BASSENTIN, Paraphrase de l'Astrolabe. 8vo. Lyon, 1555. GEMMÆ FRISII De Astrolabo Catholico, 4to. Antwerpiz, 1584. BATTINGII FRISII Astrolabii Methodus. 8vo. Paris, 1558. DANTI, Trattato dell'uso et della fabbrica dell' Astrolabio, &c. 4to. Fiorenza, 1569. DANTI, Primo Volume dell' uso e fabrica dell' Astrolabio, &c. 4to. Fiorenza, 1578. COPP, Astrolabium, &c., translated into German by ZACH. BORNMANN, 4to. Bresl. 1584. STOFLEPINI Elucidatio fabricæ usûsque Astrolabii: Astrolabii declaratio à JAC. KOEBELLIO, adjuncta est. 8vo. Paris, 1585. BLAGRAVE, The Mathematical Jewel. Fol. London, 1585. CHRIST. CLAVII Astrolabium, 4to. and Fol. Romæ, 1593. ZACH. BORNMANN, Astrolabium tetragonum. 4to. Bresl. 1595.

### Works printed in the seventeenth century—

GER. STEMPELII et ADRIAN. ZELSTII Utriusque Astrolabii tam particularis quàm universalis fabrica et usus, &c. 4to. Leodii, 1602. JO. KRABBII MUNDENSIS Astrolabium novum et ejus usus. 4to. Francof. 1609. REGNARTII Astrolabiorum, &c. Usus. 4to. Romæ, 1610. GUIL. RECHPERGERI Astrolabium ejusque usus. 4to. Aug. Vindel. 1611. FRANC. RITTERI Astrolabium, 4to. Nureberg, 1613.<sup>2</sup> BLUNDEVILLE,

<sup>1</sup> In the Epigraph, and elsewhere, it is stated to have been printed in 1512, but the date on the Title-page is 1513.

<sup>2</sup> The copy of Ritter's Treatise, which Mr. Augustus Franks has kindly placed at my disposal, bears no date.

his Exercises. 4to. Lond. 1613. p. 593, et seq. ANON. Usage de l'un et de l'autre Astrolabe; particulier et universel, 8vo. Paris, 1625. ADRIANI METII Astrolabium. 8vo. Franecaræ, 1626. ADRIANI METII Astrolabium, in his work entitled Primum Mobile. 4to. Amsterdami, 1631.<sup>3</sup> PH. LANSBERGHII in quadrantem, &c., necnon in Astrolabium introductio. Fol. Middelb. 1635—6. BENED. HEDRÆI Nova et accurata Astrolabii, &c., structura et usus. 8vo. Lugd. Bat. 1643. PETR. COURCIER, Astronomia practica. 12mo. Nanceii, 1653. LEBLANC, Éléments des mouvemens célestes, &c. 8vo. Paris, 1682. LOTH. ZUMBACH, Paradoxum Mechanic-Astronomicum. 4to. Lugd. Bat. 1696. BLAGRAVE, A general heavenly Astrolabe. 4to. Lond. 1696. JAQUINOT, Usage de l'Astrolabe, &c. 8vo. Paris, 1698.

### Works printed in the eighteenth century—

BION, Usage des Astrolabes, &c. 12mo. Paris, 1702. ERN. VOLSHI Liber de Sphærâ, Astrolabio, &c., in Institutionibus Mathematicis. 4to. Aug. Vind. 1718.

<sup>3</sup> This date and place of publication are taken from the engraved Title-page of a copy of the Primum Mobile in my library, but the type-printed Title of the second volume, entitled Astrolabium, gives the name Franecaræ as the place where it was printed;

there is no date. The third and fourth volumes have the same name, and are dated respectively 1630 and 1631.

