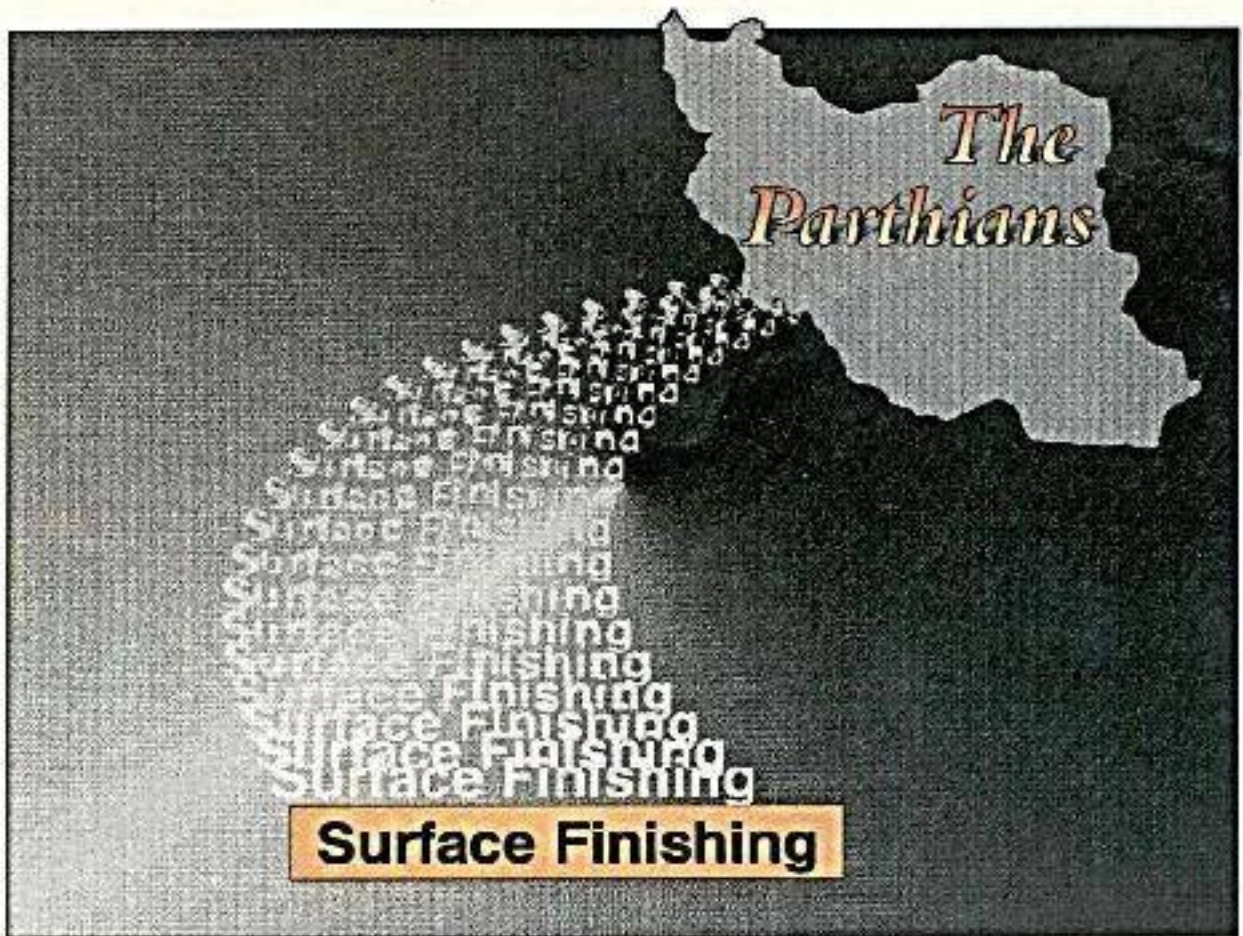


---

# Surface Finishing Through Chemical Plating

## A Parthian Discovery 2000 Years Ago?



By N.Kanani

atotech  
**ATO**

**Surface Finishing Through Chemical Plating**

**A Parthian Invention**

**2000 Years Old?**

By

**Nasser Kanani**

Prof. Dr.-Ing. Dr. habil.

Atotech Deutschland GmbH / Technische Universität Berlin

## Abstract

The Parthians, a nomadic Iranian tribe, created one of the greatest empires of all times during their rule over Ancient Persia and its neighboring countries. They considered themselves as the protectors of the rich and manifold cultures they had conquered. Numerous historical documents, such as coins, drinking horns, and potsherds discovered in the course of the centuries testify to the great Parthian civilization and cultural achievements. Archaeological excavations in 1936 near the ancient Parthian capital Ctesiphon, brought to light curious objects such as clay jars, copper cylinders, and iron rods whose real purpose were completely unknown at that time. Soon after this puzzling discovery, it was suggested that such devices could have been used by the Parthians as electric batteries to deposit metallic layers. Ever since, scientists from all over the world have performed extensive experiments to confirm or to refute such a theory. Based on compelling evidence gathered in the meantime, the Parthians are now considered to be the forerunners of our modern electroplaters. Some scientists go even so far as to believe that Parthian magicians might have used such devices for medical and therapeutic purposes, for instance, to expose their patients to electric shocks. After a brief discourse on Parthian history and civilization, the present paper discusses in some details the Parthian galvanic cell and the experimental results obtained by scientists using replicas or similar devices.

## Part One

### The Parthian civilization and cultural achievements

„They (the Parthians) were brave warriors and honorable foes, treated prisoners decently, admitted foreigners to high office, and gave asylum to refugees. They were tolerant of religious diversities, allowing the Greeks, Jews, and Christians among them to practice their rituals unhindered.“

Will Durant

„The Story of Civilization“

To put the historical facts in true perspective, I would like to draw your attention to the following chronological table that displays the names of the pre-Islamic dynasties in Ancient Persia.

#### Pre-Islamic dynasties in Ancient Persia

The Medes	835 - 559	BC
The Achaemenids	559 - 330	BC
The Seleucids	321 - 64	BC
The Parthians	240 BC - 224 AD	
The Sassanids	224 - 651	AD

The Medes appeared on the historical scene in the ninth century BC and built at the early stages of their history a confederation of Iranian tribes. In the course of

time, however, they became sovereigns of a vast area and established the first Iranian empire. The Achaemenid era began in 550 BC when Cyrus the Great, from the Achaemenid line governing over Persia, deposed the Median kingdom and established himself as the King of the Kings. Under his successors the Achaemenid empire reached its greatest extent embracing the major parts of the then known world. In 334 BC, Alexander the Great succeeded in overthrowing the Persian empire and putting an end to the Achaemenid era. After his death, fierce fighting broke out among his generals over the division of his huge empire. In 300 BC, after prolonged and bloody internal battles, Seleucus, who was one of Alexander's most powerful commanders, finally succeeded in seizing control of the entire Middle East and establishing a Hellenistic rule in Persia that lasted almost a century and a half. Very soon, however, the Seleucid rulers experienced the first major challenge to their control of Iran when, only 60 years later, the Parthians staged a long and fierce war of attrition against them.

Arsaces, the founder of the Parthian dynasty, was soon in firm control of much of the Iranian plateau. His successors continued expanding their rule in all directions. Thus, it did not take very long until the Parthians established themselves as undisputed sovereigns of a vast empire whose borders reached from the river Oxus in the east to the river Euphrates in the west. As one can see from the previously shown chronological table, the Parthians ruled over Greater Iran, that is, Persia and its neighboring countries, more than 500 years; longer than any other dynasty in the entire history of this country. They soon turned out to be not only fearless and awesome warriors but also resourceful merchants and as such they greatly profited from the exchange of goods between China and Rome via the famous Silk Route.

