AN INTERPRETATION OF SOME SELJUK, ATABEG AND AYYŪBID MINA'I, LUSTRE AND UNDER-GLAZE PAINTED DEPICTIONS AS PROVIDING A RECORD OF TYPES OF 12TH AND 13TH CENTURY CYPHER MACHINES EMPLOYED FOR CODED COMMUNICATIONS

Selçuk, Atabey ve Eyyubi Minai, Lüster ve Sıraltı Seramiklerinde Görülen Bir Motif Üzerine Yorumlar: 12-13. Yüzyıl Haberleşme Sisteminde Kullanılan Şifre Makinesinin Betimleri

Michael Terrance DUGGAN[*]

Öz

Bu makale, çağdaş sanat tarihi literatüründe ve müze kataloglarında sıklıkla 'güneş', 'güneş parlaması' 'yıldız' ya da 'ışınları olan rozet' olarak tanımlanan bir motifin (güneşe benzemesine sebebiyle), 12-13. yüzyıllarda Selçuk, Atabey ve Eyyubi topraklarında uygulanan haberleşme/istihbarat sistemi içinde kullanılan bir şifre makinesinin betimlemesi olabileceğini önermektedir. Bu tip bir aracın betimlerini 'güneş' motifinden ayrılan belirli özellikler bulunmaktadır: Üç diskten oluşan araç motifte de iç içe üç dairesel form ile betimlenir: sıklıkla yüz (insan ya da büyük kedigil) tasviri olan, bazen düşeyde bir işaret imi bulunan ve dış çepherde bir sıra daire motifi bulunan bir merkezi daire; bundan çıkan ve aracın ışınları/işaret imlerini iki farklı seviyede (iç/üst ve dış/alt grup) ayıran daha geniş bir çember; ve dışta disk benzeri bir çerçeve. Bazı ışınların sivri uçları bu çerçeveden dışarı taşarak dış diskte okunması gereken harflere/rakamlara işaret eder. Aracın betimi olduğu önerilen motif, yüksek seviyeli haberleşme sistemi ile ilişkili kompozisyonlarda gözlenmektedir. Motifin bulunduğu seramik kaplarda, şifreli mesajları betimleyen kutu sıraları ile ışıklı sinyal

[*] Akdeniz Ünivetsitesi, Öğretim Üyesi

araçları ve barid sisteminin elemanlarının tasvirleri de yer almaktadır. Bu nedenle bu motifin güneş tasviri ya da güneş ışınlarını yansıtan bir nesne olarak tanımlanması yerine şifre makinesi tasvirleri olarak yorumlanması düşünülebilir. Bu araç sultanın barid teşkilatı tarafından, atlı haberciler (kasıd), posta güvercinleri (haman) ve daha da önemlisi özel sinyal araçları ile yansıtılan ışıklı mesajları şifrelemek ya da gelen şifreli mesajların okunması amacı ile kullanılmış olsa gerektir ve olasılıkla 12-13. yüzyıllar boyunca, Moğol istilalarına kadar kullanılmıştır.

Anahtar kelimeler: Selçuk şifre makinesi, barīd-istihbarat, haberleşme, 'güneş' – 'güneş motif'

Abstract

Repeatedly described in modern art historical and other literature and in museum catalogues as the representation of a 'sun', a 'solar design', 'sunburst', a 'star', or as a 'rosette with rays', this article suggests that some examples of this type of depiction - whilst having the form of a 'sun' or of a 'sunburst' or 'star' – rather, and in some cases with considerable accuracy, record the types of cypher device/machine that was employed to make and to read secure encrypted communications in the 12th to 13th centuries within the Seljuk, Atabeg and Ayyūbid territories of the Abbasid Caliphate. The primary distinguishing features between the representation of what has been termed a 'sun', 'solar device' etc., and the depiction of this type of encryption device, consists in the depiction of three disks - an inner disk, often carrying the depiction of a face, human or feline, sometimes with a noteworthy vertical marker, and often with a series of circles around its rim – a wider disk that separate the rays/pointers of this device into two separate layered groups, an inner/upper and an outer/lower group - within an outer disk-like frame, across the edge of which the pointed ends of some of these rays/pointers pass, with the setting of the machine's pointers-rays determining the sequence of the letters-numbers to be read off the outer disk. Furthermore, the context within which these depictions occur can be associated with the depiction of high level state communications, with at times the depiction in an encircling band of coded messages in boxes, the depiction of signalling devices and of members of the ruler's *barīd-istihbarat.* It is therefore suggested that this type of representation having the form of three-disks with pointers-rays, while having the form of a '*sun*' or

'*a solar device*', can rather to be understood as depicting examples of the types of cypher machine that was employed by the ruler's *barīd-istihbarat* to encrypt and decrypt some of the messages sent by means of couriers-*kasıd*, by messenger pigeons-*haman,* and most rapidly, through sequences of signals of reflected light/coloured light during the course of the 12th and into the 13th centuries until the pagan Mongol interventions.

Keywords: Seljuk Cypher/Cipher, *barīd - istihbarat* communications, "sun"-"solar device"

Although we have some idea of the types of codes that may have been employed, codes involving substitution and perhaps also transformation in the 13th c.,[1] and a Mamlūke work recording cyphers-encryption, Shihab al-Din abu'l-Abbas Ahmad ben Ali ben Ahmad Abd Allah Qalqašandī's *Subh al-A'sha* completed in 1412, who employed a 14th c. work on encryption by Taj ad-Din Ali ibn ad-Duraihim ben Muhammad ath-Tha'alibi al-Mausili (1312-1361) in his work, which has survived to the present day[2], our knowledge of the

[1] 'Alī ibn 'Adlān (1187-1268) of Mosul wrote in his treatise, *al-mu'allaf lil-malik al-'Ašraf*, on frequency analysis of simple substitutions for code breaking. He grouped the 28 Arabic letters into 3 categories, 7 with high frequency, 11 moderately often and 10 rare letters, and wrote that texts of over 90 letters may be broken by frequency analysis, ie. a plain text consisting of roughly 3 times the number of the letters of the alphabet of 28 letters. Ibrāhim Ibn Moḥammad Ibn Dunainīr (1187–1229) in his *Miftāh al-Kuniūz fi Idāḥ al-Marmūz* shows for example that the individual letter of a word can be converted through the *abjad* system into a number, a system frequently employed in Arabic astronomy, by instrument makers (there is a table of *abjad* letters in al-Jazari's work on mechanical devices, written in Amid, 602 (1206), Topkapi Saray Library A3472, fol. 256.) as elsewhere, with this number then doubled, or tripled etc. and left as a sequence of numbers and spaces, or, the result of the doubled or tripled number is then reconverted back into two different letters, see Al-Kadi, "*Origins of cryptology*," 1992, Cryptologia, 16:2, 97-126, 115 and 119. For these works in the Series on Arabic Origins of Cryptology, Ed. Mrayati. M. Y. Meer Alam- At-Tayyan., M. H., *ibn 'Adlān's Treatise al-mu'allaf lil-malik al-'Ašraf (The book written for King al-'Ašraf),* King Faisal Center for Research and Islamic Studies, Riyadh, 2004; Ed. Mrayati. M., Y. Meer Alam- At-Tayyan., M. H. *Ibn Dunaynīr's Book: Expositive Chapters on Cryptanalysis,* King Faisal Center for Research and Islamic Studies, Riyadh, 2005. For a contemporary substitution alphabet different from *abjad* see D. Link, "*Scrambling T-R-U-T-H: Rotating Letters as a Material Form of Thought*," Variantology, 248-249 http://d13.documenta.de/research/assets/Uploads/DavidLinkScramblingTruth2010100dpi.pdf.

[2] See, Taj ad-Din Ali ibn ad-Duraihim ben Muhammad ath-Tha'alibi al-Mausili (1312-1361), whose writings on cryptography have been lost, but he recorded both substitution and transposition and a cipher recorded for the first time with multiple

appearance and of the types of 12th and 13th century cypher machines that would have been employed by the members of the ruler's *barīd-istihbarat* for coded communications[3] is today non-existent.

The aim of this article is to present some examples that appear to depict such cypher-machines. These six examples on 12th-13th century ceramics are here interpreted as most probably representing types of this most singular enciphering-deciphering device. They are recorded on ceramics produced in Seljuk, Atabeg and Ayyūbid territory and presumably some, if not all, were painted to detailed designs supplied by *nakkaş*-designers employed by the state.

To date these examples: *haft-rangi* - *mina'i* painted and gilded, painted in lustre, and under-glaze painted, have for quite obvious formal reasons been repeated identified as carrying depictions of "*the Sun*," a "*Solar device*," a "*sun*." etc. However, if one places to one side the formal resemblance to the sun, of which no doubt the designer-engineers of these device were themselves well aware, due to the relationship between light and knowledge in the temporal, religious and metaphysical worlds, as of the temporal sun as a symbol of The Sun, of the light-knowledge of the Almighty[4], and, given their different places of production and looking in a little more detail at what may be represented by these depictions not previously thought to represent any engineered device, most are recorded with considerable detail and care, this interpretation suggests that what

---

substitutions for each plain-text letter, as also the text hidden in every third letter of a word, whose work was employed early in the 15th c. in Mamlūke Egypt, by Shihab al-Din abu'l-Abbas Ahmad ben Ali ben Ahmad Abd Allah Qalqašandī in his chapter on codes, with examples of substitution ciphers, in which each character is substituted for another, and transposition ciphers, in which the order of the letters is changed. In several codes the *abjad* numerical values were used to represent letters. His system of code breaking was based on the structure and phonetic patterns of Arabic words, Bosworth 1963, 17-33. Earlier the Ghaznavid chancery of Sultan Masʿūd b. Maḥmūd made use of messages in code (moʿammā, moʿammā-nāma) in 423/1032 (Bayhaqī, ed. Fayyāż, pp. 403-04; tr. A. K. Arends, Moscow, 1969, 403-04), Bosworth 1992, 883-885.

[3] Some messages were also sent *en clair* at this time, as for example a carrier pigeon sent from Jerusalem but brought down by a hawker during the siege of Jerusalem in 1099 which carried a message from the Fatimid governor of Jerusalem Iftikhar ad-Dawla requesting attacks be made by the Fatimid governors of Acre and Caesarea on the Crusaders besieging the city, and this message was read by the Crusaders, suggesting it was not enciphered, Frankopan 2012, 174-5.