## POSTSCRIPT.

SEVERAL causes having concurred to retard the printing of the preceding pages, written many months since, some fresh materials in illustration of their subject matter have in the meantime presented themselves, and require a concise notice. In the first place, Dr. Dorn has kindly communicated to me an account of an Astrolabe which, as well as the instrument I have described in the text, was constructed for Shâh Husain Safawî. This account is contained in a letter to Dr. Dorn from M. Khanykov, dated Tabriz, 22d Sept. = 4th Oct. 1854, and will be found at p. 447 of the second volume of the Mélanges Asiatiques. The Astrolabe in question presents many remarkable differences from all those that I have met with: for the particulars of these differences I refer the reader to M. Khanykov's interesting letter. I must add that the writer mentions incidentally a memoir by Dr. Dorn which I have not yet seen: it is entitled "Ueber ein viertes in Russland befindliches Astrolabium, etc." Secondly, I must inform the reader, with reference to Note 8 at p. 4, *suprà*, that five parts of M. Jomard's great work, "Les Monuments de la Géographie," have been published in the course of the present year. In a note prefixed to the first part, the learned Academician explains the reasons that had induced him to suspend the publication of the work; and he adds, that, at length the solicitations, the complaints, and even the reproaches of the savants, both in France and elsewhere, had determined him upon issuing the plates, so far as they were completed, amounting altogether to about sixty in number. The five published parts do not, however, contain any drawings of instruments of observation. It is needless to say that the work is one of the greatest interest, and the form and manner in which it appears exhibit almost unequalled splendour. Unfortunately, its costliness will prevent its extensive circulation, and will confine it, almost exclusively, to the libraries of public institutions and wealthy amateurs: but it is difficult to avoid this inconvenience; and those who have studied the maps published by M. Lelewel, whilst they cannot but admire the almost incredible patience and industry that he has shewn in their execution, will be forced to confess, that comparative lowness of price and compactness of form are only to be attained by such minuteness in the engraving as almost to amount to obscurity. In fact, the student may be said to pay with his eyes instead of with money. I do not say this in disparagement of M. Lelewel's most praiseworthy labours, but the lovers of geographical science owe much gratitude to M. Jomard for his valuable work; and it is to be hoped that fresh solicitations, and, if need be, reproaches, will cause him to complete the collection of facsimiles according to the first grand plan that was formed, and that he will illustrate the whole with descriptions and explanations which no one could furnish so well as himself. Lastly, I have met with three Astrolabes, two Oriental and one English, in addition to those described in the text and the first Appendix. Two of these have been recently acquired by the British Museum, the third is the property of Mr. Williams, Assistant Secretary to the Royal Astronomical Society. I subjoin a succinct account of these Astrolabes, merely mentioning the peculiarities which distinguish them from those already described, commencing with those which are deposited in our National Collection.

I. This magnificent Astrolabe was constructed for Al-Malik al-Ashraf, son of Al-'Adil, and nephew of the great Salâh ad-Dîn, by 'Abd al-Karim al-Misrî al-Usturlâbî, in A.H. 633 (A.D. 1235.) Al-Malik al-Ashraf ruled at Damascus from A.H. 626 (A.D. 1228) to A.H. 635 (A.D. 1237). It was discovered, accidentally, by Mr. Augustus Franks in the shop of Mr. Pratt, of Bond Street, and we have no clue to



its history beyond the record it itself presents. It is made of brass, beautifully inlaid with silver, and is 13 inches in diameter; it is in excellent preservation, and perfect in all its parts, with the exception of the 'Ilakah and the Faras, which are wanting. The inscriptions are in the Kúfic character. On the face of the Umm is traced the Safihah-i 'Arz-i Tamám-i Mail-i Kullí.<sup>1</sup> There are but three tablets which are Tamm in the arrangement of the Almucantars outside the tropic of Cancer, but bipartite within that circle; on one surface, however, every Almucantar is traced throughout. The Azimuths are only drawn on the last-mentioned surface, and in that instance only below the earth. On one of the tablets is traced the Safihah al-Áfakiyah,<sup>2</sup> the horizons being traced at intervals of eight and eight. The chief peculiarity observable in this Astrolabe is the introduction of the forms of men and animals: I have already said, at page 15 of the text, that the anonymous Persian writer mentions the practice of their introduction into the 'Ankabút, but I have never seen the practice adopted except in the present instrument. In the 'Ankabút of this Astrolabe the Shazíyahs of the stars are principally shaped in the form of heads of birds and nondescript animals, but in some instances the figures of entire animals appear, and in many the forms chosen bear relation to the names of the stars whose position they indicate: e.g. the pointer of Rás al-Játhí is represented by the figure of a man kneeling; that of At-Táir by an eagle; that of Kalb al-'Akrah by a scorpion; that of 'Unuk al-Hayyah by the head of a serpent, &c. On the back of the instrument one of the circular bands offers the signs of the Zodiac, represented by engraved figures of the objects designated by their names. The upper quadrants enclosed within the circular bands on the back are occupied with tables of sines and cosines; in the lower, there are some semicircular bands containing Astrological tables, and in one, viz., that which contains the planets in the order of their Terms, the planets are represented by conventional marks, almost exactly similar to those in use with us at the present day. The 'Izadah is of the species which I have termed interchanged.<sup>3</sup>