Continuous struggles for expanding their empire westwards finally brought the Parthian kings into sharp conflict with their powerful rivals, the Romans.

The first major encounter between these two superpowers occurred in 53 BC and resulted in a disastrous defeat for the Roman vice-consul Crassus and his army. Crassus was killed and his head was brought to the court of the Parthian king Orodes, when he was attending a cultural event. Legend has it that when the gory head was being presented to the king, one of the actors seized it and cited, to the delight of the audience, the famous poem

**„We bring from the mountains  
A young lion freshly killed,  
A fortunate prey.“**

from „Bacchae“ by the Athenian dramatist Euripides (480-406 BC).

Another attempt on the part of the Romans to beat the Parthians, the battle of 36 BC led by Mark Antony, was similarly abortive and ended with a decisive defeat for the Roman legions. Sextus Propertius, a Roman poet and musician, who would pluck his lyre in praise of war to please his masters, now began to sing another song to his mistress Cynthia:

**„Why should I raise sons for  
Parthian triumphs?  
No child of ours shall be a soldier.“**

On occasions such as these two battles, the Parthians succeeded in blocking the aggressive Roman advances into their territory. The Romans, in turn, finally realized that their glorious army was no match for the extremely mobile and flexible Parthian cavalry and made, for more than a century, no challenge to the hegemony of their eastern rivals.

Due to such victories, the prowess of the Parthian cavalry in the art of archery

became proverbial as »the Parthian shot«. This expression is still used in the English language as a figure of speech. By the way, I happened to come across the following phrase

**„a Parthian volley of expletives from Uncle Billy“**

in one of the short stories by the American novelist Francis B. Harte (1836-1902).

The Parthians, being tolerant of cultural diversities, considered themselves as the protectors of the rich and manifold cultures they had taken over. So, a wide variety of cultures and traditions began to flourish under their soft rule. Painstakingly manufactured coins, marvelously decorated drinking horns, beautifully designed potsherds, and many other relics and works of art from this period testify to the high level of Parthian civilization and cultural accomplishments.

An impressive example of the remarkable workmanship of the Parthian craftsmen is a large bronze statue from a sanctuary. It represents a man wearing an outfit of belted jacket and leggings. After a popular Parthian fashion, he is carrying his hair in bunches under a headband. The English historian and archeologist, A. J. Arberry describes this work of art in his book „The Legacy of Persia“ as follows:

**„The statue, which is most impressive, and gives a picture of a Parthian prince of the Blood, would be spectacular whatever its period and origin.“**

The Parthians excelled themselves also in the realm of architecture and, thus, deeply inspired the succeeding dynasties in Iran. Their architectural innovations have amazed generations of historians. The following judgment by A. J. Arberry in his book „The Legacy of Persia“ is typical:

**„The chief architectural feature that emerges from these buildings, to enjoy later a long history in the Sassanian and Muslim Arab periods, is the long tunnel-vaulted hall or IWAN open to the front and close at the back, of which the most familiar example is in the remains of the Sassanian Taq-i Kisra Arch at Ctesiphon.“**

There were also significant developments in the realm of music during the Parthian period. In fact, many innovations of the greatest importance for contemporary Persian music can be traced to these times. A great deal of musical traditions from this historical era bear witness to the intimate love of the Iranian peoples for this finest art, a deep affection that has survived the centuries. Also from a scientific point of view, many musical works of art from the Parthian era are of great importance for the understanding of traditional Persian music. These artistic remains often provide detailed and valuable information concerning the structure of different musical instruments in antiquity.

When narrating the story of the battle between the Parthian commander Surena and his Roman counterpart Crassus, Plutarch (46-125 AD), the famous Roman historian, gives an illustrative description of a typical episode:

**„Surena, the great Parthian general, used to take his concubines to the battle fields on two hundred sedan chairs. The majority of his female traveling companions were musicians, singers, and dancers.“**

As far as religion is concerned, the Parthians, according to the American historian Will Durant in his book „The Story of Civilization“:

**„veering from Zoroastrian orthodoxy, worshipped the sun and the moon, and preferred Mithra to Ahura-Mazda.“**

Most revealing and interesting in this connection are Arberry's remarks with regard to Mithraism:



„It was during the Parthian period that Rome received, indirectly, a legacy from Persia. Many of the Roman legionaries who had been sent to Cilicia and other outlying provinces to guard them against the traditional foe proved more vulnerable to their enemy's religion than to his army, and became converts to Mithraism. Its militant element had a strong appeal for the Roman soldiers, and it was through them that the religion spread to all parts of the Roman world. It is improbable, that many of the Western converts to this faith realized its Persian provenance.“

There is conclusive evidence of high degree of not only the cultural but also political and religious tolerance exerted by the Parthian rulers vis-à-vis their subjects. They were obviously fair enough to allow religious minorities to follow their own faith and to practice their own rituals unhindered.

Speaking of religious matters we may remember that Jesus Christ was born at a time when the Parthians had already been on the historical scene for almost 250 years. The Holy Scripture of the Christian faith tells the story of the infant Jesus' birth as follows:

**„Now after Jesus was born in Bethlehem of Judea in the days of Herod the King, behold, *magi* from the east arrived in Jerusalem saying: »Where is He who has been born King of the Jews?«**

*Magi*, a caste of wise-men specialized in astrology, medicine, and natural sciences, were Zoroastrian priests with considerable power and influence. Now, if we were to believe the story of Jesus' birth according to Matthew's Gospel, then we would have to assume that the three wise men who traveled to Bethlehem to pay homage to the infant Jesus were Zoroastrian priests from Parthia.

It is worth mentioning that the English words magic, magical, magician, and magus have their origins in the Persian denotation *madjus*, meaning Zoroastrian priest. Expressions such as magic bullet, magic eye, magic lantern, magic spell, and magic square are quite common in English literature.

## Part Two

### The Parthian Battery

„And if this curious device was not used as a source of electricity, for what purpose was it used? Perhaps you can think of one, I can't.“

W. Winton

"Baghdad Batteries B.C."

In the course of earth-moving operations carried out on June 14th, 1936, on the archaeological site in Khuyut Rabbouà near the old Parthian capital Ctesiphon, the workmen came across an ancient burial covered with a stone slab. At first, the archaeologists considered the tomb as just another ordinary discovery and did not become very excited about it. They proceeded routinely with their excavation work until something quite unexpected occurred. It did not take them too long to realize that they were actually digging out strange objects of unknown purposes. In his detailed report, „The Rabbouà Galvanic Cell“, A. Al-Haik gives the following account of this discovery:

**"The site was soon examined by the Iraq Antiquities Department and identified as an important settlement of the Parthian time (248 BC-226 AD) with good archaeological prospects. The Department has, therefore, started digging here immediately. These excavations brought to light some 613 stratified pieces of various objects comprising sarcophagi, skeletal remains, pottery and glass vessels, beads, stone objects, bricks engraved with**

politic characters, metal objects, clay figurines, etc. But more spectacular among these artifacts, from a scientific standpoint, was a curious aggregate composed of an ovoid pottery jar (18×9 cm) with dented mouth containing a copper cylinder with one end closed, iron rod and a number of small crumbs.”[5].

The German archaeologist Professor W. König, who was in charge of the Iraq Museum Laboratory, studied this unit closely and continued searching for any objects that could help him to establish the real purpose of this device in antiquity. In the course of further excavations similar objects were discovered: Photographs of such units can be seen from Fig. 1. These pictures display a clay jar, a thick-walled copper cylinder with one end closed, an iron rod, and small particles of iron.