[4] For an account of this association see: Duggan 2014, 129-157.

was depicted are versions of a disks and pointers type of encryption/decryption device, one that was employed by the members of the ruler's *barīd*[5]*-istihbarat.*

Two of the ceramic examples on which it is suggested this device is depicted can with certainty be associated with state communications, as the context of the rest of the depictions recorded on these two *haft-rangi - mina'i* painted bowls can be read as being concerned with the depiction of state communications-diplomacy (Examples One and Two). It can be suggested that three other depictions all in lustre (Examples Three, Four and Five) also carry in addition to the depiction of this device, other designs that can also be related to communications by means of signalling with reflected light, while the under-glaze painted bowl (Example Six) carries a depiction of this same type of cypher device and may likewise come from this same state communications context.

Although interpreting six of these painted designs as providing a record of examples of 12th and 13th century cypher machines is, in the absence of any publication recording the survival of the physical objects themselves for their comparison with these painted depictions and in the absence of contemporary written descriptions of these devices, a seemingly adventurous suggestion, this interpretation is offered on the basis of and for the following reasons: Firstly, we lack today any written description of the physical appearance of an encryption/decryption device dating from this period, yet it seems certain such a device would have been employed given the complexity of the codes that are described.

Secondly, artefacts are themselves historical sources and the present unsatisfactory description of these depictions on these 12th and 13th c. ceramic artefacts as depicting a "*sun*", "*solar device*", "*the human faced sun with its rays painted in black,*" etc., when, unlike the typical depiction of a sun-sunburst-*shamsa*, although they have the form of a sun, they are quite clearly divided into a series of three disks and two rings of rays-pointers[6], and the inner disk often with

[5] From the Assyrian, *puridu*, swift messenger, originally runner, which passed into Arabic as *barīd*, courier.

[6] There is a Syria unglazed Medieval moulded and incised bottle today at LACMA, USA, gift of Camilla Chandler Frost (M.2002.1.90), which has a neck consisting of three disks with incised pointer-marks on each ring, having some resemblance to this type of device, as also to the form of the combination locks of the period, see below.

the face of a human or feline is frequently surrounded on its outer rim with a series of circles - these differences serve to distinguish these depictions from the typical representation of a sun-sunburst-*shamsa* and suggest they may have served some different function. Further, the number of rays-pointers in four of these examples is unrelated to 6, the six planets, or to 12 or to multiples thereof, i.e. the 12 months, and so seems to be unrelated to astrology-astronomy, as the sun-*shamsa* at this time is often depicted with 12 or multiples thereof, or with 20[7] or 40 rays, numbers indicating many. No reason or explanation has to date been offered in the relevant literature for these differences from the depiction of the typical "sunburst".

Thirdly: In those examples that record it, there appears to be a deliberate relationship between the number of circles on the innermost ring and between the number of pointers-rays that are depicted in the two rings, one above and one below the middle disk, a ratio between these parts that does not seem to be either fanciful or random, but appears to be considered and deliberate.

Fourthly: All of these depictions, through the particular scenes depicted or through the designs-patterns employed on these ceramic examples can, it is suggested, be associated with communications-signalling.

Fifthly: Although contemporary written sources concerning the ruler's *barīd* - *istihbarat* are, perhaps unsurprisingly, rather scarce, we do know that cyphers-codes were employed by Muslim rulers in communications during this period[8], that instrument

[7] In the depiction of the sun-moon on Seljuk 8 pointed under-glaze painted frit-ware tiles, as from Kubadabad, in the inner circle there is a human face surrounded by a single circle of rays, usually 20, often in alternating colours, examples, Arık-Arık 2008, Fig. 397 and page 371. For a lustre example where the human face in the sun is surrounded by a ring with probably 32 lustre dots, with probably 16 of these dots located at the base of stylised rays, Arık 2000, Fig.175. On the famous silver dirham of Sultan Giyaseddin Keyhüsrev II there is a human face in the sun-moon, with a single ring of 40 positions surrounding the face, and between 20 and 40 rays, the forty presumably meaning-representing the many beams of sunlight-moonlight. In the depiction of the sun in copies of Abu Yahya Zakariya' ibn Muhammad al-Qazwini (d.1283-4)'s *ʿAjā'ib al-makhlūqāt wa gharā'ib al-mawjūdāt*, there are examples with a face surrounded by 22 rays touching the outer ring; of two rings of 32 rays and of two rings of 32 and 36 rays.

[8] See for example, Ragheb 2002, 151-152. Likewise Holt 2004, 215, from the end of this period, cites Muḥyi 'l-Dīn Abu 'l-Faḍl ʿAbd Allāh b. Rashīd al-Dīn Abū Muḥammad ʿAbd al-Ẓāhir (1223-92) who relates Qalāwūn received a despatch in cipher from his chief spy

makers were often in this period connected to the ruler's court,[9] as also that the minute script employed for pigeon and secret correspondence, a variant of *naskh* termed *Ghubār al-hilya* (dust)[10] script, which was probably developed during the 9th c. and which is mentioned by Ibn an-Nadim in his late 10th c. *Kitāb al-Fihrist*, was the script for the language of birds, bearers of secrets, of bird language-*kuş dili,* a secret language of initial letter substitution, for enciphered messages, received and decoded by the wise. If there was also at that time an entirely numeric script employing *Ghubār* numerals is uncertain.

These six Example depictions seem to record examples of an advanced letter/number substitution mechanical device - an ingenious machine, which, it can be suggested, was the scientific device employed to convert text messages concerning state affairs in the 12th -13th centuries into enciphered messages for communication. Two examples show colour coding, one employing three colours, red, blue and green, the other two colours, red and blue,

Within this context of the representations of a suggested 12th -13th century cypher device, it can be noted that there are related surviving devices that have designs and mechanisms that can be related to this suggested type of cryptographic device, having a similar purpose. These examples are also mechanical devices concerned with security, with an *abjad* code, a cypher, and which likewise present any potential code-breaker with a vast array of potential combinations. They are the six published examples of surviving four dial rotary combination locks on boxes-caskets, five date from the 12th and 13th centuries and there are at least another two unpublished;[11] while this same type of device, but of a more

---

reporting on events, and gives its contents, although not the type of the cipher that was employed nor if a mechanical device for deciphering was used.

[9] For further on the production of scientific instruments within a court context, see for examples, Charette 2006, 126-128; and on the relationship between craftmen and mathematicians see Saliba 1999, 637-645.

[10] *Ghubar al-hilya/Ghober* script was so small it required magnifying to write and to read it and it was not employed for all carrier pigeon messages. More properly *Ghubār al-Halba*, meaning literally, the 'dust of the race track,' Mansour 2011, 276, but also, *al-bada'iq* slips of paper, or *al-janah* wing.

[11] "*One is in a private American collection, while the other is in the Hermitage Museum, St. Petersburg*." See:

advanced design, the dials work with three combinations set on each dial, resulting in a code of twelve letters, was described by ibn ar-Razāz al-Jazarī in his 1206 work,[12] and a working model of which has recently been constructed and exhibited. These examples are:

Boston Museum of Fine Arts, Acc. No. 55.1113, from Khurasan or Iran, and dated 593 h.-1197, a box attributed to Muhammad ibn Hamid al-Asturlabi al-Isfahani, with a combination lock of four two-level dials in a line. To open the box all eight dials had to be set in the correct position, requiring an eight-digit code[13].

1. David Col. Inv. No. 1/1984, signed by Muhammad ibn Hamid al-Asturlabi al-Isfahani and dated 597 h.-1200-1201. It has four double dials on the lid in a line, with each dial on the lid to be turned to one of the sixteen letters on the six-pointed disk, which in turn had to be pointed to the correct letter on the 16 position scale below it, providing a total number of 4,294,967,296 possible combinations, only one of which will open the box[14].

2. An ivory box with combination lock of four dials on the corners of the front face, each *abjad* dial with 16 positions per dial from Syria, c. 1200, today in the treasury of St. Servatius, Maastricht [15].

3. A brass and silver inlaid casket signed by Muhammad al-Baghdadi, produced in the 13th c. probably Jazira, northern Iraq. The mechanism has been replaced, it is suggested by a copy of the

---

http://www.christies.com/lotfinder/Lot/a-rare-mosul-combination-lock-casket-signed-by-5358612-details.aspx There is also an example attributed to Sicily, said to be 12th c. and later, missing its mechanism, re-used Christies, London, King Street, 5th October 2010, Sale 7871, Art of the Islamic and Indian Worlds, Lot. 132. http://www.christies.com/lotfinder/lot_details.aspx?intObjectID=5358726&lid=1

[12] Tekeli-Dosay-Unat 2002, 238-244.

[13] Combination lock box | Museum of Fine Arts, Boston www.mfa.org/collections/object/combination-lock-box-21956 Fragment of a box with a combination lock | The Met*metmuseum.org/exhibitions/view?exhibitionId=%7B74efafb7-a808-4ede-bf58...*

[14] https://www.davidmus.dk/en/collections/islamic/materials/metal/art/1-1984, www.museumwnf.org/thematicgallery/thg_galleries/database_item.php?id...

[15] Hattstein-Delius 2000, 194. Also given to Sicily in the 12th c.

original mechanism, but the four dials on the corners of the lid remain in place. Sold at Christies, London, in 2010[16].

4. Another example, Christies, London 10th October 1989, Lot. 526, today in the Nasser D. Khalili Col., No. MTW 850, from the 13th c. Jazira, northern Iraq. The lid has four dials, each with 16 letters in *abjadi* (numerical value) order . The dials are in place, the mechanism is missing[17].

5. The remains of another example (the four dials have been removed), dating from 1300-1350 is today in the V&A, London, Museum No. 459-1873 [18].

The locking devices on these caskets provide, in terms of the mechanism, of rotating rings and in the possible number of combinations, examples that are closely related to the type of rotary cypher machine of disks and pointers-rays which, it is suggested, are recorded in this type of depiction on these 12th and 13th c. ceramics. These rotary combination locks come from the same areas, Iran, Jazira, Iraq and Syria, where it is suggested these rotary "sunburst" disks and pointers-rays cipher machines were employed and where the mathematical and engineering skills, the types of substitution cyphers and the materials (brass inlaid with silver), were available at that time to manufacture such devices by court related figures, who also designed and made such ingenious devices as astrolabes, boxes with combination locks, automata and signalling devices - scientist-engineer figures such as Muhammad ibn Hamid al-Asturlabi al-Isfahani, Muhammad al-Baghdadi and ibn ar-Razāz al-Jazarī.