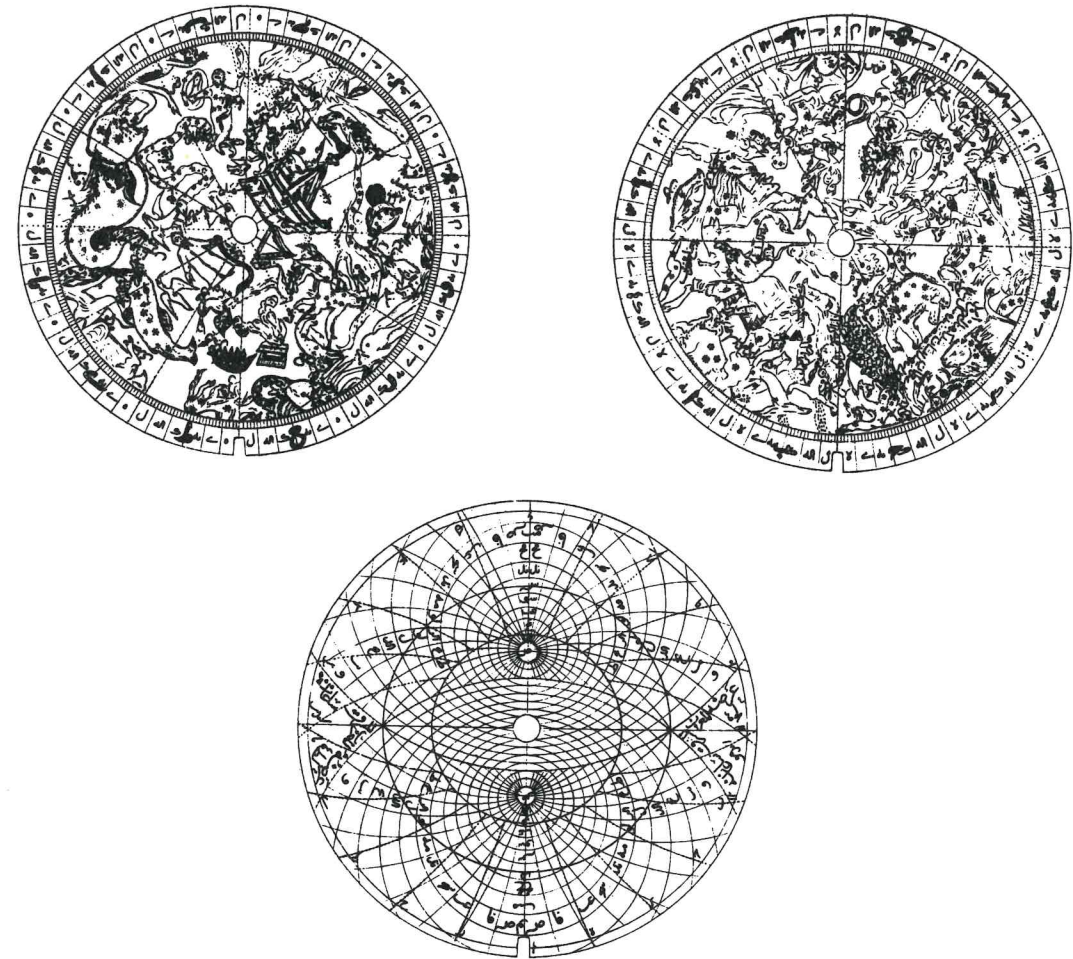
II. This is a beautiful little brass instrument, of English workmanship. It is  $3\frac{1}{16}$  inches in diameter, and was made by Humfrey Cole, A.D. 1574, and subsequently belonged to Henry Prince of Wales, son of James I., as is sufficiently proved by the initials H. P., and the feathers and coronet engraved on a silver ornament attached to a velvet case in which it reposes. This Astrolabe is entirely different from the ordinary instruments, but the inscriptions it bears closely resemble those found on the planisphere of De Roias, as figured and described by Danti.<sup>4</sup> It was purchased for the British Museum at the sale of Mr. Bernal's remarkable collection.

