WISDOM OF THE EGYPTIANS
by W.M. Flinders Petrie

First Digital Edition

2019

EDITOR'S INTRODUCTION

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This is a digitized and manually edited version of Flinders Petrie's book *Wisdom of the Egyptians,* published in London in 1940. The digitization project was carried out by scanning an original copy of the hardback version of the book and then processing the images through Optical Character Recognition software. The pages were then manually assembled, edited, and proofread into a finished document. The work was in part carried out by crowd sourced volunteers. In the editorial introduction that follows, I attempt to contextualize the book for modern readers and explain why it remains significant, 80 years after it was published.

W.M. Flinders Petrie was one of the most esteemed archaeologists ever to work in the field of Egyptology. *Wisdom of the Egyptians* (Petrie 1940) is a remarkable synthesis of his accumulated knowledge regarding the crafts and sciences of ancient Egypt. It was written towards the end of his long and productive career when he could draw on an immense volume of directly acquired knowledge. Despite the fact that many of Petrie's works are already available online, this book appears not to have been digitized previously. It seems to be a remarkably rare book when compared to many of Petrie's other publications, and it is rarely referenced elsewhere. There are several reasons for this and it is important for modern readers to understand the issues involved in order to understand why its distribution was so limited, and why its content should be treated judiciously. A degree of reserve is required when it addresses two fundamental subjects: chronology and race. Petrie was an advanced scholar for his era by any measure, but the book is now obviously dated in some respects. That is certainly not to say that the content is without value, but readers are encouraged to be selective when reading and to compare details and theories with more modern studies when required.

Petrie was an elderly man by the time he wrote *Wisdom of the Egyptians,* and he had been practicing archaeology for more than 70 years. He was living in Jerusalem with his wife Hilda as WW2 broke out and the conflict surely impacted the reception of the work for the reasons discussed below.

Chronology

A few years after *Wisdom of the Egyptians* was published, wartime advances in atomic science produced the Carbon 14 dating method. This proved to be effective and accurate and was quickly adopted by younger scholars (Arnold and Libby 1949). As a result, Petrie's long-standing chronology, which many had already suspected to be skewed to the earlier side of the timescale, was shown to be 'relatively' correct but 'absolutely' wrong in places. The sequence of historical events he had described was broadly correct, but the actual dates he gave in years were wrong, particularly for the earlier periods. His chronology relied in part on a method of using ancient stellar records known as Sothic dating, but his attempts to reconcile Mesopotamian and Egyptian chronologies seem to have led him to place the earlier periods of Egyptian chronology a whole Sothic cycle too far into the ancient past. For example, on page XVI, the date given for the start of the first dynasty is 4,326 B.C., as opposed to 3,000 B.C.; a date more broadly accepted today. This difference corresponds quite closely to a single Sothic cycle, which is 1,460 years long. His chronology for the later dynasties was not affected by this error, but as a result of the disruptive new atomic dating technology his books became unreliable as authoritative resources regarding ancient Egyptian chronology. Readers may also notice the abbreviation S.D. used throughout the text of *Wisdom of the Egyptians,* and this refers to Petrie's own *Sequence Dating* timeline and the relative positions along it, which he used for the

Predynastic Period. SD 30 equates to the start of Naqada I, while SD 79 was the beginning of the 1st dynasty. For the dynastic era, Petrie refers to particular dynasties rather than absolute dates, or the SD system, so that the majority of the text remains understandable in that respect. NB: An additional note on chronology can be found at the end of this introduction in the editor's notes.

Race

WW2 also changed perceptions of race around the world including in the field of Egyptology. *Wisdom of the Egyptians* was written during an intense period of racism in Europe and America leading up to WW2, and before the full dangers of that mindset had become apparent. The intellectual world was still dealing with the theory of evolution, and concepts from the biological sciences had become mixed with the intensifying issue of nationalism. Attempts were made to address human genetics by treating national populations and minority religious groups as different races. Warfare between races was regarded as historically decisive and served as a proxy for military and industrial competition between nations.

Petrie considered these issues with respect to the ancient past, and discussed the underlying principles as if they could shape policies affecting modern human development just as they could be applied to the rise and fall of ancient civilizations. These ideas can be seen in *Wisdom of the Egyptians*, where he attributes periods of rapid development in ancient Egypt to colonization by groups of superior foreigners or more vigorous races. This phenomenon is seen in scholarship from other regions produced during that inter-war period, and has been referred to as 'invasion syndrome'.

Should we condemn Petrie's work to the dustbin of history as a result of his racial views of the ancient world, or should we save the work for posterity, with appropriate caveats? Petrie's views were relatively widespread in scientific circles at the time he was writing, and in some respects the biased aspects of his work are just as informative as the more factually sound parts. Some chapters of this work can still be read like a modern textbook, while other parts retain interest from a historiographical point of view alone.

Modern archaeology operates from the premise that human races are not fixed, scientifically verifiable, groups. The concept of race is a shifting social construct that varies from time to time and place to place. Archaeological material cannot be attributed to particular races, as the well-worn phrase 'pots are not peoples' attempts to convey. Similarly, scripts are not attributable to particular races, as Petrie attempts to do in *Wisdom of the Egyptians.* Ultimately, all humans are part of one very large family with many intertwined branches. Culture is learned and passed on by communication rather than genetics, and it develops along the way. Terms and concepts like "negro" and "Asiatic", which appear in *Wisdom of the Egyptians*, are typically avoided in more modern texts.

Like many of his colleagues at the time, Petrie was a scientific racist in some respects, but he was not racist in his personal social interactions with people in Egypt and the Near East, and he should not be judged as a racist in that respect (Ramsey 2004: 18). He had many friends in Egypt and Palestine and judged individuals by character rather than by appearance, religion, or nationality. An excellent biography of Petrie shows the wide range of his experience and associations (Drower 1985). This introduction is not intended to be a hagiography of Petrie, nor is it meant to condemn his memory unfairly. His life and work must be understood with respect to the context of the era and the societies in which he lived and worked. He was a unique individual within that context, with special characteristics and abilities, who gained extensive experience and made significant developments when working in the Near East during a tumultuous period in world history.

Life and Legacy

Egyptology first developed into a systematic field of study at the end of the 19th century, under the influence of the newly developing “archaeology”. English Egyptologist Flinders Petrie played a significant role in that process, and his work in Egypt began with his 1880 triangulation survey of the monuments of the Giza Plateau. That project, and his early work elsewhere in the Memphite necropolis, resolved many unanswered questions surrounding the pyramids and the monumental architecture of Old Kingdom Egypt.

When Petrie set up his tripods on the dusty sands in the shadows of the ancient pyramids, he took with him all the religious, academic, nationalist, and political concerns that influenced people in 1880 A.D. The young Flinders Petrie was in many ways acting out the role of a typical colonial European gentleman, and recreating at Giza, on a small scale, what was happening on a regional and global basis. The 27-year-old archaeologist arrived in Egypt, alone, with his father’s theodolites, at a time when colonial survey of new territory was very much in the air. Unlike the formally-trained Royal Engineers of the Palestine survey, Petrie never went to school or university due to his problematic health as a youngster, but quite independently developed an interest, and eventually an expertise in surveying and archaeology. His engineer father and his highly educated mother, whose own father had been the first European to circumnavigate and chart Australia, were able to give Petrie the skills he needed to begin a systematic study of the ancient world that lasted for over 70 years.

Archaeology was emerging at the time from a subject practiced by gentlemen scholars into a subject of professional academic study. Most archaeologists were still amateur, so Petrie’s lack of formal education was no bar to his acceptance by those who were interested in the field. In fact, in 1880 when Petrie headed out to Egypt, there was no academic department of Egyptology anywhere in Britain. But all that was about to change.

In 1883 the British invaded Egypt by force and remained there as the occupying power until 1936. While this military domination was very real, Petrie’s amateur triangulation survey of Giza, and his professional archaeological excavations that followed all over Egypt, helped to put England in a powerful position with respect to European academic and ideological domination over ancient Egypt and the Middle East, and this lasted into the early 20th century. At a time when nationalism was an ever-growing force across the world, the achievements of scholars from different countries became of national significance.

Although he was initially working alone and was virtually unknown, Petrie’s Giza survey became an important event for the advancement of English intellectual ideology outside of the official organizations of the British Empire. The results were published in 1883, one year after the Egyptian Exploration Fund was launched. Almost immediately after the publication of the survey Petrie became involved with the new EEF organization thanks to the wealthy and successful novelist and amateur Egyptologist, Amelia Edwards. She noticed Petrie’s talents and went on to support him financially and professionally throughout his career.

Petrie and his father were first drawn to Egypt by Astronomy Professor Charles Piazzi Smyth’s theories regarding the Great Pyramid, which mixed nationalism, religion, and science in a way that proved difficult to unravel. Petrie’s father had followed the development of those theories closely, but Petrie’s legacy to the study of the Great Pyramid turned out to be quite secular in nature, as he cut through the chaff of Smyth’s work and drew out the aspects that had real value. Perhaps because Petrie initially worked independently of any official organization, he was able to stand back from all the ideological issues and produce a remarkably frank, balanced, polished, and objective scientific survey report. The publication accurately reflected the archaeological remains at Giza, and accurately discerned the details of the work set in place by the ancient pyramid builders.

Petrie measured the pyramids, discovered their true dimensions and properties, and soon established himself as a new authority on ancient Egypt. Even today Egyptologists frequently refer to his survey, which remains the authoritative source for the basic measurements of many of the features of the whole Giza funerary complex. The report of all the work was published in 1883 (Petrie 1883). It included a mass of measurement details, an extensive and comprehensive historical analysis of the data and theories, and a detailed retrospective analysis of the precision of the survey.

Wisdom of the Egyptians includes information derived from those early years and surveys, and the text shows that Petrie stood by many of the key conclusions he had drawn in those early studies. Chapter 3 discusses the architectural concepts that he found within the designs of the great monuments during the excavations carried out more than half a century previously.

That project at Giza set Petrie up as a scientific authority on the pyramids, and the excavation work that followed meant that by the end of the 19th century Petrie was an accepted archaeological expert. By using the experience built up over those early years, he went on to train almost every British Middle Eastern archaeologist until 1935 (Moscrop 2000: 156). Petrie was doing for sites in Egypt what Schliemann had done for Troy. He was bringing the archaeology back to life, as real, physical pieces of the past. Through his knowledge of classical texts such as Herodotus's *Histories*, he was able to demonstrate direct links between historical records and archaeological remains. With his exceptionally prompt publication of the excavated sites, often in the same year that they were uncovered, he was able to disseminate the knowledge rapidly and earn valuable income to finance his subsequent excavation work, through the sale of books as well as artefacts.

This sustained focus on the archaeology and history of ancient Egypt meant that Petrie amassed an unprecedented level of familiarity with the ancient Egyptian culture. His technical mind was able to retain a great volume of detail, which is distilled onto the pages of *Wisdom of the Egyptians*. Here he sets out his findings on a variety of subjects ranging from astronomy to music, and from architecture to precious metal working.

In Egypt and later in Palestine, Petrie demonstrated the importance of establishing a ceramic typology; dating sites and graves by establishing a sequence of pottery sherd types. His work at Tell el-Hesi became the foundation of Palestine archaeology, and later practitioners in the field acknowledged their debt to him. William Foxwell Albright, the great authority in Biblical Archaeology, labelled him a genius. In a memorial note after his death, archaeologist Nelson Glueck wrote, "All of us who are engaged in archaeological pursuits stand on the shoulders of men like him who pointed the way which we follow today". In recognition of his valuable contributions to archaeology, Petrie received a knighthood in 1932 (Davis 2004: 30). It was his attention to the small technical details like the characteristics of pottery sherds that made Petrie so effective in the field. *Wisdom of the Egyptians* is a compelling synthesis of that archaeological knowledge, and the many details he draws on mean that the work is still relevant in many significant respects.

Ultimately, Petrie was able to step away from the religious, nationalist, and racist ideologies of his time more effectively than some of his contemporaries. He was able to evaluate the ancient Egyptians, their archaeology, and their monuments, from a fairly impartial, empirical, and scientific point of view. While he was certainly a product of the 19th century, and clearly a man of the British Empire, he was also a scientist at heart, and in *Wisdom of the Egyptians*, we see him begin to consider the origins of scientific techniques and principles in the ancient Egyptian culture from a theoretical perspective.

The Document and its Conventions

The conversion of this 80-year document into digital format was not without challenges. The original typesetters used a sophisticated lettering system incorporating many different fonts, italics, complex fractions, superscripts, subscripts, and Greek symbols. Once scanned and automatically read by the OCR software, the text on each page was adjusted and checked manually so that the layout of the digital pages looks similar to the pages as they were printed. In some places the fractions were simplified, but the values were retained. The text on each page is largely the same as the original, but it was not possible to justify the electronic text on every page in precisely the same manner as the original. This issue becomes most evident on the last line of each page, which may finish before the end of the row even if the sentence is not at an end. The text nevertheless continues on the following page. This should be easily apparent for readers, as in these cases there is no full stop at the end of the truncated lines at the bottom of the pages. There are other idiosyncrasies in the formatting. Petrie often used .ins for inches, which helps readers to distinguish the units of length from the angular seconds that were marked with double quotation marks.

One final takeaway from *Wisdom of the Egyptians* is that Petrie was a very good writer. It is worth reading the book for his erudite, concise, technical prose alone. This is not surprising, as he was intimately familiar with the subject matter and wrote hundreds of books, articles, and letters during his prolific career in archaeology. Given its eclectic subject matter and the historical issues outlined above, readers may prefer to dip into relevant parts of this book rather than read it as one continuous text.

Acknowledgements

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Editor's Notes

①

Page 20 - Readers familiar with ancient Egyptian astronomy may be surprised to see the symbol Iota before Draconis on this page on Egyptian astronomy. It is widely held that Thuban was a star probably used as a pole star during the Old Kingdom, but Thuban is Alpha Draconis rather than Iota Draconis (proper name Edasich). What is this star Petrie is referring to and why? In fact, the mention of this star is due to the same chronological error that impacted Petrie's dating system. Incorrect assumptions caused him to place his chronology for the early dynasties one Sothic cycle too far in the past. This put Djoser's reign around 4,100 B.C. by his estimates. Due to Precession, Iota Draconis was indeed closer to the Northern Celestial Pole (NCP) than Thuban at that time. Iota Draconis is a star one step along the asterism of Draco from Thuban, and would have been closest around 4,400 B.C. That explains why Petrie assumed Iota Draconis was the pole star during the Old Kingdom, rather than Alpha Draconis (Thuban), which actually was the closest pole star to the NCP when Djoser was pharaoh. C14 dating methods now show that we should use approximately 2,650 B.C. as the current best estimate for Djoser's reign.

②

Page 25 - It seems likely that this value 3.184 in the text of page 25 is a typographical error. The text refers to the same ratio used with this method described in section 43 (page 35). In that case it is given as 3.1604. This is likely to be the correct value that should have been used in the sentence on page 25. 6 and 0 confused as 8 would produce this error. It should, therefore, more correctly say "This depends on 3·1604 as approximating to π."

③

Page 93 - Readers may be confused by recent articles in popular news sources, which state that Tutankhamun's dagger was made from meteoric iron as a new revelation. In fact, as we can see from Petrie's *Wisdom of the Egyptians* this was known in 1940, and it had been established more than two decades previously. An extensive article on the subject area was written by George Zimmer and appeared in *The Journal of the Iron and Steel Institute* (1916), no. II, vol 94, pp. 306-352. entitled "The Use of Meteoric Iron by Primitive Man". This was followed in the 1970s by an article "Meteors and Meteorites in the Ancient Near East" by J.K. Bjorkman, in *Meteorics*, the journal of the Meteoritical Society (1973), pp. 91-132. A table in section VIII of the latter article lists tests carried out by the Egyptian Egyptologist Zaky Iskander, Director of the Chemical Laboratory of the Department of Antiquities, Cairo, that proved the meteoric origin of the iron used to make Tutankhamun's dagger.

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WISDOM OF THE EGYPTIANS

BRITISH SCHOOL OF ARCHAEOLOGY IN EGYPT

WISDOM OF THE EGYPTIANS

WITH 128 FIGURES

By

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CONTENTS

CONTENTS

LIST OF PLATES

LIST OF FIGURES

ABBREVIATIONS

OF TITLES OF BOOKS TO WHICH REFERENCE IS MADE

For brevity P. (for Petrie) is often omitted in text.

Anc. Eg.	Ancient Egypt
A.S.	Annales du Service
B.A.S.	Berthelot, Archéologie des Sciences
B.D.R.	Breasted, Development of Religion
B.L.	Brunton, Lahun I.
B.M.	Arundel and Bonomi, Brit. Mus.
C.Cail.	Cailliaud
C.D.A.	Capart, Débuts de l'Art
C.E.	Clarke and Engelbach, Ancient Egn. Masonry
C.M.	Cairo Museum
C.T.K.	Caulfeild, Temple of Kings
D.AM.	Devies, Tel el Amarna
D.AN.	Davies, Tomb of Antefoker
D.E.	Description de l'Egypte
D.GB.	Davies, Deir Gebrawi
D.NK.	Davies, Tomb of Nakht
D.P.A.	Davies, Ptah-hetep and Akhet-hetep
D.S.S.	Davies, Sheik Said
E.P.M.	Evans, Palace of Minos
G.BH. iv	Griffith, Beni Hassan
I.S.I.	Iron and Steel Institute
J.E.A.	Journal of Egyptian Archaeology
L.D.	Lepsius Denkmäler
L.M.	Leyden, Monuments
L.N.	Layard, Nineveh
L.P.	Leyden, Museum Catalogue P.
L.P.M.	Lucas, Preservative Materials
M.A.F.	Mission Archéologique Francaise
M.D.C.	Maspero, Dawn of Civilisation
M.T.B.	Murray, Tomb of Two Brothers
N.BH.	Newberry, Beni Hasan
N.BS.	Newberry, Bersheh
N.D.B.	Naville, Deir el Bahri
N.RK.	Newberry, Rekhmara
N.T.N.	Newberry, Theban Necropolis
P.A.	Petrie, Abydos
P.A.C.	Petrie, Arts and Crafts
P.A.G.	Petrie, Ancient Gaza
P.A.M.	Petrie, Amulets
P.Art	Prisse, Histoire de l'Art Egyptien
P.Ath	Petrie, Athribis
P.C.A.	Peet, Cemeteries of Abydos
P.DS.	Petrie, Deshasheh
P.E.	Petrie, Ehnasya
P.E.A.	Petrie, Egyptian Architecture
P.F.A.	Petrie, Formation of Alphabet
P.G.	Petrie, Gurob
P.Ger	Petrie, Gerar
P.G.R.	Petrie, Gizeh, Rifeh
P.H.A.	Petrie, Heliopolis and Kafr Ammar
P.H.B.	Petrie, Hawara and Bishmu
P.H.I.	Petrie, Hyksos and Israelite Cities
P.H.S.	Petrie, Historical Studies
P.I.K.	Petrie, Illahun and Kahun
P.K.G.	Petrie, Kahun and Gurob
P.L.	Petrie, Lahun II
P.L.G.	Petrie, Labrynth and Gerzeh
P.M.	Petrie, Memphis
P.MD.	Petrie, Medum
P.M.E.	Petrie, Making of Egypt
P.M.M.	Petrie, Meydum and Memphis III
P.NQ.	Petrie, Naqada
P.N.H.	Pliny, Natural History
P.P.E.	Petrie, Prehistoric Egypt
P.P.I.	Petrie,Palestine and Israel
P.Q.	Petrie, Qurneh
P.R.E.	Petrie, Roman Ehnasya

P.R.S.	Petrie, Researches in Sinai
P.R.T.	Petrie, Royal Tombs
P.S.C.	Petrie, Scarabs and Cylinder Seals
P.S.E.	Petrie, Syria and Egypt
P.S.H.	Petrie, Student's History
P.S.I.E.	Petrie, Season in Egypt
P.S.T.	Petrie, Six Temples
P.T.A.	Petrie, Tell el-Amarna
P.T.C.	Petrie, Tomb of Courtiers
P.TR. or TK.	Petrie, Tarkhan
P.T.W.	Petrie, Tools and Weapons
Q.H.	Quibell, Tomb of Hesy
Q.HP.	Quibell, Hierakonpolis
Q.K.	Quibell, El Kab
Q.R.P.	Quibell, Ramesseum, Ptahetep
R.C.	Rosellini, Mon. Civili
Ros.S.	Rosellini, Mon. Storici.
S.Ti.	Steindorff, Tomb of Ti
Str.	Strabo, Geography
T.S.B.A.	Trans. Soc. Biblical Archaeology
T.T.P.	Tylor, Tomb of Paheri
T.T.S.	Tylor, Tomb of Sebeknakht
U.C.	Flinders Petrie Collection, in Univ Coll. London
Vit.	Vitruvius
W.M.C.	Wilkinson, Manners and Customs
Wres.	Wreszinski, Atlas
Z.A.S.	Zeitschrift Aeg. Sprache

PERIODS

Badarian begins about 9,000 B.C.

Amratian begins about 7,471 B.C.

Gerzean begins about 6,000 B.C.

Semainean begins about 4,800 B.C.

1st Dynasty begins about 4,326 B.C.

At 9,000 B.C. Osiris worship marks the adjustment of the Kalendar by five days added.

At 7,471 B.C. count of days of month began with heliacal rising of Sirius.

At 4,800 B.C. with writing, began the signs of the three seasons.

These stages probably mark the entry of fresh peoples.

WISDOM OF THE EGYPTIANS

FOREWORD

WHEN WE speak of Egyptian wisdom, it is obvious that it does not imply a scope like that of modern Science, but the wisdom of the ancients contained the elements of what we now call Science.

Wisdom is primarily knowledge in its higher sense, but it included natural science and skill, expertness, all that is acquired and not inborn.

Moses was “learned in all the wisdom of the Egyptians,” sophia, and in the present volume we try to enter into the ideas of the Egyptians regarding various sciences.

When we speak of Egyptian Science moreover, it is the acquired knowledge and skill in the various branches of civilisation which have been elaborated by the successive dwellers in the Nile valley. Our scope is an outline, without giving all the details needed for a subject like weights and measures, or architecture, both of which have been treated separately.

We must always remember, in working at the sources of Egyptian ideas, that six successive races have entered the country (besides political conquests), so we must be prepared to find a composite origin for everything Egyptian. There was first a crude condition, akin to all Africa; upon this came (2) the Tasian, (3) a skilful civilisation, Badarian from Asia; next (4) a Libyan influence, Amratian, from the west; (5) an eastern civilisation, Gerzean, akin to the Amorite; lastly (6) Semainean, the dynastic race from Elam, by way of Punt (Somali) and the Red Sea, which brought in art, and rapid growth of ability. The successive periods are named from places where each is found with least admixture.

During historic times there have been frequent political conquests but without much change in the population. All of these changes Egypt assimilated, usually as a stimulus to its innate abilities, for Egypt has never been strong except under foreign inspiration. It needs outside pressure, and falls like China when left to its own initiative.

The traditions of the land, developed in thousands of years, were taken up by each conqueror, until it met a stronger mental vigour in the Greek; after that the true Egypt was finally wrecked, and there was only an old influence but no continuity of thought.

We must approach each subject along the path of Egyptian thought, however clumsy it may seem, if we would understand the Egyptian mind.

CHAPTER I

OBSERVATIONAL ASTRONOMY

Kalendar dating in the prehistoric periods is uncertain within a few decades.

1. *Observed year.* In considering Egyptian sciences, the earliest observations of man are the starting point, namely the simple day, and its recurrence as the measure of the seasons. For the count of the days the moon gives a natural multiple; the words mensio a measuring and mensis a month have a common derivation. The count of months will give a register of days, and the veriest savage knows this much. The complications which have always plagued man are due to the number of days and months in the year being entirely irrational or fractional.

To determine the true amounts, a definite position of the sun has to be settled, such as its position on the horizon at rising or setting. This is most popularly observed at the shortest or longest day, but more accurately by marks set up in a line east to west, and the day fixed by the sun being in that line, as it changes rapidly day by day at the equinox when the night is equal to the day. Near the equator the change of direction is as much as two diameters every day at the equinox, so that the identical day of the year can be distinguished.

2. *360-day year*. The year started at 360 days, ruled probably by the convenience of a division into twelve months of 3 x 10 days each. The date of the addition of 5 days is indicated by those days being dedicated to divinities of the Osiris family. That form of theology came in with the Osiris worship of the Badarians who introduced corn, and Osiris was said to have brought

corn into Egypt. These five days were termed, in Greek, Epagomenoi, the days "brought on to the months."

3. *365-day year*. This improved system left the fraction of a day unrecognised (·2422). We now include that by adding an extra day once in four years, at leap year, when all fixed festivals leap two days forward in the week. This year is known as the wandering year, for the kalendar would thus wander round the seasons in 1,508 years, though usually reckoned at 1,460 years. Owing to the shift of the pole in the sky, the period is actually 1,466 years at 600 B.C. and 1,448 years at 2000 A.D. It is usually called the Sothis period from the name of the star observed.

4. *365¼-day year*. Finding the practical inconveniences of such a system, the Egyptians always maintained a seasonal year, fixed by the seasons, and adjusted probably by empirical observation. Such a year is still kept in use in Egypt, designated by the old Coptic names of the months, and men talk of Hatour or Baramhat (Hathor or Pharmuthi) instead of the legal Muslim months such as Ramadan or Moharram.

5. *Lunar year*. Beside these varieties of the year, there was the lunar year, fixed by the months of the moon (29·530 days). Twelve only amounted to 354·36, or 10·88 days short in the year, usually made up by inserting a thirteenth month every three years. The Muslim kalendar of Arab origin depends on actual observation of the new moon. The Roman kalendar was lunar, but in consequence of neglect the year of Numa had slipped eighty days out of place, and we owe an almost perfect system to Julius, finally adjusted by Gregory XIII and adopted in England in 1752. The continuance of the lunar kalendar in ancient Egypt is due to Semitic influence, and the practical convenience of regulation by new moon.

6. *Four kalendars*. Thus Egypt had four kalendars, which certainly in the xiith dynasty were all observed, as

four different new year festivals are stated as times for offerings. This is by no means incredible, as Egypt now keeps (1) a lunar (Muslim) kalendar in official use, (2) a fixed seasonal kalendar in agricultural use, (3) a true kalendar in European use, and (4) a Greek kalendar in religious use.

As the months were denoted in records by their number, and not by a name, there is nothing to prove to what kalendar a record refers. On this point depends the meaning of a date of star-rising in one of the xiith dynasty papyri of Kahun. If we read it as based on the wandering year, this contradicts all ancient Egyptian statements of chronology; if on the seasonal fixed year, we can accept all the Egyptian records as correct (Ancient Egypt, 1931, 1) and find our result closely in agreement with the general empirical dating accepted before. The recent misunderstanding of this papyrus has led to an error of dating which is still popularly accepted.

7. *Precession.* After a few centuries of observation, a different influence would become visible. The year, as regulated by the Equinox, would not agree with the star rising, in other words, the place of the sun among the stars. The date of the Equinox preceded the star date, and this precession of the equinoxes was due to the change of direction of the earth's pole wobbling round the pole of the orbit. Hence the star date of the heliacal rising of Sirius, which was determined on the 1st of Thoth in A.D. 139, had been on 18 Mesore in B.C. 1317, on 6 Mesore in B.C. 2775, on 1 Mesore in 3385, on 24 Epiphi in 4235, on 14 Epiphi in 5705, and on I Epiphi in 7471 B.C. The numberjng of months in the kalendar had therefore begun in 3385 B.C. or 7471. This date of 7471 would accord with the beginning of the Amratian occupation, and being the beginning of Epiphi is in accord with the Semitic first month Abib, brought from Egypt by Hebrews (Exod. xii. 2).

8. *Hieroglyphs of seasons.* Another question which may provide vaguely a starting point for the kalendar is given by the precessional shifting of the natural seasonal signs. The year of twelve months was not divided in quarters as in Europe but in thirds, in accordance with three naturally defined seasons. These were the seasons of *aakhet* written as a growing plant, *pert* as a house sign, and *shemu* with a water sign. These signs obviously refer to the period of growth, November to February, and the living in a house after that from March to June, and the inundation from July to October. Owing to the neglect of precession, and trusting the kalendar to the Sothic year, these names became transferred wrongly, the growth sign to the inundation season, the water sign to the driest season. The original names must have been established at about 3300 or 4800 or 6300 B.C. As writing was fully developed by the period of the lst dynasty, it is probable that 4800 B.C. was the time when the natural signs of growth, dwelling, and water were applied to the seasons, at the Gerzean invasion.

9. *Cycle periods.* Long periods of years have been identified by Mahler, who derives the 25-year period of Apis from the equality to 309 lunar months. This cycle is 1/20 of a day short (strictly ·0481), and Mahler supposes that a longer cycle was taken when the error amounted to 1 day, i.e. 520 years. Tacitus states the Phoenix cycle as 500 years; but actually the occurrences were under Ptolemy III (247-222 B.C.), in 34 A.D. recorded by Tacitus, and under Constans (346-350 A.D.). As the detail periods were thus 255-280 years and 312-316 years, no conclusion can be drawn about the Phoenix period.

In the xiith dynasty, the monthly offerings to the moon were made in a kalendar at intervals of 30, 29, 30, 29, 30, 29, 30, 29, 30, 29, 30, 30, total 355 days, to agree with the new moons.

10. *Early festivals.* We may now turn to the last simple reckoning, without instrumental aid, in the hieroglyphic lists of festivals that are recorded, with quotation of some entries in the Coptic kalendar. The order of these varies in different ages, so here the order in which they are stated is quoted from each list; the date is added at the head of the column.

	Dynasties										
	iv	v	v	xii	xii	xii	xviii	xix	xx	?	xxvi
Opening of fixed year *(up renpet)* (365 ¼ days)	1	1	1	2		5			5		2
Feast of Thoth	2		4		2	2	2		3	2	3
Beginning of vague year (*tep renpet*) (365 days)	3	2	2	1	1	8			7	4	1
Great year (360 days)				3							
Small year (354 days)				4							
End of year (epagomenal days)				5							
Rejoicing (*uag*)	4	3	3		10	1	1		2	1	4
Great feast Mekhir 4	5				3					6	5
First coming, 'spring of crops'						3	3	1			
Great coming, grown crops						4					
'Coming of Sothis,' heliacal rising VIm. 20d					8		4	2		3	
Great heat, 'extreme heat' VII. 27	6		5	6	4	7	5	3	8		6
Lessened heat ' night colder,' VIII. 21				7	5		6	4			
Going on water, IX, 11					6				1		
Placing of braziers								5	4		
Receiving the river, ' cutting dam,' VIII. 23						7	7	6			
The following were unidentified:											
Good feast on the Nile						9					
Hebs									9		
Crossing over river *(zat)*							6		10		
Fires *(sazu)*							9				
Circulating *(thennu)*							10				

The fixed year cannot be anything but that of 365 ¼ days: the vague year must be that of 365 days. Then the other two, of 360 and 354 days, are called the great and small year, and as they only occur in one list they were certainly the least important. It does not seem that we can base conclusions on the order of the festivals.

For instance, on the second list of the xiith dynasty, the rising of Sothis could not succeed the great heat of August or coolness of September; moreover, in the xixth dynasty, the cutting of the dam could not succeed the September coolness. It is clear that the fixed year, which occurs in seven lists, was almost as important as the wandering or Sothic year in nine lists.

So far, we have only dealt with what could be observed without any artificial means. We now turn to instrumental astronomy.

CHAPTER II

INSTRUMENTAL ASTRONOMY

For illustrations, pls. I-VI, figs. 1-10, see end of this chapter, p. 20.

11. *Sun's altitude.* For dividing the day or night, there were various methods. During the day the continual sunshine of Egypt gives the most obvious means. The height of the sun was most usually observed and, as the position was within 30° of the Equator, the height was not so variable with the season as it is in Europe. The instrument had a raised end to cast a shadow, and divisions for the hours along a horizontal bar (fig. 1). This was represented as a hieroglyph, with a plumb-line hanging to fix the level of the base on which the hours were read, see fig. 1 A, B, C. It was further improved by sloping the reading scale in D, E, F, and G. Another advance was made by graduating the slope differently for different months, fig. 2. On this example Khoiak was in winter and Pauni in summer, which would be the case at about 100 B.C. The shadow must have been cast by a point held out rather in front of the base, and at the level of the top spots. This might be by a pointer held by a statue fixed at the top. Another example, of 400 B.C., was found at Qantara (*Rec. Trav*. xxxvii).

12. *Sun's azimuth.* A common method of the peasant now, for telling the time, is by the direction of the sun casting the shadow of an upright stick; or else by a projection from a wall casting a shadow on the wall. The graduation for this is on a slab, the Mond dial, fig. 3,

a form which descended to mediaeval times. The Greek improvement on tli1s was by a stick or gnomon slanting to the pole (fig. 4), and so giving true readings on a curved surface around it. An example has a supplementary line at 4° 48' to the pole. Such would serve for adjusting the positions by the western elongation of *Ursae minoris*, the pole star at 300 B.C. (*Hawara Portraits*, XVI, 12).

13. *Clepsydra*. Figs. 5, 6. At night the method of deciding time was by the clepsydra, dropping water in, or out of, a graduated vessel (*Anc. Egypt*, 1924, 43). In fig. 5 is an alabaster basin, with varying graduations around it (marked here by the slanting lines outside). This change was to compensate for the rate of dropping being varied by the seasonal temperature.

The rate of dropping would also vary by the pressure of water in the vessel, and the divisions should contain more in the upper part. This is provided by the vessel being wider at the top; strictly it should be of parabolic outline, but an average slope, and a rather wide base, gave an approximation. Another way of giving a larger amount of water where the pressure was greatest was by having a cylindrical vessel, fig. 6, in which a solid cone was to be placed. Such cones of limestone are known (*Anc. Egypt*, 1927, 16). That both of these vessels were to be filled and then water dropped out, is proved by the graduations being level at top, and varying downward.