The tantalizing question was: What purpose these mysterious objects might have had? König decided to deal with this issue systematically. So, two months later on August 29th, 1936, he sent one complete unit to the University of Vienna to be examined by Professor Menghin. Unfortunately, there are no records available on the results of these investigations.

In his paper, „*Ein galvanisches Element aus der Partherzeit?*“ (A Galvanic Element From the Parthian Time?), published in 1938, König referred to this device for the first time as a *galvanic cell* and put forward the daring theory according to which the Parthians might have used such a device for surface finishing. He included in his detailed report a photograph of the original unit and produced a hand-made drawing, see Fig. 2, to support his theory [1]. We see from his schematic representation that the copper vessel is centrally placed in the clay jar and the iron rod is set axially into the copper cylinder separated from it by means of a plug made of asphalt. König's assumption was that an assembly such as this, with a suitable electrolyte, could easily function as a galvanic cell providing

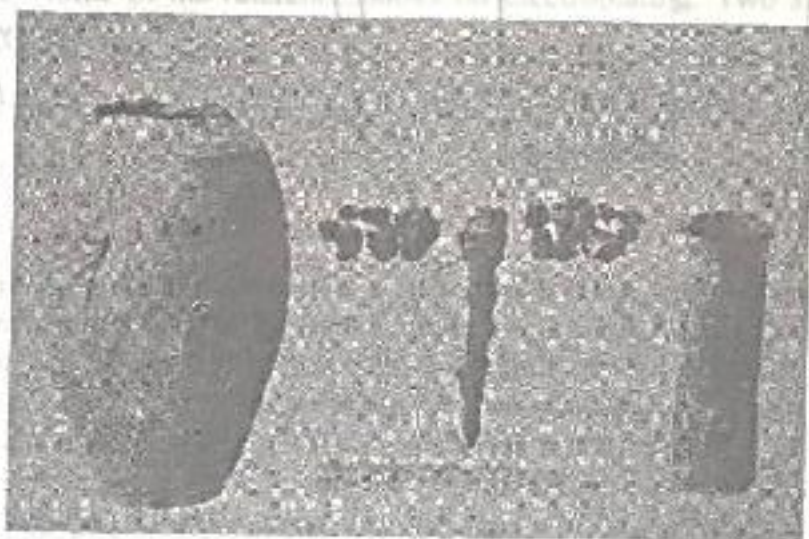
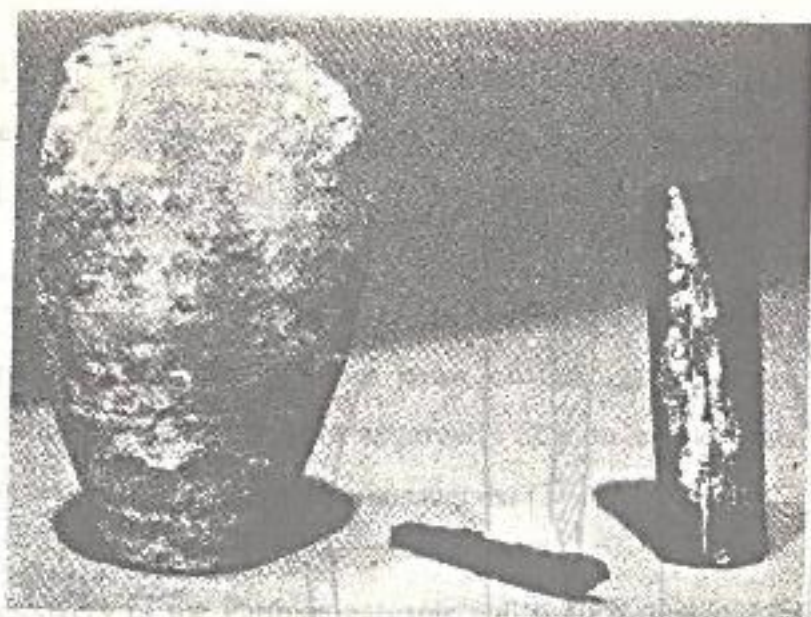
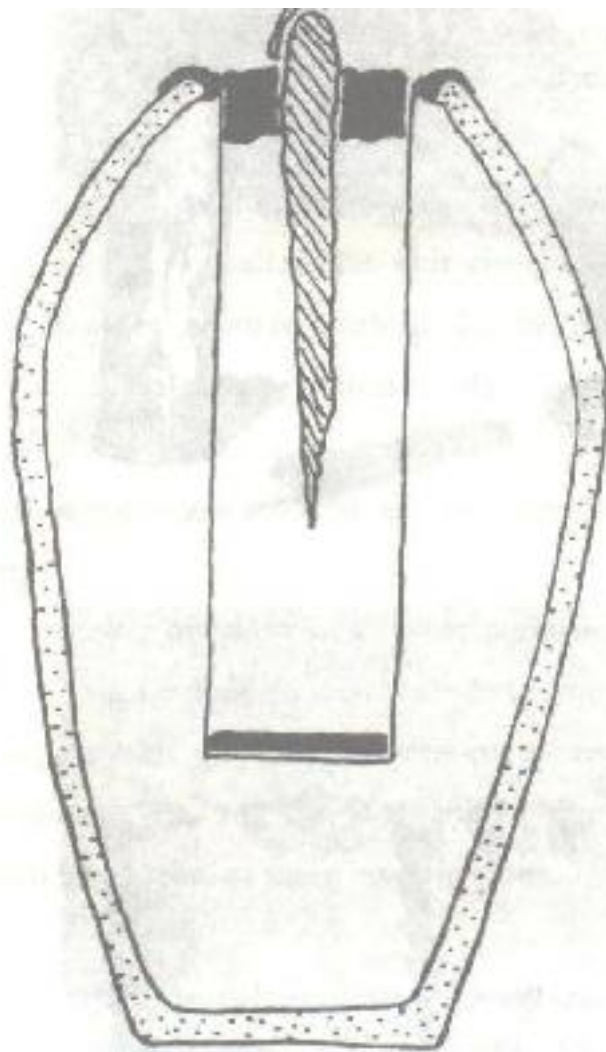


Fig. 1: Schematic representation of the "Parthian galvanic cell" hypothesis who was the first to suggest that objects discovered in Khuyut Rabbouh could generate electric current for plating purposes, if put together in this manner.

**Fig. 1: Curious objects discovered during archeological excavations in 1936 in Khuyut Rabbouh near the old Parthian capital Ctesiphon. It is assumed that the Parthians, a nomadic Iranian tribe, might have used such devices for surface finishing purposes almost 2000 years ago [1, 11]**



- | Cu
- ▨ Fe
- ▨ gebr. Ton
- Asphalt
- ⤿ Kappenschicht (Rest)

**Fig. 2:** Schematic representation of the „Parthian galvanic cell“ by König who was the first to suggest that objects discovered in Khuyut Rabbouà could generate electric current for plating purposes, if put together as indicated in this picture [1].