First Example

The Fitzwilliam Museum, Cambridge's catalogue description of No. C.146-1935, a *mina'i* painted and gilded Kashan bowl, dated c. 1170-c.1220, (Figs. 1 and 2), in part reads as follows:

"*Interior: the rim is painted with a blue dentillated pattern. On the neck a kufic inscription is outlined in black and surrounded by*

[16] *Christies,* London, King Street, 23rd April 1996, Lot 194; 5th October 2010, Sale 7871, Art of the Islamic and Indian Worlds, Lot. 16. http://www.christies.com/lotfinder/Lot/a-rare-mosul-combination-lock-casket-signed-by-5358612-details.aspx

[17] http://www.khalilicollections.org/collections/islamic-art/khalili-collection-islamic-art-casket-with-the-remains-of-a-combination-lock-mtw850/

[18] See Melikian-Chirvani 1982, No. 90, 197-200; Box | V&A Search the Collections

black scrolling tendrils, all reserved on a blue band. In the centre of the body, a horizontal line of three mounted horsemen with up-stretched arms, wear polychrome robes and ride blue or brown steads with gilded reins. The central horseman holds a string in his right hand that is connected to a blue, red, green and gold balloon comprising a pair of split leaf palmettes, which flank central dotted tear drop cartouche on which a bird is perched. Either side of the balloon two figures are seated, wearing polychrome robes with gilded arm bands. Three red, green and blue quatrefoils are painted around the human figures. Below the horsemen two inversed sphinx are painted either side of a similar balloon to that on the upper section. Exterior: on the neck, a kufic inscription is outlined in black and reserved on a blue band. On the base a human face forms the centre of a radiating solar design of blue, red and green triangles and lines."[19]

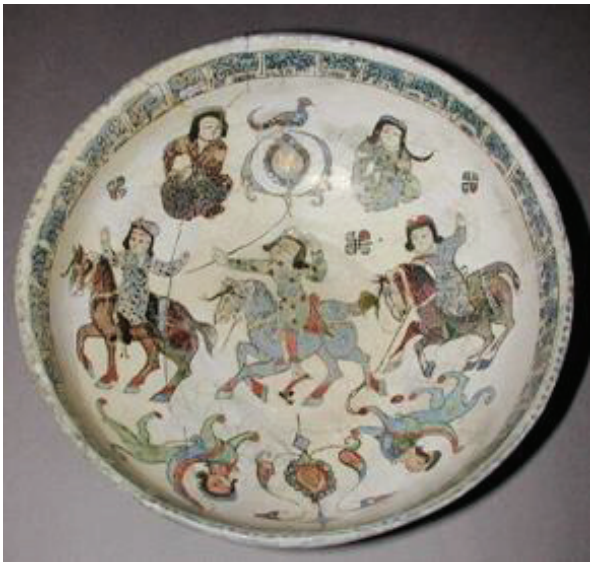

Fig. 1. Iran, Kashan, c. 1170 - c.1220, interior of a frit-ware mina'i painted bowl, Fitzwilliam Museum, Cambridge, no. C.146-1935.

[19] http://webapps.fitzmuseum.cam.ac.uk/explorer/index.php?qu=syria%20fritware&oid=72039

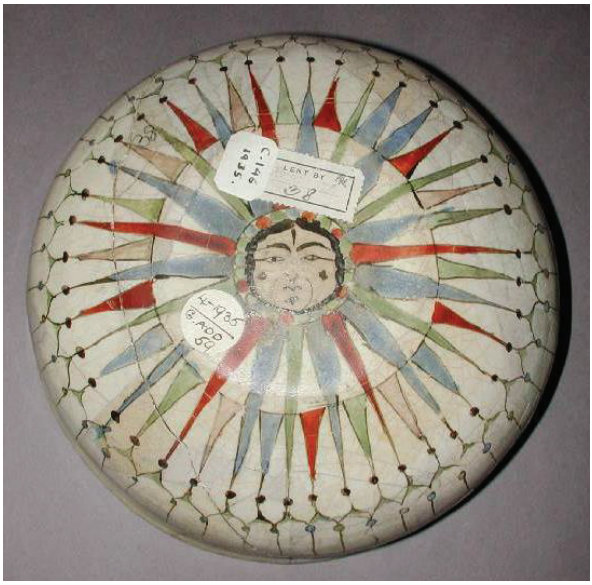

Fig 2. Iran, Kashan, c. 1170 - c.1220, view of the base of a frit-ware mina'i painted bowl, Fitzwilliam Museum, Cambridge, no. C.146-1935. Ex. Frank Brangwyn R.A. collection.

However, the scene depicted in the interior of this bowl (Fig.1) can be perhaps rather be understood as representing the jinn-like rapidity of 12th-13th century communications employed by the ruler, represented by the depiction of three figures on horseback across the middle of the bowl, the central figure possibly represents the ruler, as the signal from the mirror signalling devices depicted above and below, reach this figure, the other two, messengers-*kasıd*, all moving from right to the left, as the script is read, and above each rider there is a four petal motif, each with two petals blue, the others red and green (this same sequence of colours Red Blue Green Blue is found depicted on the base of this bowl in the sequence of pointers/rays on the middle disk, a RBGB repeat that can be related to the signallers' colour code employed (see below) and, consequently, these four petal devices should probably be identified as indicating the colour keys to colour coded enciphered messages, rather than being termed, as in the catalogue entry, '*quatrefoils',* a word culturally displaced and thereby occluding meaning, rather than context specific or neutral). Above these riders are depicted two signallers/observers on either side of the representation of the

mirror signalling device[20], with what can be understood as the representation of a messenger pigeon[21] on top of the mirror and, below the line of riders, the depiction of two Jinn of the Land (crowned, human headed, winged, feline bodied creatures, rather than being termed '*sphinx*' or '*two inversed sphinx*', terms culturally displaced, rather than relevant, as is the term 'Jinn of the Land', or neutral, and thereby through the use of the term '*sphinx*' in modern times applied to this type of depiction in an Islamic context unintentionally occluding contextually relevant meaning[22]) to either side of the lower signal mirror device which faces the depiction of the signal mirror device directly above it, on the other side of the interior of this bowl. The lower of these two mirror signalling devices is supported on a vertical rod and has a pair of stylised wings, rather than having a messenger pigeon sitting on top. As a pair of mirror devices are depicted yet the adjacent figures are respectively, a pair of seated humans (the suggested signallers/observers) and the representation of a pair of Jinn of the Land, one can suggest that the depiction of these two Jinn of the Land figures was to indicate the speed of communications by means of signals of reflected light. The term jinn is perhaps the more appropriate, culturally, scientifically and religiously relevant term, being repeatedly mentioned in the Holy Qu'ran, where they are recorded as being made of smokeless-scorching fire, السَّمُومِ =scorching-blazing-smokeless-searing/*alssamoomi*, Qu'ran, Al-Hijr, 15.27[23], attributes distinct from those of the "sphinx" or the "siren-harpy" of antiquity. Each of the

[20] For further on this matter of signalling by means of mirrors, lenses and reflected light see: Duggan 2014, proceedings forthcoming; Duggan 2016, proceedings forthcoming; Duggan – Şen 2016, 1-17.

[21] On messenger pigeons, a system of communications employed from 3000 B.C. onwards see for 12th and 13th c. examples: Ragheb 2002; Silverstein 2007. Hence Jelalad-Din Rumi's association of the two, remarking, "*Bird, speak the tongue of birds: I can heed your cipher!*" Rumi 2006, 168.

[22] For further on this matter of the modern use of the pagan-jahiliyya terms, sphinx, siren and harpy to describe 11th-14th c. Islamic depictions of winged human headed crowned felines and birds, which are often depicted on either side of the depiction of this device, when the human figures - the suggested signallers/observers - are not depicted in these same positions, is a terminology which is somewhat unhelpful, see Duggan 2015, 178-198.

[23] Likewise, of smokeless fire, Surat Ar-Raĥmān 55:15. Light is for example recorded as the personal name of a Jinn in The Tale of Pomegranate-Flower and Badr Basīm, Madrus & Mathers, 1996, III, 101.

mirrors carries around its edge a series of disks, representing the coloured filters, while the colours and their sequence on the disks around these two mirrors differs. All three tiers of messaging, mounted courier, pigeon post and beam/flash of reflected light are depicted, enclosed by the inscription band below the rim, repeating a series of Arabic letters-numbers, forming, it can be suggested, the representation of a coded message, an encoded message read as a sequence of letters/numbers, each within a colour coded box, that was passed at the speed of light from one signalling mirror station to the next. The inscription band, consisting of a series of boxes, ensuring the message of communications depicted through the scene recorded in the bowl was at the time of manufacture, clearly understood, together with the blue and white zigzag pattern, which is described as "*dentillated*" in the catalogue entry, relating it to teeth rather than relating it to the Arabic numbers seven plus eight = a repeat of the number 6 around the rim of the bowl. This blue and white zigzag design, served as a reminded of the flash of reflected light, as from the surface of water,[24] as from the polished surface of a mirror[25], and, as such, it can be suggested, was employed as the design on the official dress of some members of the ruler's intelligence service, a textile design which is recorded repeatedly on *mina'i* painted frit-ware ceramics in the depiction of the dress of

[24] A reflection of light from the surface of water, as on: a *mina'i* frit-ware bowl, Iran c. 1200, Museum für Islamische Kunst, Berlin, see, Kalter 1993, Abb.72, "*Im Zentrum des Spiegels Darstellung eines von Höflingen umgebenen, im "Türkensitz" thronenden Fürsten. Auf der Außenwandung Reiter auf der Jagd*."; as also the design on the lake depicted at the foot of the *mina'i* frit-ware plate, Freer-Sackler F1909.75 Smithsonian Inst.; as likewise on a Persia, late 12th/early 13th century *mina'i* bowl with a rider on horseback and attendants. Sothebys, London, 24-04-2013, Lot. No. 173 http://www.sothebys.com/en/auctions/ ecatalogue/2013/arts-of-the-islamic-world-l13220/lot.173.esthl.html#. See also, Fehvari 2000, 127, No. 156, CER456TSR, where there is a blue and white zigzag on the water of the lake; Fehevari 1998, No. 29., and it is also the design of the dress of the horseman to the right of the tree, presumably a courier; as also MIA, No. G234 where it forms the pattern on the water between the two horsemen, at https://collections.artsmia.org/art/1085/minai-ware-bowl-iran.