14. *Plumb-line pendulum*. Whether the Egyptian treated the well-known plumb-line as a pendulum is not indicated by any remains, though the plumb-line was commonly in use from very early times. But the notable fact is that 29·157 ins. (the diagonal of the 20·62 ins. cubit), which was the basis of all land measure, is the length which would swing 100,000 times in 24 hours, exactly true at Memphis latitude. This is so remarkable that it suggests that it may have been derived from that

observed length, and the source entirely forgotten after the scientific age of the pyramid builders.

15. *Weeks.* The division of the month was, like usual Egyptian arithmetic, in decades, 3 periods of 10 days each (P.P.I. fig. 51). This is a northern system, of Indians from Northern Asia, Celts, and Goths; as such, it has probably been brought in from the Caspian region. It is adapted to the sun year, and almost ignores the moon. On the other hand the lunar system was based on the obvious quarters of the moon, giving four weeks of seven days, with an awkward surplus of a day and a half. The Arab naturally travels by night for coolness and secrecy, so the moon is his timekeeper, from the lighting on which single days can always be read. To the Egyptian the 7-day week was of no consequence, and 360 days gave a much better year than the lunar 354. The continuous 7-day week is seen on a tally of the time of the Jewish monarchy (P.P.I. fig. 52). Our own week is due to continuance of the Jewish kalendar and was not brought into the west before that was known; yet, strangely, we have named our days from the gods of the Norse version. The Egyptian reckoned in decimals, yet nevertheless divided the day into twelve hours, being constrained by the twelve months of the year, ordained by the moon. The fractions of a day were twelve hours, *un-nut*, of day and twelve of night. Fractions of an hour are marked by a hippopotamus head, a few minutes out of water, for breathing (*at*); *hat* a dropping, a few seconds; *aayu* an outcry, a second?; and *ayn* an eye, merely a wink.

16. *Star observation.* The most important document that we have in Egyptian astronomy is the long table of culminations of stars at each hour of the night on every fortnight of the year. This is given in the tomb of Rameses VI, and with less accuracy in that of Rameses X.

It was translated and discussed by Renouf (T.S.B.A. III, 400), and the who e material tabulated by Gensler (*Thebanische Tafeln*).

Neither of these works has identified the outlines of the constellations, which we now proceed to do here. The first step is to lay out, for the first time, a star map of the xviiith dynasty, by finding the hour meridians, and the pole, of that age on a globe, and transferring them for this map. As the proper motions of the stars amount to a degree or two in the interval, it is of no consequence to lay out nearer than that, especially as we only have whole hours defined, of 15° each. The direction of the meridians was largely askew to those of the present time, and that is important to bear in mind, so as to see what stars would fall in given hours. In the present description the star maps given here are followed (figs. 7, 8), designed to fit the places of the stars.

17. *Constellations.* It is a surprise to find that the Egyptians usually reversed the signs in drawing them. Of eight examples of groups of signs from the xxth dynasty to the Roman age, two are as seen, and six are as on a globe. There can be no question of this, as the well-known sign of the Thigh or Bull for *Ursa major* cannot be mistaken. Another surprise is the enormous space which was comprised in one figure. The Egyptians being accustomed to regard the whole sky as a single figure of the goddess Nut, supported on hands and feet, it was not difficult to them to suppose figures of half that extent. The figure of the “mighty man” *Nekht* must extend over six hours by the description of parts in those hours (fig. 7); it cannot be shortened by supposing it near the pole, as all the other signs in the list are near the Equator, or not above 45°. The meridian lines drawn here are not exactly fixed, they might be placed a little to one side or the other by lapse of time; but having Regulus in the XIIth hour, and Orion in the XVIth, the

meridians seem to lie there very nearly as drawn. The hour numbers are those of the 1st of Thoth, the new year's day, which starts the table. The general relation of the Egyptian hours to the sky is absolutely fixed by the place of the well-known names of Sirius and Orion, so that there can be no question of the hours to which reference was made.

The first sign *Nekht* is defined by the ankles being in the VIth and the knees in the Vth hour. These cannot be other than the four great stars of Pegasus, as there are no other distinct pairs in those hours. A specially bright star, placed at the ankles, will be Alpherat. A very probable outline of figure falls in with various other stars in the limbs, fork, belt, head, and feathers, which are specified. The head of the sceptre, which is specially named, cannot be other than Altair and its companions; Delphinus forms the wrist and hand. There is, however, a discrepancy in position, as the sceptre head should be higher, into the first hour, and the feathers touch the beginning of the first hour. The stars are in such exact agreement, as here drawn, that we must accept them. The back arm has the breadth of upper arm and wrist, neatly marked by pairs of stars. The VIIth hour has, in one list, the soles of the feet of *Nekht* (*pakh*, see *pakhed*, to touch the earth); in the other list it has the head of the goose, and the next hour has the rump. The head can hardly be anything but Mirach; the rest of the figure falls in well with other stars, and the feet accord with five small stars.

18. *Lesser signs.* The “group of thousands of stars” refers to the close and baffling group of the Pleiades. The *sor* or *sar* is evidently Aldebaran in Taurus, the Semitic *Shoher*, a bull. The head or beginning of Sahu, Orion, comes in the next hour, and Orion as a whole in the following hour. The position with the head turned and one arm raised, is that usually shown in drawings of

Sahu. Sirius is the best known point; what shape the figure took is uncertain, as it is sometimes a female figure (Isis), and otherwise a couchant cow in a boat.

Fig. 8. The "two stars" are in the XIVth hour. These have been supposed to be Castor and Pollux, but those really preceded Sirius; it seems more likely that Procyon and its companion are intended. The “stars of waters” cannot be identified; but as the lion's head is said to be by “the tank,” these must be nearly connected.

The “multitude of stars,” or starry host, is evidently *Coma Berenices.* The Egyptians called *Ursa Major* the “bull” or later, the "thigh." The bull is shown with a tail extending down to the hand of the Hippopotamus, and the thigh has a chain or cord tied on it, held by the hand. This is evidently the line down to Arcturus, “the bear's tail.”

19. *Rert, the hippopotamus.* The hand of the “Hippo-potamus” goddess is shown, in other drawings of signs, resting on a mooring-peg, which was an important religious symbol; this was varied by the hand resting on a pot, or holding a crocodile by the tail. The mooring-peg is however the original, as it is here named *menat*, meaning “mooring,” determined by the figure of a peg. This peg coming from Arcturus, evidently ends in Spica at the level of the feet. In the XIXth hour, stars are named “going before the peg”; otherwise there is a star called *tha nefer*, which has been rendered the “lute bearer,” and more probably the “beautiful boy,” i.e. Horus identified with Spica. In the figured groups of signs, Horus is shown touching the *menat* and extending towards the Lion.

The immense hippopotamus, called *Rert* in Egyptian, accords very well with the stars, around the legs, the fork, the pendant breast, and the square jaws. Antares also gives a point to the tail. The feet and legs are named for the XXIst hour, the fork and thigh for the XXIInd, the rump and breast for the XXIIIrd, and the feathers on the head for the XXIVth. In the drawn figures, feathers are never shown, but always a crocodile on the back of *Rert.* To this, Vega as the eye, and other stars marked here, would well agree.

On the whole, we may rather wonder that the Egyptians succeeded in imagining figures which fall in with so many stars for the outlines, as shown here. The groups of figures or constellations indicate the hippopotamus *Rert*, with the bull or thigh, and the lion, which we can safely identify by the different parts of *Rert* and the lion stated in their respective hours. The positions in the groups are vague, the lion always facing *Rert*, while the star list shows that its tail was in that direction. It is not practicable therefore to settle what stars formed parts of the other signs that are figured-the man spearing a crocodile, the man above the thigh, and the goddess Selk.

20. *Parts of the body.* A puzzling feature of the star lists is that each star is assigned-both by words and by diagram-to one of seven positions on the body, (1) right arm, (2) right ear, (3) right eye, (4) middle of breast, (5) left eye, (6) left ear, (7) left arm. These positions are not the same for the same star in successive fortnight lists. The most obvious explanation is that these positions refer to small differences of position of the main star of each group within its hour, so that it shone past a meridian mark upon a different point of the observer. Yet the entries for any one star differ in different fortnights. Nor is this due to a leading star of a fortnight list setting a different zero of observation; for, on averaging all the entries for each star; they do not agree in either direction with the position of the star in its hour space. Any astronomical meaning seems therefore impossible. The older view was that the position

was astrological, referring to organs of the body. If so, it is not the star that is good or bad, as most stars are found in opposite positions in the list, from 1 to 7, or 2 to 6. In the calendar of lucky and unlucky days (Sallier Papyrus) there are seven degrees of luck; calling good g, medium m, bad b, they are compounded as ggg 134 days, ggm 1 day, mmm 68, bgg 6, gbb 0, mbb 1, bbb 4, the number of days of each quantity being here stated after it. It seems possible that here the seven positions refer to 7 degrees of luck, from all good to all bad. The Egyptian often referred to doing anything "in a good hour," and so the luck of each hour of the night might be considered very important. The number of examples of these 7 positions is (1) 12, (2) 12, (3) 42, (4) 121, (5) 39, (6) 20, (7) 23.

21. *Decan constellations*. Another list of constellations (Brugsch, *Thesaurus* 137-152) more closely defined, is that of the decans; these being named as within 10°, and near the ecliptic, because referring to the sun's course, are capable of being attributed within a few degrees and therefore leave no choice as to the stars intended. The lists are in the tombs of the xixth-xxth dynasties, and others in Roman temples, for example Dendereh and Esneh. As the latter are mixed with classical signs and have become rather confused, we describe here the earlier lists as the standard, and only allude where necessary to the later lists, marked Ro. The ecliptic, in broken line on the map, is of course the same as the present, the earth's orbit being almost invariable. The best defined points are the Pleiades at 31 and Aldebaran at 32. From those the other decans are numbered. The connections are as follows:-

1 "Beginning of *Kanemut*," 2 *Kanemut*, under side of Kanemut; this "cow of Mut" is unknown, but later it was altered to taking 1 as the Nile Tortoise from the example of Cancer (gr.), and 2, 3, were Kenem or Kenmem

the vine, and the scattered group of stars would easily outline a vine, starting from Cor Hydrae.

4 “Front of *Zat*,” 5 back of *Zat*. This exactly falls on Leo; whether the name is a variant of *Zam* or *Tham*, a lion, may be suspected.

6 “Upper *Themat*,” 7 lower *Themat*. Later versions seem to explain this by the variant *Demat*: a wing, with which the stars would agree, as drawn.

8 “*Ushti*” bird, in classical figures Corvus.

9 *Bekti*, “the pregnant”; “the great goddess of Western Asia was both virgin and mother” (Brown, *Prim. Const*. i, 65), hence this may equal the later Virgo. Otherwise named “star of the north, and a star,” that is Arcturus and Spica.

10 “Beginning of *Khenti*,” 11 over *Khenti*, 12 under *Khenti*, 13 edge of *Khenti*. With the uncertain meanings of *Khenti*-an inner room or office, a tank, a point-it is difficult to assign any figure to the stars here.

14 “Borders of the tank” (*khennu* or *khenti*).

15 “Midst of the barque.”

16 “Wine press,” fairly outlined by stars in Sagittarius.

17 “Vine,” probably some straggling stars beyond the wine press.

18 “Beginning of mid month.”

19 “Middle of the month." This is strange, as these are the solar decans of the year but applied here to the moon.

20 “Ram,” in late Ro. a goat figure, Capricornus.

21 “Sons of the Ram.”

22 “Beneath the Ram.”

23 “The two glorious ones,” Fomalhaut and Sadalmelik.

24 “The two spirits.”

25 “Upper *Khenti*,” 26 *Khenti*, 27 lower *Khenti*; “the tank,” Pegasus square.

28 *Qednu*, 29 Sons of *Qednu*. (Continued over)

30 “House” or solar station; with large hexagonal star, Menkar.
31 “Thousand stars,” Pleiades.
32 “Arm over the support of Sahu” (Orion); the head of the staff, with a radiant star, Aldebaran.
33 “Child of the limit of Sahu.”
34 “Lower arm of Sahu.”
35 “Arm of Sahu” (raised).
36 “Sahu.”
37 “Sothis.”

In Roman lists the divisions were sometimes different, as:

30 “Thousand stars.”
31. “Jaws” (of the bull).
32 “Upper arm.”
33 “Girdle.”
34 “Leg” or “boat.”
35 “Sothis.”
36 “Nile Turtle.”

To most of the decans the Dendereh list gives the numbers of stars; in some instances these are obvious, in others it is difficult to see how they are made up. In any case this is due to classical influence. The further additions of mythology which were involved in nearly all the astronomical statements are omitted here, as they do not belong to the subject of knowledge, but of beliefs of the Egyptians. The above lists are the most complete ones of the xixth dynasty, but decans and hours are listed on coffins of the ixth and xth dynasties, see *Isis*, XVII, 6.

22. *Dates of positions.* There were full-length tables of the dates of heliacal rising, of midnight southing, and of evening rising of each decan. These latter were, however, entirely theoretical, and not the record of observation; for where a decan sign is north of the zodiac and the next one south (as 7 and 8), the interval of rising and setting is the average 10 days; and where

there are two bright stars at different periods of the decan (as 4 and 9), the southing intervals are also a multiple of 10 days.

23. *Planets.* The planets were also observed. The simple names were for Saturn "star of the west"; Jupiter "star of the south"; Mars "star of the east"; Venus "star of crossing over," as in a ferry, from one side of the sun to the other; Mercury "small star." The outer planets had also mythological names, Saturn "Horus the bull of heaven"; Jupiter "Horus illuminating both lands" (E. and W. banks of Nile); Mars "Horus of both horizons (E. and W.), travelling in reversal," that is retrograding in the apparent motion.

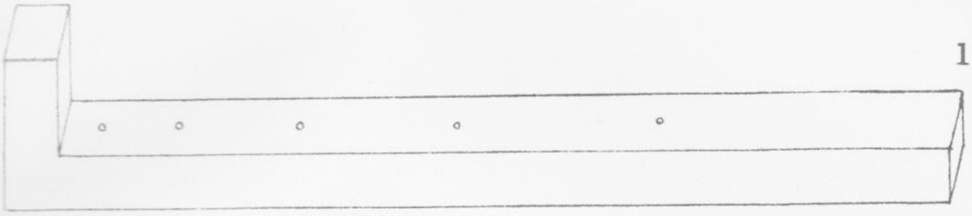
24. *Greek Zodiac*. The Greek influence brought in the zodiac, as we know it. At Dendereh a zodiac on a ceiling was long looked on as Egyptian, but it only preserves remains of the old system overlaid by the Greek signs. The explicit drawings of the zodiac as a horoscope, with the place of the owner of the tomb, are found at Athribis (figs. 9, 10). In this the positions of the planets are shown by their different hawks, and the souls by hawks with human heads (P. Ath.). The upper zodiac divides at the solstices, Capricornus to Gemini above, Cancer to Sagittarius below. The lower zodiac divides at the May-year, Scorpio to Aries above, Taurus to Libra below. This dates from 140 A.D., and the interest had probably been stimulated by the zodiacal series of Alexandrian coinage in honour of the Sothic cycle at 139 A.D.

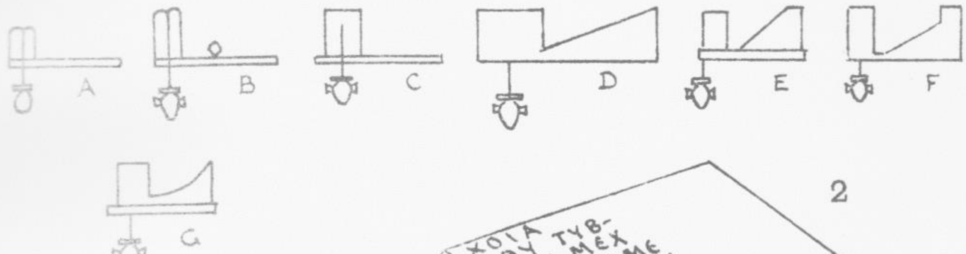
25. *Fixing north point.* Of the methods of observation nothing is recorded, and no instruments have been preserved except rough forms of sundial, dependent on altitude. Yet it is certain that fair accuracy of stellar observation was reached, and it only failed of being a complete system by the lack of a precise time measure. In the setting out of the more accurate of the pyramids,

the similarity of the direction shows the precision. In the Great Pyramid (Khufu) the mean of the body and entrance passage is 3' 6" ± 72" W. of N., the second pyramid (Khafra) 5' 32" ± 10". As no lineal measures could be taken across the broken ground from one to another with such agreement, these show that 1' 30" was about the angular accuracy attainable. This is comparable to the direct lineal observation, as the entrance passage of Khufu is -3' 44" ± 10" as a whole, but -5' 49" ± 7" on its built part, so that 1' was about the lineal accuracy attainable. Other pyramids differ much more; the third pyramid (Menkaura) +14', that of Sneferu -24', that of Dahshur, southern -9', and small pyramid -14'. The step pyramid of Saqqarah +4° 21' may have pointed to the eastern elongation of the pole star then ι Draconis.①To realise how this accuracy of 1' could be practically attained, let us suppose a pile of masonry being left during the pyramid building with a vertical face running N. to S., and 60 ft. high. If a rod were placed vertically at the top of the face of 60 ft., and the eye moved to and fro on the ground level, to see where the pole star appeared extinguished by it, the error of 1' would be equal to double the width of the aperture of the eye, which is 1/4 in. in darkness. Such an accuracy would be fairly attainable, and on plumbing from the rod down to the ground, on a still day, the 1/2 inch error might not be exceeded; joining the plumb-line and eye-point would give the azimuth of the star. Repeating this at opposite times of year, the mean of both observations would be true north. The discrepancy of about -4' may be due to shift of the earth's pole in 6,000 years.

26. *Transits.* On the east side of Khufu's pyramid there are some long and deep trenches cut in the rock. The lengths are about 170 ft., depths about 20 ft. The widths at the top are 100 to 200 ins., but one trench

1





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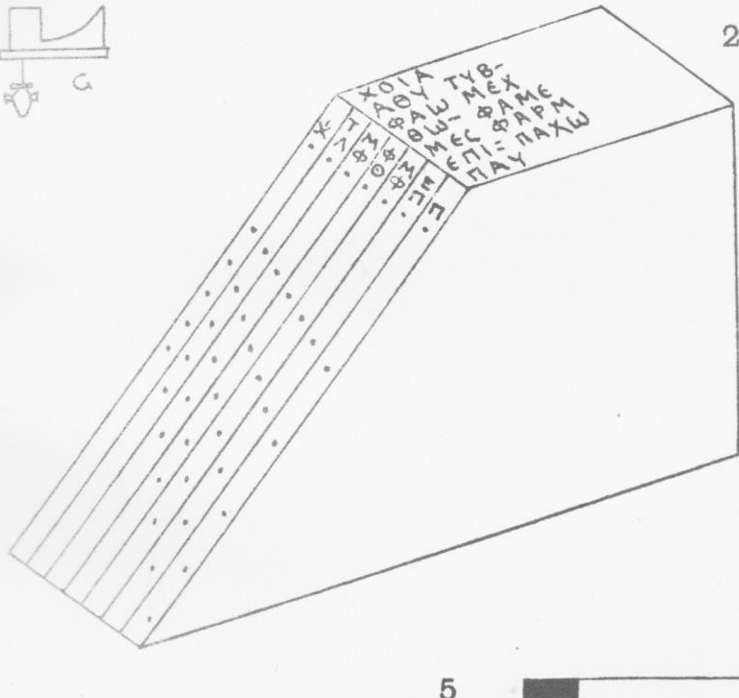

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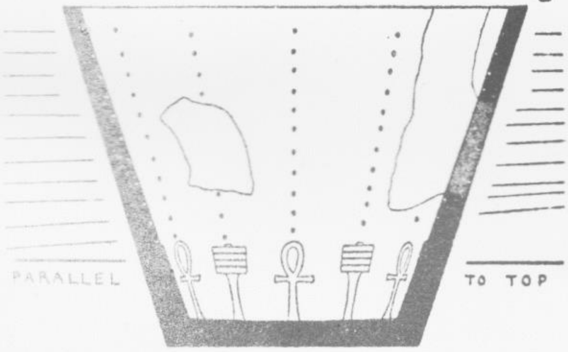

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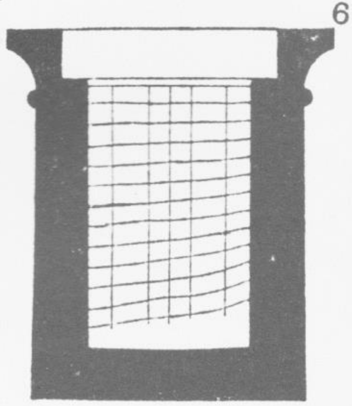

SECTION OF THE CLEPSYDRA OF EDFU

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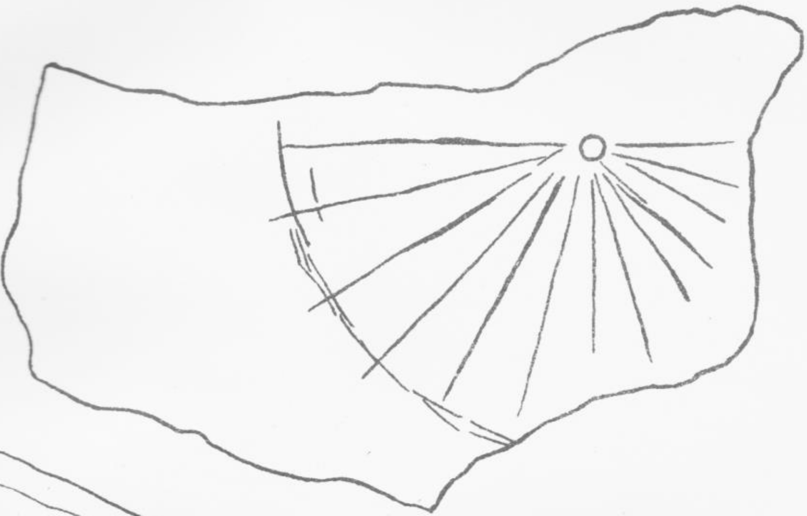

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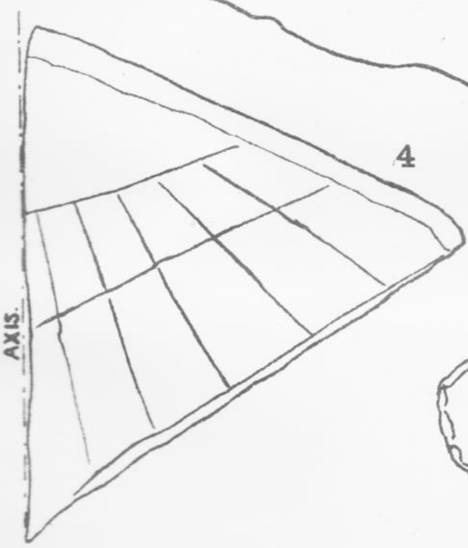

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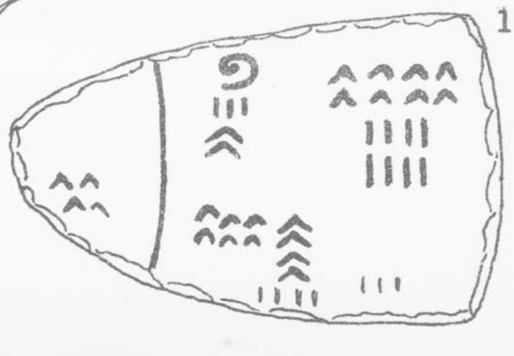
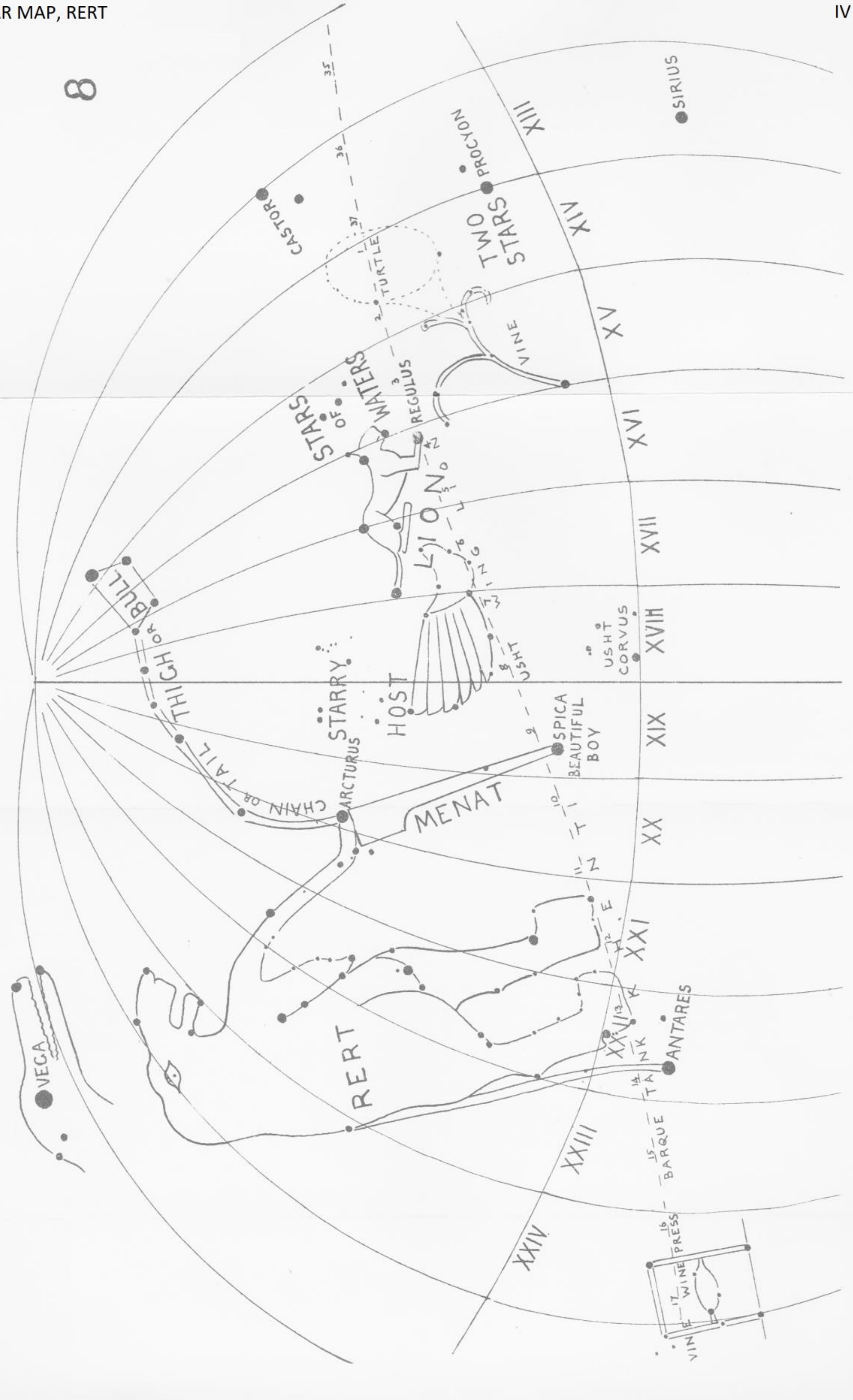


11


7
EQUATOR
ECLIPTIC
HALF MONTH
NEKHT
GOOSE
IMAGE
PLEIADES
THOUSANDS
JAWS
SOR
BULL
SAHU
SOPDET
SIRIUS
SOTHIS
GLORIOUS ONES
FOMALHAUT
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII



8
CASTOR
PROCYON
SIRIUS
TWO STARS
TURTLE
VINE
STARS OF WATERS
REGULUS
LION
WING
USHT
USHT CORVUS
THIGH OR BULL
CHAIN OR TAIL
STARRY HOST
ARCTURUS
SPICA BEAUTIFUL BOY
MENAT
RERT
VEGA
ANTARES
TANK
BARQUE
WINE PRESS
VINE
XIII
XIV
XV
XVI
XVII
XVIII
XIX
XX
XXI
XXII
XXIII
XXIV


9

10

For 11, 12, see pl. II

narrows below to only 35 ins; As all the sides of the trenches show the cutting back for the irregularities of lining blocks, and many lesser blocks still remain in place, the width may have been reduced to only about 30 ins. or less, between the faces of the finished lining. These trenches, then, would be narrowed slits about 170 ft. long, 20 or 25 ft. deep, and under 3 or 4 ft. wide. Two of them run in one line N. to S. No better device for observing accurate transits could be made than by stretching a thin rope from end to end, adjusted to true north, and looking past the rope to the reflection of the rope occulting the star in its reflection from water below. If a ring opening were included in the rope, and a lamp below lighted the reflected rope, the conditions would give the fullest accuracy of naked eye observations. Any star above 14° could be observed. The north trench would serve for polar observation, the south for simultaneous equatorial transits.

27. *Angular measure.* Measurements of angles were unknown in Egypt or elsewhere till perhaps 200 B.C., after which Eratosthenes used a divided circle. It is strange that Ptolemy (2nd cent. A.D.) still calculated a long table of chords of angles, in order to measure them by a rod at a fixed distance, a method which was originated by Hipparchus about 150 B.C. It was probably some Babylonian who made the advance of a graduated circle, giving direct measurements of altitude, which has culminated in the modern transit circle and equatorial. As Babylonian degrees have left no trace in Egypt, it is only by hour divisions that the right ascension is designated, and there is no record of declination.

28. *The Inundation*. The inundation of the Nile became linked with the rising of Sirius, Sothis, at the season when it is just visible before sunrise. This increase of the Nile does not begin to show till the middle of July, or sometimes the end of June, according to the

gauge at Memphis. Now the heliacal rising of Sothis was at the end of June in 2000 B.C. and at the beginning of June in 6000 B.C. Hence it appears that the Sothis connection would not be noticed as related to the inundation till well into the historical age, and was not a primitive idea. The height of the inundation was carefully registered every year from the 1st dynasty onward, to even 2/3 or 3/4 of a finger breadth, in the regular annals, giving differences of 1/12 of a finger or 1/16 in.

CHAPTER III

ARITHMETIC AND GEOMETRY

For figs. 11 and 12, named below on pp. 24, 25, *see* pl. II, foregoing.
For fig. 13, see pl. VII, facing p. 52.

29. *Prehistoric*. These subjects are so closely united in every-day work that it is impracticable to regard them separately, so long as the actual usage is before us rather than the theory. In Egypt there seems hardly any care for theory as such, while the working of common sums was as advanced as in recent centuries.

Of the prehistoric age of Egypt (about 9000-4326 B.C.), there is neither consecutive writing preserved nor accounts. As the material we have is almost wholly from tombs, it is not to be expected that tallies of daily accounts should be found. There is in another way, however, good evidence of reckoning in the early prehistoric times. Almost at the beginning of the Amratian civilisation a stone weight is found, carefully wrapped in leather, and put in the hands of the dead. This weight agrees with ten others of the Amratian civilisation, all being on the "gold" standard of historic times, *beqa*. In the Gerzean civilisation other weights are found, of the standard known as *daric*, Babylonian. The Semainean civilisation of the dynastic races brought in the usual *qedet* standard which was the main one of historic times. No people require to weigh unless they can record the weight. A standard implies that, over a wide area, a people have need of fixed amounts for trading; and that the barter stage of mere agreement on some exchange that may suit both parties is already past. For trade, some sort of tally to record weight is needed, and the foundations of a numerical system are being laid.

30. *Early decimal system.* These evidences, then, go to explain how it is that at the very beginning of the 1st dynasty (4326 B.C.) there was as complete a system of enumeration as the Egyptians had at any later age. On a ceremonial mace-head, King Narmer, who was probably Mena, records his capture of 120,000 men, 400,000 oxen, and 1,422,000 goats. The signs denoting each decimal place are completely fixed, exactly as they were used during thousands of years afterwards. We must credit therefore that account-keeping up to millions was already developed at the very beginning of the written record that we have.

31. *Notation.* The necessary basis of any scientific knowledge is a good notation for recording results. Even Newton, a couple of centuries ago, was hindered and encumbered by the notation then used, which we have since greatly simplified. The Egyptians started in prehistoric times with an excellent notation, purely decimal, for each place of figures up to millions. Each sign is repeated as often as required up to 9. The unit was commonly written by a stroke, but in detail it was represented by a short piece of rope (fig. 11). The ten was a longer piece of rope, bent. A hundred was a coil of rope. For a thousand, the plant sign is the initial of *khaa*, a measuring cord. Thus the essential idea of numbering was the length of rope. The finger used for 10,000 seems to be a phonetic rebus. The tadpole for 100,000 is the idea of multitudes. The man with arms raised, for 1,000,000 is the sign of vastness or eternity. All these signs appear on registers of captured cattle before the 1st dynasty, so there was no lack of the means of calculation. A row of totals is found inscribed on a flake of flint of the 1st dynasty, in a scribe's tomb, along with

stone palettes for ink, with numbers 40, 320, 88, 60, 44, and 3 (fig. 12). Another note of numbers is on a flake of limestone from Meydum, of the IIIrd dynasty (P.M.M. xiv).

32. *Fractions of food.* Fractions were also dealt with, and the examples of working show that the basic question was the division of food. If half a dozen men have ten loaves to divide for the day's work, each receives a loaf, and then the remaining 4 loaves are halved, and each takes a half, and the remaining halves must be cut into six pieces, so each has 1+1/2+1/6. This is the Scotch way of dividing the earnings of a fishing boat. First, sovereigns were dealt out, and when insufficient, half sovereigns; then half-crowns, shillings, sixpences, pence, and lastly the remainder in sweetmeats. Most unwieldy sums resulted, but the answers could easily be realised in practice, when dividing goods (see sect. 42).

33. *Gauging.* One of the frequent questions which arose was the content of a circular granary. For this, the working method was that a disc of 9 diameter equalled the area of a square of 8 (see sect. 43). ②This depends on 3·184 as approximating to π. Another approximation was 22/7 or 3·1428 instead of 3·1416. The Egyptian never troubled about a theory, but only sought working formulae. In geometry there was more advance. The contents of a pyramid, and of a frustum of a pyramid were correctly rendered. Here, also, practice in the volume of stone required for building must have been an incentive. When working out the sum of squares of successive courses, there would be found to be 1/3 of a cube of the same base and height.