(Cu: copper, Fe: iron, gebr. Ton: burnt clay, Kappenschicht: remaining top layer)

electric current. He delivered further evidence of the possible purpose of this curious device in his book *„Neun Jahre Iraq - Im verlorenen Paradies“* (Nine Years in Iraq - In the Lost Paradise) that was published in 1940. [2]

In the same year, the German newspaper *„Die Neue Leipziger Zeitung“* (The New Leipzig Journal) brought the news of this astonishing discovery and suggested that the Parthians were apparently able to employ this apparatus to plate silver and gold coatings onto other metals. [3]

The discovery of the Parthian galvanic cell with plating capability has been outlined in some of the reference books on electroplating. Two such examples given below are taken from *„Die Geschichte der Galvanotechnik“* (The Story of Electroplating) and *„Electroplating of Plastics“*, published in 1959 and 1977 respectively:

**„Ähnliche Gegenstände wurden anscheinend öfters unter den Resten der alten parthischen Kultur gefunden, doch nie so gut erhalten, wie der eben erwähnte Fund. Bemerkenswert ist, daß sich in der Nähe der Vase noch Reste von Eisen- und Kupferstäben befanden, von denen anzunehmen ist, daß sie als Leitung oder auch als Ersatzteile dienten.“ [3]**

„Similar objects were found among the remains of the Parthian culture. However, none of them was as well-kept as this one. It is worth mentioning that remains of iron and copper rods were discovered lying around the clay vase. They might have served either as connecting rods or as spare parts.“

**„Some time ago small clay jars were found with metallic parts inside; they may have conceivably served as current sources for electroplating. Iron rods arranged centrally in copper pipes were connected in the jars with asphalt, and by using vinegar or citric acid, the galvanic cell was able to discharge current. It worked exactly like the first galvanic cell constructed about 1800 by Volta. But we do not know how initial electrical conductivity was achieved and if any electroplating occurred.“[7]**

Since their discovery, these objects have aroused much scientific curiosity in the scientific community. Many scientists and experts from different countries have performed extensive laboratory experiments to find the real purpose of these puzzling and mysterious devices in order to confirm or to refute the theory put forward by König. In the following I will try to outline the highlights of such activities chronologically.

One strong proof of the functionality of such a »battery«, (as it was to be referred to henceforth), came about when scientists working for General Electric in Pittsfield (USA) succeeded in obtaining electric current from a replica of the Parthian galvanic cell in 1957. [9]

Compelling evidence of the possible correctness of König's assumptions was delivered by an American scientist in 1960. A. Al-Haik's report contains the following passage dealing with this event:

**"It is interesting to mention here the extensive research made in March 1960 by Mr. John B. Pierczynski of the University of North Carolina on this intriguing discovery. Mr. Pierczynski conducted laboratory experiments with replicas of this unit and obtained very favorable results. When he used a 5 percent solution of vinegar or wine as electrolyte, one-half volt of current was gained from each cell for a period of eighteen days. This, he says, is sufficient enough to electroplate silver onto copper. He further expresses the notion that this object may represent the antique forerunner of the electroplating process used by local silversmith."** [5]

During the Summer and the Fall of 1962, Mr. W. Winton of the Science Museum in London closely examined the „Parthian Battery“ when he was on mission in Iraq for the reorganization of the Iraq Museum. In his paper „Baghdad Batteries B.C.“, published in 1962 in the Journal of Archaeology and History in Iraq „SUMER“, he summarized his observations as follows:

„Imagine a thin-walled copper vessel about the size of a number 8 torch battery, an iron rod set axially in it and separated from the copper cylinder by means of a bung made of asphalt and by a thin disc of asphalt on the bottom of the vessel. Now if one were to set these objects in front of a physicist, or an electrician, for that matter, any person who only vaguely remembers his school physics, what would his reaction be? Would these objects, arranged in this way ring a bell in his memory? Simple cell: Galvani, Volta, Daniell. Yes, of course! Put some acid in the copper vessel - any acid, vinegar will do - and, - hey, presto! - you have a simple cell which will generate a voltage and give a current of electricity.“ [4]

He concluded his report by a cautionary remark stating that despite all indications, the Baghdad Battery should remain in the realm of conjecture until further and absolutely conclusive evidence was found. Nevertheless, he could not help acknowledging:

„Perhaps the incredibility is in the mind of the unbelievers and that arrogant pride in our modern scientific achievements makes us unwilling to believe that effects of current electricity could be known to our Mesopotamian ancestors 2000 years ago.“

Based on the results of such investigations, H. Huber opened his paper on „Die galvanische Zelle - eine 2000 Jahre alte Stromquelle im Zeitalter der Nuklearenergie“ (The Galvanic Cell, a 2000 Year Old Battery in the Age of Nuclear Energy), published in 1970, with the following introductory remarks:

„Ein schockierender Titel im Hinblick darauf, daß man bis vor kurzem berechtigt war anzunehmen, daß die Entdeckung und Erforschung der galvanischen Phänomene zu den Großtaten der neuzeitlichen Naturwissenschaft gezählt werden muß.“ [6]

„A shocking title in the light of the fact that until most recently we were justified in assuming that the discovery and investigation of galvanic phenomena should be considered as a master piece of the contemporary natural sciences.“

The desire to provide further evidence of the true purpose of such devices in



antiquity and to come up with conclusive proof concerning their performance as plating cells, continued to be a strong driving force for many scientists and experts. The following extract may be taken as an example:

**„Im Sommer 1978 wurden im Hildesheimer Roemer-und Pelizaenus-Museum anlässlich der Ausstellung "Sumer-Assur-Babylon" noch weitergehende Versuche mit einer solchen (nachgebauten) Batterie gemacht. Dabei nahm der Ägyptologe Arne Eggebrecht als Batterieflüssigkeit den Saft frisch ausgepresster Trauben, und er gewann einen Strom mit einer Spannung von 0,5 Volt. In einem zweiten Teil des Experiments wurde die Stromquelle mit einer Galvanisierwanne verbunden, in der innerhalb von zweieinhalb Stunden eine kleine silberne Figur rundum vergoldet wurde.“ [8]**

„In the Summer of 1978, on the occasion of the »Sumer-Assur-Babylon Exhibition« in the Roemer-Pelizacus Museum of Hildesheim, the German Egyptologist Arne Eggebrecht succeeded in demonstrating that even by applying freshly pressed grape juice as electrolyte one could obtain a voltage of about 0.5 Volt from such a battery. In a second experiment, he connected the battery with a galvanic bath and plated a small silver figurine with gold in a matter of two and a half hours.“

The eminent German weekly magazine *„Die Zeit“*, that reported on this scientific event and similar experiments in its issue No. 45 of November 5th, 1982, under the heading *„E wie Elektrizität: Von den Parthern schon vor 2000 Jahren genutzt“* (E as in Electricity: Exploited by the Parthians 2000 Years Ago) could not help but to jump to the conclusion:

**"Ganz ohne Zweifel aber steht fest, daß die Parther zur Zeit Cäsars und Kleopatras elektrische Batterien gekannt haben." [8]**

„Now there is evidence beyond any doubt that the Parthians knew of the electric battery already in the time of Caesar and Cleopatra.“

Based on considerable amount of historical documents available now, we know for a fact that the Parthians were also skilled wine-growers and resourceful wine-merchants. The discovery of the huge Parthian archive in the vicinity of the

city of Nisa, the old Parthian residence and capital near the modern city of Ashkabad (Eshgh Abad) in Turkmenistan, by Russian archaeologists brought to light some 2000 ostraca with 2758 inscriptions. [14] The majority of these potsherds contain official entries dealing with production and delivery of wine. One of these documents, taken from Wiesenhöfer's book „*Das antike Persien*“ (The Antique Persia), is reproduced in the following by way of example:

**"In diesem Xum (Tonkrug) sind aus dem *uzbari* Weinberg des Guten *Friyapatikan*, der im Besitze des Satrapen ist, 17 mari (ca. 11 Liter) Wein. Geliefert für das Jahr 188 (der parthischen Ära = 60 v. Chr.), gebracht von *Humayak*, Lieferant des Weines, der gebürtig ist aus *Artastasvanak*. 2 mari Wein sind sauer geworden."** [14]

„There are 17 mari (approximately 11 liters) wine from the *uzbari* vineyard that belongs to *Friyapatikan*, the genial, who is also the Satrap's vassal, in this Khom (clay jar). The wine was delivered in the year of 188 (Parthian calendar = 60 BC) by *Humayak*, who comes from *Artastasvanak*. 2 mari of wine has gone sour.“

It should be noted in passing that the word *khom* (pottery jar) is still used in the Persian language in its original meaning.