III. Is a small but elaborately ornamented Persian Astrolabe belonging to Mr. Williams, Assistant Secretary to the Royal Astronomical Society. It is made of brass, and is  $4\frac{1}{2}$  inches in diameter: it is Sudsí or sexpartite. The engraved characters and ornaments, with which it is completely covered, are of the finest and most elegant form and workmanship; and the instrument is perfect with the exception of the Halkah and the 'Ilakah. The inscriptions on the Kursí inform us that it was constructed for a certain Muhammad Bákir Isfahání, whose titles are restricted to those ordinarily conferred on men of learning. The names of the constructor occur on the back of the Astrolabe: they are Muhammad Mahdí al-Khádím. The inscriptions are partly in Persian, but principally in Arabic: those in the former language are written in the Nasta'lík, those in the latter in the Naskh character. In the Umm there is a table of the names of Cities, with their Longitudes, Latitudes, Inhiráfs, and Jihats. The tablets are five in number; on one of them is the Safihah al-Áfakiyah, containing sixty-four horizons, traced by intervals of eight and eight in each quadrant: this tablet has four notches, one at either end of each of the diameters, for the reception of the Mumsikah, according to the position of the Safihah al-Áfakiyah required. Another tablet offers on one of its surfaces a double projection, similar to that found in Professor Wilson's Astrolabe, but more perfect, since it contains, in addition, the Azimuths above the Earth: a portion of them, however, being omitted in the space intercepted between the two horizons. I have added a transferred impression of the double projection at the end of this postscript. The most important difference between this and the other Astrolabes which I have seen is, that one of the tablets has traced upon one of its sides a star map in polar projection of the Northern, and on the other, of the Southern hemisphere; the constellations are figured, and the principal stars are marked with due reference to their respective magnitudes. I defer a more elaborate notice of this last-mentioned tablet to some future period, and content myself with appending to this postscript transfer-copies of these curious and interesting maps. The 'Ankabút of this Astrolabe, in addition to the Shazíyahs of the stars, has five other pointers, which bear the names of cities, viz., Makkah, Mashhad, Kúfah, Baghdád, and Surra Man Raa. The outer circle of the 'Ankabút has written upon it a series of verses, alluding to the several parts of the Astrolabe, the last being a chronogram of the date of its construction, viz., *آئینهء سكندر و جام جهان نماست*, "It is the mirror of Alexander, and the mirror representing the whole universe," the letters of which hemistich, according to the Abjad, give the date A.H. 1070 (A.D. 1659). At the two points of this outer circle, at the top of the 'Ankabút, two small portions of turquoise stone are inlaid into the brass. On the back of the Kursí is written the entire Verse of the Throne: in the centre there is a circular concavity, surrounded by a margin of silver, on which are inscribed the four cardinal points and the names of certain cities, the concavity is void, but it is probable that the vacant space was originally occupied by a compass needle, a somewhat similar compass existing in the instrument last mentioned. The back of this Astrolabe resembles almost exactly that

of Shah Husain's. The upper left hand quadrant presents a nonagesimal series of Mabsút sines; and the only difference is that radii are drawn from the centre to the circumference at every 5th degree: the remaining quadrants are occupied by the parallels of the Signs of the Zodiac, with the Meridional arcs and the Azimuthal arcs of the Kiblah; the degrees of the shadow in fingers and feet; the astrological tables; and the square of the shadows, all of which are arranged as in Shah Husain's Astrolabe. The name of the constructor is not only inserted in exactly the same place as in the last-named instrument, but the lozenge-shaped space in which it is engraved is of precisely the same form. The pattern of the ornaments is almost identical in both throughout. The 'Izadah is divided, and the bevelled edge of one half of it is divided into sixty parts, which would correspond with the sexagesimal division of the whole sine if such division existed: the Libnahs are each pierced with two holes. The Kutb has a silver head, and in the smaller end there is cut a female screw which receives the Faras consisting of a male screw with an octagonal silver head. The body of the instrument and the 'Ankabút have been washed with a hard varnish or lacquer, which although somewhat detrimental to its appearance, has no doubt contributed to the preservation of its surfaces.

W. H. M.

15, SERLE STREET, LINCOLN'S INN,  
Dec. 8th, 1855.



<sup>1</sup> Described at p. 12 *supra*.

<sup>2</sup> Described above at p. 12.

<sup>3</sup> See p. 20 *supra*.

<sup>4</sup> Trattato, &c., 4ta. Parte.