[25] See for examples: a repeat of circular mirrors with this design, in a band on the interior of a Kashan Iran c. 1175 – c. 1220, *mina'i* frit-ware under-glaze bowl with applied gold over glaze, No. OC.158-1946 in the Fitzwilliam Museum, University of Cambridge; on both circular mirrors on a *mina'i* frit-ware bowl, Iran c. 1200, Museum für Islamische Kunst, Berlin; on both circular mirrors depicted on an Iran, 12th -13th c. *mina'i* painted frit-ware bowl offered for sale at icollector.com, withdrawn from sale 07-2002.

members of the ruler's *barīd-istihbarat*,[26] together with similar figures dressed in a blue and white vertical stripe, dress that may record another rank in the *barīd-istihbarat*[27]. It can be suggested that the use of this blue and white zigzag pattern on the rim of *mina'i* painted frit-ware ceramics can be understood as marking Kashan produced *mina'i* painted ware, many of which carry subjects that seem to be related to the ruler's *barīd-istihbarat* and state communications.

There seems little possibility that the so called '*string'* mentioned in the catalogue description as connecting to the so-called '*balloon'* sic. (the representation of the light reflecting mirror signalling device) to the horseman is original, as in numerous other examples there is no '*string*' connected to the representation of these mirror signalling devices, but it clearly indicates that at the time this painted 'string' was added, the idea that this device represents a signalling mirror was entirely unrecognised, that is, the '*string'* (presumably leading to the word '*balloon*' that is employed in the catalogue entry to describe the mirror signalling device) is a modern addition to the surface of this bowl. There seems to be no evidence of the use of balloons of the hot air type in 12th -13th c. Iran.

Extraordinarily, this bowl, which, it has been suggested above carries the representation on its interior of all three types of long

[26] Examples include: the dress of the mounted courier on a Seljuk Iran, 12th -13th c. *mina'i* painted frit-ware bowl, No. C.1234-1919 Victoria and Albert Museum, London; on the figures to either side of the enthroned ruler on a circa 1200 Central Iran, *mina'i* frit-ware bowl. Christies, King St. London, Lot. No. 0208, Sale No. 6628, 15th Oct. 2002, possibly depicting *ashāb akhbār*; the dress of the mounted courier on a circa 1200 Central Iran, *mina'i* frit-ware bowl, Christies, South Kensington, Lot. No. 0090, Saeed Motamed Collection, Part I, Sale No. 8652, 22nd April, 2013; on two of the seated figures depicted on a Kashan *mina'i* painted frit-ware bowl c. 1170-1220 Fitzwilliam Museum, Cambridge, no. C.129-1935; on the dress of a courier on horseback depicted on a circa 1200 *mina'i* frit-ware bowl, restored, Christies Sale 2335, Lot. No. 464, New York, Rockerfeller Plaza, 31st August 2010; as also, Fehvari 2000, 127, No. 156, CER456TSR, where there is a blue and white zigzag design on the dress of the horseman to the right of the tree, presumably a courier; Fehevari 1998, No. 29.

[27] Examples of figures in this communications context wearing a dress of blue and white stripe include: two seated figures on a Seljuk Iran, 12th -13th c. *mina'i* painted frit-ware bowl, No. C.1234-1919 Victoria and Albert Museum, London; the dress worn by the courier on horseback on a c. 1150-1200, Iran, Kashan, *mina'i* over-glaze painted frit-ware bowl. Acc. No. 925.13.80, Royal Ontario Museum; Iran, Kashan late 12th-13th c. *mina'i* frit-ware bowl with 8 figures, To Okayama Orient Museum, Okayama, Japan.

distance communications available: mounted courier, messenger pigeon and signalling by means of reflected light, has on its base what can be understood as being the representation of the encryption-decryption device that was employed for coded communications (Fig. 2), rather than simply as the catalogue reads: "*On the base a human face forms the centre of a radiating solar design of blue, red and green triangles and lines.*"[28].

One can wonder, if it is a sun-sunburst-solar design, why it was depicted on the underside of this bowl, when there are no other similar examples of a sun/solar device-sunburst depicted on the underside of a *mina'i* or lustre painted dish, or bowl or other vessel. It is suggested that this is a depiction of a cipher device, a device consisting of two rings of 22 rotating pointers separated by a disk, that provided the sequences of the different colour settings of the code, with the smaller inner disk with the human face, in the centre of the "*sun-burst*" of rays, with the prominent vertical line between the eyebrows providing the particular setting, presumably to be set in alignment with one of the rays/pointers and the ring of 22 coloured circles (6 Red, 6 Blue and 10 Green) around the rim of this inner disk. The Arabic letters/numbers would have been recorded in the blanks at the end of each of the 44 rays, so the signal code could be converted, encoded/decoded presumably directly into/from Arabic letter-numbers and colours. Given its detail and complexity and that it is painted in the most expensive of ceramic techniques gilded *mina'i*, it may even depict an example of the emir's or of the ruler's own type of cypher machine.

This device with its inner sequence of 22 coloured dots around the face on the inner disk of the "sun-burst", with a sequence of 22 coloured rays, "*al-Shu'a'at*", or pointers, both above and beneath the middle disk, providing a total of 44 coloured rays-pointers reaching the outer ring and provided the sequence to read the enciphered-colour coded text. These three disks, each with a different sequence of the same three colours, determined the particular sequence of colour pointers above and below the middle disk, to read the colour coded enciphered text that had been sent. The 44 empty panels at the ends of the rays/points can be

[28] http://webapps.fitzmuseum.cam.ac.uk/explorer/index.php?qu=syria%20fritware&oid = 72039

understood to carry a sequence of letters-numbers, presumably some of these panels carried more than one letter, a word/term, a sign, a void or a number/letter repeated, to evade the known problem of the frequency of common letters, first remarked upon by Abu Yūsuf Yaʿqūb ibn ʾIsḥāq aṣ-Ṣabbāḥ al-Kindī (c. 801–873 A.D.), in the attempt to prevent code-breaking through frequency analysis.

It seems probable that the inner circle of dots was set to a particular colour sequence, the middle and outer disk of rays moved, in response to this particular setting, as is indicated in the representation of the device, with the total of the colour pointers recorded on the inner and middle rings 44, the same as the total blank positions forming the outer ring. When the text needed to be enciphered-deciphered it seems this machine provided the correct sequence of the possible permutations with which to decode the message, that is, a cypher machine.

It is worth looking at the colours depicted in some detail as in the colours used there are sequences, rather than the random or simple repeat of the three colours. The depicted sequences of the three colours where R=red B=blue and G=green are as follows:

Reading the colours of the inner disk of 22 dots:

From the top of the head of the face anti-clockwise around the face reads: GRBGBGRGBGRGBGRGBGRGRB

Clockwise around the face reads: BRGRGBGRGBGRGBGRGBGBRG

The number of each coloured circle on this inner disk is: 6 Blue, 6 Red, 10 Green

Reading the sequence of colours: BR GR GB GR GB GR GB GR GB GB RG, the pair GR is repeated four times and GB five times, once doubled GBGB, with the sequence GRGB repeated four times. Or as: RG RG BG RG BG RG BG RG BG BR GB, the pair BG is repeated four times and RG five times, once doubled RGRG, with the sequence RGBG repeated four times.

The 7 dot colour sequence before the red dot of the chin is mirrored by the subsequent 7 dots:

GBGRGBGR (the red dot marking the mid-point the chin)

Followed by the reverse order of coloured dots

GBGRGBG

The rest of the circle is formed of the 7 dot sequence coloured:

BRGBRGR. The sequence BRG repeated being followed by a red dot. It seems evident from the distribution of colours on the dots around the depiction of this inner disk, that this was no random or fanciful use of colour, but records with care precise sequences of colours.

Reading the colours of the upper/inner ring of pointers, a sequence of 22 coloured pointers-rays:

Anticlockwise: RBGBRBGBRBGBRBGBRBGBGB

Clockwise: BGBGBRBGBRBGBRBGBRBGBR

The number of each colour of the three colours of ray on this inner/upper ring of pointers above the middle disk is: 11 Blue, 5 Red and 6 Green

The colour sequences RBGB, GBRB, BGBR and BRBG, are each repeated 5 times. The probable start position of the sequence of colours on this disk is marked by the BG repeat, the only two colour consecutive repeat in the sequence of pointers-rays forming this inner/upper ring of pointers. BG also occurs four times on the inner disk and once in the outer/lower ring of pointers below the middle disk. It is noteworthy that the sequence GBRB also occurs four times on the inner disk and BGBR also occurs once on the inner disk. None of the sequences of four colours RBGB, BRBG, GBRB, BGBR, occurs in the outer/lower ring of pointers.

Reading the colours of the outer/lower ring of pointers together with the pointers from the upper ring, provides a sequence of 44 coloured pointers-rays:

GBRGBBRGRGRGBRGBBRRGBRGBBRRGBBGRBRRGBRGRBR
RG

The number of each colour of pointer/ray in this outer/lower ring of pointers is: 14 Blue, 17 Red and 13 Green

It is of course speculative, but it may be that the start/fixed position for the device was when the BGBR sequence on the inner

disk was aligned with one of the five repeats of this same sequence on the inner/upper ring of pointers.

BGBRGBRGRGBGRGBGRGBGRG The inner disk sequence beginning from BGBRBGBRBGBRBGBRBGBRBGBRBG the inner/upper ring of pointers above the middle disk sequence beginning from the first (?) BGBR incorporating the second of the doubled BG that seems to mark the start of the sequence in this ring, being the only pair repeated consecutively in this ring.

Although if the single occurrence of BG on the lower/outer ring of pointers was also aligned with one of the five pairs of BG on the inner/upper ring of pointers, and which one of the five is of course speculative, the initial setting of this colour cypher machine may have read as follows:

BGBRGBRGRGBGRGBGRGBGRG inner sequence beginning from BGBRBGBRBGBRBGBRBGBRBGBRBR inner/upper ring of pointers sequence beginning from the first (?) BGBR but as the middle ring revolves determining a start point is problematic. It could equally have been aligned to the first occurrence after the doubled BG, in which case it would read: BGBRBGBRBGBRBGBRBRBGBRBGRBRRGBRGRBRRGGBRGBBRGRGR GBRGBBRRGBRGBBRRGB The suggested initial lower/outer ring of pointers sequence with the single occurrence of BG in this ring aligned with the first of the five repeats of this BG sequence in the inner/upper ring. It is however noteworthy that the sequence BGR with which it is suggested the outer sequence began, also occurs three times in the inner circle, but which does not occur in the inner/upper ring of pointers.