34. *Co-ordinates.* The early pyramid builders visualised planes, and would put the trace of a sloping plane upon a wall, and also on an opposite wall, and construct a sloping face anywhere in the same plane between the

two. Thus a building slope could be laid out truly over ground however rough and uneven (see *Egyptian Architecture*, fig. 10).

The co-ordinate sense of space was certainly familiar. A roll of plans shows a shrine drawn on squared papyrus, front and side elevations. The detail hidden behind other parts is entered in thin line (side view, fig. 13, where the red lines of squaring are represented by broken lines). This example is of the xviiith dynasty, and though no earlier working drawings have been preserved, we can hardly doubt that the highly mechanical minds of the pyramid builders had made use of equal facilities in laying out their work.

35. *An invariable spring*. This drawing is also important as showing the meaning of the curious top of shrines, rising steeply on one side and then sloping down to the other. We see here a heavy shrine slung by ropes from a curved roof of this type. Half the weight hung from the convex part of the top, and would tend to flatten the curve, and so lengthen the roof; the other half hung from the flat part and, by bending it, would tend to shorten the roof. Thus the total length of the roof from side to side would remain unaltered, although it might be greatly bent. This compensation, to keep the length between the supporting sides unchanged, is a most ingenious idea, which no engineer of later times has utilised. Other rope slings below prevented the suspended shrine from swinging about, as the frame was carried along.

36. *Measurement*. Measuring standards were not minutely regarded at the beginning of the 1st dynasty, as brickwork cannot be wrought delicately, and the use of stone for building had not begun. At Tarkhan, however, the irregularities of brick tombs are only one or two tenths of an inch. One of the simplest tests of accuracy is levelling a course of building. At the pyramid of

Khufu, the variation of a course of casing is ·04 in. on 20 ft., and ·00 to a course of the core 40 ft. distant. The sides of the pyramid varied 2·3 ins. on an average in a length of 9069·4 ins., or 1 in 4,000. If this were laid out with copper measuring rods, this error would result from 15° C. difference of temperature. The angular accuracy of building is also a test; on the same pyramid (where the diagonals could not be laid out, owing to rock) the average error is 1' 12" from a right angle, or 2 ins. on the length.

Considering these limits of accuracy, which must have needed extraordinary care to carry them out in a gigantic mass of masonry, it is reasonable to look for accuracy of proportion. It so happens that five different relations of the parts would each give the same angle as that of the Khufu pyramid, within 2' or 3'. A help in judging which of these is likely is given by the Meydum pyramid of Sneferu, next in age before that of Khufu, and of the same angle. If supposed numbers of proportion will not result in a recognised unit, when applied to both these pyramids, there is little probability that they were intended. There remain two possible designs, (1) the base circuit equal to a circle struck by the height (or the modification of this in height to base as 7:11); (2) the face area = height squared (or height a mean proportional between half base and slope). The first design is strongly supported by the dimensions in cubits being multiples of 7 and 11; and this is made almost certain by the Meydum pyramid dimensions also being multiples of 7 and 11. Thus:-

Pyramid of Sneferu 25 x 7 high, 25 x 11 base in cubits.
Pyramid of Khufu 40 x 7 high, 40 x 11 base in cubits.

The angle of 7 on 11 base is 51° 50' (strict π ratio 51° 51'); observed at Meydum pyramid 51°48' ± 7' and Khufu's pyramid 51° 52' ± 2'. We conclude therefore that the approximation of 7 to 22 as the ratio of diameter to circumference was recognised.

The second pyramid of Gizeh opens another question. The angle is 53° 10' ± 4' and the angle of the triangle 3 : 4 : 5 is 53° 8'. The agreement is so exact that we must suppose that it was intended; if so, it suggests that the principle of the square of the hypotenuse being equal to the sum of the squares on the sides, was recognised, as 3 : 4 : 5 is the simplest right-angled triangle of whole numbers.

37. *Sides of areas.* This brings up the question of relations of squares of dimensions. In this connection it must be remembered that the Egyptian used two standards. One of these was the royal cubit. The other was the digit, and 40 digits went to the diagonal of the cubit, or the cubit may be regarded as the diagonal of 20 digits. Thus it was always easy to construct a square half the area of another. This system must have made the squares of lengths, and their relations, well known. The strangely irregular height of the King's Chamber of Khufu is thus explained. The length and breadth are most precisely 20 and 10 cubits, the height is the square root of 125 cubits. Therefore:-

Length squared	400	<-
Breadth squared	100	<- Square cubits sum 25 squared
Height over floor squared	125	<-
Diagonal of floor squared	500	
Diagonal of end squared	225	
Diagonal of side squared	525	
Cubic diagonal squared	625	
Sum of all squared	2,500	Sum of 50 squared

The height is accommodated to this size by raising the floor 5 ins. between the walls; while the wall height + wall length is π x breadth of chamber. Both of these two conditions were thus satisfied by raising the floor, see sect. 38. Of course if the three dimensions of a chamber are even numbers when squared, the diagonals will be so likewise; here the sum of every dimension and diagonal comes to the notable square 50 x 50.

In the so-called Queen's Chamber of Khufu, the dimensions in even cubits are not exact, but are more nearly the sides of simple squares:-

Length squared	120 square cubits
Breadth squared	100 square cubits
Height squared	80 square cubits
Side diagonal squared	200 square cubits
Floor diagonal squared	220 square cubits
End diagonal squared	180 square cubits
Cubic diagonal squared	300 square cubits
Sum of all	**1,200 square cubits**

It is a noticeable feature of the pyramid that the builders started thick courses in the construction at precise intervals, the courses being gradually reduced on going upward, until another thick course is reached. These intervals are at points where the horizontal area of the pyramid is at even 25ths of the whole. The thick courses are at 1/50, 1/25, 2, 4, 6, 7, 9, 10, 14, and 16, 25ths of the area. Of course 1, 4, 9, 16, 25ths are the lineal 1, 2, 3, 4, 5ths of the base; but the other numbers, 6, 7, 10, 14, are quite as marked, and show that the area was considered.

38. *Radius and circle*. As we have seen, the external form of the earlier two pyramids is defined by the height being the radius of a circle equal to the circumference. This same proportion is found in the King's Chamber; the breadth is the radius of a circle equal to the circuit of the side wall. Here, as the workmanship is very exact, and the length is exactly double the breadth, the height of the chamber is the dimension which makes up the odd amount. Keeping to the old 7 : 11, or rather 7 : 44, proportion, there being 7 palms in the cubit, the radius or chamber breadth is 70 palms, and the side circuit 440 palms. The length top and bottom being 280 palms,

this leaves 80 palms for the height, i.e. the height should be 1/7 more than the width. The actual amounts are:

1/7 over the width	235·58 ± ·10
Or true π ratio	235·32 ± ·10
Actual height of wall	235·22 ± ·07

The actual height thus agrees more nearly with the true ratio of the circle, than with the 7 : 44 approximation ; and this suggests therefore that the Egyptians already knew that 7 : 44 was not exact.

The same ratio exists in the height : circuit of the sarcophagus, but cannot be proved so exactly, owing to irregular work.

Thus the pyramid, the King's chamber, and the sarcophagus were all wrought to the same proportion, and this proportion is not found in any other building, except the pyramid form of Meydum. There are many other possibly intentional relations in the Khufu pyramid, which is by far the most accurate; but these relations of areas and of circle ratio are so systematic that we should grant that they were in the builder's design. In the second pyramid, that of Khafra, there is no trace of the circle ratio; but the chamber dimensions when squared are even numbers of square cubits. The third pyramid, of Menkaura, has no signs of refinement, but is roughly hewn to even numbers of cubits. The great difference in the accuracy and finish of work accords with the decline in the principles of design.

39. *Accuracy maintained.* When we reach a period of fine work again, in the xiith dynasty, there was fairly good accuracy in the south pyramid of Dahshur, with a mean error of 3·7 on 7,459 ins., and the small one by it with 1·1 error on 2,064 ins. These are 1 in 2,000, or double the error of Khufu's work. The most striking accuracy of work is found in the granite sarcophagus of Senusert II in the pyramid of Lahun, at the entrance to the Fayum. The dimensions of this sarcophagus are all

in even numbers of palms, of 1/7 cubit: the resulting lengths only vary from the mean value by an average of ·03 in. on the actual dimensions. The parallelism of the sides only differs ·02 in. outside, and ·01 in. inside. The curvature of the planes is only ·005 and ·002 in. The average errors from a straight line along 106 ins. are only ·007 in. These include all the errors of measurement, which I ascertained by offsets from stretched threads and plumb-lines, and must certainly add somewhat in the minute amounts stated. The finish of the surfaces is matt, without high polish. The edges are bevelled ·27 to ·30 in. wide, and meet in a triangular pyramid on the corners. The sarcophagus is wrought in pink granite, without perceptible flaw. The workmanship is marvellous, perhaps unrivalled; but there does not seem to be any detailed design in it, such as we see in Khufu's plan. Two other sarcophagi of the royal family at Lahun have an error of straightness of 7/1000 in. as above, and 4/1000 in. Both are in red granite.

CHAPTER IV

MATHEMATICAL PAPYRUS

40. *The papyrus described.* The next stage of our knowledge is fortunately very complete, and exactly dated. The Rhind Mathematical Papyrus is an entire work of gradual teaching and examples. To judge by the opening of it on fractions, and the introduction of fractions in all the examples, it may be that it is rather a treatise on fractions than a complete arithmetic. From the mistakes made in some parts, it was probably a copy of earlier work, and we might expect so elaborate a treatise to belong to one of the flourishing periods. The prominence of the proportions of pyramids suggests that part of it belongs to the Old Kingdom or to the xiith dynasty. This may seem too rapid a development, yet we must remember that such rapidity is found, occasionally. We may instance the historical work of Beda and the astronomy of Ulugh Beg, as tokens that a shifting people may quickly rise to doing skilful work.

The papyrus is well dated in the 33rd year of the fourth of the great Hyksos kings of the xvth dynasty, or 2239 B.C. The words used for various operations show a different mind from ours, whose ideas in this respect are based on Latin. We name addition from *addo*, giving to, but the Egyptian said “going to.” Subtraction, to us the withdrawing from under a mass, is “going from.” Multiplication, denoting many turns, was called in Egyptian “increase” like growth. Division, from *viduo*, deprive, to the Egyptian was “breaking,” and he multiplied by a fraction. A residue, or remainder, *residuum*, was in Egypt an “ignored” quantity. A balance unused, in Egypt was “in store.” Proportion, or the relation of parts, to the Egyptian was “the cause of form.” We inherit the Greek attention to whole numbers, but the Egyptians thought in fractions and fluxional variations.

41. *Problems.* They only occasionally reduced the quantities to the least common multiple of the denominators, and preferred to deal with addition of fractions. They never used any numerator beyond 1, except for 2/3 and 3/4: all other fractions which we should write with higher numerators, were split up into a sum of fractions with numerator unity. The following examples will show the lines of thought.

Addition. “350, increase thou 100 upon it, making 450.”

Subtraction. “15 his third is 5, if 5 goes, there remains as 10.”
“Break thou 1 from 9, remains 8.”
“1/30 + 2/3 from 1, total 21, its remainder as 9,” i.e. 9/30.

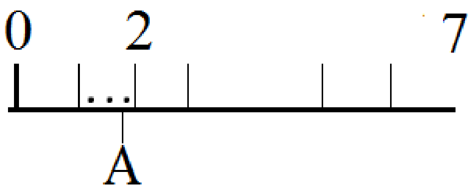
Multiplication. “Increase 10 times 10, it makes 100.”
“Increase the number 1,185 by 1/20, as 59 ¼.”
“Do thou 1/20 of 960, as 48."

Division. “66 2/3 which broken by 10 is 6 2/3.”
“Increase the times 30 unto the finding 100, making 3 1/3.”
“Do thou increase of number 93l unto the finding of 70.”

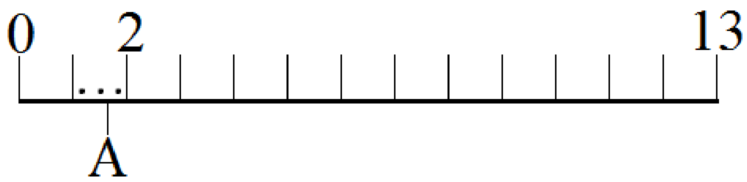
93 1/3,	½ is	46 2/3	½+1/4 of 93 1/3 is 70.”
	¼ is	23 1/3	
	¾	70	

42. *Fractions*. Division was rather looked on as multiplication by a fraction. These examples are only extracted from larger questions to show the ideas of method. The work begins with the breaking up of all fractions 2/n, from 2/5 to 2/99, into sums of fractions 1/n.

The course of thought in this process is not the most obvious, when stated either in figures or by algebra; but looked at geometrically, it is inevitable. Take the resolution of 2/7:



A is ¼ of 7 = 1 ¾; leaving ¼, or 1/28 of the whole, over; so 1/4 + 1/28 = 2/7. Or take the resolution of 2/13:



A is l/8 of 13 = 1 5/8; the 1/4 and 1/8 over, up to 2, are 1/52 and 1/104 of 13; so 1/8 + 1/52 + 1/104 = 2/13. These examples show obviously how the Egyptian looked at the question, as it is the most evident way of finding the resolution of multiple fractions.

A case given is, divide 9 loaves among 10 persons, what is the share of each? 2/3 + 1/5 + 1/30, or as we should say (20 + 6 + 1)/30. There is usually more than one simple resolution, such as l/2 + 1/3 + 1/15 here.

A form of sum is called "making complete," that is, finding the amount required to make up a given total. For instance, given 1/4 + 1/28, what will make up to ½? Call the smallest fraction unity.

		Add ½ values		add ¼ values		Total
¼	1/28	1/8	1/52	1/16	1/112	= ½
Call 7	1	3 ½	½	1 ½ ¼	¼	= 14

Here, for clear working, the whole of the terms are multiplied by the Egyptian, though not enough to get rid of the addition of fractions.

Another form of sum is called the “store” or “heap.” For instance, “Heap on 1/7 more and the total is to be 19, what is the first amount?

7 + 1/7 = 8, 8 in 19 is 2’ = 16	2 ¼ 1/8 = 1 part	7 parts being 16 ½ + 1/8
¼ = 2	4 ½ ¼ = 2 parts	1 part being 2 ¼ + 1/8
1/8 = 1	9 ½ = 4 parts	-------------
--------	---------------------	The whole is 19.”
8 x 2 ¼ + 1/8 = 19	16 ½ 1/8 = 7 parts	

To the end of their history, the cumbrous treatment of fractions continued, even into the classical age.

43. *Volumes and areas.* In dealing with the areas of circles, the Egyptians took the square of 8 as equal to the circles of 9 diameter. This gives the ratio 64/81= 3·1604/4, which is not so exact as the ratio 22/7 = 3.1428, for the true 3·1416 ratio of circumference to diameter. The 64/81 had the advantage that, being square numbers, they reduced diameters in whole numbers, 8 and 9 for square and circle, and the error of 1 in 170 was not worth notice in actual measuring.

“Begin to do a granary, round of 9, 10 (high). Divide thou the 1/9 from 9, leaving 8: multiply the number 8, times 8, making 64; do thou multiply the number 64, times 10, making 640 (cubic cubits); give its half upon it, make it 960 (*khar*, measure of 2/3 cubic cubit), its contents in the body. Do thou 1/20 of 960, that is 48 (a measure of 20 *khar*) goes in it, namely the volume of corn 48 measures.” There are many other such sums; and also the inverse sum, given the volume to find one of the dimensions.

44. *Rectangle.* “Beginning of reckoning areas. If asked of thee a rectangle of a field of 10 *khat* by 2 *khat*. what is its area?

Do like making 1,000 (cubits = 10 *khat*)	1/10 of 100,000 = 10,000
x 10, 10,000	1/10 of its 1/10 1,000
x 100, 100,000	that is the area.”

Griffith regarded this working as mistaken. Here 20 square *khats* = 1,000 Square units, 1 *khat* = 50 units = 10,000 square cubits, so the unit square is 200 square cubits, or a square of 14.14 cubits, or 100 palms, perhaps the length of measuring reed, 24 feet.

45. *Triangle.* "Begin to do a triangle in a field. Say thou a triangle of 10 *khat* in height, 4 *khat* in base, what is its area? Do it as making 400 x 1,000 (cubits) ½ 200. 2,000 its area is 1. Do thou the half of 4, that is 2, as making its square: do thou multiply the numbers 10 times 2, that is its area." Here the area is stated as 2,000 of a square of 10 cubits, or 2 of 10 square *khat*. The latter is 100,000 square cubits, the *kha* field unit. Assuming a furrow length of 100 cubits (=172 feet), the first unit is 1 cubit width, and was known as the cubit or πηχυς; the second unit was 1,000 cubits width, or about 7 acres. (For field measures, see Griffith in *Proc. Soc. Bib. Arch.* 1892, 410).

46. *Trapezium.* The portion of a triangle, after cutting off the acute angle, was called by the same name, *hakt*, as the side produced by the cut. Our word "cut" equally expresses both; "a cut of meat" is a piece, "a cut" is also a line of severance.

"Begin to do the cut of a field. Thus say thou a cut of a field, 20 *khat* is its height, 6 *khat* at its base, and 4 *khat* at its cut. What is its area? Add thou its base to its cut, it makes 10; take thou the half of 10, that is 5* for the square. Do thou the multiplying of the numbers 20 times 5, that makes 10 its area, do thus to make it."

6 + 4 *khats*	1,000 cubits.	2,000 cubits height
breadth.	½ 500 cubits.	10,000 area +

Here again there are the two land measures, 10 square *khat* * and 100 square cubits.+

The slope of a pyramid comes next as being connected with triangles. The technical terms used are "seeking the sole" for the base; "giving in the extent" for the vertical height. This latter, *peremus*, is doubtless the source of the Greek πυραμυς; it has usually been taken to be the slant height, but Egyptians always set out slopes by the proportion of vertical to horizontal (see list in *Pyramids and Temples of Gizeh*, 162); we must regard "the extent," therefore, as being the solid axis.

47. *Angle of a pyramid.* "Begin to reckon a pyramid 360 in the base, 250 in the vertical thereon; give thou to know its proportion. Do thou 1/2 of 360, it makes 180. Do thou multiply the numbers. 250 to the finding of 180, makes ½ 1/5 1/50 of the cubit (vertical). It is the cubit of 7 palms. Do thou multiply the numbers. In 7, ½ = 3 ½, 1/5 = 1 1/8 1/15, 1/50 = 1/10 1/25, proportion palms 5 1/25." That is, the proportion of the slope is 7 palms vertical on 5 1/25 palms horizontal. There are also given sums of base and proportion, to find height; and height and base, to find proportion.

The steeper form of an acute pyramid placed upon a small tomb, as often shown in paintings of late tombs, is also dealt with. "Steep pyramid of 15 cubits base, 30 height to heaven, give thou to know its proportion. Multiply 15, its half 7½; multiply the number. 7½ times is 4 in 30, make thus known 4 is its proportion thereon." It is not certain whether the "height to heaven" is the same as the vertical *peremus*; the different name suggests that this might be the slant height pointing up to heaven. Yet the proportion 4 on 1 is the well-known angle of mastaba sides.

48. *Simultaneous fractions*. "Begin to divide 700 loaves among 4 persons, 2/3 for one, ½ for another, 1/3 for another, 1/4 for another, give thou that I should know that which belongs to each one among all. Add thou 2/3, ½, 1/3, ¼ making 1½¼. Divide 1 by 1½¼, making ½ 1/14. Do thou ½ 1/14 of 700 that is 400. Do thou 2/3 of 400 =

266 2/3, ½ of 400 = 200, 1/3 of 400 = 133 1/3, ¼ of 400 = 100, concerning each one among all. Do as making the sum of 700:

2/3 of 400	266 2/3
1/2 of 400	200
1/3 of 400	133 1/3
1/4 of 400	100
Total	700"

"Begin the division with differences. Thus say thou the corn measures 10 among 10 persons. The difference of each person to his next is l of a measure, thus. I divide in the middle of the mass, into 1/2; and take 1 from 10 leaves 9 (intervals). Do the half of the difference = 1/16; do 9 times and make thou ½ 1/16 (over and under the average of 1). Increase upon the dividing of the mass, and take thou from the mass, 1/8 for each person to reach the end. Do thus to make it. 1 ½ 1/16, 1 ¼ 1/8 1/16, 1 ¼ 1/16, 1 1/8 1/16, ¾ 1/8 1/16, ¾ 1/16, ½ 1/8 1/16, ½ 1/16, ¼ 1/8 1/16, total 10." Divide 100 loaves into 7 single and 3 double portions. Divide by 7 + (2 x 3)=13. Divide a yearly allowance of 10 *khar* of fat=3,200 *ro*; find the quantity per day, 3,200/365 = 8 2/3 1/10 1/2190 *ro* = 1/64 *khar* + 3 2/3 1/10 1/2190 *ro*.

49. *Powers of numbers.* The old arithmetical puzzle about going to St. Ives is at least 4,000 years old, as it first appears in the Hyksos papyrus. "In one woman's house are 7 store rooms, each had 7 cats who each caught 7 mice, who each ate 7 barley ears, which each grew 7 measures of grain; how many stores, cats, mice, barley ears and grain measures are there altogether?" The working is:-

(The house	l)	(1	2,801
Stores	7	7	5,602
Cats	49	49	l l,204
Mice	343	343	l 9, 607 total
Barley ears	2,401	2,401	
Measures of grain	16,807	2,801)	
	19,607		

Thus the total excluding the last stage, + 1, is x 7 to produce the grand total. The above is Prof. Griffith's reading, which differs in the first two items from Dr. Eisenlohr's reading.

50. *Pyramidal volume.* Another mathematical papyrus, which may be rather older than the previous treatise on fractions, contains nineteen problems, four of which are geometrical. One of these is published (*Ancient Egypt*, 1917, 100), on the volume of a truncated pyramid.

"Begin to do the truncated pyramid. Thus say thou, a truncated pyramid 6 cubits high, 4 cubits upon the base, 2 cubits upon the top. Do thou this, 4 in going, making 16 (square of 4 base, 16). Do thou repeat the 4 making 8 (multiply base by top width). Do thou this 2 in going, making 4 (square of 2 top, 4). Do thou add the 16 with the 8 with the 4 (sum of base, mid, and top areas) makes 28. Do thou 1/3 of 6 (high) makes 2. Do thou 28 twice, makes 56 (sum of 3 areas x 1/3 height). Behold it, itself 56, found according to thee well."

This agrees with the modern formula, in which the sum of the top area, base area, and square root of the top x base areas, is x 1/3 of the height. The Egyptian took the simplest course of multiplying base and top lengths, instead of square root of areas. The phrase "*n* in going," or increasing, for the square of π is new to us.

Though enormous quantities of accounts of all kinds, from the xviiith dynasty to the Roman age, still remain to us, there is a dearth of any fresh methods or problems preserved to us. In the geometry attributed to Thales and Pythagoras, as a result of their visiting Egypt (about 600 and 520 B.C.), there are only elementary ideas, such as would be familiar to Egyptians who had mastered what we have already described. The later development in Greece and its growth in Alexandria belong to the Greek geometry.

51. *Coptic fractions.* We reach again the Egyptian ideas in a list of fractions on a writing tablet of about

the fifth century A.D. This is exactly of the type of the fractions in the treatise on fractions of the Hyksos age. (*Ancient Egypt*, 1914, p. 52.)

"The 15th part	of 1 = 1/15
	of 2 = 1/10 + 1/30
	of 3 = 1/5
	of 4 = ¼ + 1/60
	of 5 = 1/3
	of 6 = 1/3 + 1/15"
and onward to	"of 15 = 1."

CHAPTER V

WRITING

S.D. (Sequence Date) is used to denote the relative order of the stages in the five predynastic periods. Tasian, 20 -- Dynastic, 80.

For pls. VII-XI, figs 13-37, *see* p. 52.

52. *Three systems.* Three different systems of notation were used in Egypt, apart from later transformations of each. These systems first appear each with a different race and civilisation.

(1) The Amratian prehistoric civilisation used a system of linear or geometric signs which have no pictorial origin that can be traced. The people of this age were from the West, and this system of notation - probably personal signs at first - became gradually developed into a signary, which was the parent of all the western alphabets, and was considerably shortened and altered when adopted by the Semites.

(2) The Gerzean prehistoric civilisation brought into use various pictorial signs, which started as early as S.D. 39 and continued in use as hieroglyphs throughout later history.

(3) The Semainean people, who founded the dynastic history, began phonetic signs in Egypt upon the cylinders which were characteristic of this people. The mixture of the pictorial and phonetic signs constituted the hieroglyphic system of writing, while the linear signs of the first civilisation continued among the lower classes, and foreigners, for personal marks. The hieratic and demotic writing is only a transformation of the hieroglyphic for rapid use, subject to the current changes of language. We will now briefly describe each system.

53. *The Signary*. This consisted, in its most widely spread form, of sixty signs (fig. 14) which were known from end to end of the Mediterranean (P.F.A.). In the Amratian age there were thirty of these signs used; in the Gerzean age there were fourteen more in use, but six of the early ones have not yet been found in this age, though they survive elsewhere. This makes forty-four signs in all, before the rise of the hieroglyphic system of writing. At what point these signs began to be used, for more than personal marks, cannot yet be fixed. Certainly by the xiith dynasty there were people using the signs for continuous writing (fig. 15) and, from the presence of vowel signs as often as consonants, it seems that they were purely alphabetic and not syllabic in value. By the 1st dynasty there were fifty-three signs used, and three more begin in the xiith dynasty. Thus the whole system was familiar a thousand years before the Semite is known to have used it.

54. *Wide spread of Signary*. Outside of Egypt, both Karia and Spain retained the old full alphabet longer than other countries, so that simultaneously with the shortened Phoenician alphabet of 22 letters, Karia had 41 letters and Spain 48 letters, of which 33 are in common between these countries (fig. 14). This large common stock of letters, alike in two countries two thousand miles apart, separated by the Aegean, Adriatic and Corsican seas, and without any link of race or language, is strong evidence of the importance and antiquity of their joint alphabet. When, further, this alphabet is found to have been used in Egypt, as a system of personal marks from early prehistoric days, and for consecutive writing in the xiith dynasty, it is evident that the source of the Mediterranean alphabets was an old matter at the time of the earliest Semitic writing known.

55. *Origins.* There have been various attempts to father the alphabet on other sources. The comparisons

here given (fig. 14) with Hieratic, Phoenician, or Cretan, will none of them account for half of the Karian-Spanish alphabet, but the whole of that long series is found in the Egyptian Signary. Another supposed source is that of the Serabit inscriptions of Sinai. Even at the earliest date for these, they are far later than the Signary; the translations that have been attempted are few of them likely, and are mostly absurd in following mere natural cracks. The Greek forms of many letters were already known before 1500 B.C. (E.P.M. III, 406).

We now turn to the historical view, the exclusion of different possibilities as shown by the distribution of various signs. In fig. 16, there are twenty signs which are in common between prehistoric Egypt and the alphabets of Karia and Spain, almost all found in the three countries. They must belong to a very early common stock, yet the Semite knew nothing of them, either in Phoenicia, or the Arabian alphabets of Nabathaean, Thamudite, or Sabaean. The Semite therefore only took up a minority of the much larger alphabet, and cannot have been the source of it, even if we were to imagine that all early Semitic writing was lost.

Another kind of distribution is traced in 10 signs (fig. 17) which are in common between the south Semitic alphabets and the western world of the Runes and Spain and Karia; yet none of these were used by Phoenicians. It is impossible to suppose that both east and west of Syria a collection of similar signs should be added independently to the Phoenician alphabet. It is manifest that the Phoenicians only took a selection from a much wider alphabet that lay on both sides of their land.

A distribution that touches European history is seen in fig. 18; these 9 signs were in common between the Runes of northern Europe and the Mediterranean, but were never adopted in the Greek or Latin alphabets.

These prove that the Runes were not merely derived from Greek or Roman influences, but that they formed a part of the widely diffused alphabet, and yet other parts of it were adopted in Greece and Italy. There are various other evidences that neither the Phoenician, nor any other short alphabet, originated the long alphabets, but that the long series was the earlier, and the shorter series consisted of selections, dropping out the less needed signs. What really forced the Phoenician series on the Mediterranean world was the use of it for numerals; so soon as numbers were attached to letters for trade purposes, the selection and order of the signs could not be altered. Even the Greek tradition was not uniform. Diodorus says (V, iv), “There are some who attribute the invention of letters to the Syrians, from whom the Phoenicians learned them, and communicated them to the Grecians. . . To those who hold this opinion, it is answered, that the Phoenicians were not the first who found out letters, but only changed the form and shape of them into other characters, which many afterwards using, the name of Phoenician grew to be common.” Here the real source is left as quite an open question.

The fullest detail on this Signary is in *The Formation of the Alphabet*, and shorter accounts in *Scientia*, Dec. 1918, and *Royal Tombs* I, 31-2.

56. *Picture and word.* The second system of notation came in with the Gerzean prehistoric people, who were probably from the east. Beginning from S.D. 39, we find many signs used which were later incorporated in the hieroglyphic writing (fig. 19). There are the following: the plant of the south; the fishing net (see P.R.T. I, xvi, 20); the cartouche, on a slate palette of S.D. 58; the disc with central spot, sign of the sun god Ra; the crossed arrows of the goddess Neit; the wreath of flowers (?) of the god Min; the harpoon, *Ua*, one, sole,

or only; the three hills, *semt*, a desert or foreign land; the falcon on a crescent, the sign of the god Mehti; the upraised arms, sign of the *Ka* or family spirit; and the crown of Lower Egypt, like the Doge's cap, with an ostrich feather in it, which became entirely conventionalised on reaching historic times. All these are signs of ideas, word-signs, which passed on into historic use. If we had any objects on which writing was necessitated, we might find many more such signs; but at least these show that word-signs were in use by the Gerzean prehistoric civilisation.

57. *The phonetic method*. The third system is first seen on a class of small cylinders of black steatite or of ivory, which are not known until the coming in of the dynastic people. The earliest that can be dated is fig. 20, not later than S.D. 76 (P.S.C. 82). This is a period before the earliest kings of dynasty 0, and before the temporary capital of Tarkhan, 25 miles S. of Memphis, which preceded the founding of Memphis. The next in age is fig. 21, about the beginning of the first dynasty (P.S.C. 56). In these we see phonetic signs, *s, n, kh*.

The development continued, as in fig. 22, of the early part of the first dynasty (P.S.C. 95). It is written from right to left, and reads: “Of King Athet's, carver of meat, Tepa, glorified.” The actual signs are:- Athet (king) knife (carver) tongue (flesh) Tepa, the bird *akhet*, or glorified spirit, between the ancestral arms. Here the date is fixed by the name of the king, otherwise called Zet or Uazet; the owner and his office are both named, and he had died and was ranked as glorified. Slightly later is fig. 23, in the middle of the first dynasty, which appears to read “*Her per senth Neit per ka, her per-s*”, that is “Over the house of plans of the house of the Ka of Neit (Temple of Neit), over her house”; that is to say the estate office of the temple lands (P.S.C. 33). The style became more regularised at the end of the 1st dynasty, and fig. 24 is of the end of the iind dynasty, reading *Mut nesut-mes, Hapenmaat, zed khet neb ar ne s, Hapenmaat, khetmi* (seal on cord) *ukhret. H.*; that is "Mother of the royal children, Hapenmaat; said things all, done for her (all things asked are done for her) Hapenmaat; seal of the storehouse of Hapenmaat" (R.T. II, 210). This was the official seal of the Royal Sealer of the Storehouse of the Queen. At this point we reach the full development of writing, which was scarcely altered or improved, later, in its expression or structure. There are nearly two hundred cylinder seals known of the early period, and fully half are of the irregular character of the first two here. These cylinders date from before the 1st dynasty, or just reaching the beginning of it. They fall into two main groups, those with the *akhet* or bird representing the glorified soul (fig. 22), constantly found on the funeral steles at Abydos, and those with the seated figure before a table of offerings (fig. 23) which is constantly the subject of the funeral steles of Memphis. These cylinders seem, then, to be equivalent to the later funeral steles; and the subjects, so far as can be gleaned from the very primitive writing, are like the stele inscriptions, a prayer for food and for association with the gods, stating the titles and name of the deceased person.

58. *Royal seals.* We may turn now to another line of development, the well dated official seals of royal servitors, the impressions of which we found on the sealing of jars and packets in the royal tombs of dynasties 0, i and ii. They are a very different class from the private funeral seals just described, being more regular. The earliest known, fig. 25 (R.T. II, xiii, 89) is of a king Ka, whose sign of two arms is also found incised on pots before baking, or else painted on them. Rather later, fig. 26 (R.T. II, 96), is a king Ro, the sign of a mouth, which is held by the royal falcon, also found

marked on large jars before baking. This is a much larger seal, though rough in its style, and it has the royal falcon associated with the name, as found in all later times. The next stage is seen in the seals of Narmer (Mena), fig. 27 (*see* R.T. II, ii, 3; TK. I, ii, l, 2, 3; R.T. II, xiii, 91-92). These show how much variation was made in the writing, and how system was disregarded. The first (R.T. II, ii, 3) gives the name written with the *nar* fish and chisel *mer*. This fish was the emblem of the Delta goddess Mehyt, so it reads "beloved by Mehyt." The next (TK. I, ii, 2) has the same signs with the duckling *that* added, meaning "boy," so it was the "beloved son of Mehyt." The next (1) abandons the panelling (imitated from the front of a wooden house), and adds a plant and two balls, meaning unknown. Further (3) is the name with two balls, and no plant. Lastly (R.T. II, xiii, 91, 92) there is the framing, only containing the fish of Mehyt, and a row of *mer* signs put beneath it. Here are five different ways of writing the same name, which show how plastic and variable writing then was.