In view of a few magnificently crafted and richly decorated drinking horns from the Parthian period discovered in the course of the centuries, we can certainly assume that the Parthians themselves appreciated the drinking of wine. Two such examples that testify to the amazing artistic skills of the Parthian craftsmen, are shown in Fig. 3. What makes such works of art so special from a scientific standpoint is that some of them are selectively gold plated.

In recent years, Professor W. Jansen of the University of Oldenburg and his colleagues have carried out extensive laboratory experiments under different conditions to study the performance of the Parthian Battery. Using both closed and open end copper cylinders, they have been able to demonstrate the capability of such a device to generate electric current.



*Fig. 3a: The Parthians were resourceful wine-growers and wine-merchants. Works of art such as these richly decorated drinking horns bear witness to the amazing artistic skills of the Parthian craftsmen and the appreciation of wine by the courtiers.*

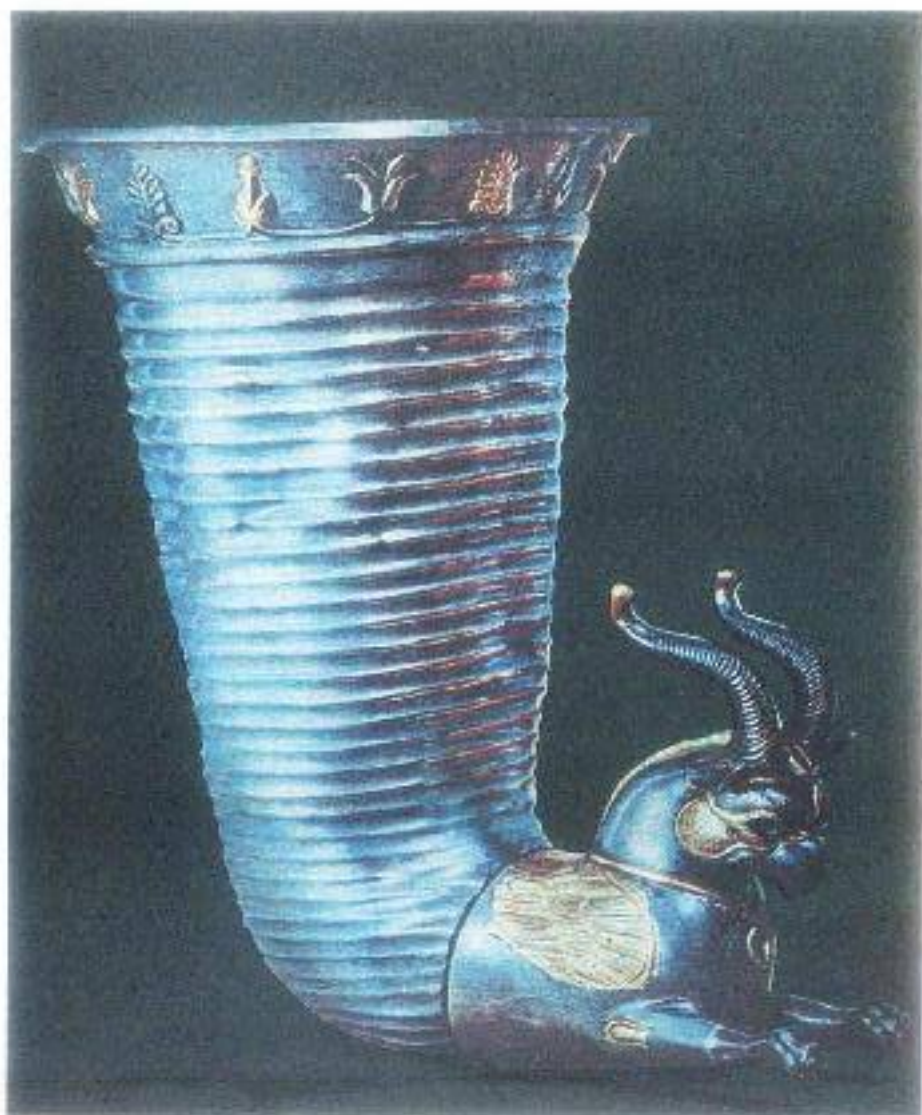


Fig. 3b: Drinking horns such as this particular one are not only highly admirable as a work of art but also most puzzling from a scientific point of view due to the fact that they are selectively gold plated.

In their paper „*Entwicklung and Wandel von Theorien - Mit Beispielen aus der Elektrochemie*“ (Development of and Changes in Theories - With Examples from Electrochemistry), published in 1986, the authors express their views with regard to the Parthian art of gold plating in the following way:

**„So waren die Parther, die 141 v. Chr. Mesopotamien erobert hatten und dort für einige Jahrhunderte herrschten, Meister der Vergoldung. Ihre Vergoldungen waren so rein und glänzend, wie man sie heute nur durch Galvanisieren erzeugen kann.“**[10]

„The Parthians, who conquered Mesopotamia in 141 BC and ruled over that region for many centuries, were true masters of gold plating. Their gold coatings are extremely pure and bright. We can deposit such gold coatings only by means of modern electroplating.“

In a set of three articles with the title „*Die Batterie der Parther und das Vergolden der Bagdader Goldschmiede*“ (The Parthian Battery and the Gold Plating of Bagdad Goldsmiths), published in 1987 and 1993 [11,12,13], these researchers discuss the results of their comprehensive studies and tests with regard to the Parthian Battery and its plating capabilities. As already mentioned, they used experimental setups equipped with either closed or open end copper cylinder, as represented schematically in Fig. 4, to measure the performance of the Parthian galvanic cell as a function of oxygen concentration in the copper cylinder where the chemical reactions take place. They also constructed a special galvanic cell to examine the gold plating capabilities of the Parthian Battery and to deposit gold layers similar to those of Bagdad goldsmiths as they chose to refer to the Parthian gold platings. The schematic representation of their experimental setup for depositing gold coatings can be seen from Fig. 5.

It would go far beyond the scope of this lecture if I were to describe and discuss their experimental findings in full length. One puzzling aspect, however, deserves to be dealt with on its own merits. It would be fascinating to know