This depiction it is suggested of a 12th - 13th c. three colour cypher machine has 22 position pointers in both the inner/upper and in the lower/outer rings, above and below the middle disk, giving 44 positions on the outer circle, 11 Blue, 5 Red and 6 Green pointers in the inner ring and 3 Blue, 12 Red and 7 green in the outer ring of pointers, with the total of each of the three colours employed, 14 Blue, 17 Red and 13 Green = 44. In consequence, the total number of possible settings to produce and/or to decode a colour coded displacement cypher of this type seems rather vast and without access to the settings of this device, which no doubt were regularly changed, would have been a message written in an unbreakable code.

If one looks carefully at the sequences of the colours employed for the circles on the inner disk and on the two rings of pointers-rays, it seems evident that this was no random or fanciful choice of colours employed by the painter of the bowl, rather it appears the sequences of colours employed were it seems, most carefully copied and the frequency and the sequence of distribution of the colours employed in the depiction of this device, on the inner disk and on the two sets of pointers, provide us with the evidence to state this distribution of these three colours was purposeful, careful and deliberate, and can probably be understood to provide an accurate depiction of the form of the device in use at the time this work was commissioned. In consequence, it is suggested the depiction on the base of this bowl does not depict a sun, but rather a scientific device having the form of a sun.

It is noteworthy that the decoration of this entire bowl is concerned with exhibiting the three levels of speed of this encoded signalling-communications systems, and it can be suggested that the depictions recorded on this bowl were the result of designs drawn up by a palace *nakkaṣ* designer concerned with the matter of state communications and aware of the appearance of this type of cypher deciphering machine and presumably this bowl was produced as a presentation gift to an important state official, possibly the head of the ruler's *barīd*. The importance of the coloured light signalling of messages seems emphasised through the Jinn of the Land figures either side of the depiction of the lower of the mirror signalling devices; the face and the sunburst of coloured rays-pointers forming the colour cypher machine depicted on the base of this bowl, as well as indicated with the complexity of the cyphers that can be produced from a palette of only three colours on three rotatable disks.

Example Two

Another example of what is here suggested as being the depiction of a cypher machine, is to be found at the centre of a famous late 12th– early 13th century *mina'i* painted and gilded frit-ware bowl from Central or Northern Iran, today in the Met. Museum, New York, No. 57.36.4, which has been said to carry depictions of '*courtly and astrological motifs*', with the catalogue entry reading: "*The figures and decoration on the interior of this bowl combine*

imagery of the courtly cycle and astronomy. In the center the sun is surrounded by personifications of the planets"[29] (Figs. 3, 4).

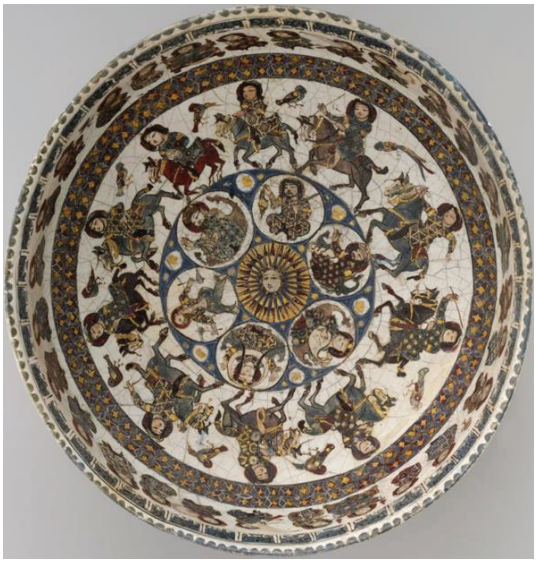

Fig. 3. Late 12th – Early 13th c. Mina'i painted and gilded frit-ware bowl today in the Metropolitan Museum, New York, No. 57.36.4[30]

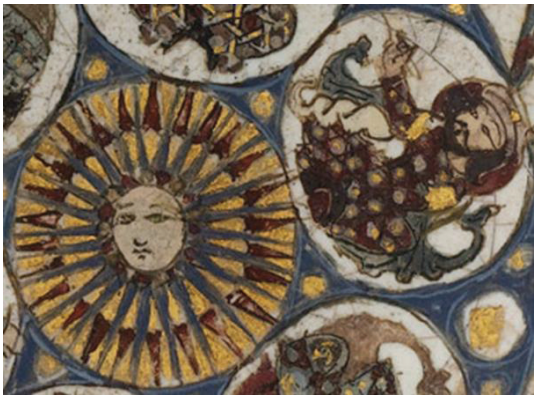

Fig. 4. Detail of Fig. 3, showing the three disk enciphering machine and the pointers of this device that cross into the field carrying the depiction of the planet Mercury as a seated scribe pen in hand.

[29] http://www.metmuseum.org/art/collection/search/451379 See also: Canby-Beyazit-Rugiadi, 2016, No. 123, 206.
[30] Catalogue entry at: http://www.metmuseum.org/art/collection/search/451379

This restored bowl carries some of the same types of decoration as are described above and which can be associated with the depiction of communications including: below the rim the blue and white band consisting of a series of message signalling boxes, here containing words of a formulaic type in Kufi script, communicating wishes and blessings, good fortune, mercy, victory, happiness, grace, and power. There is in the centre of the interior of this bowl the depiction of a device which is today described as a "sun"[31], but which is a depiction markedly similar to the depiction of the deciphering engine described above (Fig. 2.), consisting of 3 disks and 2 rings of pointers. The inner disk with a human face is surrounded on its outer edge by a ring of perhaps 16 or 19 (?), perhaps originally prior to being damage, with 25 circles, coloured in red, blue and yellow, but the complete sequence of these coloured circles is unclear, although the lower left hand side of the face seems to have the majority of the blue circles. In other words the sequence of colours depicted on the edge of this inner disk is no simple repeat. The inner/upper ring has a series of 25 pointers-rays in dark blue, the outer/lower ring below the middle disk of 25 pointers-rays in red, provides at total of 50 positions (Fig. 4) in the outer circle, rather than the 44 positions of the first example (Fig. 2).

If the design in the centre of this bowl was in fact related to astrology-astronomy as has been repeatedly suggested in the literature, to the sun and to the cycle of the months of the year, Sūrat At-Taubah 9:36 "*Lo! the number of the months with Allah is twelve months by Allah's ordinance in the day that He created the heavens and the earth. Four of them are sacred: that is the right religion." So wrong not yourselves in them*.", then perhaps one would expect to find the rays around the inner disk number 12, or multiples thereof, to be read as indicating the months of the year. This is in fact the case for the early 13th c. Cizre Mosque doors, three complete sunburst-*şamsa* on both leaves of the door, with each sun-*shamsa* with 12 points-rays; it also the case for each of the 16 radiating celestial

[31] "*In the center is the sun surrounded by the personifications of six planets. Moving clockwise from the top right are Mars, holding a severed head and a sword; Mercury, the scribe, seated crosslegged with a pen in his right hand and scroll in his left; Venus, seated on a throne or chair and playing the lute; the moon, a female figure with a crescent moon around her head; Saturn, holding a sickle in each hand; and Jupiter, on a thronelike seat, holding something resembling a chain.*" http://www.metmuseum.org/art/collection/search/451379

sphere-sun-*shamsa* in the dome of the Karatay Medrese, Konya, in cut-tile mosaic, with each complete sun with 12 rays, symbolising the months of the year, a complete ray, one half black, the other white, like night and day; or in the cut-mosaic tile panels from the Sırçalı Medrese, Konya today in the TIEM. But this relationship of 12, 24, 36, 48 (48 also for the number of the constellations), 60, or 72 pointers-rays around the sun, which could thereby relate the design to astronomy-astrology and the months of the year is not the case for four of these six examples (Example Four has 48 pointers-rays and Example Five probably had 60 pointers-rays, but both seem to be of this suggested three disk and pointer type of cypher device and are not otherwise associated through the designs employed with astronomy-astrology).

The pointers that are shown to cross the outer circle of the device touch the circle of the figure of Mercury, who is depicted as a scribe sitting crossed legged, and this scene on the interior therefore presumably relates to messages, diplomacy, to coded communications passed between the two enthroned rulers depicted facing each other in the band below the boxed messages around the rim. The band of horsemen separated by birds presumably represents the *kasıd*, the mounted couriers and the *haman*, the carrier pigeons, the means employed to convey the encrypted messages from Northern Iran to the Caliph in Baghdad and to convey his evidently favourable reply from Bagdad to Northern Iran, rather than depicting "*the courtly activity of hunting*". The favourable reply resulting in the production of this bowl with the depictions it carries, as it seems probable, from the fragmentary inscriptions on the exterior, that the scenes depicted on the interior concerned the enciphered communications that passed between the Caliph and the ruler who commissioned this bowl and, given the two seated rulers depicted in the band below the band of message boxes, it seems reasonable to think that these are representations of the parties involved in this diplomacy, depictions of the Abbasid Caliph and of the ruler who commissioned this bowl, and who is recorded with the title awarded by the Abbasid Caliph of "*ally of the prince of faithful*." [32]

[32] Read by A. Ghouchani, at http://www.metmuseum.org/art/collection/search/451379

Example Three

There is a further example of the depiction of what appears to be this same type of cypher engine device, currently described as a "sun", on a restored 13th c. Ayyūbid, Raqqa, light reflecting lustre painted frit-ware bowl in the Aleppo National Museum, Inv. No. 561[33] which was a find made from an excavated context in 1973/1974 in the castle of Qal'at Ja'bar, by Raqqa.