In fig. 28 (R.T. II, 93) there is the same falcon name alternating with the personal name, Men or Mena. In fig. 29 (R.T. II, 109) is the falcon name of Zer and personal name At, known as Ateth in later times. Fig. 30 gives the falcon name Zet, and personal name Ata, written Ata later. Fig. 31 has the falcon name Den, and by its side the royal titles *nesut bati*, "king of upper and lower Egypt," Semti, the personal name; below is the title of the official *ur she*, "Mayor of Fayum." Lastly there is the fully developed style of the falcon name of Azab, 32 (R.T. I, 57), with the royal titles and personal name Mer-pa-ba. After this, only slight and gradual changes in style took place. Here we see the steady course of development of the writing, from a single sign to full titles.

59. *Irregular syntax.* The irregularity seen in the forms of Narmer's name shows how the writing was not yet systematic, but depended on individual choice. This is prominent in the early cylinder inscriptions where the same elements of a title will be inverted in repetition; see fig. 23, where there is *per her* at first (right) and *her per* secondly, “the house overseer” and “overseer of the house.” There was a love of repetition with variation in the early writing, akin to the Hebrew repetition with variation in sentences, so prominent in the Psalms. As long as all the signs were there, the magic value of them was assured, and they would give the benefit however they were written, much as it would be the same result whether we wrote “pay one pound to Philip,” or “to Philip one pound pay.” This lack of formalism extended to the early iiird dynasty, when the inscribed panels of Hesy seem confused, and only at the end of that dynasty is a clear and orderly mode of writing established. Of course the knowledge of the words of the language is essential to reading of any period; but the familiarity with the regular inscriptions no more helps to read the early stages, than reading William Morris will help in the understanding of Saxon grave-stones. The same roots may be there, but the mode of expressing them and the sense of form are widely different a thousand years apart.

60. *Fusion of methods.* The systematic writing in its developed stage retained its double origin. Many words continued to be written by a single sign, as *onkh* life, *mes* born, *kheper* being, *men* firm, *per* house. On this, two opposite developments took place: (1) phonetic signs were added, as *onkh-n-kh, mes-s, kheper-p-r,* and this expansion went to great lengths in the hieratic of the Ramesside age, where every sign and letter and determinative is written out in full: (2) in another direction the word-signs were used merely phonetically,

as *per* a house became used in the word *per* to go, distinguished by being written *per-r*, with two legs after it, and *per* corn distinguished by the feminine *t per-r-t* and grains of corn written after it. Here the word-sign becomes a mere rebus. In some instances, the wordsign, if only of one syllable, became used for merely the initial consonant. The dynastic system of a purely phonetic writing of alphabetic signs did not have much scope, but was mainly confined to the spelling out of grammatical forms, as *anek* I, *entek* thou, *entef* he, *pen* this, without any word-sign or determinative. Other such words are *mak* to wrap, *pus* vase, *nefa* who?, *sekhen* residence, each purely phonetic, without any added sign or syllabic; such writing is rare, and most words have syllabics, word-signs, or determinatives.

The determinative sign is always placed at the end, to show to what class of object the word belongs. Words of similar sound need distinction. The Chinese contrive this by an elaborate system of tones of speech, and some vocal differences may have existed in Egyptian; these were not written, but a sign to show the kind of word was usually added to nouns and verbs. This is as if, in English, we added after the word "box," a square for a wooden box, a wheel for a carriage, a hand or a fist for a blow, a branch for the tree, a coin for Christmas, a chair for a theatre. These determinatives are never sounded, they are solely ideographs, and they are of much use in reading, as they also separate the words at a glance, like other spacing.

61. *Degradation of writing.* Such a complex system of notation, with many hundreds of forms mostly pictorial, naturally degraded under pressure of use. Already in the early dynasties of the pyramid builders, the cursive writing was of much simplified forms; by the xiith dynasty there is hardly a sign which would be certainly identified with the hieroglyphic, if without any clue by

intermediate forms or the context of other signs. It is rather more diverse than our written hand is from the original capital letters and, owing to the large number of signs, the confusion is greater than ours. The xixth dynasty made still wider the separation of writing from the signs. At last, under joint pressure of changes in the spoken language and centuries of scribbling, the demotic writing came into use, in which it is seldom that any resemblance can be traced to the original signs, and much of it consists of rows of slightly varying strokes and dots, so roughly made that the whole differences seem submerged in casual irregularity. At last the familiarity with the Greek alphabet broke the chain of six thousand years, and in the 1st century A.D. the Greek alphabet, which was extended with seven letters derived from the old writing, became the mode of writing the Egyptian language, henceforward named Coptic. This, in turn, has been supplanted by Arabic, and only a few of the old words can be heard in names of months and names of places.

In looking at the history of the Alphabet as a whole, the early vowel system used in the Signary all over the west never had a fair chance where taken up by the Semite, whose grammatical forms were internal vowel changes, instead of our affix and suffix leaving the vowels of the stem unaltered. This Semitic variability upset the permanent root, and to this day the Semitist ignores the great alphabet or Signary with its many vowels. He tries to view the alphabet as of Semitic origin, instead of recognising it as belonging to a much larger system cut down by the use of some signs for numerals, while the half of them were omitted.

CHAPTER VI

DRAWING AND DESIGN

62. *Prehistoric.* In the early stage of the prehistoric pottery, the drawings in white line show a great love for natural forms. While the figures of animals in prehistoric Egypt and Europe have been supposed to be due to a wish for magical influence, it is impossible to account thus for the dozen different kinds of plant represented in Egypt. In these there is unquestionably a love of nature, and a wish to recall natural beauty in handiwork. This was due to the Algerian invaders of Egypt, in the Amratian age, and though it died out, yet there remained a basis of observation in the race, which revived again in succeeding civilisations.

The Gerzean civilisation, coming from Syria, was inferior in artistic feeling; the drawing of plants and figures is very diagrammatic, and it hardly ever shows a sense of beauty, though full of interest as reflecting the life and products.

63. *Dynastic Elamites.* The dynastic people brought with them as perfect an artistic sense and ability as is known anywhere. The earliest of their known productions, the ivory knife-handle in the Louvre (figs. 33, 34) has perfect figures of dogs, goat, ibex and cheetah, unsurpassed in truth and spirit. The later stages of this art in the slate palettes, just before the 1st dynasty, are decadent and crude; but the skill in ivory work continued in the 1st dynasty figures such as the "old King" (M.E. xxxvii, 10), and was revived in the ivory statuette of Khufu (M.E. Ivi, I).

The low relief figures of Old Kingdom age border on drawing, as they seldom have much interior detail, and in the scarcity of drawings of that age, they may be considered together. In the earlier flat reliefs there is some detail shown, as in the panels of Hesy (P.A.C. fig. 55), and figures from Meydum (P.M.M. xx). In these there are the same conventions as in the drawings (L.D. ii, 96).

64. *Conventions.* The main convention is that of showing various parts together from, different points of view, such as the breadth of the body and of the eye along with the profile. In judging of this, we must remember that greater flexibility will often combine what we think incongruous. To give an example from a photograph; in a chance group of Egyptian boys, one of them is seen kneeling with knees in profile to right, chest front view, and face in profile to left. Thus the Egyptian was accustomed to see in one view what we only see in different views, and this prevented his regarding such figures as unnatural; there was no check on figuring each part in its most distinct form. His drawings are a portrayal of facts and not a perspective scene; this belongs to the same system as that of showing successive events in one view, for instance, in an old Italian picture.

The same combination of two views is seen in the figures of decorated vases; the profile view of the vase is shown, and the decoration of the interior standing above it; or an altar or table is figured in profile, and a plan of the offerings on it placed over that (Z.A.S. 1893, 1). In ordinarily looking down on a vase or a table, both views are seen, only each foreshortened; the Egyptian represented both, but without foreshortening.

In no case is there converging perspective in a purely Egyptian work. In Roman painting convergence is avoided if possible, and figures are placed where a

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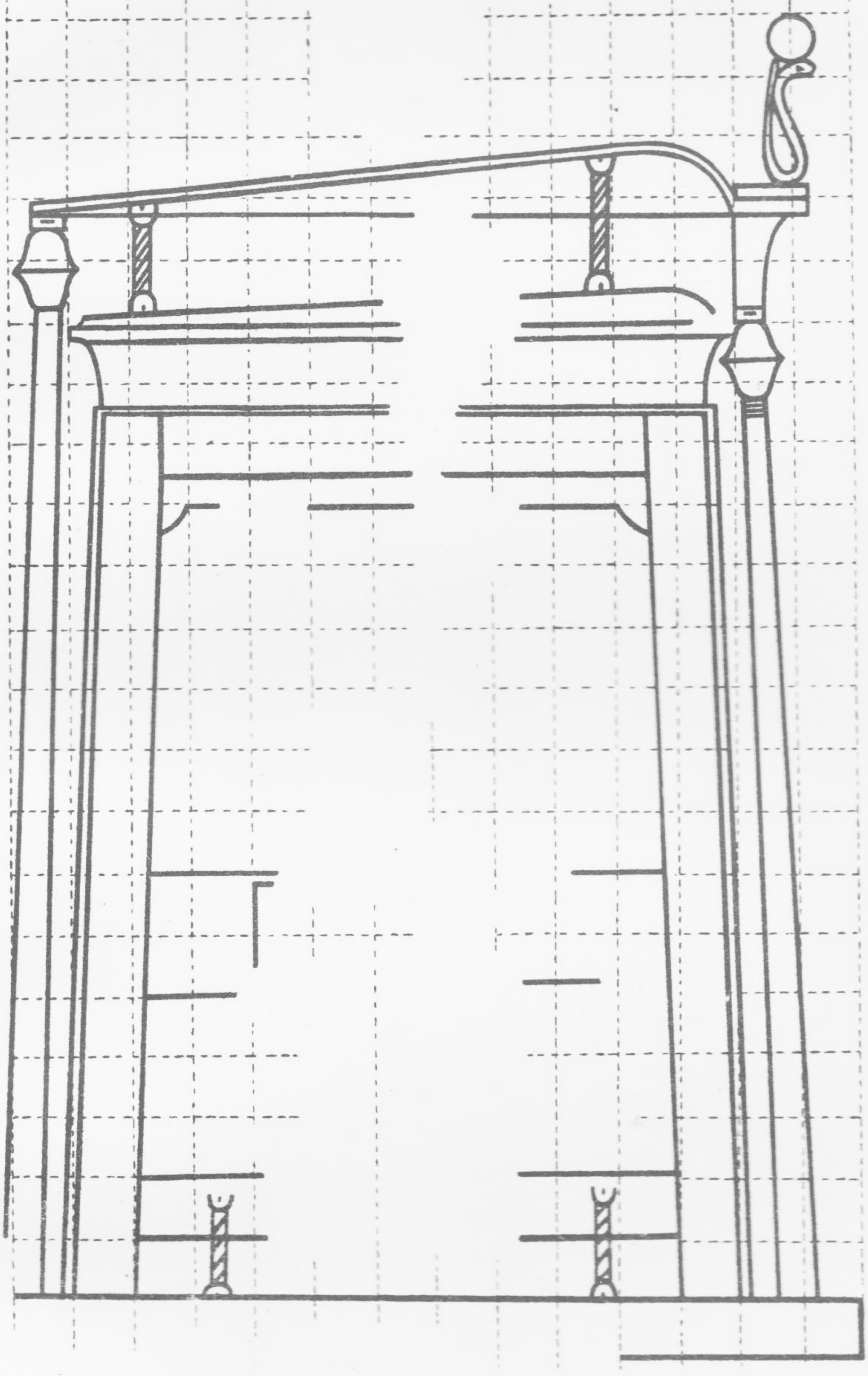


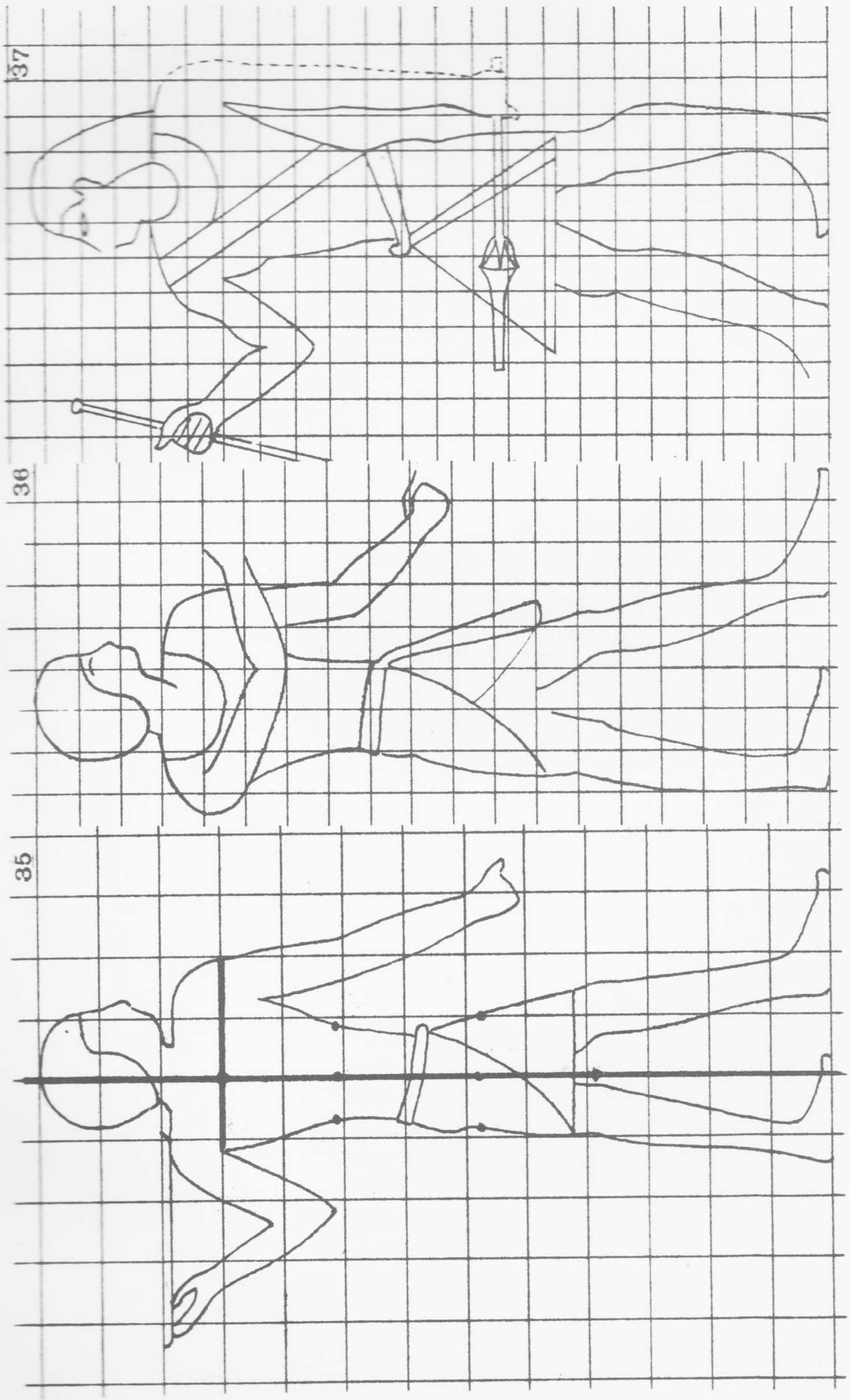

EGYPT
KARIA
SPAIN
HIERATIC
PHOENICIA
CRETE
14
a ai ai e e e i i o y ō
b b f f p b ph v v
g g? g k h h kh kh k
q q k d th th dh t t t
l l m m m m n r
z s s s sh ss ts ts tz tz


XII DYN.
15
16
UNKNOWN IN PHOENICIA OR ARABIA
FOUND IN PREHISTORIC EGYPT AND {KARIA SPAIN
17
UNKNOWN IN PHOENICIA
FOUND IN ARABIA, RUNES AND {SPAIN KARIA
18
UNKNOWN IN GREEK OR LATIN
IN RUNES AND S. IN SPAIN, KARIA, CYPRUS, THERA
LINEAR SIGNS IN AMRATIAN AGE.
19
PICTURE SIGNS IN GERZEAN AGE.
20
-76
21
78-80
22
80
KHU-KA of TEPA CARVER of FOOD & ATHET.
23
81
OVER HOUSE of PLANS of TEMPLE of KA of NEIT, OVER HER HOUSE.
24
MOTHER of ROYAL FAMILY, HAPENMAAT
ALL THINGS SAID are DONE FOR HER, "
by SEALER of the STOREHOUSE, "
25
KA
26
RO
27
NARMER – VARIANTS
28
NARMER, MENA
29
ZER ATETA
30
ZET, ATĂ
31
DEN, SEMTI
32
AZAB, MER-PA-BA

33

34

Ivory Knife Handle, Gebel el 'Arak


37
36
35

symmetric convergence should be shown; sometimes a chamber is drawn with converging sides, and of course ground and ceiling are both shown. Yet the artist never felt safe, and knowing that there should be convergence, the slope is often in the wrong direction, really diverging apart. It took many centuries before perspective was understood; by A.D. 1300, Giotto was fairly safe with it, though timid, and he lacked a feeling of relative distance and scale. It was not till the sudden development of Jacopo d'Avanzo at Padua, about 1380, that a mass of complex perspective of figures was treated freely, without any incongruity.

65. *Relative distances*. The sense of relative distance was observed in the position of the Egyptian scenes at relative levels. On one wall there will be seen at the top the hunting on the high desert and, below that, the furnishing of the tomb on the low desert; then, the offerings being taken to the tomb, and below again are the fields, and at the bottom, nearest of all, is the house (N.BH. I, xiii). Beneath the scenes is frequently a dado of the papyrus plants of the Nile. Thus each stage of the landscape is represented in the order in which it is naturally seen.

66. *Outlines.* The greatest feature of Egyptian drawing the beauty of the line (P.M.E. lxxviii). There was no tentative touching and smudging. Each line was drawn at one sweep from end to end of a limb, even from neck to foot of the whole figure. Each muscle in the outline is brought in, without exaggeration, almost imperceptibly. There is never a quiver or hesitation. The artist must have had the precise form in imagination on the surface before him, and followed with his hand what his mind already saw in place. This is like a musician playing a note because he has realised it mentally from the notation.

67. *Squared grounds*. The use of squared grounds

was usual for working drawings or copies. The front and side elevations of a shrine (fig. 13) are drawn in black on large sheets of papyrus squared up in red lines, here copied with broken lines (Univ. Coll. London). Finished wall-scenes are sometimes squared over for setting out work, and for students to work from as models. Slabs divided in squares were used for designing figures, which could be afterwards transferred to larger grounds.

68. *Canon of figure.* A regular. canon of proportion was recognised. In the pyramid age this was 13 divisions for the height of a man (fig. 35): 2 for the head, 1 to the armpit, 4 to the fork, 2 to the knee, 4 to the ground. For the position of the figure, from the 1st dynasty down to the Ptolemies, the rule was that a vertical line must pass the front edge of the wig, or centre of the head, the middle of the chest and waist, equidistant between the knees, and between the heels (L.D. ii, 65; P.H.I. xiv, xv). In the xviiith dynasty the height of the standing figure was divided into 19 units (fig. 36). The head down to the top of the shoulders is 3 units, divided at the top of the forehead and base of the nose. From the shoulders, 4 units to the waist, then 6 to the knees, and thence 6 to the ground. Seated figures are 15 squares high, thus assigning 19-15 = 4 units to the thigh bone. The seat is 5 units over the ground. A third canon was adopted in the xxvith dynasty (fig. 37), the figure being 22 1/4 or 22 1/3 units high; of this increase 1/3 unit is in the head, 2 units in the trunk and 1 unit in the lower leg (*J.E.A.*, 1917, 74).

Though the above proportions are those of figures on squares, yet the actual results from measuring figures show less difference. In the following dimensions they are all reduced to agree with the total height as 1,000. The fork is only estimated by the outline. The median examples are quoted.

	20 of II-III		13 of XVIII-XX		5 of Ptolemaic	
	theory	actual	theory	actual	theory	actual
Head to chin	154	136	132	140	136	129
Head to shoulder	173	160	158	167	146	160
Arm, total	383	364	348	362	385	371
Arm, upper	210	212	210	212	225	205
Arm, lower	173	155	138	153	160	155
Hand	84	105	-	107	-	130
Leg, total	460	465	500	512	505	481
Leg, thigh	173	188	210	193	225	150
Leg, shin	300	292	290	308	280	317
Foot, long	146	159	158	150	145	167

How far the larger differences, as length of leg, may be actually due to change of population we cannot say, without a full analysis of skeleton measurements. No difference less than 5 is significant, owing to the small number of examples, and their range of variation.

69. *Figures in motion.* Though the nature of the scenes in most cases required stationary or slowly moving figures, yet, when needed, the Egyptian readily drew figures in rapid motion. The long rows of wrestlers at Beni Hasan in the xiith dynasty (N.BH. I, xiv-xvi) and dancers (P.Q, i) and the field workers in action in the xviiith (P.A.C. 70, 71, 72), or the acrobat (75), all show how readily the instantaneous positions were grouped and reproduced.

Light and shade began to be introduced in a tentative manner about 1380 B.C. in the naturalistic art of Akhenaten (P.A.C. 76); but this was not continued, and did not revive till about 400 B.C. in the painting of Apollodoros in Greece.

CHAPTER VII

MUSICAL INSTRUMENTS

For pls. XII-XV, figs. 38-63B, *see* end of this chapter, p. 64.

70. No instruments have been found in the prehistoric or early ages, nor are any represented in the tomb of Hesy, of the beginning of the iiird dynasty.

Tambourine. The earliest form of the drum is the tambourine. This was of two types: the plain circle, fig. 38, as on a relief at Cairo (Prisse, *Art*, 23), and in a painting of dancers (W.M.C. 220, Caill. 40A); and the oblong rectangular frame, which is sometimes straight-sided (according to Caill. 40A), or slightly drawn in (W.M.C. 220; Prisse, *Art*, 32; R.C. 98), or strongly bent in along the sides by the contraction of the parchment (M.A.F. V. xiii), or with a cross-stay, fig. 39, to keep the long sides apart (P. *Art*, 32; R.C. 98). The closed form, a vessel with parchment over the mouth, like the modern *darabukkah*, is also shown (W.M.C. 220, 221), but is rare. All of these are of the xviii-xixth dynasties.

71. *Drum.* The double drum is shown used by negroes under Horemheb (M.A.F. V. 434, iv); it had a long barrel form, lashed around and diagonally both ways, fig. 40. Similar drums, rather shorter, are borne by soldiers (W.M.C. 224, 227). A large copper drum, now in Paris, is of a wide cask form, with red leather over the ends, strained by double catgut lashing passed through about forty holes in the circle of the end. It

was beaten with short curved drum-sticks, not padded (W.M.C. 229).

72. *Sistrum.* The Sistrum is a name often applied to two distinct objects, which should not be confounded. There is the emblem of Hathor, with a face bearing horns, and a building placed over it, thus reading *Hat-her*; and there is also a rattle placed over a head of Hathor and lotus flower. The first of these is only a religious emblem, carried by Hathor herself (Tehutmes III, Ellesieh, L.D. iii, 46) or by the queen as priestess (Amenhetep III, Thebes, L.D. iii, 72; Amarna, L.D. iii, 110), in the xviiith dynasty. In the xixth dynasty it appears carried by Rameses II in adoring Hathor (L.D. iii, 147). Hathor has similarly a building placed over her head on pillars at Abu Simbel (L.D. iii, 192) and Dendereh (C.A. 170-1). These are not instruments of sound, but purely emblems, and for such horned heads of Hathor, see *Sphinx X*, 106-119. In some of the examples made in glazed pottery, of xxvi-xxxth dynasties, the building is pierced through, and holes pass through the sides for cross-bars, so that it could be used as a rattle, like the next type.

The sounding Sistrum first appears at Berri Hasan, xiith dynasty. It is a horned head of Hathor on a handle of ebony (BH. IV, xxv), with a frame upon it carrying two cross-bars, with two discs (?) seen edgeways, fig. 41. It is borne by a servant, and has no religious connection (R.C. 77; N.BH. I, xii). There are five variations in the late xviiith and xxth dynasties, all with a loop of metal to carry three cross-bars, over the head or flower, and without any horns or curled projections at the sides. Variety (A) has a face with ears, fig. 42 (L.D. iii, 175), as in sistrum handed by servant to Rekh-ma-ra (R.C. 78), held by princesses (D. *Amarna* III, 91; P. *Amarna*, xii), held by all daughters of Rameses II at Sabua, Derr, and Abu Simbel (L.D. iii, 179, 184, 186), and held by queen at Medinet Habu (Caill. 49). (B) has a lotus flower in place of a head, fig. 43 (P. *Amarna*, xi), evidently a change made by Akhenaten to avoid representing Hathor (*Amarna* I, xxvi; *Amarna* III, 97). (C) The Hathor head is placed above the lotus flower, combining (A) and (B), held by Nefertari (L.D. iii, 175). (D) has the head alone, and on the bars are rattling discs, four on each, held by Nefertari (L.D. iii, 193). (E) The bars are modified as serpents with discs on them to rattle (P. *Amarna*, xi; fig. 43; priestess of Amen in Prisse, *Art*, 44). To emphasize the difference between the types, Bantanta carries one of each, the emblem head and the rattle (A) (see L.D. iii, 175).

Actual sistra of bronze are in the British Museum W.M.C. 257), Berlin (W.M.C. 258-9), and at University College, with bust of Horus on the top, of Roman age. Also at U.C. is the blue glazed Hathor head of a sistrum of Amenhetep II (P.S.T. iii, 22) and late fragments of Apries, Aahmes, and Nekhtnebef (P.S.C. lvi, lvii).

73. *Trumpet*. The trumpet was only used for military purposes, and apparently not beyond the xviiith-xxth dynasties. There were two forms, one, a thin tube with conical splay end (fig. 44) (L.D. iii, 121, Horemheb; Ros. C. 116; W.M.C. 18, 224-5), about 2 ft. long or more; the other a shorter form (fig. 45) for rougher use (Ros. S. 95, 102, both of Rameses II).

74. *Flute*. The flute was often long enough to rest on the ground, as the performer sat, being actually up to 38 ins. long, and in drawings probably 40 ins. It was therefore a tenor instrument. It is seen in the earliest musical groups, of the ivth dynasty.

The double pipes needed a vibrating reed, which was held within the mouth, as shown in the B.M. fresco (R.C. 99). They were certainly as early as the xiith dynasty (*Kahun*, viii, 9); in the xviiith they are figured (*Qurneh*, xxxiv), and actually found (*Illahun*, xxvii, 22-24;

Sedment, xii) placed in a large reed as a case. Such pipes are common in the Roman period, and are used generally by the peasant boys in modern times.

The sources of the various instruments may be compared. The flute and pipes are essentially native Egyptian, as they appear on the earliest monuments, and are most usual among the natives now. The harp may not be aboriginal, as it is derived from the bow, which belonged to the Libyan and Semite, and is always shown in the hands of auxiliary troops in early times. The lute never appears till after the Syrian conquests of Tehutmes III, and then has tassels hung on it which are typically Syrian. The lyre may have started from threads stretched in a frame for embroidery; it is first shown in the hands of Semite immigrants (Berri Hasan). The drum is figured as used by negroes in the xviiith dynasty, and not in earlier ages; it is still the main negro instrument. The sistrum belonged to Hathor, and is still familiar in the Abyssinian Church; it is therefore probably African.

75. *Lute.* The lute, from its shape, has usually been confounded with the *nefer* sign. Three facts prove the separate nature of the figures. (1) The marks on the body of the *nefer* are never found on a lute, and the stem of the lute crossing the body is never seen on a *nefer*. (2) The lute has pegs only on one side, the *nefer* has projections on both sides. (3) The *nefer* was figured as early as the 1st dynasty, on the black cylinders; the lute does not appear till the xviiith dynasty. The real source of the *nefer* sign, meaning “good,” is echoed in the tradition in Horapollo, “a man's heart hung from the windpipe means the mouth of a good man.”

The lute does not seem to appear in any religious ceremonies, and was only used by dancers; nor are there examples before the time of Tehutmes III, or perhaps Amenhetep II. It is doubtful if any can be dated later than the xixth dynasty. In almost all instances it has two, or more, small tassels hanging from the upper end, which confirm its Syrian origin. The longest form of the body (fig. 59, P. *Art*, 31), 3 or 4 widths in the length, is also in Horemheb (M.A.F. V, 434, ii = W.M.C. pl. xi) and W.M.C. 246. A wider shape, 2 or 3 widths in length, is in Ros. 95, and W.M.C. 213. Still wider (fig. 60), between l and 2 widths, is the most usual; with 9 frets for shortening the string, in Davies, *Nekht* (*frontis*.); without frets in Ros. 96, 98 M.A.F. V, 196, xli, xlii; 434, i; 579, 00; W.M.C. 247. A pointed end appears once in Horemheb, M.A.F. V, 432, ii= R.C. 96. An almost circular body (fig. 61) is copied in Cailliaud 55. In all of these the stem is barred across two or three times on the body; this seems to show that it was threaded through slits in a parchment cover, so as to communicate its vibrations to the stretched membrane. In two of these the strings are marked, both 3 in number. This was played by plucking with the right hand, while holding the stem with the left.

There is no trace of a bow being used in Egypt, on this or any other instrument; yet it was known at least in the lst century A.D. as named by Josephus, *Ant*. vii, 12, 3.

Besides the lute with the long straight stem, there was a short instrument between the lute and the harp, with a bowl body and a curved neck (fig. 62, W.M.C. 239). According to Engel (*Mus. Anc. Nat.* 211) it may be called the *Sancho*, from the instrument now used in Guinea. There are three, four, or five pegs, and a piece at University College has four pegs. A development of this type had a larger sounding-board box of nearly half the length (U.C.). There was no stopping, and each string had only one value, so that the type is really a small harp. The results of the reckoning are therefore placed with the harps here, nos. 2, 7, 39.

76. *Harp*. The harp (fig. 46) is one of the earliest instruments represented. It was at first a long, stout,

slightly curved beam with a few strings, only varying over part of an octave (L.D. ii, 52). It was sometimes expanded more widely at the base to give a vibrating plate, as early as the iiird to vth dynasty (Hagarseh, P. Ath. i) and in the xiith (Meir and Beni Hasan). In the xviiith dynasty the resonance was provided by a large bowl at the lower end (fig. 47), and such harps were usually put upon low stands, possibly to avoid damping the vibration (fig. 48, W.M.C.).

The representations often show only half of the strings, which were in double row; and of 63 harps there are 8 in which there are many more pegs than strings, often double the number, and there are two instances of the two sets of strings crossing each other, proving the double set (fig. 49, C.T.K. xx). Thus about one in six was double-strung. There is no evidence of three rows of strings, as in some Welsh harps.

77. *Trigon*. The trigon (fig. 50, Paris, W.M.C.) was a form of harp, essentially modified by being made in two pieces joined at an acute, or a right angle. This does not appear till the Semitisation of the xviiith dynasty, and as the form is also Assyrian, its source is probably Asiatic, as from Ur (fig. 51, W.U.).

There is also the main stem of a trigon, covered with green leather, in Leyden (*Mon*. II, ccxli), which shows four slits for strings. It is restored in dotted line as having 22 strings, but it is not clear for what reason. In University College is the stout upright pole of a trigon, which shows traces of the diagonal direction of the strings; it is 14.3 ins. long, with 18 pegs, and has, further, a tenon of 7·0 ins. long, to secure it in the base. It is catalogued as the pole of a loom in P.T.W. lxvi, 137, but the diagonal lines of the strings, since found in cleaning it, show it to be a part of a trigon. The instrument was essentially short-stringed, and of a treble pitch, with a range of about two octaves. It must have been of a low tension, as no third side is shown, and the whole strain of the strings came with leverage on a joint at right angles.

78. *Lyre.* The lyre appears first with the Amu or Bedawin of the xiith dynasty (fig. 52). It was then a rectangular frame, with· half the length of the strings crossing a wide resonator. The strings only occupy a quarter of the width of the opening between the sides, and are 8 in number; see also N.BH. I, xxxi; L.D. ii, 133; Prisse, *Art*, 27. As Newberry traced the figure, it is probably to be accepted thus; but there is a different version, with strings wider apart, and 7 in number (Ros. H. xxviii) or 6 in number (W.M.C. pl. xii). This form was probably derived from an embroidery frame.

The next stage was that of bulging the sides outward to make an almost circular opening (R.C. 96). In no case does the Egyptian lyre have sides or horns rising above the top, like the Greek lyre; the two types are quite distinct, and probably of separate origins.

The benefit of a difference in the length of the strings was early perceived in Chaldea, as in the form 53 from Telloh (Heuzey, *Cat. Louvre*, p. 151), and in figs. 54, 55 from Ur (Woolley). In the xviiith dynasty in Egypt, similarly developed forms have 5 strings (fig. 56, W.M.C. 212; D. *Am.* VI, xxviii), 7 strings (Wres. 142; M.A.F. V, 579, ii), 10 strings (W.M.C. 243), 13 strings (fig. 57, Berlin W.M.C. 244), and 18 strings (W.M.C. 215).

Lastly, the top bar only was skewed, and the strings were all attached to a crescent piece on the resonator, as with 7 strings (W.M.C. 242; another Prisse, *Art*, 32) and 8 strings (W.M.C. 242), also at Ur. An actual lyre of this pattern, without strings, is at Leyden (*Mon*. II, ccxlii = W.M.C. 245). A standing lyre on an ornamental base, of 8 and of 6 strings, is shown at Amarna, fig. 58, doubtless Syrian by the form (D. Amarna III, v; VI, xviii).

79. *Scales of flutes*. We now turn to the question of the scales given by the actual instruments, and what we can glean from the representations. The flute is the most decisive instrument for giving the scale; as, being open at both ends without a reed, there is no complication or uncertainty. The flute and reed pipes have been practically reproduced by Mr. Southgate, and the scales studied. The results are l 2 semitones or 8 tones to the octave.
The examples in detail are:

Florence. Open Tube A flat; and five semitones over that to D flat.