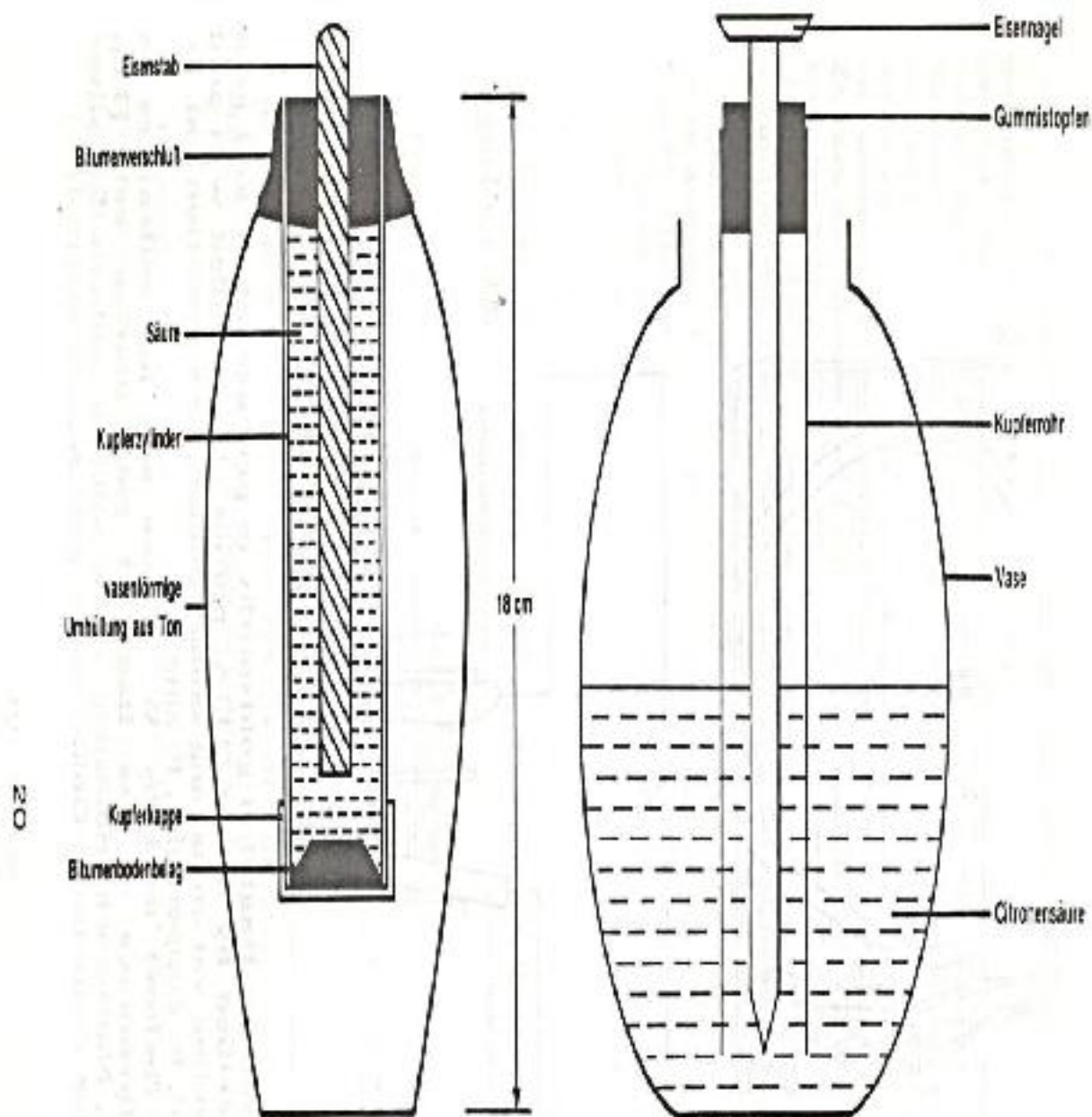


Fig. 4: Schematic representations of the objects discovered near the old Parthian capital Ctesiphon. The thin-walled copper cylinder with an end closed (right) or with one end open (left) is centrally installed into the clay jar; the iron rod is axially set in the copper cylinder and separated from it by a disc made of asphalt. Experimental setups similar to these units were used by W. Jansen and his colleagues to study the plating performance of the Parthian galvanic cell under different conditions [12, 13].

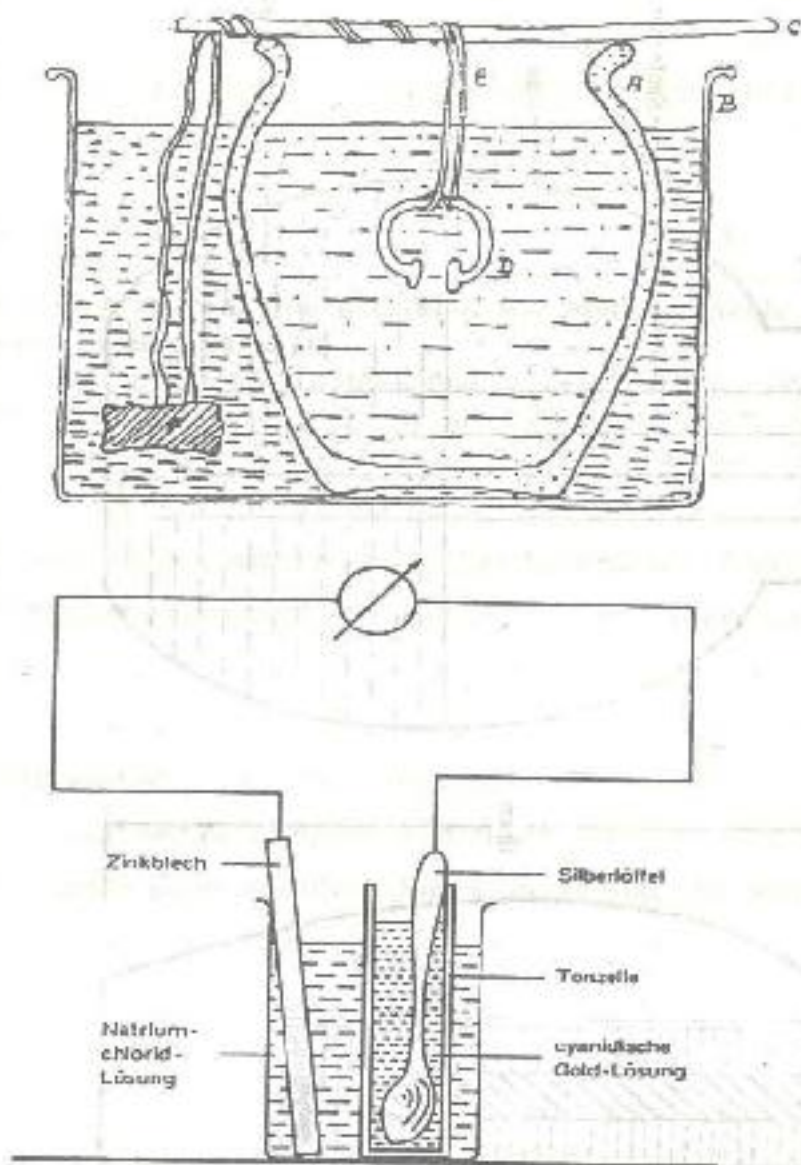


Fig. 5: Equipment used by Baghdad goldsmiths to produce silver and gold platings (top) as described by König [1]. (A: porous clay jar filled with gold cyanide solution, B: boiling vat containing saline solution, C: suspension rod, D: object to be gold plated, E: copper wire, F: zinc bar).

Experimental setup (below) used by W. Jansen and his colleagues to investigate the performance of the Baghdad gold plating cell [12]. (Zinkblech: zinc sheet, Natriumchloridlösung: saline solution, Silberlöffel: silver spoon, Tonzelle: clay jar, cyanidische Gold-Lösung: gold cyanide electrolyte)

„Wie haben die Parther das für diese Technik erforderliche Goldcyanid gewinnen können, das in der Natur nicht vorkommt. Untersuchungen haben gezeigt, daß wenn man Gold zwischen schlecht gegerbtem, verrottem Leder hämmert, es oxidiert wird und unter Bildung von Goldcyaniden als Komplexverbindung  $K[Au(CN)_4]$  in Lösung geht. Eine andere Möglichkeit bestände darin, daß die Parther Gold mit zerquetschten Obstkernen in wäßriger Lösung bei Luftzutritt behandelt hätten. Das in den Kernen vorkommende Amygdalin spaltet hydrolytisch Cyanid-Ionen ab, die in Zusammenwirken mit Luft Gold zu komplexen Goldcyaniden oxidiert haben könnten.“ [8, 11]