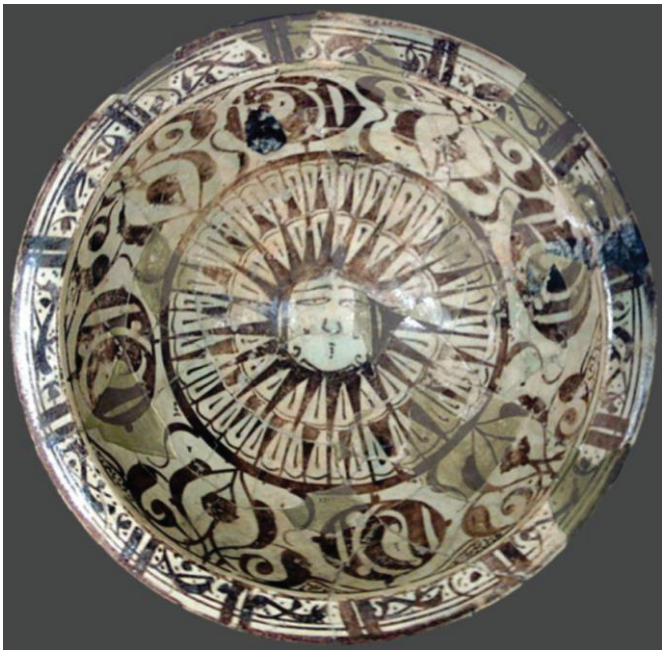

Fig. 5. 13th c. Raqqa lustre painted frit-ware bowl, Aleppo National Museum © Discover Islamic Art (MWNF)[34]

The representation of this device likewise has on the central disk the representation of a human face, with the vertical marker perhaps provided by the line on the chin, rather than the vertical line on the forehead, as on the human face in Example One, Fig. 2, but in this example there is no inner circle of 22 coloured dots around the

[33] Julia Gonnella "Lustre bowl with a sun motif" at, Discover Islamic Art, Museum With NoFrontiers,2017.
http://www.discoverislamicart.org/database_item.php?id=object;ISL;sy;Mus01_A;47;en
Likewise at: http://l7.alamy.com/zooms/e72c4f7260cb4e23bc8b6a35bb88a8ce/fine-arts-islamic-art-craft-handcraft-bowl-sun-raqqa-syria-13th-century-a3yadr.jpg
[34] http://www.museumwnf.org/images/zoom/objects/isl/sy/1_a/47/1.jpg

face to provide the setting. However, noteworthy is that there are 22 rays extending out across the second disk and a further 22 rays extending out from below the second disk. The presence of the third disk below the second set of rays-pointers is clearly marked on this example. These 44 rays reach the outer circle, as is likewise the case with Example One, Fig. 2, indicating the same number of possibilities of encoding provided by the settings of both of these devices and thereby suggesting the probability that both rulers in Seljuk Iran and Ayyūbid Syria employed the same type of enciphering-deciphering technology. The design on the flat border to the rim of the bowl is divided into a series of 12 message-type boxes and, in the wide band between the rim and the outer disk of the enciphering device, it can be suggested there are depicted the representation of four circular signalling mirror-receivers, each with four points indicated on the mirror's circumference at right angles to each other, marking the points employed to align the mirror, although the outer ring within which the mirror was aligned is not depicted[35]. These lustre depictions of circular signalling mirrors are each separated from the other by stylised depictions of the mirror signalling device.

Three further examples of this type of late 12th – early 13th c. cypher machine, two recorded in light reflecting lustre and one painted in under-glaze, indicate the importance of this type of three disk and pointer cypher device, a most considerable advance in cryptography over the simple displacement cyphers of the Caesar Cypher type, and over the historically later and simpler substitution device of 1466-1467 designed by Leon Battista Alberti, a cypher device consisting of two disks, the inner rotated.

This 12th – 13th c. device represented an advance, both in the number of possibilities, given the number of possible settings, as also in the use of three colours, as is supplied by the *mina'i* example Number One above, or as in the use of two colours, as is supplied by the *mina'i* example Number Two above, and in the total number of

[35] For depictions of the outer ring around this type of circular mirror see: Kalter 1993, Abb.72; Iran, 12th -13th c. mina'i painted frit-ware bowl, offered for sale at icollector.com, withdrawn from sale 07-2002 at: http://www.icollector.com/Iran-Seljuk-Minai-12th-13th-Century-A-b_i174062; Iran, Kashan late 12th-13th c. mina'i frit-ware bowl with 8 figures and four circular mirrors, each with the four pivot points set within an outer ring in red, To Okayama Orient Museum, Okayama, Japan, at: http://www.kotobukiya-art.com/_src/sc2120/minai1_0001.jpg.

possible displacement positions, and such a device provides an indication as to the quantity of secure state communications-correspondence that needed to be accurately and rapidly enciphered and deciphered.

Example Four

Although the late 12th c. frit-ware lustre painted bowl from Iran, today in the Ashmolean Museum, Oxford (Fig. 6), is described as a "*Bowl with sun*."[36], it seems from the above examples that it records in the centre a similar type of cypher engine to those depicted in Examples One, Two and Three, Figs. 2, 4 and 5. It depicts the inner disk with a circle of 16 dots, a ring of 15 pointers-rays above the middle disk in which there are 15 circular holes, one in each segment divided by the pointers-rays, which may have been made to clearly show that this circular disk overlaid the pointers below it, and a lower/outer ring of 33 pointers-rays, providing a total of 48 pointer positions on the outermost ring. It seems reasonable to suggest that around the outer rim were the 28 letters/numbers of the Arabic alphabet plus perhaps 6 doubled letters and also including symbols and voids, representing a large and complex range of possibilities in enciphering a text message.

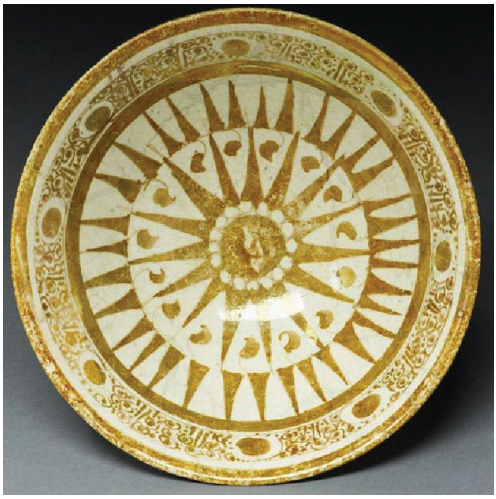

Fig. 6. Iran, late 12th c. frit-ware lustre painted bowl. Acc. no. EA1978.2344 © Ashmolean Museum, University of Oxford.

[36] http://jameelcentre.ashmolean.org/object/EA1978.2344

However, this depiction of the device differs from the *mina'i* depictions of this type of instrument, Examples One and Two, Figs. 2 and 4, and from the lustre example in the Aleppo Museum, Example Three, Fig. 5, not just in depicting 15 holes through the middle disk, that show in these holes the form of the pointers below the middle disk, clearly indicating the sun was not the subject of this depiction, but in employing a quite different ratio, the numerical relationship between the number of circles depicted around the edge of the inner disk and the number of the inner/upper and the number of the outer/lower pointers of the device. In this example the inner disk has 16 circles around its edge, while the number of pointers-rays in the upper/inner ring over the middle disk is 15 and there are 33 pointers-rays extending from below the middle disk, indicating a total of 48 pointer positions on the outer disc. However, on Example One, Fig. 2, the numbers of each are the same: 22 circles on the inner disk, 22 pointers-rays above the middle disk and 22 pointers-rays below it, indicating a total of 44 pointer positions on the outer disk. The number of pointers-rays are the same above and below the middle disk, and this appears to have also been the case for Example 2, Fig. 4, although there are perhaps 19 (?) coloured circles around the inner disk, the inner series of pointers-rays number 25 and the outer series of pointers-rays below the middle disk likewise numbers 25, indicating a total of 50 pointer positions on the outer disk, and this ratio is likewise the case for Example 3, Fig. 5, where there are 22 pointers-rays above and 22 pointers-rays below the middle disk, indicating a total of 44 pointer positions on the outer disk.

In this example (Example 4, Fig. 6) the rays on top of the middle disc are depicted as extending in places over the edge of the disc beneath, while the points of the outermost rays touch the encircling lustre band. Instead of the depiction of the *en clair* letters/numerals or the depiction of the 48 empty boxes representing the spaces where the letters/numbers would have been recorded, as in Example 1, on the other side of the encircling lustre band in this example there is, perhaps, the representation of the message sent, suggesting that this bowl depicts both the setting of the encoding device and a representation of the message, presumably sent by means of light signalling. There are 8 in-filled lustre circles surrounded by a circle in reserve, that can be read as the representation of flashes of light, between the cartouches/message boxes which contain both Arabic letter forms and smaller flashes of

reserved circles, each containing a lustre filled circle, suggesting the flashes of the light within the text boxes of the messages and with this depiction of messaging forming the band between the central design of the encoding device and the rim. These cartouches/message boxes are of two different lengths, the smallest two presumably signifying the sender/identifier/message header, the longer six, messages each divided into sections, comprise one shorter message in two consecutive cartouches/message boxes, and the second, the longer message, comprising four cartouches/message boxes of text.

Example Five

The fifth example was produced at Raqqa, Syria, painted in lustre on a jar and unfortunately has suffered considerable damage to the lustre paintwork in key areas (Fig. 7). It is possibly by the hand of the same painter as painted Example 3 excavated from Qal'at Ja'bar, or a copy after the work of the same. Unfortunately, in consequence of the damage it is today unclear if there were any circles around the face on the inner disk, nor if, as seems probable, a feline rather than a human face is represented on the inner disk. It is evident that an upper and a lower ring of pointers-rays, clearly divided by a middle disk are depicted surrounded by the conspicuous outer disk which both sets of pointers-rays touch, and it therefore seems to be a depiction of the same type of device as that depicted in the preceding examples. However, due to the damage, today the total number of rays-pointers is unknown, although it seems to be about 60. Nor is it known for certain if the number of pointers-rays in the inner and outer rings was the same, although this appears to have been the case.

At the four corners of the panel within which this device is depicted there are the flashes of light represented by the reserved circles each containing a lustre filled circle; possibly suggesting the flashes of the light related to the use of the cypher machine and these also occur on two of the vertical panels on the back of the jar, each having three flashes, positioned one above the other.