Louvre. Open Tube A flat; and C to E fl.at, four semitones.

Brit. Mus. Open Tube E; F sharp, G, A, B (i.e. E minor scale).

Brit. Mus. (W.M.C.). F, G, A, C, D (i.e. F major scale, pentatonic).

Brit. Mus. (W.M.C.). C, D, E, F.

Beni Hasan. Open tube E; F, G, B flat.

Beni Hasan. Open tube F; F sharp, A sharp, C.

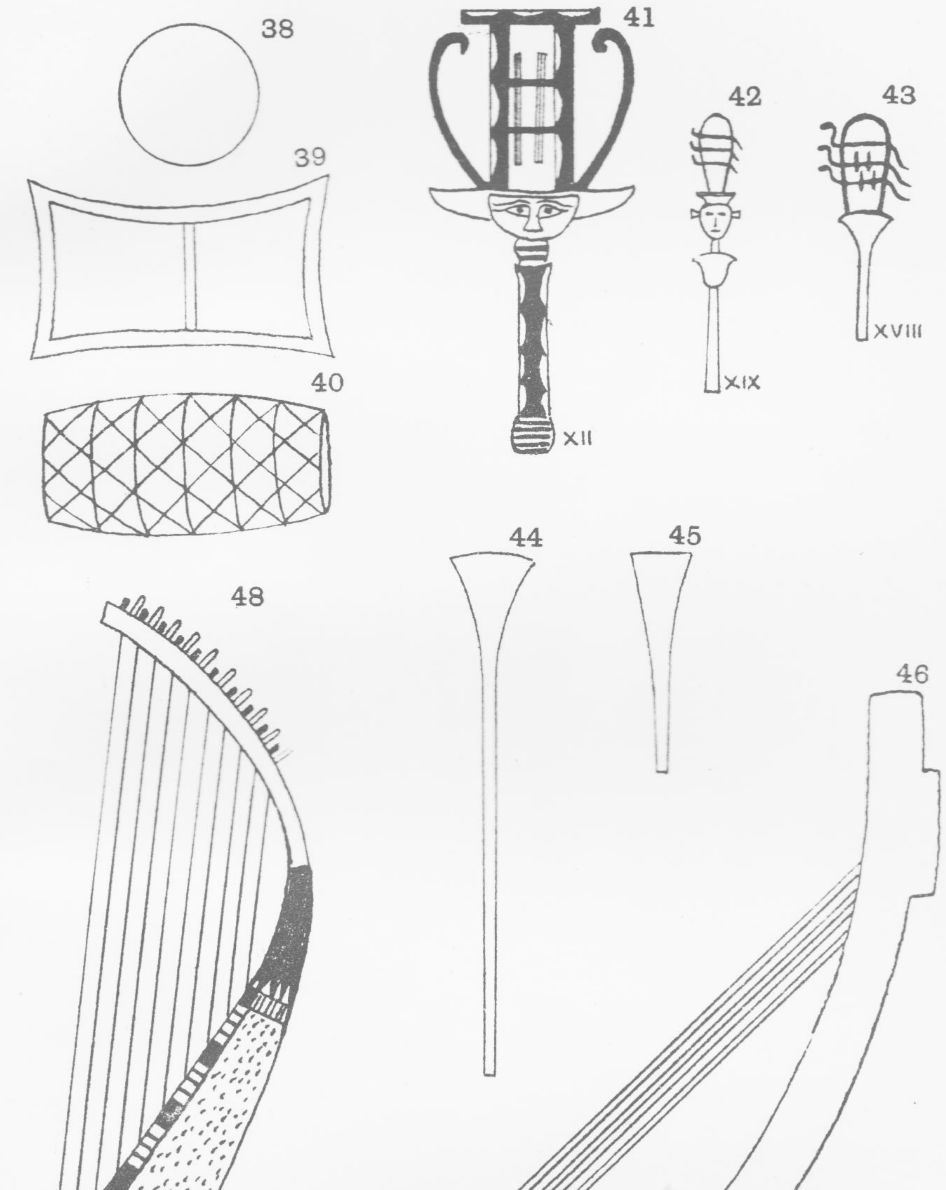
(See *Proc. Mus. Assoc*., 9 June 1891; *Musical News*, l Aug. 1908.)

Pipes, which require a reed for sounding, do not define the original pitch when the reed is lost; they give the intervals of the scale approximately, but modified by the reed. There is usually an interval of a third (three or four semitones), between the whole pipe and the lowest hole; the holes, give scales of semitones in examples at Turin, Louvre, and from Ekhmim; whole tones in examples at Turin (2), from Maket tomb (2), and from Sedment (2); see fig. 63A, with approximate scale. The general result then is that there are, in flutes and pipes, five examples of semitone scales, and seven of whole tone scales. There are also two quarter tones in the Ekhmim flute. (See also *Proc. Mus. Assoc.*, 11 November 1890; *Musical Times*, l December 1890.) How then can we regard the class of harps with only 4 intervals in the octave? They cannot have been for a melody such as was played on the wind instruments, but rather for a drone or fundamental note. They are usually shown accompanying the pipes or the voice, and would therefore serve for the support of a melody. It is clear therefore that not only melody in unison, but harmony of related notes, must have been followed when a scale of 4 notes and another of 8 or 12 notes were played together.

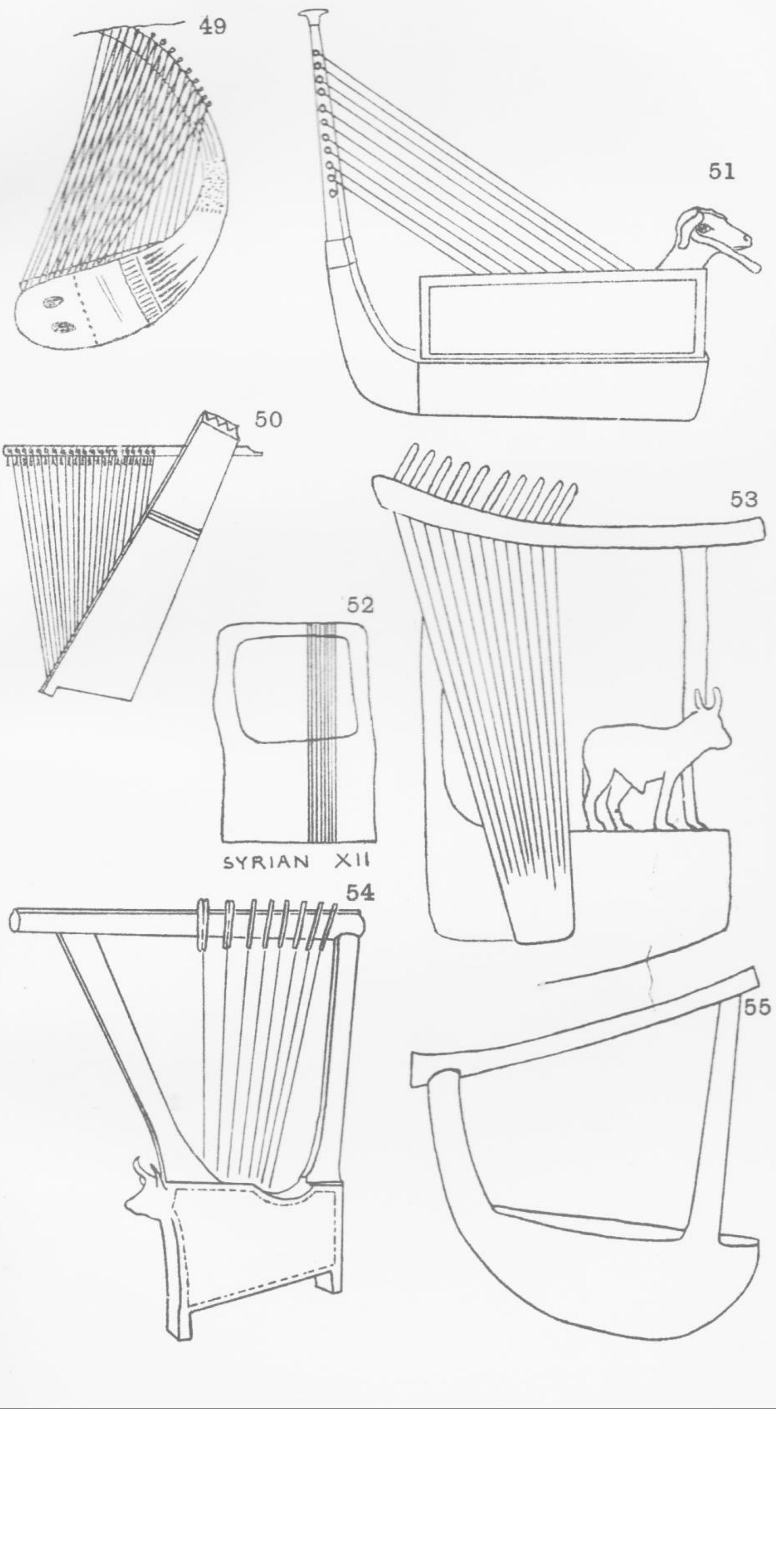
The actual length of the flutes are 19 ins. (Brit. Mus.), 27¼ (Louvre), 28 (Florence), and 36, 38 (Berri Hasan), varying from low treble E to high base E. The figured examples, estimated by an average height of 68 ins. for a man and 64 for a woman, are 30 (L.D. ii, 36), 32 (R.C. 95; Caill. 40), 34 (L.D. ii, 10, 36, 74; S.Ti. 60), 35 (Wilk. 209), 36½ (L.D. ii, 109; D.E.V. 17), 37 (L.D. ii, 61), and 40·5 (S.Ti. 127) ins. long. The lengths of pipes without the reeds are shown alike by the actual pipes, and by the figures where the reed is within the mouth. The actual pipes are 10, 10 1/4, 10 1/2, 12 1/2, 14 3/4, 17.6, 17.8 and 20 1/2 ins. long. The figures show lengths of 14·2, 14·4, 16, 18, 18, 20, 20, 20·6, 22·5, 24·5, 24·5, and 38 ins. The variations in length of both flutes and pipes show that there was no uniform pitch of scale, but that at least five and probably seven different notes might each be taken as the base for a scale. Hence semitones would be needed, as we find in the actual scales remaining. Besides this there was no established pitch, but it varied as in modern use.

80. *Scale of lute.* The lute has, in one instance, frets shown on the stem. If we can trust the ancient artist, we can get the scale, though not the pitch. The modern copy is a tracing, and therefore exact, in Davies' *Tomb of Nekht*. The notes, if we assume the highest as C, would

1 : 16 DRUMS, SISTRA, TRUMPETS, HARPS XII



1 : 16 HARP, TRIGONS, LYRES XIII



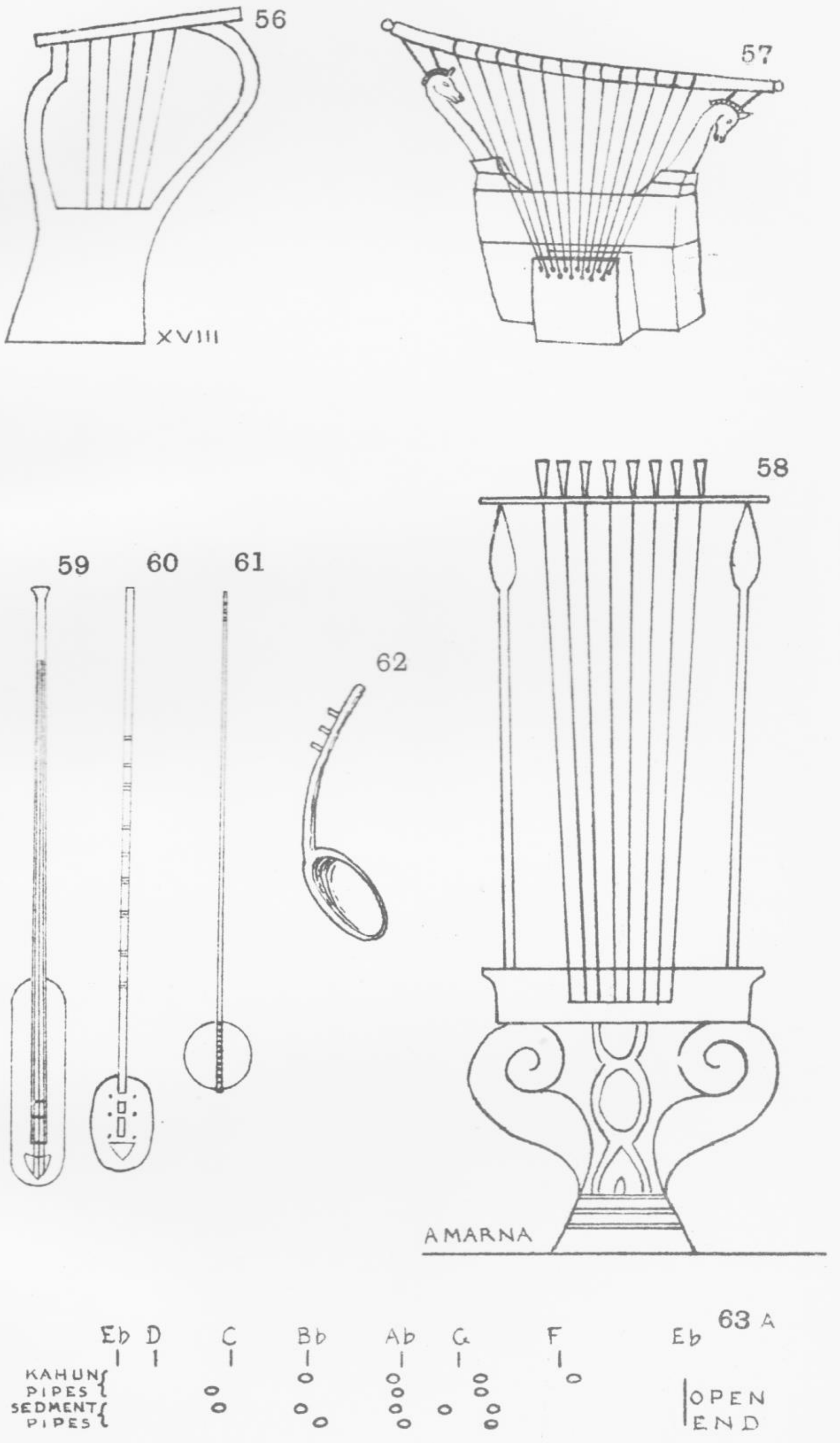
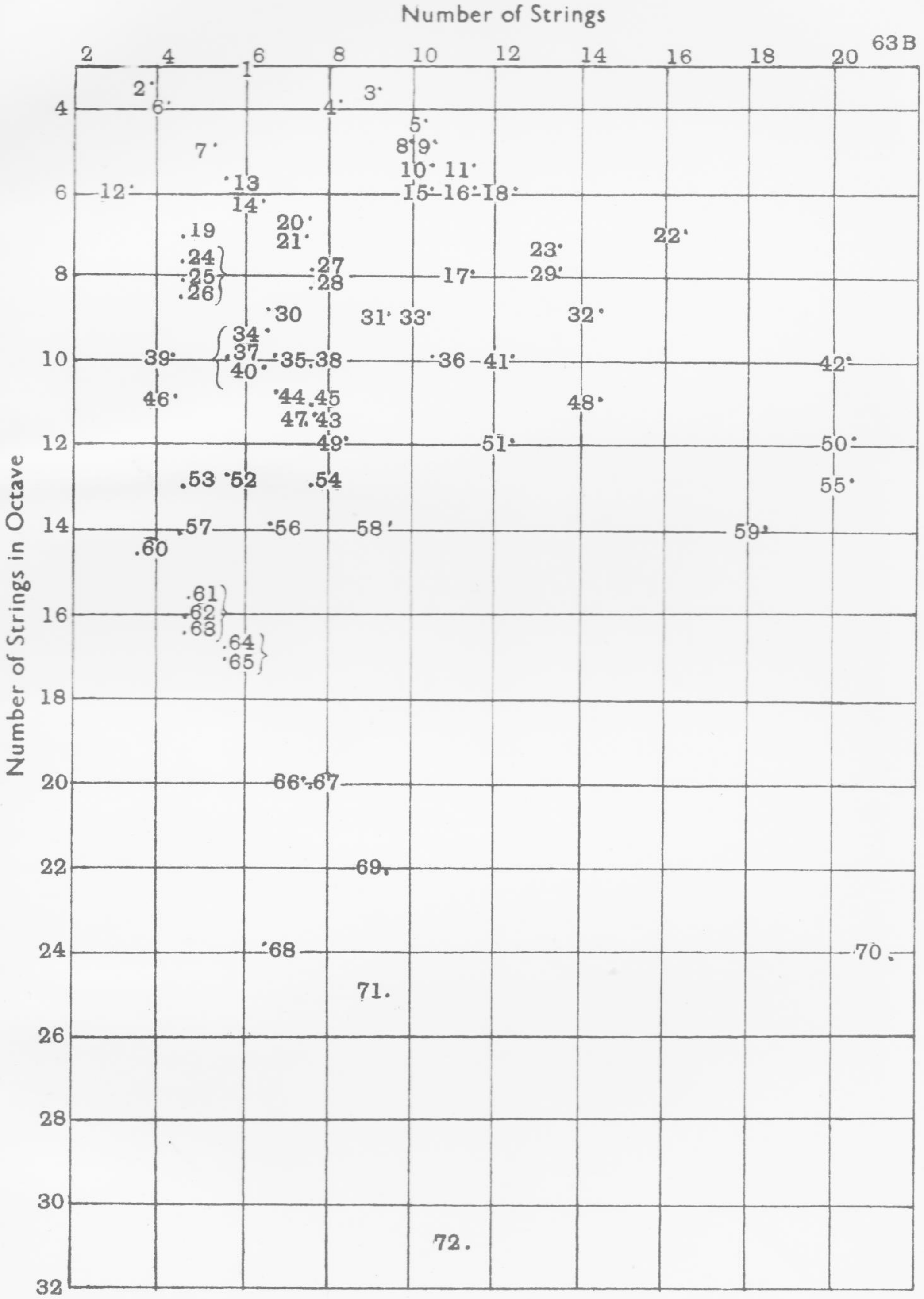

56
XVIII
57
58
59
60
61
62
AMARNA
63 A
Eb D C Bb Ab G F Eb
KAHUN PIPES
SEDMENT PIPES
OPEN END

DIAGRAM OF HARP INTERVALS



be in descending order, C, A, G flat, D, C, B flat, A, A flat. The measured lengths on the drawing vary from 1·58 to 4·00 ins., and the discrepancies from the lengths for true pitch are, in hundredths of an inch, 0, 2, 3, 4, 7, 5, 2, 8, 5. As the intervals average 30, the differences are not serious.

81. *Scales of harps.* The harp will serve to give a limitation of the intervals in the octave; and as there are 68 examples of harp and trigon here measured, there is enough material for examination. Though we do not know the tension or weight of the several strings, yet the figures will suffice to show how few intervals were in the octave.

It is, of course, familiar that a stretched string sounds a higher note if it is shorter, or more tightly stretched, or thinner. Accordingly, almost every stringed instrument has shorter, tighter, and thinner strings for the upper notes. It would be impossible to suppose that the Egyptians acted contrary to these obvious requirements. But as we know nothing of the tension or thickness, we may say that if they are supposed equal throughout, the length of the scale is reckoned at a minimum; if these elements varied, it might be a much longer scale than is shown by the relative lengths, but it cannot be a shorter scale. The *minimum* length of the scale is thus shown by the lengths of string; if the longest is double the shortest, there was at least one octave range, as a minimum; if it is four times the shortest, there was a minimum of two octaves, and proportionately for intermediate lengths. The number of intervals is shown between the strings. If we divide the octaves of range by the number of intervals, there is given the *maximum* number of notes that there could be in the octave. If the top strings were thinner or tighter, then the length of range was more, and the number of intervals in the octave less.

The method, then, is to reckon the maximum of notes in an octave; those examples between two numbers must be counted to the lower number. We may arrange these in the order of the intervals in the octave, stating the number of strings shown and the number of pegs. Probably the strings are more precisely copied than the pegs; but sometimes the pegs show that there were two rows of strings.

The results are best seen in a diagram (fig. 63B). The number of strings is from 3 to 21, left to right; the *minimum* number of intervals in an octave is from 3 to 31, reading downward. Any variety in the thickness or tension of the strings will bring the marked points further up the page, thus there were some harps which cannot have given more than the common chord; and, if the strings varied, all from 3 to 6 intervals may well have been common chord, and all from 6 to 12 may have been plain diatonic, also none here need be more than ordinary chromatic scales. The numbers refer to the list of sources below. The spot before or after a number shows the period, top left= Old Kingdom; low left, Middle Kingdom; top right, New Kingdom; low right, Roman. Where the number of pegs differs from the number of strings, it is put in ( ). The sources are as follow:-

1. R.C. 96, 1.-2. W.M.C. 334.-3. L.M. II, ccxlii.-4. R.C. (10) 96, 4.-5. W.M.C. 212 (20).-6. D. Am. VI, xxviii (5).-7. W.M.C. 240, 1.-8. W.M.C. 208.-9. W.M.C. 214.-10. D. Am.III, p. 6.-11. M.A.F. V, 579, ii.-12. D. NK.; R.C. 98.-13. L.D. ii, 36.-14. D. Am. VI, xxviii.-15. D. Am. III, v.-16. D. NK. (14).-17. Wres. 142.-18. M.A.F. V, 434, i; W.M.C. 216.-19. D. An. xxix.-20. D. Am. I, xxiii; W.M.C. 218.-21. W.M.C. pl. xi.-22. C. 44.-23. D. NK.; R.C. 98.- 24. D. An. xxvii (8).-25. D. An. xxvii (9).-26. D. An. xxix (9).-27. L.P. IV, vii; W.M.C. 254.-28. W.M.C.

213 (16).-29. Ram. III tomb (19).-30. L.D. ii, 61.-31. W.M.C. 214 (13).-32. W.M.C. 215.-33. Ram. III tomb (11).-34. Nekht. Wrez. 174.-35. S.Ti. 59, 60.-36. Q.R.P. xxxv.-37. N.Bh. II, xvi; R.C. 96 (7).-38. N.Bh. I, xii; R.C. 77.-39. W.M.C. 240.-40. D.NK. xvii.-41. C.T.K. xx.-42. W.M.C. 240, 3.-43. Wres. 409 (10).-44. P.DS. xii.-45. B.M. II, xxxii.-46. R.C. 96, 5.-47. R.C. 96, 5.-48. C.T.K. xx.-49. W.M.C. 210.-50 P.T.A. 32.-51. C.T.K. xx (11).-52. S.Ti. 127.-53. N. Bk. II, iv (6).-54. Dahchour II, xxv.-55. W.M.C. 230.-56. S. Ti. 127.-57. D. An. xxvii (8).-58. R.C. 78; M.A.F. V, xlii.-59. C.T.K. xx (15?).-60. N. Bh. II, xiv (5).-61. N.Bh. II, xiv.-62. D.An. xxvii (9).-63. D.An. xxix (9).-64. A.S. xv, 243.-65. A.S. xv, 243.-66. R.C. 96, I; W.M.C. 211.-67. Dahchour II, xxv (10).-68. W.M.C. 209.-69. D.E. i, 23.-70. D.E. ii, 44.-71. W.M.C. 233.-72. D.E. i, 15.

For abbreviations, see list with Contents.

CHAPTER VIII

MEASURES AND WEIGHTS

(See further, the catalogue volume *Weights and Measures*)

For pls. XVI-XX, figs. 64-92; *see* p. 124.

82. *Lengths*. There are no examples of the measuring instruments of the early dynasties, when extreme accuracy was attained. The oldest cubit rods of Egyptian measure known are of the xviiith dynasty; they are of wood, with deeply cut notches of division. In one instance there is a round hole in the end, apparently for inserting a harder terminal (Univ. Coll.). Some stone cubits are of the same age, and of later dates down to the Ptolemaic age. None of these show any special accuracy in the divisions. The stone cubits are mostly ceremonial, belonging to the temples, crowded with inscriptions referring to the religious aspect of the digits, connected with the gods and with the signs of the nomes. The fractions of the digit were shown by dividing the first into halves, the second into thirds, and so on down to sixteenths. The Babylonian method was better, where the successively divided digits were alternate with plain digits, which made them much more clear for reading. The Egyptian scales are square rods with one face half bevelled; the Babylonian are double feather-edged scales like modern plotting scales. There are no rods remaining longer than the double cubit, 41·2 ins., nor any ropes nor chains for measurement.

83. *Capacities*. For capacity measures, the most distinctive are the plain cylinders, figured as a series in the

tomb of Hesy, iiird dynasty. These were of copper for liquids, and of hooped staves for grain (fig. 64A, Q.H.; B, L.D. ii, 103). The actual measures begin with the Amratian age, a basalt vase being marked "one half," and intended to contain half of ten *debens* of water. Possibly the marks were put on later in historic times, as there is no other evidence of liquid measure or of the deben weight before the dynastic age. Many of the stone vases of the xviiith dynasty have the irregular amount of the contents marked on them; but there are no regular marked measures until about the xxvith dynasty. The form of the measures represented are barrels hooped in xiith dynasty (fig. 65, W.M.C. 465), or contracted to the top in xviiith dynasty (fig. 66). The actual cylinders are of cast bronze without any brim (fig. 67). One of Roman age has the interior divided in four parts by raised rings round the side: this was cast in one piece, along with feet and a handle, by *cire perdue* process (fig. 68, Univ. Coll.). The cylinders were also made in pottery (fig. 69) and in wood (fig. 70). Another type, of Persian to Roman age, was widening to the top, with a slight brim; these were almost all in blue glazed ware. There were various other forms occasionally used, and the measures merge without distinction into ordinary vessels utilised for various purposes, which appear to be made approximately to given sizes, like our pint bowls or quart pots. There are no measures with a defining line below the full contents, they appear to be all intended to be filled to the brim.

84. *Balances:* The balance was certainly used from Amratian times, as a few weights then occur. The oldest balance is a small beam cut from pink-brown limestone, a material scarcely ever used later than prehistoric work, but common in that. It has a slight middle stem above the beam, bored through vertically for suspension, and a vertical hole near each end of the beam,

for hanging the pans (fig. 71). The arms are 1·595 and 1·600 ins. long between the holes, or equal within 1/320. On actual trial, however, the error of equality was 1/120, and 1/500 could be easily seen by the tilt of the beam.

In the tomb scenes of the ivth-vith dynasties (fig. 72) the weighing of copper vessels is represented (L.D. ii, 13; P.DS. xiii), and always with a pan held by a single string (L.D. ii, 64, 74). In the xiith dynasty a double string is figured (L.D. ii, 127), and also in the xviiith with a flat pan (Nebamen M.A.F. V, 569, ii). A triple string was more usual for the pans then (Paheri, R.C. i, 110; D.E. ii, 46).

The great balances used in the xviiith dynasty had shallow concave pans (fig. 73; N.D.B. lxxxi). The beam was always hung by a cord, or a loose ring, from a projecting spur on the stand. It had a long tongue pointing downward, and a plumb-bob hanging down the tongue, so as to test its verticality and the level of the beam (P.S.I.E. xx). The cords for the pans came out through a hole in each end of the beam.

All Egyptian balances had much stability, owing to the suspension of the beam being much above the cords of the pans; hence they needed careful handling in order to get accurate results. There are many drawings of balances at the scenes of weighing the soul, in the Book of the Dead, but none of them show any fresh features. A small balance beam in Cairo is 10 ½ ins. long, with lotus ends, and a hole for the pan cords passing out at the ends. This is of the type of the xviiith dynasty or later (Weigall, *Cat. Weights*, 31, 489).

The late balances used in Roman times, belong to the Roman system of suspension by a sling, with a tongue projecting upward, and have been dealt with in the *Weights and Measures* volume. The steelyard is entirely Italian in origin, and was brought by the Roman influence into Egypt.

85. *Lineal units.* The unit of linear measure was the royal cubit of 20·6 ins. The half diagonal of this was the *remen*, a second unit of 14·6 ins., which was divided in 20 digits of ·73. Thus, by the use of the diagonal, the half of any square area could be readily formed and defined. That this was fully recognised is shown by the half of the area of 100 x 100 cubits being also called *remen* in land measure. On the pendulum origin, see sect. 14. The result of this system was that the royal cubit was 28·28 digits, commonly reckoned as 28 digits, and on one cubit rod the digit value is exactly retained, and the last digit lengthened, to make up 1·28 with the fraction. The name of the cubit, *meh*, is also that of a binding, or girdle, or diadem; as it is just the length of a head-band for a smallish head (size 6 5/8), and it cannot agree with any defined part of the arm, it seems that the primitive measure was named from the head fillet. The *remen* means an arm, or branch of a tree, and agrees with the fore-arm down to the clenched knuckles, still a favourite mode of measuring in Egypt.

The cubit was divided into 7 palms, each of 4 fingers, as the nearest approximation to the true digit; it was multiplied by 100 to make the *khat*, which was the basis of land measure. This length squared, of 10,000 square cubits, was about 2/3 of an acre; or 1/10 more than the Roman *jugerum*, and therefore natural as a unit of ploughland.

Various other measures were in use in Egypt, as the northern foot of 13·2 ins., the Syrian foot of 11·1 ins., the Persian of 10·8 ins. and 19·2 ins. (see briefly in the small summary volume, *Measures and Weights*, 1935).

86. *Volume units.* For capacity, the unit was the *henu* of 29·0 ± ·3 cubic ins., practically the old pint. This was multiplied by 10 for the *heqt*, on which various multiples were formed for the larger units of corn measure.

There is an approximate relation of capacity to weight of water, as the *henu* of water weighed 5 *debens*. There were also other measures of capacity introduced into Egypt, as:-

	c. ins.	c.c.
the Syrian	21·5 ± ·3	353
Hebrew *log*	33·1 ± ·2	542
Attic *kotyle*	17·4 ± ·2	285
Persian *kapetis*	74·9 ± ·3	1,227

Of these the Phoenician *mina* of water, was 21·8 cubic ins., the Syrian measure; the *necef mina* of water varied from 30·3 to 33·3, the Hebrew *log*; 8 Attic *minae* of water was the *khous*, giving 17·6-18·2 for the *kotyle*; and the Persian *kapetis* was 100 *khoirine* weights of water. These values above are from actual examples of measures found in Egypt. It appears that capacity standards were derived from weights of water.

It seems not improbable that the adoption of 2/3 of the cubit cubed as the *khar* unit of capacity, arose from the form of the measure. It was accepted that a diameter of 9 gives an area = 8^2. If a measure were made of diameter 9 palms, and half a cubit deep, it would hold ·65 of a cubic cubit, the khar being ·66. The form of such a vessel has exactly the proportions of the old English bushel standard, which is a convenient form.

87. *Weight units.* The very confused subject of ancient weights has now been largely cleared up, by studying several thousand examples from Egypt. It was long known that there were many important standards of weight widely diffused, and each varying so much that they practically ran together. It is now found that in early times in Egypt, before any weights are known from elsewhere, there were 14 different standards used, and these were corrupted by copying so that two or three united, and in later times there were 8 standards.

The names of them set out here are in current usage. The original values of these standards, in British grains, are:

124, 121, 124}	*Peyem*, Palestine.
127.5, 131.5}	*Daric*, Babylonian.
134.5}	*Stater*, Attic.
145}	Qedet, Egyptian.
154.5, 162}	*Necef*, Syrian.
171, 185}	(*Khoiriné*), Persian.
196, 210}	*Beqa*, "gold" Egyptian, Aeginetan.
220}	*Sela*, Phoenician.

These names are the native names, except *khoiriné*, which is uncertain; I adopted it from their being marked in many instances *kho*, and many of them formed as a cowry.

In Egypt the weights vary much, the national standard of the *qedet* being found from 138 to 152 grains. Even weights in one single batch, found together, vary widely. Much more accuracy was reached in Egyptian sets of weights of the late Roman age, which only vary a grain or two on the uncia. When, in the Arabic period, glass coin weights were adopted they increased in accuracy, and the half-dinar weights only vary 32·51 to 32·67 grains in A.D. 765. The producing of three weights of 32·662, 32·665, and 32·667 grains, in A.D. 780, was a marvellous result, the average error being only 1/600 of a grain or 1/10 of a milligram. About A.D. 1000 the average error is ·12 grain, and by 1150 it was increased to 1/3 grain.

The usual forms of the weights of each period are given in fig. 74. These serve to distinguish the age of variations of the standards.

88. *Early commerce.* In the Gerzean civilisation there are evidences of considerable trade. Emery, and probably electrum and obsidian, were brought from the Aegean, and lazuli from Persia. By the beginning of the 1st dynasty, pottery was brought from Crete, probably containing oil. The figures of ships are often painted on the pottery of the Gerzean civilisation, and they bear over twenty different signs referring probably to their home ports. At the end of the iiird dynasty there is a record of 100 ships being built in a single year by Sneferu (P.M.E. 84).

The social condition of Egypt precluded much internal commerce. The great estates of the nobles produced enormous quantities of animals and crops, which are registered in their tomb scenes. Thus in one tomb are recorded 1,055 kine, 760 asses, 2,235 goats, 974 sheep (L.D. ii, 9). These provided for the administration of the district, which was carried on by the household of the noble. Each district was self-supporting, and there was not much need of trade, as the people were in the stage of production for use rather than for exchange. The work of the country was not, however, restricted to the staff of the estates; there were free producers and open markets for, about the vth dynasty, a scene of barter is painted (fig. 75). In the first group, a weaver sits with a roll of linen, and a woman offers him pots (of perfume?) saying “smell it, take it for thy satisfaction.” In the second group, a man has a fish to barter for vegetables. Next is a man seated with cakes in a basket, “Look at sweet cake,” and he is being offered a necklace and sandals, “Look at stout sandals.” In the lower line, a man has a stock of split fish and vegetables; next, a seller of fish hooks; at either end, a seller of vegetables saying, “Observe it, give the exchange,” while a buyer holds out a string of coloured beads, “See thou well a fine necklace for thy dwelling,” and another buyer offers a fan, “Behold a fan, oh dealer!” (L.D. ii, 96).