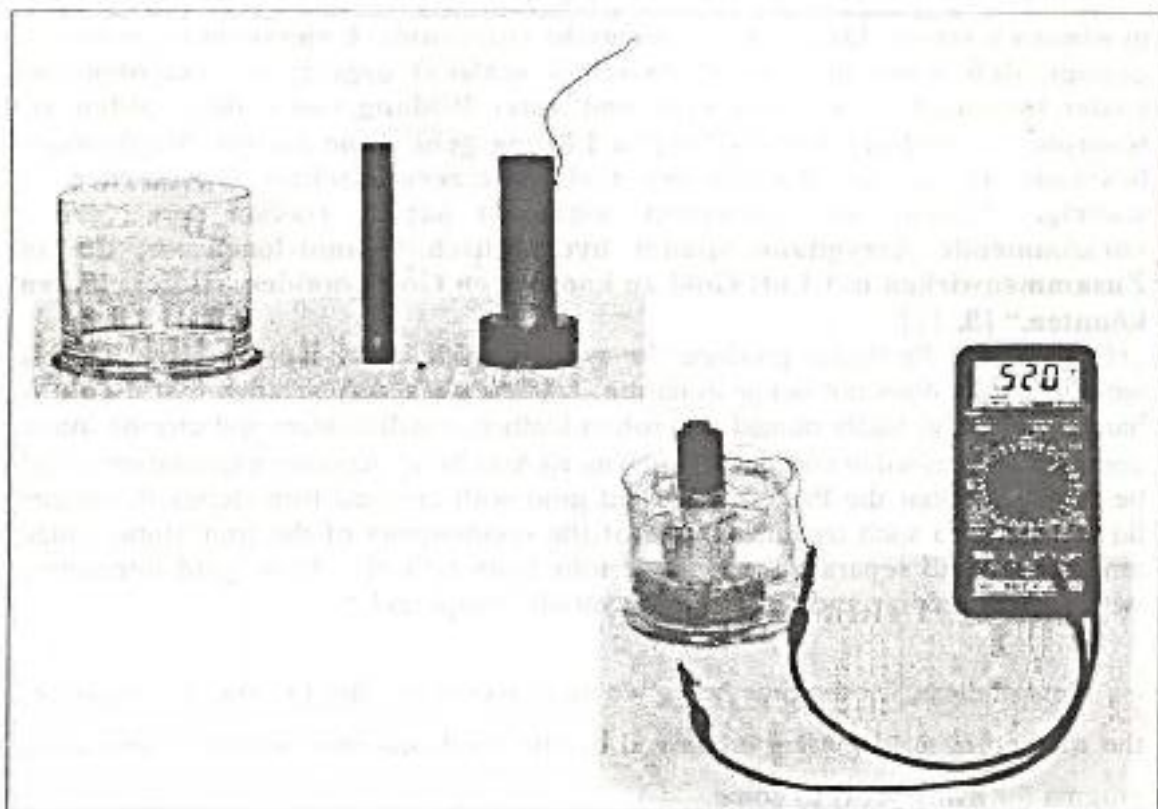
„How did the Parthians produce the gold cyanide which is necessary for this technique; but does not occur in nature. Investigations have shown that if gold is hammered under badly tanned and rotten leather, it will oxidize and change into a complex gold cyanide compound such as  $K[Au(CN)_4]$ . Another explanation could be to assume that the Parthians treated gold with crushed fruit stones in aerated liquids. Due to such treatment, one of the components of the fruit stone called amygdaline will separate the cyanide ions hydrolytically. Thus, gold interacting with air will oxidize and build a gold cyanide compound.“

Nevertheless, for the time being we must accept the fact that the true nature of the method of gold plating employed by the Parthians may remain a tantalizing enigma for many years to come.

The photographs shown in Fig. 6 represent the experimental setup used by myself and my co-workers most recently to examine the performance of the Parthian Battery under certain conditions. The reading by the voltmeter of 0.52 V displayed on one of the photographs was generated by the cell using dilute acetic acid as electrolyte [15]. The results of this study that concerns itself with the plating abilities of the Parthian galvanic cell are to be published in the near future.

Interestingly enough, some experts believe that the Parthians may have used such devices for purposes other than metal plating. One of them goes so far as to theorize:





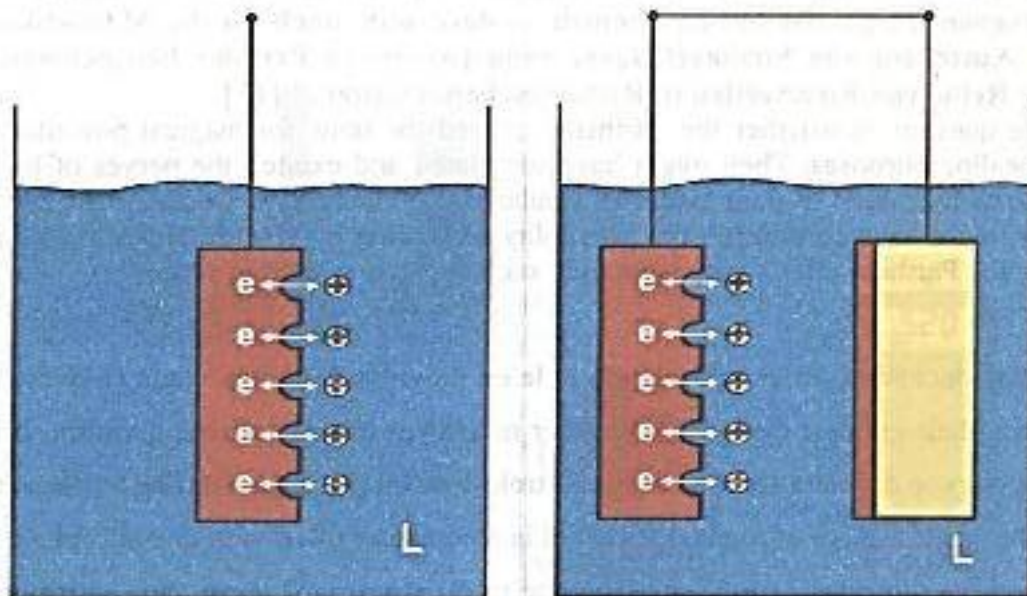
**Fig. 6: Experimental setup employed by the author to study the plating capabilities of the „Parthian Battery“ under certain laboratory conditions. Using iron wire, copper cylinder and dilute acetic acid a voltage of 0.52 V could be obtained [15].**

**"Die Frage ist, ob die Parther die gefundenen Geräte zu magischen oder Heilzwecken benutzt haben könnten. Dabei denkt man einerseits daran, daß die Parther mit Hilfe ihrer Batterie im Sinne einer Akupunktur Nervenenden gereizt haben könnten, andererseits auch an die Möglichkeit des Austeilens von Stromschlägen, wenn parthische Priester beispielsweise eine Reihe von Einzelzellen in Reihe geschaltet hätten."** [13]

„The question is whether the Parthians utilized the units for magical procedures or healing purposes. They might have stimulated and excited the nerves of their patients by means of their batteries similarly to acupuncture. On the other hand, they might have considered the possibility of healing by electric shocks. To this end, the Parthian priests may have used such units connected in series.“

In conclusion, let us speculate a little on how the Parthians might have come across their greatest discovery. In order to answer this tantalizing question, it is necessary to consider the basics of electroless metal plating according to the state of the art: If a piece of a metal is placed in a container filled with an acid solution, as indicated in Fig. 7, most probably the metal atoms will leave their lattice and enter the solution in the form of positively charged metal ions leaving behind negatively charged electrons. However, in a fraction of a second, this so-called anodic dissolution will come to an end due to the strong attractive forces acting electrostatically between the two differently charged particles. A state of dynamic equilibrium is reached whereby no further changes take place. Now, if another piece of a metal of different nature is immersed in the solution and somehow connected to the first one, for example by means of a wire, the electrons will flow through the external connection to the second metal imparting to it an excess of negative charge. Subsequently, the positively charged metal ions, that are now loosely moving around in the solution, will be attracted towards the negatively charged second metal and will become neutralized by the electrons as soon as they reach its surface. As a consequence, the second metal will be covered with a thin layer of the first one.