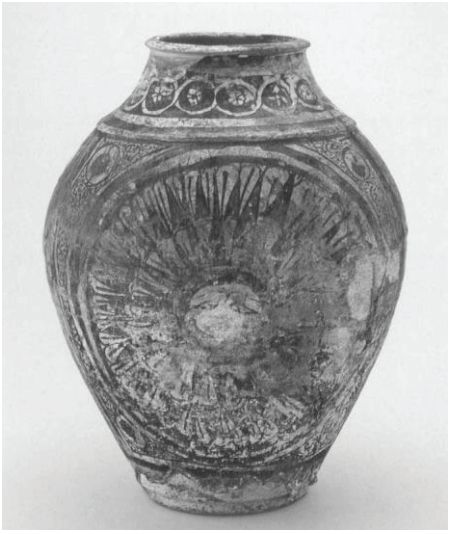

Fig. 7. The front face of an under-glaze and lustre painted jar, Raqqa, Syria 1200-1230, Purchased in 1908 by Charles Lang Freer for $6,000, Freer Gallery of Art, Smithsonian İnstitution, Washington D.C. Gift of Charles Lang Freer (1908.116) (from Jenkins-Madina 2006, 18)

Fig. 8. The reverse face of the jar (Fig. 7) showing the three lustre flashes. (from Jenkins-Madina 2006, 18)

Example Six

Although this sixth example, a Kashan early 13th c. frit-ware bowl under-glaze painted in blue and black, today in the Ashmolean, Oxford, Fig. 9, is described as a "*Bowl with central sun*"[37], "*Here the central motif is the face of the Sun.*"[38], "*bowl with sun face on it*"[39], as with the catalogue description of Example Four, Fig. 6, from the preceding five examples it seems probable that the depiction in the centre of this bowl can to be understood to record another example of the proposed three-disk 12th -13th century cypher machine. The depiction shows the inner disk edged with 30 ellipses, the inner/upper ring has 30 pointers-rays and the lower/outer ring has 30 pointers-rays, providing indication of 60 positions on the outer ring. That an alpha-numeric code was employed seems probable with the 28 letters/numbers of the Arabic alphabet plus perhaps, *i'jām* and *rasm,* providing a total of thirty, doubled and presumably recorded in a random order for the 60 positions on the outer ring, which in this example are blank. The number of positions maintains the same ratio as is depicted in Examples One and Two and Three, where the number of pointers-rays in the upper and lower rings of the device are the same, and this example has the same number of circles around the inner ring as there are numbers of pointers-rays in both the upper and lower rings, as is also the case with Examples One and Three. It seems therefore that the three disk type of cypher engine is here clearly depicted, with the ellipses - 'circles' edging the inner disk and with the rings of rays-pointers above and below the middle disk, with the pointers of both rings extending out to the same distance.

Perhaps the feline face in the centre, like the restored feline face in Example Three, and like the human face on the inner disk of Example One and Two, may have been markers of the specific type of cypher device, perhaps those with a human face related to foreign affairs and with feline type to the ruler's territory, or possibly was an indicator of the official office and rank to which this type of deciphering device belonged. The depictions of the human and feline faces on the inner disk of Examples One, Three and Six have a conspicuous vertical orientation mark, and this may originally have

[37] http://jameelcentre.ashmolean.org/object/EA1978.2311
[38] Allen 1991, 22-23; Cat. No. 11.
[39] Allen 2005, 36.

been the case for the restored face in Example Two and on the damaged face on Example Five. This marker's location was probably important, providing the position of the inner disk setting relative to the outer disk.

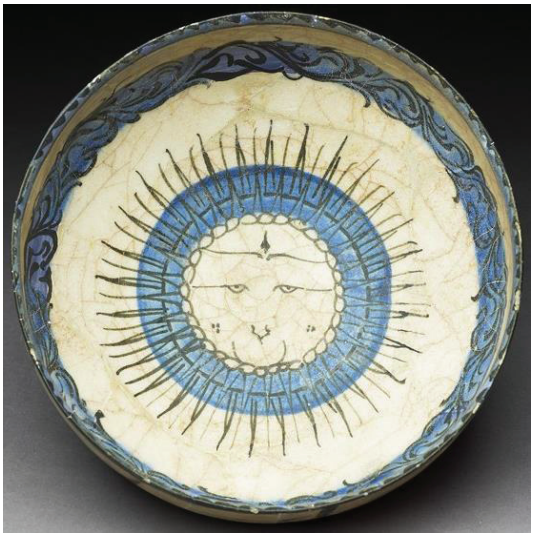

Fig. 9. Iran, Kashan early 13th c. frit-ware bowl under-glaze painted in blue and black. Acc. No. EA1978.2311 © Ashmolean Museum, University of Oxford

Conclusions

Artefacts carrying depictions of things are of course historical sources, and it is suggested that in this case they supply us with what has not been recorded in the surviving written sources, that is the general types and form of the mechanical cypher machines that were employed in the 12th -13th centuries on behalf of the Abbasid Caliph and Seljuk, Atabeg and Ayyūbid rulers for enciphered communications.

The absence from both the surviving contemporary 12th to 13th century sources and the modern literature of a recognised technical name for the cypher machine employed, that it is suggested is depicted in these six examples, although it was probably some form of the word for sun, *shamsa,* or *dā'ira,* and was perhaps related through its function of the conversion of an input into a different output, to the type of the device termed a *zā'icha* or *dā'ira*; and while there does not appear to be written record of this cypher machine's

method of use, nor is there any published record of the physical remains of this device from any archaeological site or collection known to the author, this should not to be understood as being evidence of the absence of this cypher device and of its use in the 12th to 13th centuries. Nor should Nizām al-Mulk's reference in his *Siyāsat Nāma* to the lack of interest by the House of Seljuk in intelligence agents-the *barīd*, and al-Fatḥ ibn 'Alī Bundārī's reference in his *Tārīḫ daulat Āl-Salǧūq* to Sultan Alp Arslān saying to Nizām al-Mulk (d. 1092), we have no need for the *barīd,* as is also repeated by Nizāmī in his *Chahār maqāla,*[40] entirely blind us to the possibility that matters in this respect may have been quite the opposite of what was publicly recorded, or, that the situation in this respect may have changed, if not at the end of the 11th c. after the death of the Great Seljuk Sultans Alp Arslān and Malik Shah, then in the 12th century when some of these ceramics were painted.

As is the case with the suggested depictions of the reflected light signalling device with its parabolic mirror, light intensifier, lenses and filters,[41] as with the depictions of what is suggested here are representations of a three disk and two rings of pointers cypher device on ceramics, the detailed depiction of scientific instruments-devices on "palace ceramics" have not to date been read as the 12th - 13th century depiction of scientific instruments[42] - but rather have been described as "*balloons*", "*palmettes* and *split palmettes*", "*foliate arabesques*", "*Sun*", "*Solar device*", with probable rock-crystal lenses described as, "*lemons*"[43]; likewise the depictions of the Jinn of the Land and of the Jinn of the Air, have in modern times been repeatedly termed, "*sphinx*," "*siren*" and "*harpy*"[44], while the representation in an inscription band on 12th and 13th c. *mina'i*, on lustre and on under-glaze painted ceramics that carry the depictions of mounted couriers

[40] For these passages see Silverstein 2007, 136-137 and fn.223.

[41] Duggan 2016, proceedings forthcoming, as is also clearly recorded, carved in the reliefs on either side of the North door of the mosque at Divriği of 1229.

[42] As seems to be the case with a restored Kashan late 12th c. lustre painted frit-ware bowl today in the Ashmolean Museum, University of Oxford, http://jameelcentre.ashmolean.org/object/EA1978.2256, described as a "*Bowl with human-faced sun,"* which seems to depict a related device of disks and pointers, but the two sets of pointers face each other, presumably to read off accurately the co-ordinates of visible positions.

[43] Duggan 2016, proceedings forthcoming.

[44] Duggan 2015 passim.

and messenger pigeons and can be associated with the depiction of communications, of Arabic letters/numbers in encoded message boxes consisting of groups of letters/numbers, some colour coded in Red, Blue and Green, have frequently been described as, "*pseudo-inscriptions*", "*pseudo-script*", "*kufic*", "*pseudo kufi*" etc., rather than presenting us with examples of the depiction of enciphered communications.

The visual evidence presented above can be understood to provide us with some contemporary evidence for the use of this type of cypher device. From the six examples above carrying the various depictions of variant types of this device, and there are other related examples[45] and fragments thereof, all of which were produced in

[45] There are other possibly related examples, one Fehvari 2000, 113, No. 137, CER2127TSR, described as Iran, 13th c. "*Pilgrim flask*", moulded and painted in under-glaze black, "*the sides have delicately moulded decoration depicting elephants, lions and peacocks. The disk-shaped flat surfaces having identical decoration showing the human faced sun with its rays painted in black under a clear turquoise blue glaze*." On both sides of this 14 cm. high flask there is depicted a three disk type device with a human face on the inner disk and 13 pointers in the inner and 13 in the outer rings, 26 positions on the outer disk. There are no circles on the inner ring around the face. There is also the important *nakkash* depiction of a three disk type device in lustre on a bowl today in the Aga Khan Collection. It is described as: *a bowl with radiating design / Syria, 12th century / Fritware, lustre painted over an opaque white glaze, Ø 23.5 cm. Inscription (Arabic): (in central roundel) "Glory"; (exterior) min san³ Abi Mashhur khass ("one of the works of Abi Mashhur, special [royal?] commission")* http://islamicartsmagazine.com/magazine/view/22_amazing_ceramic_pieces_from_the_aga_khan_museum/ However, if this depiction represents one of these types of cryptographic devices, but with only12 pointers-rays on the upper and 12 on the lower ring, 24 positions on the outer disk, and without either the circles or the face on the inner disk, it is difficult to be certain. A further example in lustre from the late 12th c., that might depict a type of this device has on the inner disk, a lion face surrounded by a series of dotted circles around the rim, but with only one ring of 20 pointers-rays, the rays crossing the outer border and is without the depiction of a middle disk or of the second-lower ring of rays and so there remains doubt if it represents this device__at: https://www.google.com.tr/ search?q=sun+on+lustre+ceramics+Islamic&rlz=1C1CAFB_enTR680TR680&source=lnms&tbm=isch&sa=X&ved=0ahUKEwiPusCq3oXUAhXEL1AKHZ0vC0EQ_AUIBigB&biw=1366&bih=662#imgdii=WXRtyDymQ0BKWM:&imgrc=BLI6H26mmizLJM. However, all three of these examples with a total of 20, 26 and 24 positions on the outer ring, may perhaps provide too few positions for an *abjad* numerical code-cipher. There is also a related group that may indicate a less explicit representation of this type of device, such as is depicted painted in black and cobalt-blue under-glaze on a Kashan 13th c. bowl, Fehevari 1998, No. 25. As also perhaps recalled in the rosette-like device in the centre with two outer rings on an early 13th c. Kashan underglaze-painted frit-ware bowl from the Nasli M. Heeramaneck Collection,

Seljuk, Atabey and Ayyūbid territory, it seems evident that a variety of the same basic type of three-disk cypher machine with two sets of pointers-rays were produced, probably largely made of inlaid brass, and that these advanced encryption-decryption devices, some at least employing three colours, red, blue and green, with the number of positions ranging from 44, with three examples given, to those examples with 50 and 60 positions, were in regular use in territories that acknowledged the Abbasid Caliph in the 12th-13th centuries.

If this interpretation of the material presented is correct, then the repeated statement that, "*the Seljuks chose not to create and maintain such a system* (of intelligence gathering)," is not correct; rather this contemporary visual material would indicate an extensive and rapid communication-intelligence system was employed by the Seljuks, and their successors in Iran in the 12th c., which does not seem to be altogether surprising.[46] It seems reasonable to suppose that these types of devices were employed for secure state communications elsewhere in this region, including in Rūm Seljuk territory in Anatolia.