89. *Standards of value.* It must not be assumed that because there was no regular currency there was no common standard of value. How early it arose is unknown, but certainly by 1136 B.C. values were stated in weights of copper, just as in Roman law the weighing of copper continued to be a necessary part of every sale, fictitiously, long after it had ceased in practice. The report of the tomb robberies state all the missing property in weights of copper, amounting to about 170 lbs. (P.S.H. iii, 182.)

In the xviiith dynasty, the statement of tribute sent from each district to the king is so small, and restricted to articles for the court, that evidently it did not provide for the cost of the administration. That must have been entirely on the local nobles, and the king must have kept his court by means of the produce of his own estates, and only obtained small amounts of gold, linen, and cattle from the different nomes.

The enormous quantity of accounts that are preserved are estate accounts, bailiffs' rolls, like those of the Middle Ages in England, and not traders' books or bills. There are none of the entirely commercial documents, on loans, interest, and partnerships, which are so frequent in Babylonia. In the Graeco-Roman age more commercial writings appear, owing to external influence of the outer world. We do not know enough of the business writings of Greece or Rome, apart from Egypt, to be able to say how far old Egyptian usages prevailed along with classical. importations. Probably the whole of the business is entirely on imported methods. The great number of heads of Sumerians modelled in Memphis show how largely Babylonian merchants occupied trade in the Persian age (P.M. I, xxxvii; II, xxviii; III, xlii); and the exclusiveness of the Egyptian in opposition to the Greek, before that, agrees with the insignificance of trading as an Egyptian occupation.

CHAPTER IX

LIGHTING

90. *Daylight chambers.* The strong sunshine of Egypt renders small openings quite sufficient for the lighting of interiors. The inner chambers of temples were lighted by holes about 9 ins. square in the roof, with a slight combing round the edge to prevent wet from running in. The hole widened downward through the thick roofstone, so that the splay allowed all parts of the chamber floor to see the little square of blue sky (Dendereh). Though but a faint light, it was very effective as being direct. Where there were chambers over others, as in a pylon, the lighting was by a long horizontal slit near the top of the outer wall, splaying with a very steep slope down to near the floor, so as to light the whole chamber (Edfu). Another method was by reflected light only. There being a walled court on the roof, a recess was cut in the side of it, extending down at the side of the roofstone; the wall edge below was cut away with a slope, to give a splay opening into the chamber for the light reflected from the back of the recess. (Granite temple, Gizeh.)

91. *Daylight halls.* The great hypostyle halls were lighted by a square area open in the roofing, making them in effect central lighted courts with double colonnades around (Ramesseum and Karnak). The great axial avenues of columns in temples had clerestory windows of stone grating, above the level of the side courts (Karnak). The gratings of the windows were pierced in slabs of sandstone, leaving upright bars, or lattice

gratings, or designs, or symbols; this custom dates from the open-work in wood placed over the windows in the wooden houses of the 1st dynasty (P.E.A., fig. 32), usually two lotus plants tied together, or *zad* emblems (see ivory model, Louvre). The method of clerestory lighting was transferred to the Christian basilica; it was stated by Mr. Farnell of Cairo that portions of pierced slabs remain at Ravenna, showing that the clerestory light did not fall below, but only passed across the basilica, lighting the opposite mosaics, which could thus be seen originally without any window glare between them.

92. *Lamps.* The earliest lamp known is a little spouted saucer of pottery, greasy and black inside, which is certainly predynastic (*Badarian Civilisation*, liv, 21). Later there was a small granite cup of the 1st or iind dynasty, 2 ½ ins. wide, with the stain of the burnt-out wick on the side; it was covered by a small pot to protect it, in a grave at Ballas (P.NQ. 14). Early in the iiird dynasty, at the end of the long corridor of the tomb chapel of Hesy, are painted four lamp bowls on tall columnar stands (Q.H.).

The best examples of lamps have come from inside the pyramid of Lahun. These are solid bowl-shaped stones, with a small cup hollow in the centre for the oil, and a groove around it to hold water, to keep the stone moist and prevent the oil soaking into the stone. The wick of twisted fibre was upheld by a disc of pottery fitting into the cup, with a central hole for the wick. Three such lamps were in the pyramid, and another on a tall stand of limestone, cut all in one piece (P.E.A. 103). Also of the xiith dynasty are some plain bowl lamps of stone from Kahun, a lamp on a lotus column, all in one (P.K.G. xvi; P.E.A. 95), lamps on papyrus-stem columns, and supported by a figure of a boy, or on a square stand with openwork figures (P.I.K. vi). Similar tall lamps on stands are represented for burning incense

(N.BH. I, xxxv). Stone models of such, with a flame on the top, were placed in rows in front of a shrine at the Labyrinth (P.L.G. xxxviii; P.E.A. 104). There is a singular absence of figures of lamps in the abundant scenes of the New Kingdom; it is not till the Greek influence prevailed that lamps became common. There is the simple saucer with two sides turned in to grip a wick (beginning in the Hyksos time); then with a tube up the axis, so as to put it on a stick to raise it; then the tube closed so that the lamp pivots on a point. After that come in the innumerable varieties of classical lamps of bronze and of decorated pottery, passing on to simple pottery (P.R.E.) in the Byzantine times. To these succeeded the Arabic lamps with a long spout for the wick, of green or blue glazed ware. A peculiar lamp-holder of the first century is of a stirrup form, in which the lamp swung, with a long stem handle and a hook at the end (P.M.I. xxix). The triangular Byzantine lamps passed on the form to triangular open dishes of soapstone, used about the seventh century (P.H.A. xxxix).

93. *Candles.* Candles were used in the xviiith dynasty (Tutankhamen), and pottery candlesticks are known to occur as early as the ivth dynasty (*Man*, 1924, art. 28). In the 1st century A.D. a candle is found modelled on a gilt stucco bust (U.C.). In a child's grave, about the iiird century, a long wooden taper-holder was found (P.H.B. xix, I). Yet solid fats as a source of light never rivalled the use of the oils in Egypt, probably owing to the heat of the climate.

94. *Raft lights, condensers.* How a sufficient light was obtained for the artistic work inside deep rock-cut tombs has often been asked. For many situations, a white sheet outside in the sunshine will throw plenty of light a hundred feet inward. Where there are bends in the passages, which prevent direct lighting, there may have been a raft of floating wicks upon oil, which would

give a large body of smokeless flame, like night-lights. The habit of the Egyptian, in Arab times, of floating a wick on oil suggests that such a method may have been used anciently; and as any dish would do for the purpose, the absence of regular lamps would be explained.

Though the use of metal mirrors for toilet purposes was general from the vith dynasty onward, it does not seem that the Egyptians made any for reflecting light from a source. The mirrors are described in *Objects of Daily Use*.

Plano-convex lenses are found, of Roman age; the form is not accurate enough for magnifying, so perhaps they were for condensing light, or they may have been only to be set as ornaments (P.H.B. xx, 9, 10).

CHAPTER X

BUILDING

(See companion volume *Egyptian Architecture* for details)

95. *Mud structure.* The primitive materials for construction in Egypt are reeds or palm sticks, and mud: the reeds give the tensile strength, and are stiffened by the mud around them so as to bear compression. The stems of the millet, *durra*, are the commoner material now, as reeds have become scarce since the closer regulation of the canals. Columns of *durra* stalk and mud will carry the heavy swinging weights of a *shaduf* for raising water. The architectural forms of stone building are copied from reed and mud construction, as in Greece they are copied from wooden structures. In the early dynasties, wooden houses built of overlapping vertical planks were usual for the rich; these will be described under carpentry. The system of overlapping woodwork served as the model for brick construction, and started the panelled brick building which is so usual down to the xiith dynasty. This timber walling may be the source of the similar brick panelling at Warka and Sinkara in Mesopotamia.

The development from mud architecture to brick is seen in the models of houses which were placed at the sides of graves to protect the wandering soul. Starting from a mere tray of offerings, a shelter was added, and the tray grew into the forecourt of a house-model. The pillars of the shelter are copies of mud and palm stick. Brick seems demanded for stairways and closed doorways.

The arched roof, with a thrust, must have been of brick. There is thus in the peasant building the growth from mud to dried brickwork (P.G.R.).

96. *Brick building* was in use before the 1st dynasty; large structures yet remain of the subterranean tombs of the kings of the earliest dynasties at Abydos; also brick fortresses, still standing thirty ft. high, though built in the iind dynasty. The early mud bricks are about 10 ins. long; they varied up to 18 ins. in the xiith-xxth dynasties, and diminished again to 10 ins. in Roman times. Burnt brick is essentially Roman, though a few examples are known from the xixth dynasty onward. The bonding is generally "English bond," and not Flemish header and stretcher which has become usual in England. The weakness of mud brick led to the system of building all outer faces with a considerable batter, while the inner face, being vertical, made the wall thinner and lighter above. The batter held the bricks in by a sloping bed, and this slope led to all houses being built on a concave pan foundation, with curved courses. For the great city walls the difficulty lay in the thickness, usually 30 to 80 ft., which kept the interior damp and soft; it therefore compressed with the weight, and thus the drier outside scaled off, about two ft. thick. To bond the outside to the inside, the system arose of building square towers of brick, about a diameter apart, with well-bonded and dried sides, and later filling in the space between with more brickwork, leaving the face in alternate curved and straight sections, of the towers and curtain between.

97. *Soil changes*. Another difficulty in Egyptian building is the rise and fall of the ground-water with the inundation, which annually changes the level of the soil anywhere in the plain; dry soil will rise as much as twenty ins. when flooded. No brick and cement building will bear the changes. Cairo houses need a thick platform of concrete which will carry the whole building. The

Egyptian overcame the difficulty by laying a bed of sand, from one to twenty ft. thick beneath all stone buildings, and many brick buildings, so that creep should take place without a drag on the structure. For long walls a wavy plan was adopted, by which the ground might rise in a hump and merely flatten out the wave plan at the top of the wall, or contract along the whole length and merely increase the corrugation. The wavy plan was not only adaptable to all changes, but it was economical, as it gave more stiffness than a straight wall.

98. *Arching*. Brickwork was also adapted to arching; a small arch of the iiird dynasty is known, and of the vith dynasty where there are barrel-roof passages six ft. wide, covered by four courses of arching (Dendereh). A great mass of vaulted storerooms, from ten to sixteen ft. wide was built around the Ramesseum in the xixth dynasty. Barrel-roof vaulting was constructed by very tilted arching, so sloped that each course could be built on the sloping surface, and held in place by the mud mortar till the course was completed. Each superimposed ring of arch was tilted in an opposite direction, so that the bricks crossed joint, and thus each ring held those above and below it in place, and prevented splitting. The high elliptical arch was adopted in the xixth dynasty, and also by the Sassanians at Ctesiphon, as being suited to a soft material like brick. The harder the material, the flatter should be the arch in proportion. The xviith dynasty used barrel-vaulting for long passages (*Qurneh*, 10).

99. *Stone building* began with blocks, of which the faces followed the natural cleavage of the Eocene limestone; projecting parts were slightly dressed down with an adze. This was in the iind dynasty, but even earlier, in the 1st dynasty, granite blocks were dressed square for a flooring. When regularly quarried blocks were used in the iiird and ivth dynasties, the ideal was to construct a

mass with a chamber less than the required size, and then to hollow out the mass to the size of chamber intended. Thus in the corners of a chamber, each block of stone continued round the angle, and had about four ins. of face in the adjacent wall. (Granite temple, Gizeh).

100. *Quarrying*. Stone was quarried in a very regular manner. The limestone was taken from the best seams, by cutting out regular galleries crossing, leaving pillars about equal in width to the gallery, and thus removing three-quarters of the stone. Each stone was cut out of the mass by picking out a trench around and under it; the depth of the trench limited by the length of the pick and the arm together. When a larger block was needed, the trench was wide enough for a man to stand in it. The same system of picking out blocks is still in use at the Helwan quarries near Cairo: it can always be noticed by the face of the quarry showing the pickmarks, and the successive levels of the lines of blocks detached.

The same system was followed for the hard silicified sandstone of Gebel Ahmar, and for the soft sandstone of Silsileh, though these were in open-air workings. The faults and fissures at Silsileh were avoided and left untouched, resulting in the quarry being divided by high walls of rock each containing a fissure in the midst of it. Granite was preferably taken from the waterworn masses at the cataracts, as any slight fissure would be thus exposed by erosion. The blocks were split up by cutting long grooves on the surface; whether the splitting was effected by wetting wooden wedges in the grooves, or by lighting a fire on the stone and then flooding it, is uncertain. The largest blocks removed from quarries were 480 tons (obelisk) and 1,000 tons, (statue) in granite, and 1,175 tons of quartzite for the monolith chamber of Amenemhat III. The rate of working granite was marvellous: a granite obelisk was cut from the quarry in seven months, as recorded by Hatshepsut. In the Great Pyramid the granite was sawn and drilled rapidly by jewelled saws and tube drills. The ordinary limestone of the ivth dynasty was quarried, brought over the Nile, and taken up the causeways to that pyramid at the rate of 1,000 blocks a day (averaging 2 ½ tons each) during the inundation season. This handling of stone was more a matter of skill than of sheer force; a granite block of two tons' weight was taken along a passage 3 ½ ft. wide, and hoisted upward into a groove as a portcullis slab, though only three or four men could have reached it (Second Pyramid, lower passage).

101. *Stone working* was in all ages largely a matter of hammer dressing, especially on granite, for which the hammer-stones were discs of tough black quartzose rock about one to two lbs. in weight. These were held in the hand for stone working, and for beating metal; the shock to the wrist must have been severe, yet no hafted hammers are known till Greek times. Spaces of desert, near the temples, are found strewn with granite chips and dust, and fragments of broken hammer-stones. This rough work was probably done by captives.

Besides the rough dressing, much finer methods were used. From prehistoric times, emery was employed for cutting and polishing the porphyry, syenite, and other hard stone vases. By the ivth dynasty, the use of cutting points fixed in copper saws and tubes, was adopted for cutting sarcophagi inside and out, for reducing blocks for statuary, and for marking out the borders of surfaces to be reduced by hammer dressing. The saws were over eight ft. long, the tubes usually two or three ins. wide, but occasionally as much as eighteen ins. What the cutting points were is not certain; emery points were used in copper saws for hard limestone at Tiryns, but the clean cutting through quartz crystals in Egypt could only be done by amorphous diamond (bort), according to engineering opinion.

The dressing down of surfaces of granite was regulated by cutting a true drafting around the edge by saw cuts. Then placing two equal pegs on opposite edges with a string passing through the tops, stretched from edge to edge, a third equal peg was placed on the rough stone, and its excess beyond the string showed the excess of the rough face, to be dressed down. Where very large surfaces were required, diagonal true drafts were run, in order to check having any wind in the face (King's Chamber, Great Pyramid). The faces when nearly finished were tested by true planes smeared with red ochre, the modern “facing plate.” On limestone surfaces, the specks of red may still be seen on all the prominent points, and the required quality of a joint surface was that the points which caught the ochre should not be more than one in. apart (Great Pyramid). Limestone was dressed down by an adze, of hard copper in early times, and of bronze from the xviiith dynasty onward.

Straight lines were usually marked by a string dipped in ochre, stretched and plucked to leave a red line. For more delicate work they were ruled with a fine brush.

102. *Rock excavation*. In excavating rock passages or chambers, a driftway was first cut, the roof of it was finished flat, an axial line was marked on that, from this line the sides were cut equidistant, carried down true by the plumb-bob (of which many examples are found) and, lastly, the floor dressed to be parallel to the roof. The great rock halls of tombs, as at Beni Hasan and Rifeh, were cut as quarries, for fine stone to build the great houses in the cities; thus the house for the living and that for the dead were provided for, both at once.

103. *Lay-out of building*. When laying out a great building, a foundation of rough blocks was placed on the sand bed, levelled on the upper surfaces, and then the positions of the walls were marked out by deeply cut lines.

In the core-masonry-as at the pyramids-the top surface of each course was made level by letting in the thicker blocks to hollows cut in the course below. Thus each course was partly keyed in to the previous.

In marking out work, as on roofing beams to show their positions, or on buildings, it was usual to place supplementary marks, a cubit distant on each side; so that if the true line became effaced, by accident, or in working, the position could be taken from the extra line.

What the working drawings were, we have no considerable example until the xviiith dynasty or later. A side and a front view of a shrine for carpenters' work, are drawn in black to scale, probably of 1/5, on papyrus roll divided into squares by red lines, the modern “squared paper” (fig. 13). A plan of a royal rock-tomb of the xxth dynasty is drawn-not exactly to scale-with all the dimensions marked in cubits (J.E.A. iv, 130).

104. *Colossal building*. The transport of stone was by dragging it on sledges of hard wood, by gangs of men or oxen. For the minor movements, rollers were used of hard wood, short, with rounded ends to prevent staggering. Great buildings were erected in stages leading one to another; the lesser pyramids were thus in large stages which served as working platforms (Herodotos ii, 125). For the larger pyramids, the only possible method must have been to place a great slope of earth against the face, on which to drag up the blocks, and to build the casing of a course into exact position before the core blocks were filled in, one course at a time. For the completion of the last fifth of the height, less than a hundredth of the blocks, it may have been most practical to work slowly, by stepping up the blocks (*Anc. Eg.* 1930, 33). The great pylons had stages of brickwork piled against them, nearly to the top, and at Karnak these have not been removed. In modern reconstruction, it is found to

be very practicable to fill up a temple with earth as far as the walls extend and move stones into place as if on the ground level. The handling of a usual-sized block was aided by placing it on a cradle of wood, curved below, so that it could be tilted, twisted round, and raised by tilting and placing wedges below, alternately at one side or the other. Models of such cradles occur in foundation deposits. For raising large beams of stone, such as roofing slabs, the description of Herodotos that they were raised "by machines made of short pieces of wood," shows that the most practical method was followed, that of rocking up on two supporting piles near the middle, tilting the beam on one pile while raising the other.

For erecting the great colossi, a long slope of earth was used. An account, at about 1170 B.C., states the detail of piling up a gangway nearly a quarter of a mile long, 95 ft. wide and 102 ft. high, sloping to the upper end, probably about 70 ft. vertical. The sides were held up from crumbling by facings of brushwood and beams. This gangway sloped about 1 in 18, and the colossus, when dragged up on its back, would have its centre about 80 ft. high. As the figure would be about 40 ft. high, its centre of gravity would be about 15 ft. high when erected, and, allowing 5 ft. for the pedestal, the centre would be 20 ft. from the ground. Hence there was a descent of 60 ft. to be utilised in tilting it over upright. This was enough to overcome the loss by crumbling of the earth, and sliding down into position.

This method, however, would not account for raising an obelisk 100 ft. long, and we cannot be certain how such a beam was set upright. The most practical method, for Egyptians, would be to drag it up a slope and then tilt it into a pit of sand until it could be pulled upright (E.P.O.). Enormous earth slopes were essential for building the Great Pyramid, when 400 blocks of 2 or 3 tons had to be raised into position every day (*Anc. Eg*. 1930, 33), for the erection of the upper part, resting on the great bulk of the lower courses (*see* sect. 100). The earth of such a slope would serve for a like slope for adjacent pyramids.

105. *Safety limits*. The absolute strength of material had a large factor of safety. In the heaviest of the temples the total weight on the base of a column was equal to a vertical hundred ft. of stone; as mere brick or chalk will carry six times that height before crushing, there was abundant strength even in the soft Nubian sandstone.

Roofing was, however, very carefully guarded. After the earliest overlapping courses used in the iiird dynasty (P.MD. II), the system of immense sloping cantilevers was adopted. Though 6 or 8 ft. thick, these beams were butted against each other so that, even if cracked through, they would still hold as an arch. They were often in layers two or three deep, and the centre of gravity of the beam was over the supporting wall, so that it would continue to stand thus safely upon the haunch, even without anything to oppose it. Where the beams were not so long, they were butted in solid rock. Another form of safety roof is by superposing several horizontal beam roofs, and capping the whole by a sloping cantilever roof. This has almost failed, in the pyramid of Khufu, by earthquake and settlement, so that every beam of the roof is broken across, and they only hold up by hitching and pressure. As there is plaster over one of the cracks, it would seem that the injury began before the building was finished, perhaps due to settlement in the core.

106. *Accuracy*. The accuracy of building was highest in the Great Pyramid of Gizeh (Khufu, ivth dynasty). The accuracy of stone working excelled in the sarcophagi of the middle of the xiith dynasty. At the Great Pyramid, the mean error of length of the sides, 755 ft. long, is 1 in 4,000, an amount which would be produced by a difference of 15° Cent. in the temperature of copper

measuring-bars. The error of squareness is 1'12". The error of levelling averages ·5 in. between the different sides, or 12". On shorter lengths of 50 ft. the differences are only ·02 in.

The accuracy of three granite sarcophagi of Senusert II, xiith dynasty, averages four-thousandths of an inch from a straight line in some parts, seven-thousandths in others. The curvature of the planes of the sides is only five-thousandths on one, two-thousandths on another face. The mean error of the proportions of the different dimensions in even numbers of palms is 28-thousandths of an inch. This is more like the work of opticians than of masons.

CHAPTER XI

MINERALOGY AND CHEMISTRY

The metals and minerals are listed from the point of view of the ancient Egyptian, and not by modern classification.

107. *Precious metals.* The various inorganic materials known to the Egyptian are here noticed with reference to the period and manner in which they were used. The subject of the alloys that were used is dealt with under metal working. The ancient names are stated, where they are known with any probability.

GOLD, *nub* (*uher* stream gold?). This was probably named from *Nub*, Nubia, where gold is found, just as *aes Cyprium* was named from Cyprus, whence “copper.” This shows that Nubia was the earliest source of gold to Egypt. In the xiith dynasty the gold dust was washed in pans, by swirling the water round to separate the gold and sand by gravity. The speech to the washer is “You whirl it again.” There was much gold obtained from the plunder of Syria in the xviiith dynasty, about a million pounds' worth in one reign. The presence of 1½% of antimony in gold, forming an antimoniate of gold by corrosion, on electrum of Kha-sekhemui, iind dynasty, points to the gold having been derived from the telluride of gold and antimony as found in Transylvania and elsewhere (see further, under Antimony).

PLATINUM. This has been found only in two instances, as an inlay in a bronze box of the xxvth dynasty (B.A.S. 35); and as inlay in an unfinished bronze base of a statuette of Amenardas, xxvth dynasty, in the hands of a dealer in Cairo.

OSMIRIDIUM. Found in minute grains in the gold work of the xiith dynasty, such as. a scarab (P.S.C. xiv T), and the large cowries of the Lahun jewellery. It is far harder than the gold and not amalgamated with the gold, therefore not platinum.

ELECTRUM, *nub hez, asem*. From the 1st to the xiith dynasty, the gold used in Egypt was alloyed with an average 16% of silver. These alloys were probably all natural; though, in the xviiith dynasty, gold was deliberately alloyed till it was “like silver,” as the King of Babylon complains (P.S.E. 38); and, later, 20 minas of gold from Egypt did not amount to 5 minas when smelted in Babylon (40), and there was much loss in melting (43). The native electrum was probably derived from the Pactolus and adjacent parts of Asia Minor, but the yellow electrum is found in Nubia.

SILVER, *hez*, “white.” This was brought in with the Gerzean prehistoric civilisation, and was probably derived from North Syria. It was rarer than gold at first, but in the xviiith dynasty it was much commoner than gold, though by no means as low in ratio as in Roman or modern times.

Metals in common use

108. COPPER, *khemt*. Known to the Amratian prehistoric civilisation, in small quantities; commoner in the Gerzean age, and still more about the 1st dynasty, when large tools were made. Sinai was probably the earliest source; by the form of adzes in the 1st dynasty being similar to those of Cyprus, that country is indicated as the later source. In the xviiith dynasty, large quantities were brought from Syria. The alloys are dealt with under metal working. Crucibles and slag were found in Sinai (Univ. Coll.), where a mass of copper slag in the Wady Nasb may be about 50,000 tons (P.R.S. 27).

LEAD, *zehet*. Found in the late Gerzean age, and it was so common in the xviiith dynasty that it was used to weight fishing nets. As galena is very common in the prehistoric time, it is natural that lead should have been produced. Syria was probably the source.

MERCURY. Not known till Roman or Arab times in Egypt. The early Arab bottles for imported mercury are common, made of very thick brown stoneware. It was first known in Europe in the ivth century B.C. (B.A.S. 240).

TIN. Though rarely found in alloys of the early dynasties, it was regularly used in bronze from 1600 B.C.; but the earliest known piece of pure tin is of about 1300 B.C. (P.I.K. 19). It was used in late Roman times for the backing of glass mirrors (B.A.S. 108), as found in Egypt. The thin wash of melted tin over bronze or copper, common in the West, is found on Roman bronze mirrors in Egypt.

③IRON, *baă ne pet*, “stone of heaven”; *art pet* “produced by heaven.” These names show that meteoric iron was a main source of the metal at first. Zimmer has traced the wide use of meteoric iron in many countries (I.S.I. 1916). The earliest iron from Egypt was found as beads, in graves of S.D. 62, or 4700 B.C.; the metal was so rare that it was threaded along with gold beads (P.L.G. 15). Iron has been found in single examples of the ivth, vith, xiiith, xviith, and xviiith dynasties; this rarity throughout a long period agrees with its source being in small metallic finds, and not due to regular reduction of ore. The earliest iron dagger is of Tutankhamen; a steel dagger is of about 1320 B.C. (Bethpelet). It began to be freely used, from reduction, about 1200 B.C. see the furnaces at Gerar (P. Ger.). An iron sword bears the name of Sety II, 1210 B.C. (Z.A.S. 1, 61). A long knife of very elastic steel, with a bronze handle cast on it, is of about 1100 B.C. (Univ. Coll.). Later, iron abounded in Assyrian working of 800 B.C., and a fine group of various tools belongs to 667 B.C. (P.S.T. xxi). Although the Greeks brought in many iron tools in their settlements of the xxvith dynasty, yet iron was not commonly used in Egypt until the Ptolemaic and Roman ages. Black haematite iron ore abounds in Sinai, and was probably brought into Egypt, as a lump of iron slag and charcoal from a crucible was found at Memphis (Univ. Coll.). The walls of heaven are described as being of iron, and presumably the meteorites were regarded as fragments of the heavenly city. ANTIMONY was early known in Mesopotamia, and the sulphide, Sb_2S_3, is known for eye-paint in the xixth dynasty (P.MD. 43). The metal only occurs as small disc beads, threaded through the diameter, about the xxiind dynasty. On gold foil of the iind dynasty, Dr. Gladstone found a coating of antimoniate of gold, giving 1½% of antimony in the whole metal. This association of gold and antimony suggests that the source was Nagyagite, which is a gold ore containing telluride and sulphide of lead, gold and antimony, found at Nagyag, and also with antimony ores at Offenbanya, both in Transylvania. Possibly it is of Egyptian origin; but this association of antimony with gold does not seem to be known elsewhere, and would indicate that gold was traded from Europe as early as the iind dynasty; this adds to the probability of Hungary being the early source of tin and bronze.

Metallic minerals.

109. MAGNETITE is an eye-paint in the xixth dynasty (P.MD. 43). It is commonly found in the Nile sands. HAEMATITE, *qo; baă-ne-pet*. The same name was used for haematite as for metallic iron, as statuettes are described of *baă-ne-pet*, and figures of haematite are common, but none are known of iron. Sinai is the great source of haematite, dense black and fibrous (Univ. Coll.). Such was used for beads, and for kohl-sticks to paint the eyelids, in the xiith dynasty. The specular iron is found placed in graves of the 1st dynasty, as eye-paint; and

large lumps occur also in the xviiith dynasty (U.C.). Bright red pisolitic haematite is found in large masses, in the xviiith dynasty, and in lumps partly ground (U.C.). This variety occurs in the Bahriyeh Oasis, along with limonite, which was also brought into Egypt. Natural concretions of haematite were picked out, probably from the Nubian sandstone, and used as playing balls for games in prehistoric times.

LIMONITE, the hydrous oxide of iron, is found sometimes, formed from haematite. OCHRE occurs of a bright yellow, and when heated turns a bright flesh red, which a modern portrait painter has found to be better than any now made. Both yellow and red were largely used for the wall paintings in all ages. The yellow ochre was used as eye-paint in the xixth and xxth dynasties (P.MD. 43). Burnt sienna was also a Roman pigment (P.MD. 47). MANGANESE oxide, Psilomelane, and binoxide, Pyrolusite, are found mixed with haematite in Sinai. This was probably the source of (a) the manganese alloy in copper of the iind dynasty, (b) of the pyrolusite used as eye-paint (P.MD. 43), (c) the manganese wad sometimes used, (d) the manganese dark purple glaze used with blue copper glaze from the 1st dynasty onward, and (e) the purple glass common in the xviiith dynasty, and in Roman and Arab work. COBALT was used for colouring glass a deep blue in the xviiith dynasty, and glazing in the xxth dynasty; perhaps the source of it was in Egypt, on the Red Sea coast. BISMUTH occurs in copper, up to 1% in the iind dynasty; it hardened the metal, but it was probably only known as a form of useful ore, and never separated. BLENDE (zinc) was found among prehistoric remains at Naqadeh (P.NQ. 45), and zinc may have been deliberately added to copper, to brighten it, as there is 1½% of zinc in one specimen (P.NQ. 54).

ARSENIC occurs often as a hardening element in copper of the iiird and ivth dynasties, and sometimes in the xiith and xviiith.

REALGAR, the red sulphide of arsenic, has been found imported at Memphis. ORPIMENT, the yellow sulphide, was a favourite pigment in the xviiith dynasty, used on wall scenes, for high lights on flesh, and in painting on papyrus.

COPPER SULPHIDE, *khemt kem*, "black copper," was used for inlay in metal; it was perhaps artificial.

PYRITES occurs commonly as nodules in limestone, more or less decomposed; these were selected, in prehistoric and later times.

GALENA, *mesdem*?, was abundantly used as eye-paint in the late prehistoric age (P.TR.) and onward (P.MD. 42). Found largely at Jebel Rusas, Red Sea.

MINIUM was used for paint in Roman times (P.MD. 47).

SULPHUR has been found of the xviiith dynasty, imported at Gurob (U.C.).

GRAPHITE was found as a large lump of pure quality with a matrix of quartz, at Gurob, and therefore of xviiith dynasty (U.C.).

CORUNDUM is found in the Gerzean age, S.D. 56, as a round block with a wide groove across it, for polishing carnelian beads. There is also a plummet of emery, between 34-46 S.D. Lumps of emery were used for polishing granite vases; but it seems that some harder stone must have been used for the set teeth of saws and tube drills. For polishing granite, and especially for grinding out the bottom of deep hieroglyphs on obelisks, much emery must have been used in all ages. The source was probably Naxos or Smyrna, from which place *ismiri* or emery seems to get its name.

CHRYSOCOLLA, silicate of copper, is found in place of malachite in some prehistoric graves (B.A.S. 72).

MALACHITE (green carbonate of copper), *mafkat*?, *uaz*, was very commonly used as an eye-paint, put all round the eye, partly to stop glare passing through the skin, and partly as a germicide against ophthalmia. It began to be used by the Badarians, with slate palettes for grinding, and became much commoner in dynastic times as eye-paint, down to the xviiith dynasty. It was the main ore of copper in Sinai, and examples brought to Egypt are bedded in schist. *Uaz*, green, is the name for it at Meydum (P.MD. xiii). Whether it was called *mafkat* by confusion with turquoise is uncertain. Rarely, it was carved in late times, as a scarab (U.C.). AZURITE, blue carbonate of copper, was seldom used, but occurs as a cosmetic in place of the green carbonate in the iiird dynasty (P.MD. 18). TURQUOISE, *mafkat*, is found in sandstone at Wady Maghareh in Sinai, mostly in red strata in the brown stone. It was used in the Gerzean age, S.D. 55 to 63. In the middle of the 1st dynasty, an expedition for quarrying turquoise left a great tablet with figures of the king, carved on the rock in Sinai above the quarry (P.R.S.). The Persian variety, in a matrix of black rock, was also known, and imitated by making glazed beads in the xiith dynasty. Much was used for inlaying in jewellery in the xiith and xviiith dynasties, and one scarab is known.

Calcium minerals.

110. FLUOR is very rarely found. A piece of base of a figure of Rameses II in purple fluor is in University College; glass beads imitating blue fluor, as cubes with truncated cornets, were made in Roman times (U.C.). CALCITE as clear crystal (Iceland spar) occurs in great masses, entirely shattered by cleavage, on the top of the limestone cliffs about Tell el Amarna. It was produced by water filtering through strata which are now entirely denuded away, leaving the crystalline calcite in hillocks. It was occasionally used for beads all through the pre-

historic age, rarely in the xviiith, and commonly in the xxiind-xxvth dynasties. Pale green crystal calcite was found at Gurob. As marble, it was often imported into Egypt in Roman times. Hard white calcite (*aner hez*) from infiltrated limestone was used for prehistoric vases, and also later. Pink limestone was selected for vases in prehistoric times, also hard buff. Brown calcite was used at Koptos; dark green in the prehistoric. Yellow limestone, amorphous, was much used at Amarna (xviiith dyn. U.C.). Black limestone was used for scarabs in the xiith dynasty. Shelly brown limestone occurs for scarabs in the xiiith and xviiith dynasties. Breccia of hard white limestone, crushed, and cemented by red clay and calcite, was often used in the prehistoric age for vases and carving, but rarely in later times. The finest white limestone was used for the Great Pyramid casing, of which there was 62 miles' run, truly dressed. All the finest work of later times was done in this fine-grained limestone.

ALABASTER (sometimes misnamed Aragonite) was found in the limestone at Alabastron. It was sometimes employed for vases in the prehistoric age, and was greatly used in the 1st-ivth dynasties, and almost universally for vases in the xiith to Roman times. Great quarries exist in the plateau behind Amarna, where alabaster was produced in cavities by infiltration from upper strata of limestone.

GIOBERTITE, silicified MAGNESITE, was much used for mace-heads (ivth dynasty, U.C.), and for bowls in the 1st dynasty (P.R.T.).