A copper vessel filled with wine and in direct contact with an iron scoop

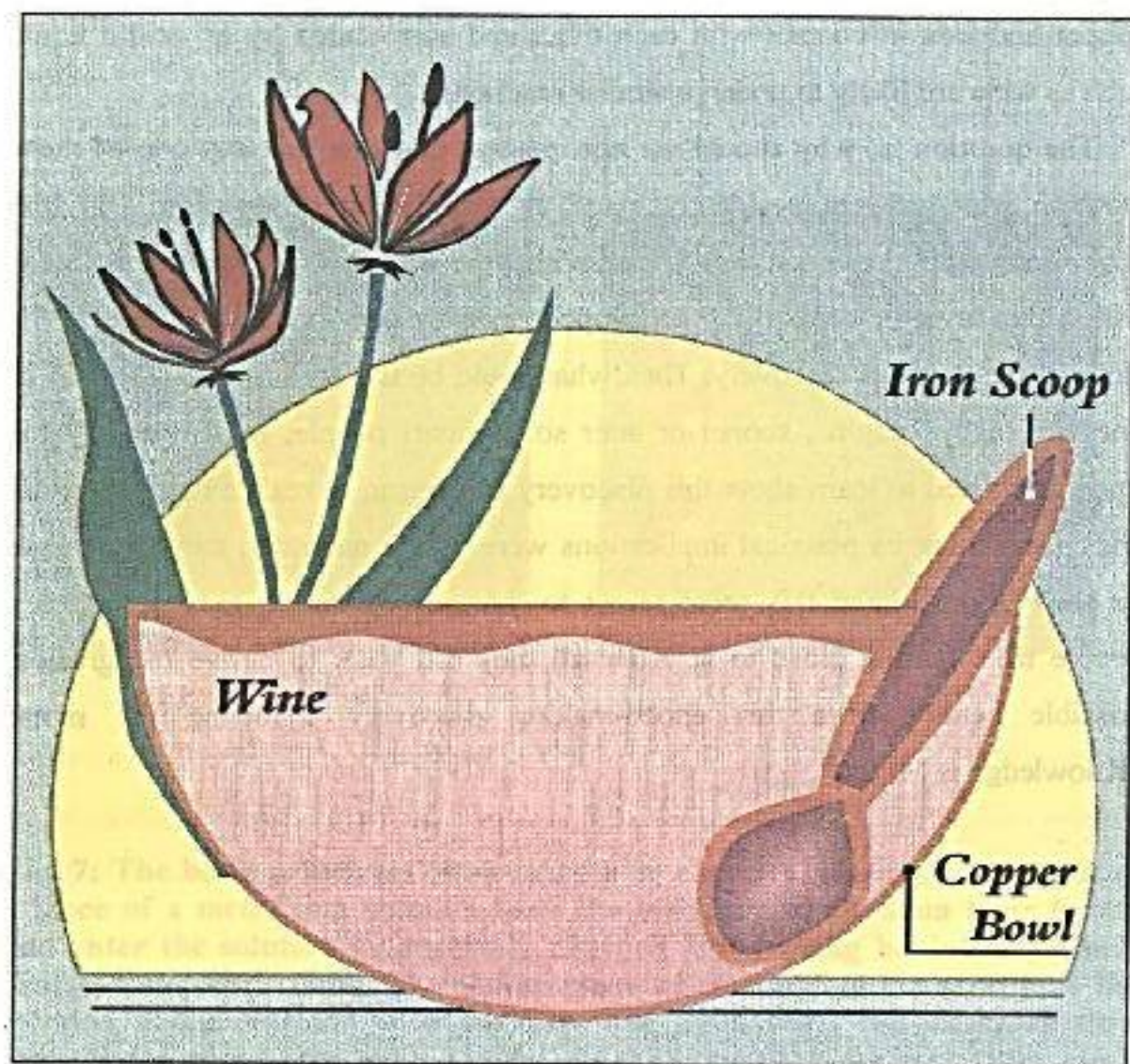


**Fig. 7: The basic principles of electroless or chemical plating: The atoms of a piece of a metal in a solution have the tendency to abandon their lattice and enter the solution as positively charged ions leaving behind negatively charged electrons (left). If another piece of a metal is immersed in the solution and connected with the first one by a wire, the electrons flow through the wire to the second metal. At the same time, the metal ions move through the solution in the direction of the second metal and cover its surface with a thin layer after becoming neutralized by the electrons (right).**

hanging in it, as indicated in Fig. 8, constitutes a similar plating assembly. In fact copper and iron in contact with each other and surrounded by an acidic liquid such as wine are likely to undergo similar reactions.

The question is, why should we not imagine that one fine day one of those Parthian wine-growers accidentally made an astonishing observation: His iron scoop hanging in the copper bowl filled with wine was covered, God knows why, with a thin layer of copper! Let us suppose just for one moment that this is the story of the Parthian discovery. Then what could be the consequences? Now, as one can easily imagine, sooner or later some smart people, most probably the magi, happened to learn about this discovery and began to realize how important and far-reaching its practical implications were. Quite naturally, they decided to do their best to keep this great secret to themselves and to prevent ordinary people from getting close to it. After all they did want to derive the greatest possible benefit from this epoch-making discovery following the motto „Knowledge is Might!“.





**Fig. 8:** A copper bowl containing wine together with an iron scoop having direct contact with it, as indicated in the drawing, establishes an electrolytic cell similar to that described in Fig. 7. Under favorable conditions the iron scoop is likely to be covered by a thin copper layer.

## References

1. W. König:  
**„Ein galvanisches Element aus der Partherzeit?“**  
Forschungen und Fortschritte, Nr. 1, 1936
2. W. König:  
**„Neun Jahre Iraq - Im verlorenen Paradies“**  
Rudolf Kohrer Verlag, 1940
3. R. Weiner:  
**„Die Geschichte der Galvanotechnik“**  
Eugen G. Leuze Verlag, 1959
4. W. Winton:  
**„Baghdad Batteries B.C.“**  
Sumer, Vol. XVIII, 1962
5. A. Al-Haik:  
**„The Rabbouà Galvanic Cell“**  
Sumer, Vol. XX, 1964
6. R. Huber:  
**„Die galvanische Zelle - eine 2000 Jahre alte Stromquelle im Zeitalter der Nuklearenergie“**  
Metalloberfläche, Heft 8, 1970
7. R. Weiner:  
**„Electroplating of Plastics“**  
Finishing Publications Ltd., 1977
8. N. N.:  
**„E wie Elektrizität: Von den Parthern schon vor 2000 Jahren genutzt“**  
Die Zeit, Nr. 45, 1984
9. E. Paszthory:  
**„Stromerzeugung oder Magie“**  
Antike Welt, Nr. 16, 1985

10. W. Jansen et. al.:  
**„Entwicklung und Wandel von Theorien“**  
PdN-Chemie, 2/35, 1986
11. W. Jansen et. al.:  
**„Die Batterie der Parther und das Vergolden der Bagdader Goldschmiede“**  
CLB Chemie für Labor und Betrieb, Heft 10, 1987
12. W. Jansen et. al.:  
**„Die Batterie der Parther und das Vergolden der Bagdader Goldschmiede“**  
CLB Chemie für Labor und Betrieb, Heft 11, 1987
13. W. Jansen et. al.:  
**„Die Batterie der Parther und das Vergolden der Bagdader Goldschmiede“**  
CLB Chemie für Labor und Betrieb, Heft 3, 1993
14. J. Wiesenhöfer  
**„Das antike Persien“**  
Artemis & Winkler Verlag, 1994
15. N. Kanani:  
**„The Parthian Battery“**,  
(to be published)