It also seems evident from this interpretation that these ceramic works in gilded *mina'i* and those painted in lustre and in under-glaze paint depicting this type of device, were not produced for public sale, as no copies of the ruler's or of other types of cypher machine employed for secure communications would have been painted repeatedly on a variety of ceramics for sale to the public. Rather, it would seem these ceramics were produced on behalf of the ruler to official designs and orders, presumably in the hierarchy of the most expensive: *mina'i-haft rang*, then light reflecting lustre and

---

gift of Joan Palevsky (M.73.5.189) LACMA, Art of the Middle East: Islamic Department; as also in the under-glaze painted design on the interior of another 13th c. frit-ware Kashan bowl, also from the Nasli M. Heeramaneck Collection, gift of Joan Palevsky (M.73.5.255) LACMA, Art of the Middle East: Islamic Department, where there are 2 rows of four pointers depicted, and the tips of the inner row join, in a manner similar to the pointers in Example one, Fig. 2, to a block of enciphered text below the encircling band of text. While the 12th c. overglaze lustre-painted frit-ware deep plate from the Nasli M. Heeramaneck Collection, gift of Joan Palevsky (M.73.5.376) LACMA, Art of the Middle East: Islamic Department, with a mounted courier in the central disk and a series of rings extending out to the inscription band below the rim may also represent the design of this type of device. https://upload.wikimedia.org/wikipedia/commons/0/08/Deep_Dish_or_Shallow_Bowl_LACMA_M.73.5.376_%282_of_2%29.jpg

[46] Eg., Silverstein 2007, 137.

then under-glaze ware in blue, black and reserve white, and that these ceramics formed official gifts for the relevant slaves of the ruler[47]. This point would seem to be of some importance in the discussion of Kashan and of Kashan-style ceramics and Raqqa lustre painted frit-ware, concerning the matter of for whom these ceramics were made and where the designs came from, as it seems reasonable to suggest that production of this kind, carrying depictions relating to the methods and means of communication of the *barīd-istihbarat* was produced for and on behalf of the ruler, with these ceramics painted to state supplied designs.

Today it seems possible from the details of this communications instrument provided by the depictions recorded on the ceramic examples presented above, that working technical drawings from these designs can be drawn up, informed by the mechanical and engineering and *abjad* skills available to a 12th c. designer and engineer such as the Cizre born Badīʿ az-Zaman Abū l-ʿIzz ibn Ismāʿīl ibn ar-Razāz al-Jazarī (1136-1206), as are recorded in his *Al-jāmiʿ bayn al-ʿilm wa l-aʿmāl al-nāfiʿ fi sināʿat al-hiyal*, and it seems reasonable to think that a working replica of a 12th-13th century example of this '*shamsa*'-like, three disk cypher machine with two rings of pointers-rays, that it is suggested was employed by the *barīd-istihbarat* of the Abbasid Caliph, the Seljuks, Atabeğ and the Ayyūbids in the 12th and 13th centuries, could be reproduced today; as a related device, a brass working model of a rotary combination lock was made in 2010 from ibn ar-Razāz al-Jazarī's text and drawings of c.1200 A.D., and which is today exhibited at the Islamic Sciences & Technology History Museum[48], IBTTM, Gülhane, İstanbul, Turkey.

---

[47] It seems evident that some *mina'i* painted bowls carry the depictions of actual events experienced by *barīdī* - couriers in the ruler's service, including being attacked by mountain lions-panthers-wolves etc., eg: Kashan, Iran, *mina'i* frit-ware spouted jug, c. 1180-1219, Fitzwilliam Museum, Cambridge, no. OC.170-1946; c. 1200 *mina'i* frit-ware bowl, restored, Christies Sale 2335, Lot. 464, New York, Rockerfeller Plaza, 31st August, 2010; Iran, 12th -13th c. *mina'i* painted frit-ware bowl, No. C.1234-1919, Victoria and Albert Museum, London, which appears to show the courier outriding a wolf, and, it seems reasonable to suggest, this design was painted on this bowl to be officially presented to this particular courier. For the later gifts of money and of robes of honour presented to *barīdī* for speedy delivery of messages by Sultan Baybars, see Thorau 1992, 105.

[48] http://etc.usf.edu/clippix/pix/brass-box-at-the-museum-of-turkish-and-islamic-art-in-istanbul_medium.jpg

Bibliography

Allen, James W. *Islamic Ceramics*, Ashmolean-Christie's handbooks, Oxford, 1991

Allen, James W. "Solar and celestial symbolism in Medieval Islamic Art" 34-41, in Ed. R. Hillenbrand, *Image and Meaning in Islamic Art*, Altajir Trust, London, 2005

Arık, Rüçan-Arık, Oluş, *Tiles Treasures of Anatolian Soil: Tiles of the Seljuk and Beylik Periods*, Kale, İstanbul, 2008

Arık, Rüçan *Kubad Abad*, İş Bankası, İstanbul, 2000

Bosworth, Clifford E. "The Section on Codes and their Decipherment in Qalqashandi's Subh al-A'sha", *Journal of Semitic Studies* (1963) 8 (1): 17-33

Bosworth, Clifford E. Codes: *Encyclopaedia Iranica*, Vol. V, Fasc. 8, 883-885, 1992

Canby, Shelia R. Beyazit, Deniz. Rugiadi, Martina, "The Great Age of the Seljuqs," in, *Court and Cosmos,* The Metropolitan Museum of Art, New York, Yale University Press, 2016

Charette, François, "The Locales of Islamic Astronomical Instrumentation", *History of Science*, Vol. 44, Part 2, 2006, 123-138

Duggan, T. M. P., Şen, M. E. "On the Exercise of Coastal Control through Observation and Long Distance Communication Systems in Seljuk Territory in the XIIIth Century". *Phaselis* II (2016) 1-17. DOI: 10.18367/Pha.16002

Duggan, T. M. P. Surviving Indications of the Communication Devices Employed in the 13th c. in Seljuk, Atabeğ and Ayyubid Territory for Signaling by means of Light - 13. Yüzyılda Selçuk, Atabeylikler ve Eyyubi Topraklarında Işık ile Haberleşmeyi Sağlayan İletişim Araçlarına İlişkin Göstergeler, *Uluslararası XX. Ortaçağ ve Türk Dönemi Kazıları ve Sanat Tarihi Araştırmaları Sempozyumu*, Sakarya, 2nd-5th November 2016, proceedings forthcoming

Duggan, T. M. P. "The O'Grady factor and false resemblance – blinding Oriental-isms and misapprehensions of the 13th century in the absence of due contextualisation and a little common sense", Akdeniz Üniversitesi, Edebiyat Fakültesi, İngiliz Dili ve Edebiyatı Bölümü, I. Dil, Talat S. Halman Kültür ve Edebiyat Çalıştayı, Haziran 2015, *Talât Sait Halman'a Armağan Kitabı*, Ed. A. Arıkan, 2015, 178-198

Duggan, T. M. P. "Taşdibi'ndeki Rum Selçuk Mânarı -The Rum Seljuk Mânar at Taşdibi", *Uluslararası XVIII. Ortaçağ ve Türk Dönemi Kazıları ve*

Sanat Tarihi Araştırmaları Sempozyumu, Aydın, 22nd -25th October, 2014, proceedings forthcoming

Duggan, T. M. P. Veil of Light, *Mediterranean Journal of Humanities*, mjh.akdeniz.edu.tr, IV/1, 2014, 129-157.

Fehevari, G. *Ceramics of the Islamic World*, I. B. Tauris, London, 2000

Fehevari, G. *Pottery of the Islamic World in the Tareq Rajab Museum*, Kuwait, 1998

Frankopan, Peter, *The First Crusade: The Call From The East*, The Bodley Head, London, 2012

Al-Kadi, Ibrahim A. "Origins of cryptology: The Arab contributions," 1992, *Cryptologia*, 16:2, 97-126

Hattstein, Markus - Delius, Peter, Eds. *Islam: Art and Architecture*, Könemann, 2000

Holt, Peter M. "The Īlkhān Ahmad's Embassies to Qalāwūn:Two Contemporary Accounts", 212-216, Ed. G. Hawting, *Muslims, Mongols and Crusaders*, Routledge, London, 2004.

Kalter, Johannes, "Die Höfe-Zentren der Macht-Zentren der Kunst-Verbreiter des Glaubens," 77-105, Hrs. H. Forkl, J. Kalter, T. Leisten, M. Pavaloi, *Die Garten Des Islam*, hansjörg mayer, Stuttgart, London, 1993

The Book of the Thousand Nights and One Night rendered into English from the literal and complete French translation of Dr. J. C. Madrus by P. Mathers, London, Routledge, 1996, Vol. III

Jenkins-Madina, M. *Raqqa Revisited: Ceramics of Ayyubid Syria*, Metropolitan Museum of Art, New York, 2006

Link, David, "Scrambling T-R-U-T-H: Rotating Letters as a Material Form of Thought," *Variantology*, 248-249 http://d13.documenta.de/research/assets/Uploads/DavidLinkScramblingTruth2010100dpi.pdf.

Mansour, N. *Sacred Script: Muhaqqaq in Islamic Calligraphy*, I.B. Tauris, London, 2011

Melikian-Chirvani, A. S. *Islamic Metalwork from the Iranian World, 8-18th Centuries*, London, 1982

Ragheb, Youssef, *Les messagers volants en terre d'Islam*, CNRS editions, Paris, 2002

Rumi 2006, *Rumi Poems*, Ed. P. Washington, Alfred A. Knopf, New York-London-Toronto, 2006

Saliba, George, "Artisans and Mathematicians in medieval Islam" *Journal of the American Oriental Society*, cxix 1999, 637-645

Silverstein, Alan J., *Postal Systems in the Pre-Modern Islamic World*, Cambridge University Press, 2007

Tekeli, Sevim- Dosay, Melek- Unat, Yavuz, *Bedi'üz-Zaman Ebu'l-'İzz İsmail b.er-Rezzaz El-Cezeri, el-Câmi beyne'l-İlm ve'l-Amel en-Nâfi fî Sınaâti'l-Hiyel*, TTK, Ankara, 2002

Thorau, Peter, *The Lion of Egypt: Sultan Baybars I and the Near East in the Thirteenth Century*, Trans. P. M. Holt, Longman, Essex, 1992