GYPSUM was often used for coarse vases in the 1st-iind dynasties, and occasionally later, as for trade to Palestine. Also it was finely ground for white paint, and as a basis for pink madder paint in Roman times (P.MD. 47). It was greatly used when burnt to make plaster of Paris, for plastering, for casting death-masks (vth and xviiith dynasties), and for innumerable casts of sculpture for learners to copy from, especially in late times. Sheets of clear selenite were sometimes used.

ALUM was obtained from the salt lake region of Nitria.

GLAUBERITE, sulphate of soda, was found with carbonate of soda (natron) in the western desert.

NATRON, carbonate of soda, not to be confounded with nitre, was also found in the western desert. SALT, chloride of sodium, also came from Nitria. Various mixtures of these salts were collected (L.P.M. 5) and were used for preserving the body for burial; probably they were never obtained pure, and various proportions of them are found together, mixed also with potash and lime salts. A sack of salt, an embalmer's stock found at Qurneh, consisted of 65% salt, 23% carbonate, and 12% sulphate of soda. SAL AMMONIAC is from the Oasis of Ammon.

111. *Silica minerals*.

The large class of the silicate minerals-nearly half of all the minerals in use--are best described together, as they often merge together. QUARTZ CRYSTAL, sef. Clear crystal is found occasionally in the Badarian period, and some smoky; it continued through nearly all the Amratian, and most of the Gerzean age. Arrowheads, serrated, and a knife of crystal were in the tomb of King Zer, 1st dynasty. Finely worked amulets of crystal are of the xviiith dynasty; rather later is a statuette drafted out, and a finely wrought statuette of Horus (bust only) in Univ. Coll. A large lump of unwrought crystal, and many separate crystals, from Mempis and Gaza, are in the Flinders Petrie collection (U.C.). The reference U.C. signifies this collection, amassed 1880-1934, by excavation, and by purchase.

CHALCEDONY. Sometimes used for burnishers, and for scarabs in xviiith dynasty; a large polished blade of chalcedonic chert is of the iiird dynasty (P.G.R. iii A). This is a far commoner stone in Syria and Babylonia where it was used for seals.

AMETHYST, *sef-s-tahen*. In the prehistoric age, it is only found at S.D. 55 and 70. A small amount is in the jewellery of Zer, 1st dynasty. In the xiith dynasty a great supply came in, used for ball beads and for barrel beads, also for hawk amulets and scarabs. In the xviiith dynasty, rarely, *uzat* eyes were made of amethyst; but no great supply came until Roman times, when polygonal barrel beads and irregular ovoids are common. The only source known in Egypt is near Gebel Abu Diyeiba, where veins of amethyst follow faults in the granite for hundreds of yards (A.E. 1915, 88).

SARD, *khenem*. This translucent stone was used just before the 1st dynasty, and is characteristic of the xith dynasty. Usually the cloudiness ranks it with the next.

CARNELIAN, *her-sed*. One of the commonest stones of all periods. In the prehistoric, it is usually dull brick red and opaque, but rarely good. It is less common in early dynasties, and merges into sard quality in ixth-xith dynasties. The great abundance was in the xiith dynasty, when the ropes of grand ball beads, and single long barrel name-beads, are characteristic. Poorer qualities, often yellower, were used in the xviiith dynasty, and in the xixth it merges into jasper. It is only roughly worked in the later times. The specimen labelled *her-sed* in the set of ancient samples (Berlin) is milky carnelian, but probably the name applied to all the varieties.

AGATE. Small pebbles of yellow and milky agate were often bored to hang on necklaces in the Amratian age, and in the latter part of the Gerzean age. They reappear in barbaric periods, particularly about the xxiiird-xxvth dynasties. At the latter period, cut agate came into use generally in squared oblong forms, and agate continued somewhat in use in Graeco-Roman work. It is curious that the agate used was hardly ever red, while the natural agate pebble is often red; there was a preference for yellow tints.

MOSS AGATE, prase. These were rarely used, about the xxth-xxvth dynasties (P.S.C. li, H.).

ONYX. One example of Hyksos age is known from Gaza. In Roman times it was common, and an engraved onyx appears to be of Ptolemy Soter (U.C.). Great quantities of glass imitations were made. From the absence of onyx in earlier work, it was probably all imported.

CHERT. This abounds in the Eocene limestone, and was not only flaked but also polished for implements in the prehistoric ages. Of the vth dynasty there is a paint-slab, exquisitely wrought, of King Zed-ka-ra (U.C.) and pieces of other paint slabs have also been found. Weights were made, of the finer qualities.

SILICIFIED WOOD. Forests of silicified trees are known on both sides of the Nile, but this stone was seldom used for carving. Part of an obelisk of Rameses II, and a scarab of earlier date are known (U.C.)

RED JASPER, *khenem*, was seldom used before the xviiith dynasty, when it was fashionable for small lotus pendants and beads. It was imitated in glass of the Roman age. YELLOW JASPER is found, rarely, used for fine engraving in the xviiith dynasty. GREEN JASPER was carved into scarabs in the x-xiith dynasties, in the xviiith, and is known in the early Greek and Persian work.

BLACK JASPER, BASANITE, was sometimes wrought into small implements, and also engraved as scarabs.

QUARTZITE, *baay*, sandstone cemented by hot springs, is white, yellow, red and purple, all the iron colours, and probably all derived from the great mass north-east of

Cairo, Gebel Ahmar, the “red hill.” This has been quarried enormously from the xiith dynasty onward, and still supplies the mill-stones of Egypt. There is but little left of the core of rock, the hill mainly consisting of heaps of spawls from ancient working. The great monolith chamber of Amenemhat III (xiith dynasty) is 22 ft. long, inside; the Memnon colossi of Amenhetep III (xviiith) each weigh about l,200 tons, and have been taken up the Nile to Thebes against the stream; these and shrines of the xixth and xxvith dynasty, all show the grand use of quartzite. The grain was too rough for making small objects.

BERYL, *neshnes*, is said to be used for papyrus sceptres (P.AM. 21), but is rarely found before Roman times, when the emerald mine of Gebel Zubara was largely worked. Roughly trimmed opaque crystals, bored along the axis, are common in Roman sites, and many glass imitations of the green and also the pale blue aquamarine, were made (U.C.). Often this name is wrongly given to Amazonite.

MICA was rarely used in the middle of the Gerzean age (S.D. 55-63). Figures were commonly cut from sheet mica in Nubia, about the xiith dynasty.

Silica rocks.

112. SANDSTONE, *aner redu*, forms the country from Silsileh southward into the Sudan. It was the principal building stone in the xviiith-xxth dynasties, but it is too weak to form slender columns, and too soft and rough for any fine carving: thus it was only fit for the cheap and showy style of building of that age, and for the Ptolemaic and Roman temples such as Edfu and Dendereh. DIORITE, *bekhen*, was the most valued constructional stone. Smooth to work and taking a fine polish, it served both for delicate vases, for the finest statuary, and for casing on small pyramids. The quarry was S.W. of Aswan. It came into use about the iiird dynasty, and

is rarely found after the vith. There is but little hornblende in it, and the finest quality is a translucent magnesian felspar, with flakes of dark green or black hornblende here and there. The fracture has the pearly or greasy look due to magnesia, with a granular tendency. HORNBLENDE was occasionally separated from its matrix in the 1st dynasty, but was generally only known in rocks. BASALT, *aner kem*?, abounds in various parts of Middle and Lower Egypt. To the west of Middle Egypt there are outcrops of columnar black basalt, as behind Deshasheh and the Fayum; at Abu Zabel, 16 miles N.E. of Cairo, is a mass of dark brown basalt, which was quarried anciently, and is still worked by convict labour for road material. This was used in the Gerzean age for vases, the earliest of which are coarse goblets with a conical foot, of S.D. 33. It was common also for bowls in the 1st dynasty, and occasionally later. The pavement of the temple of Khufu's pyramid was of this basalt, and the cylinder seal of the pyramid is also of basalt (U.C.). After this, basalt was seldom used till Rameses II, who built the basement of the west pylon of Memphis in black basalt, and probably made the basalt columns found at Ehnasya (P.E. p. 15). The brown basalt readily decomposes and the desert east of Tell el Yehudiyeh (N. of Abu Zabel) is strewn with soft brown lumps which were collected as rubble to form tumuli, or to fill in behind the Hyksos wall of the fort at Yehudiyeh.

OBSIDIAN was used from early in the Amratian age, S.D. 34 and onward, both as flakes and as beads. From the 1st dynasty there are cups and a scratch-comb; in the vith dynasty, model cups of obsidian were part of the funerary outfit. Later, it was carved for scarabs and even portrait sculpture. In the xxvith dynasty, amulets of the forked lance (*pesesh-kef*), double plumes, *sma*, and two fingers, are usually of obsidian. A large rough block was found at Memphis, brought there for working (U.C.).

Microscopical examination of an early specimen proved it to be most like that from Melos.

VOLCANIC ASH. During the 1st dynasty there was a variety of beautiful stones used for bowls, of metamorphic volcanic ash, blue-grey, green and mottled with various coloured grains and fragments. This class was hardly ever used before or after.

DURITE. This name is given to the same material as slate, but more metamorphosed and rather harder, without a slaty fracture. Its source is probably a volcanic dust deposit, indurated. It was specially used for the large heart scarabs; and probably much of the sculpture which has been called basalt is really a hard durite, but this needs a close examination.

SLATE was constantly used for the palettes on which eye-paint was ground, and for amuletic figures, throughout the whole prehistoric time. In the 1st dynasty it was the usual material for saucer-shaped dishes; pectorals of it were cut in the xixth dynasty and, rarely, other amulets in later times.

GREEN BRECCIA should be noted with other volcanic rocks, as its coarse grain and angular fragments preclude its being laid by water. It was used rarely in the 1st dynasty, and again for sarcophagi in the xxxth dynasty, as that of Nekht-her-heb (Brit. Mus.).

GRANITE, *aner ne măth*. The red quality was used, rarely, for bowls in the 1st dynasty. Paving slabs of granite were used in the middle of the 1st dynasty, sculpture was begun early in the iind dynasty, and it was quarried for building-stone. Grey granite was sculptured in relief at the end of the iind dynasty. The great use of granite for paving began in the iiird dynasty, and in building it was first employed early in the ivth dynasty, by Khufu, who used over 500 ft. run of blocks and 700 ft. of beams for roofing of the Great Pyramid, besides laying a granite floor for his burial chamber. In the next reign, two miles' length of casing blocks were put round the second pyramid and half a mile length of blocks in the granite temple of Khafra (mis-named, of the Sphinx); and after that, 3½ miles of casing were cut and placed round the third pyramid, but the latter was never dressed smooth. For columns, red granite was used in the vth and xiith dynasties, and for statuary in the xiith, xiiith and xixth dynasties. The largest blocks are the obelisks, which are 100 ft. high, and the heaviest blocks are colossi of 800 tons. The earlier granite working was from water-worn blocks at Aswan, which had the advantage of not concealing flaws; for the immense blocks used in the xviiith dynasty, quarrying was the source. Black granite was much less used than red, but the work was always the finest, as in the cap-stone of a Dahshur pyramid (Cairo), and the statue of Rameses II (Turin).

SYENITE is usually composed of black hornblende and white felspar, with very little quartz. It was used for the finest vases in the Gerzean age (Q.H. xxxvii), and also for bowls in the 1st dynasty. It is rarer in the iind dynasty, and then disappears fr.om use, and is very unusual in later times.

PORPHYRY, *behet*?, black and white, was used sometimes for vases and disc mace-heads in the Amratian age; a variety with very large felspar crystals was worked in the reign of Mena. It was also used for bowls in the 1st dynasty, but very rarely later. The red porphyry with small crystals (P.AM. 24a) was of the reign of Mena, and not seen again till quarries were largely worked by the Romans at Gebel Dokhan, 100 miles east of Siut. FELSPAR. Red and white pebbles were sometimes bored and strung in prehistoric times, and very rarely red felspar was used for amulets, such as the inscribed girdle-ties of the xixth dynasty (P.S.C. xliii). AMAZONITE or green felspar, *neshem*, began to be used for amulets in the vith dynasty (sphinxes P.AM. xxxiii), for scarabs in the xith (P.S.C. xi, L), and for jewellery in the xiith dynasty. It was sometimes used in the xviiith and later (P.S.C. li, 1; P.AM. 20, 21). The source of it was a green granite with large crystals; a block of this was found at Memphis (U.C.).

GARNET is found as early as S.D. 33, and is common from S.D. 50 onwards, and in the 1st dynasty (P.TR. II, xiv). It then disappears until the xiith dynasty, when it is frequent, both as small clear beads and larger opaque barrel beads. It is rare in the xviiith dynasty but frequent in Greek and Roman times. Garnets were then exported from Egypt in alabastra, inscribed ΠΑΡ ΑΙΓΥΠΤΟΥ ΑΝΘΡΑΚΙΝΟΝ (P.H.A. xxxvii). A perfect crystal of brown garnet was found at Koptos.(U.C.).

LAZULI, *khesdeb*, *kes-onkh*, probably from Persia, was used at S.D. 36, and is mostly from S.D. 50 to 63. The largest piece is an amulet of a coiled serpent, 2 in. across, of a rich blue (U.C.). It is very rare in the Old Kingdom, but appears in the xith (P.S.C. xi, K) and is common for jewellery in the xiith dynasty. It is found under Amenhetep III, for a heart scarab (P.S.C. xxxviii, 31), and under Rameses II, Shesheng II, and Amenardas. Beads of poor quality of the Roman age come from Nubia (U.C.). The “false lazuli” was blue paste made of the frit of silicate of copper and lime, as early as the vith dynasty and xiith (P.S.C. x, 5, 6; xii, 22).

JADE, *nemehef*, was always rare in Egypt, being imported from Asia. A translucent jade axe is probably of the late prehistoric age (P.P.E. xxvii, 6). An opaque green jade was rarely used for heart scarabs about the xixth dynasty (P.S.A. xlviii, 20, 21), and about the xxvith for *uzat*-eye amulets. It is identified by specific gravity (3·0) and is named on the Kennard board of samples, now in Berlin.

CHLORITE is found in block at Amarna (U.C.) probably used for inlay hieroglyphs. Pot-stone was worked in Roman and Coptic times for jars and lamps.

TALC. A large lump of green talc was found at Koptos (U.C.).

SCHIST of many varieties was the commonest material for small work in scarabs and statuettes. The reason for this preference is that, though soft enough to work with copper tools, it becomes glass-hard after a coat of glaze has been applied. Probably the alkali is partly removed by the glaze, and a harder silicate is thus formed. It was so used from the iiird dynasty down to Arab times.

NOBLE SERPENTINE, *seher-ab*?, clear pale green, flecked with black patches. This was selected for clear beads in the Gerzean age, and worked on a larger scale as a mottled stone for small vases and cups. It was used for amulets of the lion (P.P.E. ix, 23), ox-head (3), ram (25), hippopotamus (27), claw (21), falcon (P.AM. 245 f), beetle (P.AM. 261), forked lance (P.P.E. ix, 32), and forehead pendant (P.AM.130q).

SERPENTINE, OPAQUE, was used through the Gerzean age. A large ceremonial axe of pale apple-green serpentine, flecked with black, is probably of this time (P.P.E. xxvii, 18); a falcon is of yellow and black (P.P.E. ix, 8); there are also a bull's head (ix, 2) and beetles (ix, 35, 37). Vases of serpentine are common, and continued to be made in the 1st and iind dynasties, of very different colours; many in brown, some green with red veins, one bowl bright yellow and red, others coarse ochre yellow with black veins, due to the varying degrees of hydration of olivine, and alteration of the silicate of iron. In the xiith dynasty, a bluish black granular serpentine, varying to brown-black with separation of the iron, was common for vases and statuettes. This continued in the xviiith dynasty and on in Roman work.

STEATITE. The red steatite, and the grey, were often worked into beads in the prehistoric times. Brown was used for figures and amulets. (P.P.E. ix, 9, 28, 30). Black was the commonest, used for beads, also as a basis for glazing; but, though it forms a hard crust, the body is so soft that it often breaks away on scarabs. Black steatite was used for vases in the prehistoric, xviiith, and late periods. Carvings of girls swimming with dishes, men carrying vases, ushabtis, and statuettes of gods are often in black steatite. Green steatite was rarely used.

AMBER. Resins found in prehistoric graves are so much decomposed, that it is not certain if any of them were amber. In the xviiith dynasty, unmistakable amber beads are found, and in Roman times they are very common.

On the various organic materials used in embalming, see A. Lucas, *Ancient Egyptian Materials*, pp. 110-135.

113. *Colours*. The uses that were made of the minerals by various treatment should be noted. Colours were in demand in the prehistoric time and onward, and many delicate shades of greys and browns were reached by mixtures; but the main palette was very simple, and was entirely of mineral colours in early times. RED was chiefly haematite, in an earthy or oolitic form; this was ground up in a pottery saucer with water, and applied direct. It stains readily, and was used on leather in prehistoric times, and for figures and patterns on stone and plaster. It was rubbed in very firmly on the stone, spreading over the outline, which was limited afterwards by a white ground wash around it. Some binding material was used, which renders the colouring still waterproof, after 5,000 years. It sometimes was albumen (*Arch. Journ*. 1895, 229). In the thick inlaid pastes, a facing of turpentine with some resin seems to have been used (P.MD. 29).

Ochre was also often used for lighter tints; either natural red ochre deposited from denuded haematite, or yellow ochre burnt red: the latter is the finer colour, and the best flesh tint for a modern artist. Minium or red lead was only used in Roman times.

Madder was retained by pulverulent gypsum as a basis, and so used for Roman portraiture. It seems probable that it was the dye for the coloured weaving of Amenhetep II, but that has not been examined.

BROWN was an ochre, probably with some manganese, but also obtained by a thin wash of red over a black ground, or a wash of brown ochre over a coat of haematite. Burnt sienna was in Roman use.

YELLOW was usually a yellow ochre, some of which is very bright, and can be enhanced by removing the calcium carbonate with sour wine (P.MD. 28). For the high lights on flesh, a thin dusting with powdered orpiment was used (Amarna); and orpiment paste appears in scribes' palettes, for illuminating papyri. Yellow dye on linen is usually from safflower (*Carthamus tinctorius*), apparently fixed by sulphate of magnesia. Another dye of the xiith dynasty was iron buff, which seems to have been developed with quicklime (M.T.B. 75-9).

WHITE was usually sulphate of lime, which is found in very finely divided efflorescence. BLACK was soot, made up into little circular cakes to fit into the holes in the scribes' palettes. Manganese Wad was used for black at Beni Hasan, xiith dynasty.

GREEN was obtained by green carbonate of copper, more or less impure. The malachite was kept in small lumps, for grinding, to paint round the eyes; and such was the green paint in the Old Kingdom for the Meydum paintings and for colouring the hieroglyphs in the long Pyramid Texts of the vth and vith dynasties, and in the xiith dynasty. The artificial green silicate of lime, copper, and iron, was introduced in the xviiith dynasty; it is described in the next section (114).

BLUE was the native blue carbonate of copper, chessylite or azurite. A shell at Meydum contained finely powdered azurite; and the paint on frescoes there was apparently an earthy azurite. This blue continued to be used in colouring hieroglyphs in the xiith and early xviiith dynasties. Indigo was used as a dye, certainly in the xxiiird dynasty, and probably in the xviiith.

114. *Silica colours and glaze*. Blue frit, or silicate of copper and lime, began to be employed in the xith dynasty, and was the only blue used on walls or coffins after the middle of the xviiith dynasty. With this must be included the similar green frit, which is the blue modified by a small amount of iron. This frit was also the colouring material for the blue and green glazes. The same frit was used in early Greece, contemporary with the xviiith dynasty, and in classical Greece, and over the Roman empire. The reproduction of more than a hundred varieties of the colours was made by Dr. Russell, experimentally following Egyptian methods. Dr. Laurie has since made a precise chemical study of the compound, and the limitations of its manufacture (*Proc. Roy. Soc.* 89, pp. 418-429). The purest crystals showed a compound of CaO, CuO, $4Si0_2$, or a bisilicate of lime and copper. The method of manufacture shown by the remains of the factories, and Dr. Laurie's experiments, is as follows:-

Pure quartz pebbles were collected, roasted as floors to the glazing furnaces and, when fissured, were crushed up to fine chips. These were mixed with carbonates of lime and copper (limestone and malachite), with some soda, and placed in pottery pans, which rested between inverted cylindrical pots in the furnace, so as to allow the hot gases to pass beneath. These pans were slowly heated so that the soda should combine with the silica, which then passed on to union with the lime and copper. It is possible to make the blue without soda as a solvent, but very slowly and poorly. The mass in the pan must never be heated to fusion, but kept in only a pasty state, blown up with the carbonic acid which was displaced by the silica (see U.C.). When it settled down to a stable condition, the combination was completed. For this it was needful to keep the frit uniformly heated for one or two days, to produce completely uniform combination, and to bring out the strongest and deepest colours. The range of temperature for this is narrow. The best result is at 830° C., 800° being too low, and 900° too high; that is to say a full-red heat, but not a cherry-red, is essential. At an orange or yellow heat the process is ruined, and requires long reheating at the right heat. The long heating was done in sealed jars to prevent the furnace gases acting. As iron in the smallest amounts spoiled the fine blue, contact with ordinary pottery could not be allowed. The jars were lined with a quarter of an inch thickness of the valuable blue frit, so that the contact of the material to be roasted was only with itself. The frit to be prepared was made up in balls, from ·3 to 1·2 in. thick, and these were packed in the lined jar, and a cover luted on. Then the furnace must have been watched very carefully, to keep the heat within the range of full-red and under cherry-red heat (U.C.). If too little soda was put in, the combination was slow and imperfect; if as much as a fifth of soda, it dissolved the whole into glass: about a twelfth of soda seems to be best (*Anc. Eg.* 1914, 186). For the deep purple-blue, a heavier amount of copper is needed, and longer roasting; an excess of lime gives the violet and lilac colours, fashionable in the close of the xviiith dynasty. Though the dark blue is one of the most difficult tints to produce, it is that of the earliest piece of glass known, of the beginning of the Gerzean civilisation. It is evident that the fritting process was carried on in some other land, thousands of years before it was brought into Egypt. (See *Archaeological Journal*, 1895, 222-239; *Medum*, 28, 44, 50; *Tell el Amarna* 25; *Mem. Manch. Lit. and Phil.* 1892.)

CHAPTER XII

METAL WORKING

115. *Metals and alloys*. The nature of the metals and alloys should be considered before the methods of work. There are some 72 analyses of Egyptian. copper alloys, and 18 of gold, due to Berthelot (*Acad. Sci*. Paris, 1906), Gladstone (in various volumes of mine), and Sebelien (*Anc. Eg*. 1925, 6), referred to here as (B), (G), and (S). As copper is the earliest metal known in Egypt, we begin with its alloys. We must always distinguish three different characters of alloys: (1) natural mixtures of metal or of ores which produced involuntary alloys, and therefore occur sporadically and not generally; (2) intentional mixtures of ore, which are found by chance to produce better metal, and such occur repeatedly, but are very irregular in proportions; (3) intentional alloying of nearly pure metals, in which case the proportions should be nearly constant. It is seldom that an ore contains only one metal; Wicklow pyrites has 2% each of copper, zinc, and arsenic; sulphide of copper has ½ to 4% iron; oxide of tin has up to 5% iron; gold and silver are naturally mixed in all proportions, with copper also up to 12%, and sometimes iron. The rough ore is also necessarily far more mixed than crystals and specimens which are selected as mineralogically pure. Any amount up to 2 or 3% may be looked on as an involuntary alloy, and only the persistence of it in different cases can show that it was intended. In the following account, all amounts of metal are stated as percentages of the whole metal.

116. *Bronze.* From the practical point of view it may be said that bronze was not an intentional alloy in Egypt before the xviiith dynasty. The exceptions to pure copper before that date are scattered and varied in amount, pointing to their being casual or intentional mixtures of ores. Before the xiith dynasty, 6 out of 43 contain tin; 3·4% under Zet, 1st dynasty (B), 8·8 in iiird dynasty (G), 9·1 a bracelet in ivth dynasty (B), and 6·2% in vith dynasty (B). The rise in amount points to intentional ore mixture. Arsenic seems also to have been as frequent as tin, but in small amounts up to ·6, in the iiird and ivth dynasties. Other elements are 1.0 manganese in iind dynasty (G), which accords with a manganese bronze of modern use; of same age, bismuth in four samples, up to 1·0, which hardens copper considerably (G); lead 6·1 in a bracelet of ivth dynasty with 9·1 tin. The earliest analyses of fairly pure copper are from examples of the 1st dynasty. We also find it in the vith dynasty, where it was desirable to have copper sheeting and nails soft for hammering on a statue. It appears, then, that where hard copper was required, small amounts of tin or arsenic-rarely manganese or bismuth-were prepared, but a pure copper could be attained where needed. A similar age of copper is found in Ireland, Palestine, Babylonia, and Turkestan, but not contemporary.

In the xiith dynasty, out of twelve samples only three are free of tin; the tools are hardened with tin up to 2·2, and in two cases ·4 and 4·0 arsenic. Where fusibility was wanted for casting, there was 12·4 tin, and as much as 19·3 tin in a bracelet (B), which is the modern bell metal. These show that there was a command of real tin ore, and not merely impure copper ore. In a Syrian axe of this age there is 12·1 of tin and ·8 lead (S). In the xviiith dynasty, bronze came freely into use, and the facility of casting made many changes. Mirrors had always been beaten out and therefore had short tangs;

but in bronze they were cast thicker, with long tangs. Pure copper was only used for foundation deposits (B), where durability rather than strength was needed. Otherwise there is only bronze, varying from 6 to 16% of tin. A pure tin ring (G) shows that the metal was now imported pure; it was hardened with one-sixth of copper for use in ornaments (ring, Danagla, B.). In Greek and Roman times, a more fusible bronze for figures was made with the addition of lead, or even without any tin. This same variety of alloys was usual in Gaulish and British weapons.

117. *Sources*. Gold alloys were known to the Gerzean prehistoric civilisation, along with silver and lead. From the 1st to the xiith dynasty, there is no gold with less than 4% of silver, and the average has 16% silver. The large percentage here points to this having been obtained from Asia Minor, where the gold and silver alloys were native. As obsidian and emery were brought from the Aegean as early as gold appears in Egypt, there is no reason to question the source being the same as that of the earliest gold coinage of later ages.

Lead was known in prehistoric times, and onwards. Antimony is found as beads in the xxiind dynasty, with some sulphur, showing that it was obtained from the sulphide. As it is found earlier in Mesopotamia, it was probably brought from there by “the man of Susa,” Shishak, who founded that dynasty. Zinc is only known by 1½% in prehistoric copper. It was not regularly found anywhere until the Romans used it on a great scale for their brass coinage, which was one-sixth zinc (Smyth, *Catalogue of First Brass*).

118. *Early metallurgy*. The history of metal working begins with the Amratian age, but only small copper chisels or drills held in the fingers are found, until the middle of the Gerzean age, S.D. 55, when the adze and dagger were well developed. The heavy axe began with

the 1st dynasty, S.D.78. After that, copper was fairly common, though how much from Sinai (where an immense bank of slag remains) or from Cyprus (where it is said to be not early) we cannot yet distinguish.

The primitive way of working was continued to late times. The crucible, when small, was set on a pot of sand, with a pottery back to it. The charcoal was urged to a full heat by a blow-pipe of reed tipped with a clay nozzle. For larger fires, four men sat round with long reeds tipped with clay, and kept up blowing a continuous blast (L.D. ii, 13). Spring tongs were used to arrange the fire and the work. This simple and portable outfit was that of the travelling jobbing goldsmith, such as a Roman Governor could order to work before him in court, for making a new signet ring from gold weighed out to him.

119. *Casting*. The casting of tools was only in open moulds; the closed mould, which gave much more variety, was Asiatic. The melting was done in crucibles, which were of weak clay owing to the quantity of ash in it, to prevent fusibility. The crucible was round-based (fig. 76), as expressly shown in the hieroglyph (77); the pouring was from a side spout, so the mould must have been in the ground just in front of the crucible, which was rolled over to pour out; thus the danger of its breaking with the weight of molten metal was avoided.

This round-bottomed crucible sitting in the furnace, the sign *hem*, seems to have formed many sedentary hieroglyphs, of sitting, woman, steersman (who sat), a ball, and also metal, especially copper, from the crucible.

The cake of copper was about 8 or 10 ins. across and ¼ in. thick, as cast to start with (U.C.). The beating with a stone in the hand seems as if it must have strained and shocked the wrist badly; it must be supposed that the blow was not carried fully to the end, but the stone was allowed to drop at the last, so as to avoid the vibration to the hand (fig. 78). This would result in a heavy pounding action with lesser velocity than the hammer; and it may be that this is better for beating out metal, as carrying the expansion through the mass, rather than hardening the surface before the mass can yield. The metal for large works, as bronze doors, was cast. In a group (fig. 79), there is first the smelting of the metal in a fire urged by two double bellows; men are shown standing on inflated skins (kept tight by rope binding), and they lift first one foot and string, and then the other, while reed pipes with clay nozzles take the air to the fire. Thus there were 4 or 6 bellows making continuous blast. A heap of charcoal is by the fire. The metal having been melted, the crucible is removed with a pair of rods to grip it, a very risky and unsatisfactory arrangement, owing to the weakness of the crucible not allowing of any handle, and the lack of any tongs. The earliest tongs are Phoenician, see coins of Malaga. The metal was then tilted into one of eighteen funnels leading into a mould for a great door. How any sound casting could be formed from so many separate melts is incredible. One suspects that the artist never saw the real process. The pair of cast doors, with pointed peg below and cylindrical above, is depicted over the scene (M.A.F. V, 569, ii).

120. Cire-perdue *casting*. The only alternative was *cire-perdue* casting, by modelling in wax (either solid or over an ash core), applying a clay coating, then melting out the wax and running in the metal. This method was used as early as the iind dynasty, when double spouts were cast, for attachment to beaten copper vases. Great skill is shown in later work of this kind. The overcoming of the difficulty of thin casting, only 1/50 in. over an ash core, is explained by the modern African method. The wax model, coated with clay, has a lump of cold copper laid over the filling hole. All of this is boxed in an outer clay covering, and put in a furnace

kept at melting heat for two days. This gives time for the metal to trickle gradually into the mould, and there it equalises its thickness by surface tension, so that no stays are needed between the core and the mould. After two days the lump is left to cool slowly, which relieves strains, before opening it. This is a total contrast to the *cinquecento* method of the hasty pouring of melted metal into a cold mould, which left such pangs of anxiety in Cellini as to whether the metal reached the extremities. In the reign of Kho-sekhemui, iind dynasty, there is recorded the making of a copper statue of the king (Z.A.S. 1917, 50).

The results of casting were astonishingly fine. A core of ash was formed for figures, coated with wax, tooled in detail, and metal run in. No stays can be traced to hold the core in place, yet the metal is only 1/50 in. thick (U.C.); a shift of a hundredth of an inch in the core would have spoiled the cast. An almost equal delicacy of work is seen in the funereal spear-heads of the Bronze Age in Britain. Complex forms were also made in Egypt, such as a hollow ring attached to a flat surface (U.C.), or a ring handle, free in its holders, cast all in one with connecting ducts which could be cut away (U.C.). Bronze was also cast over iron, such as a bronze handle to an iron knife of about 1100 B.C., and bronze covers and junctions to iron railings (U.C.).

121. *Beaten metal*. The beating out of copper into thin vessels required was a skilful matter, which can be seen going on to-day for simpler forms, in the Cairo bazaars. The Egyptian never used a hammer with a handle, to give more velocity to the blow, but did all the work with a slightly convex disc of black quartzose stone (U.C.) held in the palm of the hand. This might be done by one man alone (N.RK. xvii, N.BH. II, xiv) working with one hand (fig. 78), or holding the stone with both hands in an overhead stroke, while a second

man steadies the work (R.C. 63); but usually it was done by four men sitting round, and beating in rotation like a modern group of blacksmiths (L.D. ii, 49).

The detailed forms were beaten out on wooden supports (fig. 78); a plain post in the ground served for working open bowls (L.D. ii, 49). The more difficult forms of vases with necks were supported inside, by a bent branch resting on a support and with the other end sunk in the ground (N.RK. xvii, xviii; M.A.F. V, 569, ii). Even so, it is difficult to see how a long-necked flask was worked, where the body was more than three times the width of the neck (A.E. 1915, 19, U.C.). A series of hook-shaped supports must have been successively introduced, and as these must have been slender to pass the neck, the elasticity would use up the blow. Perhaps a heavy mass at the end of the hook took the blow without trusting to rigidity in the support. As the vase, just quoted, is of bronze and not copper, it must have been the more difficult to work; it averages only 1/50 in. thick (U.C.).

122. *Spun metal*. Another method of work for soft metals was by spinning, as we now do brass for bedstead knobs, and other light goods. A silver bowl of xixth dynasty is evidently spun, the lines showing on the inside (P.A.C. fig. 115, U.C.); there is no sign of how it was attached for working, possibly set on a pitch bed laid below to hold it. The spinning allowed of the turned-in brim being formed readily and exactly; it is so effective that the bowl can be swung about with water in it, without any splashing over.

The polishing and chiselling of designs on metal vases is often represented (N.RK. xviii) on the ancient wall scenes.

123. Goldwork. For goldwork the various stages are shown. Washing the gold in pans is inscribed “You whirl it again,” while a man stands saying, “Give gold,

give it." Next it appears put in a tall furnace to be melted (?) and goes through several processes which are indistinct, until it is weighed and put by in a chest (N.BH. II, iv). The soldering of gold was perfectly done at the beginning of the 1st dynasty (P.R.T. II, 18). The delicacy of the soldering of strips of gold, to form settings for coloured stones, is marvellous in the xiith dynasty jewellery (B.L. I), and the scale was even more minute in the xxvith dynasty revival, as seen in the jewellery of Homza with about 250 inlays in a square inch (C.Mus.). The fastenings of armlets are made with long sliding bars fitting in grooves, without a shake or error of a hundredth of an inch. Gilding was done on a large scale in the xviiith dynasty; the obelisks had gilded caps, and coffins of the richer classes were largely gilt. The gold leaf weighs about one grain to the square inch, or is a 5000th of an inch thick; this would be about a pound of gold to 50 square feet.

The granular work was developed in N. Syria and imported into Palestine and Egypt, in dynasties xii-xvi (P.A.G. IV).

124. *Iron work*. In late times small quantities of iron were smelted, as a crucible full of half-reduced iron and charcoal was found at Memphis. The iron and steel made in Syria before 1300 B.C. never penetrated to Egypt in general. A very flexible steel blade with a bronze handle cast on it, from the Ramesseum (P.T.W. xxix, 246), is perhaps the earliest, and may be paralleled by the steel dagger with a cast bronze handle found in Palestine, of about 1320 B.C. Two or three other iron tools have been found before the Greek settlements; these brought in a common use of iron before 600 B.C., to judge by the iron tools being more usual than the bronze at Defenneh.

Certainly, it is very rare to find any iron dated before the Roman period in an Egyptian site. For iron furnaces and larger tools of xiith cent. B.C., see P.Ger. 14.

CHAPTER XIII

WOODWORK

125. *Training of wood*. Early in the working of wood came the attention to nurseries for the growth of suitable trees. Of the 1st dynasty, there are found wooden stools, cut from a thick stem, with three divergent branches proceeding at equal angles from the seat, to form the legs (U.C.). A form involving so many coincidences is evidently artificial; and it implies training the growth for many years. In the xiith and xviiith dynasties, right-angle pieces for strengthening the joints of furniture were commonly used; these have the grain straight along each side, and sharply turning at the corner (U.C.). No natural growth could be like this, and it was clearly held artificially during growth for several years until stout enough to allow the angle-piece to be cut from it. In later times curved pieces are found which served as loops for attaching hooks, as for a *shaduf* (U.C.). Such artificial growths as these could not be maintained on trees accessible to the public. They must have been devised in a nursery where the management was kept up continuously for a generation or more.

126. *Hewing and sawing*. Trees were cut down with rounded axes (iiird dyn., Hesy; xiith, L.D. ii, 108), which sometimes had a lengthening of the edge downward, fig. 80 (L.D, 126). After lopping off the branches (L.D. ii, 111), the stem was carried by a party of men, slung from a pole on the shoulders; half of them walked before and half after the log (L.D. ii, 108). Logs were sawn with saws of copper, 4 or 5 ft. long.

These saws were stiff blades (fig. 81), not frame-saws such as are now usual in the East. The edge was curved, and they were held in one hand; there is no example of the two-handled saw of Roman usage. The Egyptian never sawed downward, so as to get a firm push against the ground, but fixed his wood upright, and sawed with the blade sloping upward. This was a mere rasping of the wood, by the teeth which sloped equally either way, rather than a real cut of forward-sloping teeth, working with heavy pressure. The sawn surfaces show how tentative and irregular was the cutting, the saw having been tilted about in many directions, so as to cut less thickness at once (P.TR. I, xxiv). The wood, set upright, was supported by a post set in the ground. Sometimes it was made to lean against a post (L.D. ii, 49), or lashed to a post (L.D. ii, 126), or lashed, with a stick to twist the cord tight, and a stone hung on the stick to keep it from untwisting (L.D. ii, 108), or it was anchored from swaying by a rope fore and aft (P.DS. xxi).

127. *Woodworking.* The adze (fig. 82) was the main tool for trimming both wood and stone, as it still is, in Egypt. It was used on large masses of wood (L.D. iii, 26), or in boat building, fig. 83 (L.D. ii, 108), or in fashioning spearshafts held in the hand (same), or smaller objects, as a bolt (L.D. ii, 49) or chair leg (N.RK. xviii). Planing is not found till Greek times, and the plane seems to have been an Italian invention. After cutting long pieces, it was often necessary to straighten, or curve, them by bending the wood, such as strips for a chariot, and poles (R.C. 44, 65). Arrows were tested by sighting. along them to see if they were straight (M.A.F. V, 212). A sort of vice was used for holding a stick to bend it, by lashing a spar on to a stand, and a man throwing his weight on the spar, so as to grip the end of the stick by leverage (P.DS. xxi). Bows were bent by heating the wood over a fire (M.A.F. V, 212).

Chiselling in the prehistoric time was on a delicate scale, rather like graving, with a little bar held in the fingers (P.T.W. xxii, 44-6); this was sometimes sharp at both ends. The heavy, strong, chisel came in with the free supply of copper in the 1st dynasty; it was set in a wooden handle (fig. 84), and struck by a mallet to cut the mortice-holes in beams for boats and housebuilding. For levering out the chips from holes, the chisels were made deep through, even six times the cutting breadth (P.T.W. xxii, 71). At the same time the graving chisel continued in use (fig. 85); set along the side of a handle, as in the hieroglyph *mer* (P.MD. xxiv, 32). The mallet used was at first merely a thick stick (L.D. ii, 49), but by the vith dynasty a wide-head mallet was used, fig. 86 (D.GB. I, xv), and continued till the New Kingdom. Not till Greek times was a separate handle fitted to the head (fig. 87).

A large knife was sometimes used for trimming rods (L.D. ii, 61), but usually knives were only for cutting up food, and especially for slaughtering. The rasp for wood is only known in iron exactly of the modern form, brought in by Assyrians, though small conical rasps of copper foil are of the xviiith dynasty, for food. Polishing or rubbing down of tables and couches was much practised; probably this was done with sandstone or pumice, to smooth the surface in the absence of a plane (L.D. ii, 13, 49).

128. *Joining wood*. The methods of uniting woods, after its preparation, must next be noted. The most simple way was by cutting holes and lashing boards together; when lapped face to face, this was the best joint to make where exposed to sun, rain, and dew, in the timber houses, as the joint would not open (P.TR. I, ix, II, xv). The great funeral chambers of wood for royal burials in the 1st dynasty, framed underground at Abydos, were set up on a platform of beams about 10 ins.

wide and 7 ins. deep. The flooring-planks rested on a ledge of the beam, the upright planks of the sides were stepped on to the beam, as may be seen at the plastered edges. The roofing was of similar beams, covered with boards, matting and sand. The houses for the living were of planks which overlapped along the edges, and so produced the panelled pattern which was copied in brickwork and in stone, and dominated most of the early architecture. The models of these houses, made for coffins (P.TR. I, xxviii), show the doorways and the barred window openings, closed by shutters.

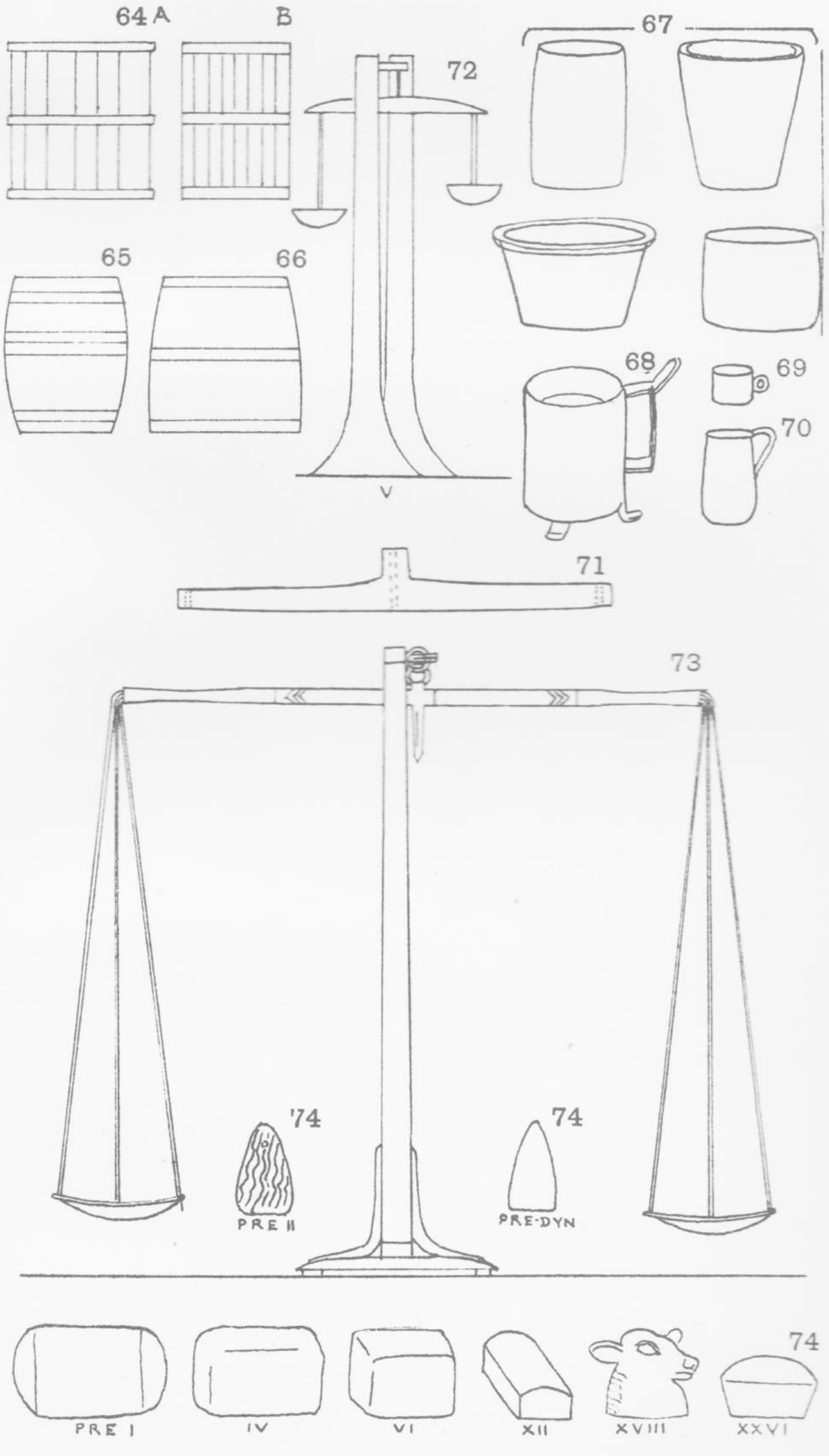
The boxes and coffins from the 1st dynasty onward were mostly united by some form of mitre joint (fig. 88). The simple butting of side to end, or "square end" was seldom used; and letting the side partly in the end, or "halving," was also rare. The simple mitre joint was usual; also we found the mitre partly let in, or "shoulder mitre," or "double shoulder mitre." The mitre was often secured by letting the side sail over the end at top and bottom and pegging through it, or "mitre housing"; further developed by the end projection dovetailing, or "dovetail mitre housing" (P.H.A. xxv). The connecting of boards was by slots and flat tongues, down to the vith dynasty; in the decay of work which followed, the easier method of boring round holes and inserting pegs of wood was adopted. Slots and tongues were again revived, and are found in coffins down to the Greek period. Plywood of even six layers of different kinds of wood is found used for a coffin of the iiird dynasty.

129. *Drilling.* Drilling holes for small pegs, and especially for the threading of seats, was done by a bow-drill (fig. 89), certainly from the vth dynasty onward (S.T1. 133), and probably earlier. In the xviiith dynasty it was not uncommon to work three drills at once with a bow (N.RK. xviii). The drill stocks were round or polygonal, with a round head which worked in a cap

(P.T.W. xiii). The head was sometimes of wood, but more usually it was of hard black quartzose stone, with a highly polished hollow. Such drill caps are common, and were used also for rotating fire-sticks; they seem to be the origin of the hieroglyph *t*. The metal drill was usually detachable from the drill stock; but in Roman times a steel drill is fixed in the stock (P.T.W. li). The drill bow was often wider at one end, to allow of holding it free from the string. From the beginning of the prehistoric civilisation, minute drills had been used for boring beads; these were usually of flint, and worked in the hand (U.C.). The use of emery for polishing beads was so constant that we cannot doubt that fine grass stems, fed with emery powder, would be used for the smaller holes, as is done now in India.

130. *Framing furniture*. Gluing joints and surfaces of wood was practised certainly as early as the xiith dynasty, and is represented in the xviiith, with a glue-pot on a fire, and the glue spread by a brush (N.RK. xvii).

Rigidity of framing was obtained in various ways, figs. 90, 91. Panels of wood, as in the backs of chairs, were the simplest. Wide joints for the back legs of chairs and couches were usual, in the form of the lion's or bull's leg (P.R.T. II, xxxix, 51, 53), which gave a wide breadth of thigh at the top. Angle-pieces of wood; grown into shape, are shown in a shrine (D.GB. I, x), and were generally placed beneath the seats to secure the stiffness of the legs. While the fore-and-aft stiffness was obtained by the lion's leg, the sideways stiffness needed the anglepiece. In tables and stools (fig. 91), direct diagonal bracing was employed. As this could not well be carried down to the ground, a cross bar to take the diagonals was introduced; this carried also upright struts, and became really a braced girder beneath the table top (P.A.C. fig. 130). In the stands made of rush-work, used for light tables, and found bearing offerings in the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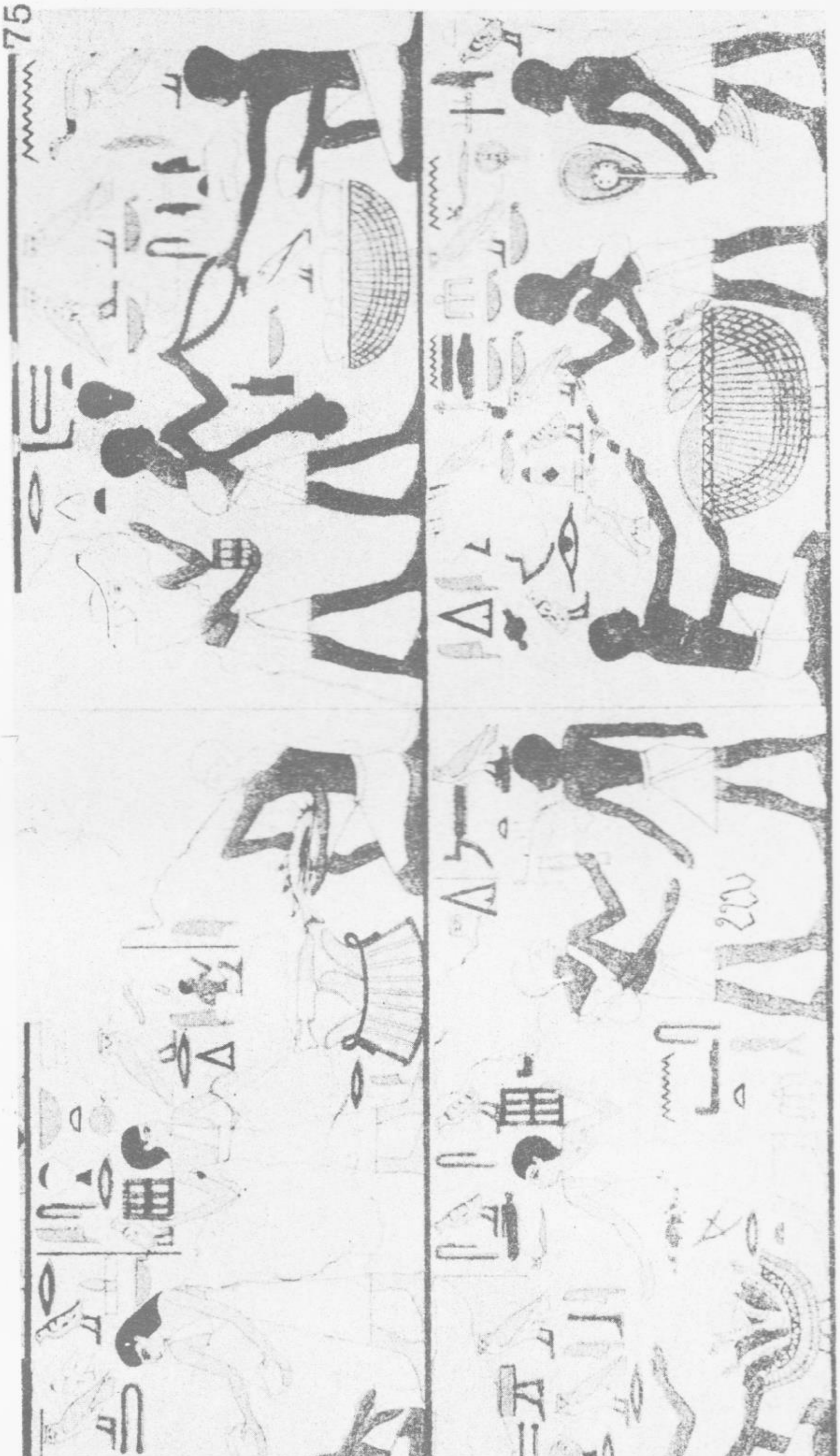

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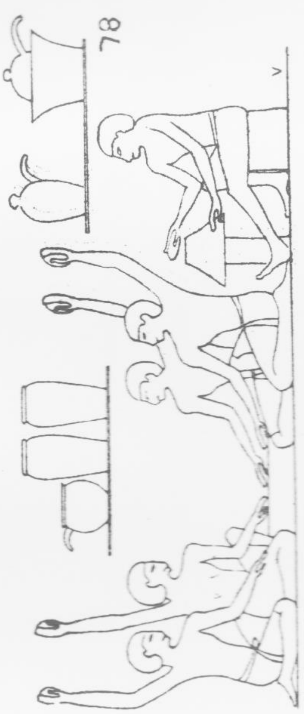

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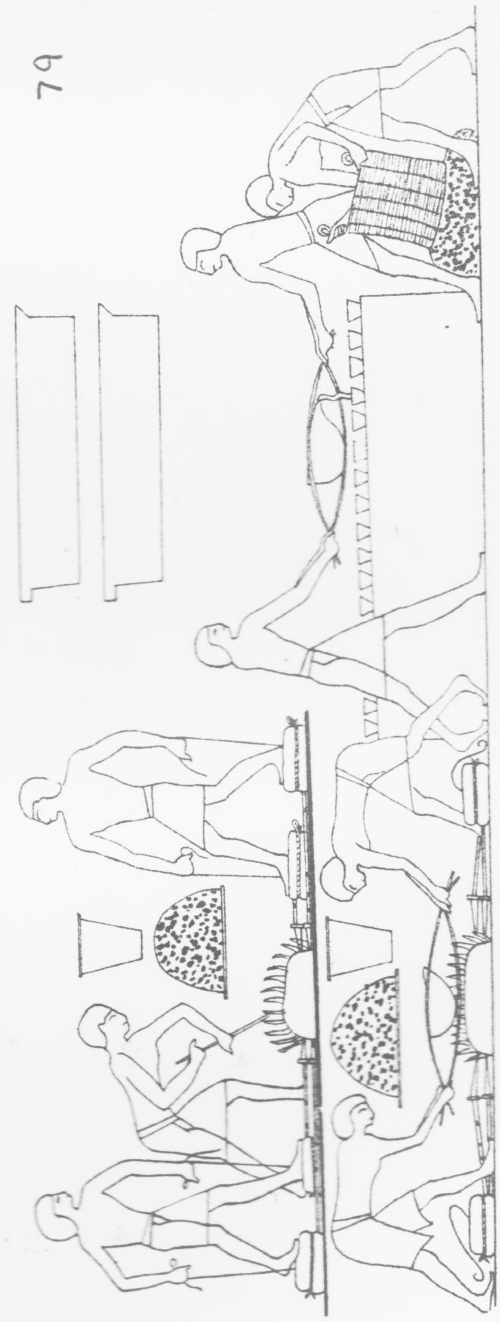

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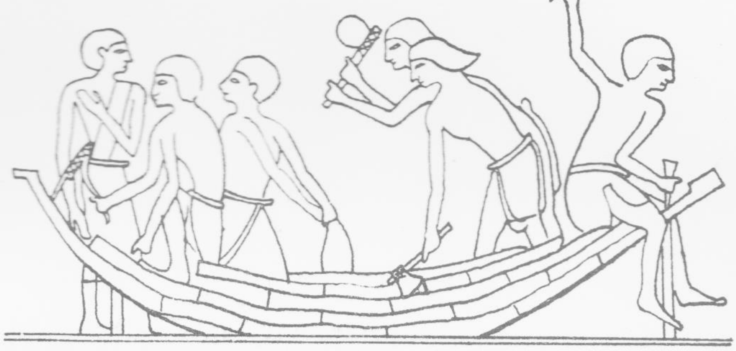

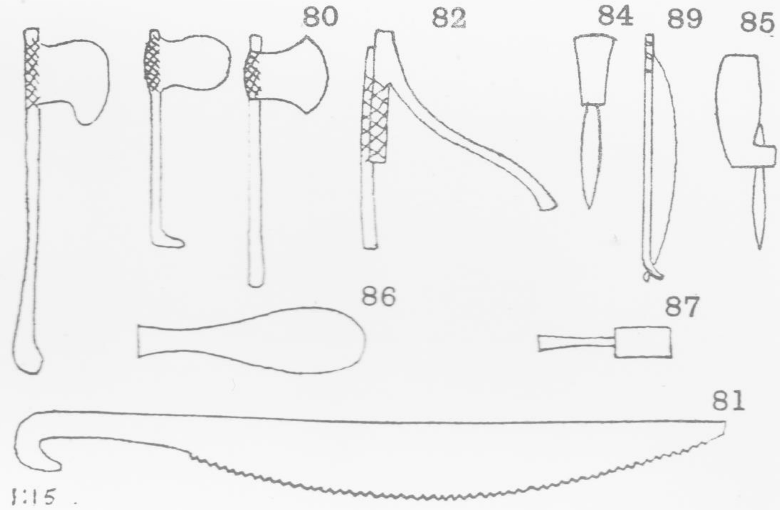

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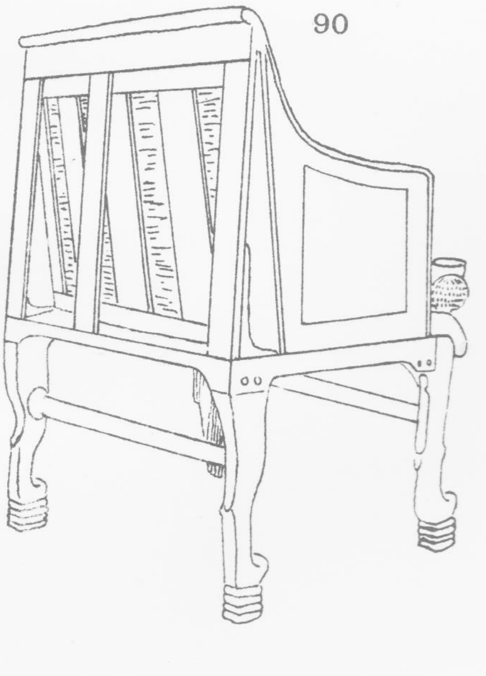

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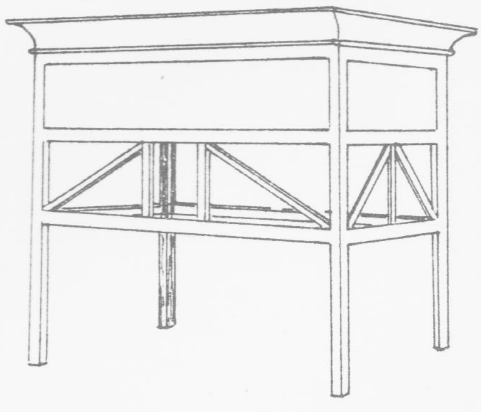

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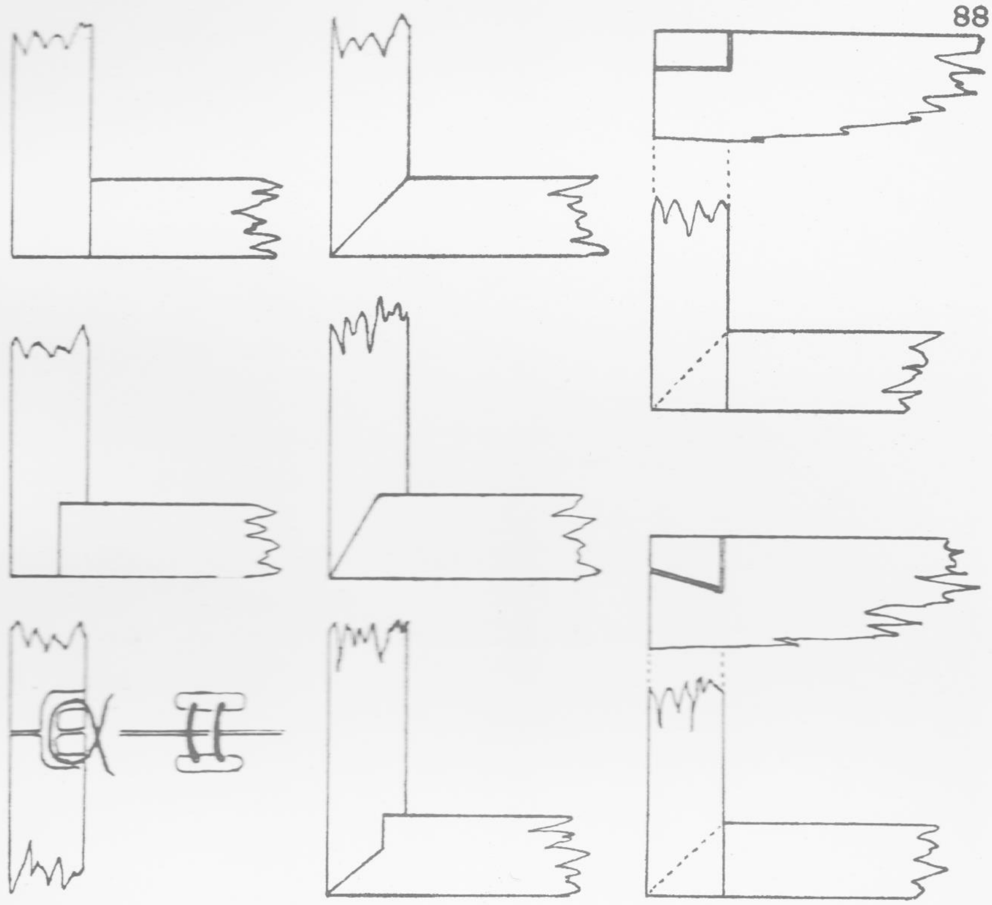

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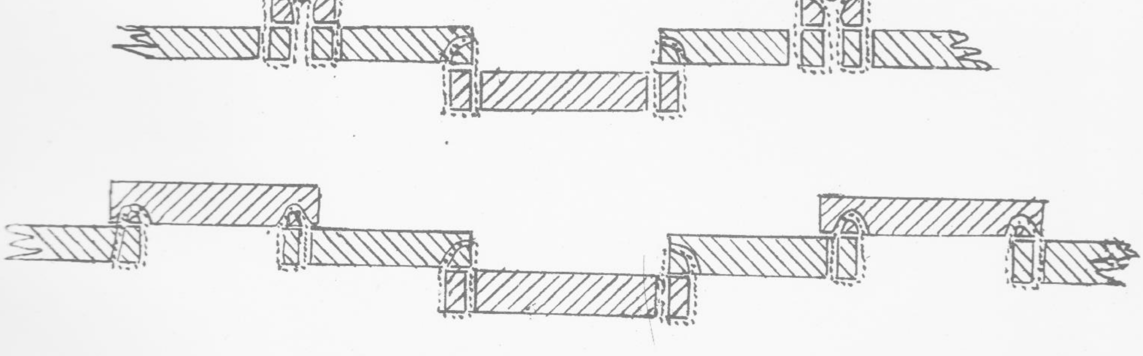


tombs, the bracing was not only on each side, but also diagonally through the stand (Cairo Mus.). An indirect method of bracing was by ornamental connections, as in the Lahun and Dahshur pectorals of goldwork. Thus in the side of a great shrine each piece of openwork ornament when glued into place would stiffen the whole, and the total result would be almost equal to a solid panel (N.RK. xviii; M.A.F. V, 569, ii). A stiffening of the back of a chair was made by sloping the back, running the seat on beneath it, and putting vertical struts from the top of the back to the back continuation of the seat, fig. 90, Yuaa. This gave an angle of about 1 in 5, to brace the back (P.A.C. 127).

131. *Inlaying and painting*. Inlaying was frequent in wooden objects such as caskets, from the 1st dynasty: it was usually done in dark woods such as ebony, and both ivory and green or blue glaze were inserted (P.R.T. II, xxxiv, 94, xxxvii, 42, xl, 40-77, xii, 1-36, etc.). In the xviiith dynasty, ivory inlay was common, and electrum is also found (Bes, Edin. Mus.).

Paintings on wooden boxes and coffins are familiar from the Old Kingdom onward. A board with painting of servants belongs to the vth dynasty (P.DS. xxvii). A painted box of the xiiith dynasty was found at Rifeh (xxiv). A beautiful painted casket with palm and gazelles, of the early xviiith dynasty, is in Turin Museum, and the splendid painted boxes of Tutankhamen show the full development. Painted coffins abound in all periods after the Old Kingdom. Graining of wood was practised in the Old Kingdom (Q.H. viii, x, xiii), and was very common in the xviiith dynasty. Wooden models of vases were also painted to imitate variegated marble and glass (U.C.). Graining, to imitate wood, was painted on stone tombs in the ivth dynasty (L.D. ii, 19-32), showing how fixed was the idea of a wooden house. The planks for a portable wooden house have been found; they had slots through them, for overlap lashing (fig. 92), so that the drought and dew should not open the joints; for details, see *Egyptian Architecture*, figs. 27-32.

132. *Turning, Cooperage.* Turning in wood was very common in Roman times, but it is difficult to trace before then. The lines round legs of stools seem to have been cut by hand, to imitate turning; the clearest instance of turning is on a wooden box from the cemetery of Herakleopolis (U.C.) of the xviiith dynasty, almost exactly like that in W.M.C., fig. 292. The lines around the side stop short before the handles, as in turning, and the whole circles on the lid appear turned. The pattern of arcs is drawn by compasses. The use of compasses for circles seems to have been unknown in Egypt, while it is common in Syria, where this same hexagonal design is often found. This suggests that turning was a Syrian art, which did not penetrate Egypt till late in the history, though stray examples of work were brought in.

Cooperage is rarely found, even in representations. There are pottery models of what seem to be coopered barrels, in the xviiith dynasty. The paintings of cylindrical measures (fig. 64), in the tomb of Hesy, iiird dynasty (Q.H. xiii) clearly show coopering, with vertical staves of wood held together by copper bands around the top, middle and base. What appear to be coopered measures are figured standing on sacks (of grain?) in the ploughing scenes of the xiith dynasty (figs. 65, 66), and used for measuring grain on its way to the granary (N.BH. I, xi, xxix, top, and 3rd row); but it is just possible that these were baskets, as also the corn measures of the vth dynasty (L.D. ii, 103).

133. *Large structures.* The greatest constructions in wood were the immense boats required for the transport of obelisks. As a boat is represented taking two obelisks end to end, it must have been at least 150 ft. long and proportionately wide, 40 or 50 ft. Other large works

were the great doors for pylons. That at Karnak fitted a gateway 24½ ft. wide, with at least 1½ ft. for the hinge beam, making each gate over 13 ft. wide. That this is no exaggeration is seen by the width of the recess, 14 ft. 10 ins. into which each valve swung when opened. The height must have been proportionate, and the weight of such a door seems incredible for swinging, certainly 40 tons at least. Even in small doors we find leather put in the pivot hole, which was doubtless well greased, as that would relieve friction.

CHAPTER XIV

LEATHER WORK

For pls. XX.I-XX.IV, figs. 93-128, see p. 152.

134. *Predynastic.* The use of leather was essential to nomadic people, and is more prominent in the less settled periods of history. The earliest burials of the Amratian age are wrapped or covered with skins. The examples of leather work in prehistoric graves are nearly all of the Amratian, and not beyond S.D. 44 in the Gerzean period. Leather again appears in graves of the invaders of the Pan-grave burials, xiiith-xvith dynasties. In the Gerzean age, linen cloth is very usual, as in the historic times, and leather was almost restricted to sandals.

In the Amratian age, leather was often painted; frequently red, also yellow, black, and blue were used. Painting was in patterns, zigzag, or imitating skins of small animals (P.NQ. lxiv, lxvii). Bags and mats of leather are found, and cord made of strips of leather twisted together. Such cord was used to check the lance thrown in hunting. Leather water-skins must have been usual, as now, among desert dwellers and also for carrying of water in towns. Many tusks are found with a row of small holes round the base, and remains of leather attachment; these were probably used to plug the limbs and other holes of water skins. The tusks are mostly of the Amratian, and do not appear beyond the middle of the Gerzean period. For removing the hide from a carcase, a special knife was used, the earliest of which is of S.D. 49; it was a small, rounded, wide blade, sharp all round, and with a slightly concave face in order to fit the curves of the body; the handle was short and weak, as but little force was required in using it (P.T.W. xxxi,K).

135. *Old Kingdom*, Nubian. Sandals with cross-straps were used as early as S.D. 32, when the only other clothing was a fringe for women (P.M.E. 25). In the vth and xiith dynasties, sandal making is represented in tomb sculptures (P.DS. xiii; N.BH. I, xi; II, iv) but without detail. Of the Hyksos age there is leather work, apparently brought in by Nubians settling in Egypt; this is used for bags of various forms. One is of chequers of red and white leather about an inch square; another had short rows of white shells, blue beads, and fringes, stitched in along the seams. Armlets were made of fine strips of leather plaited together (P.G.R. 20, pl. XF).

136. *XVIIIth dynasty*. The most complete group of leather working is of the xviiith dynasty, found in the tomb of Rekh-ma-ra (Tehutmes III) from which a selection is made in fig. 93. The working of leather rope is shown by a man cutting a skin circularly into a fine strip, two hides so cut being figured above; four of these strips are held together by one man, and twisted by another man, who swings round a stone ball bound with cord, which turns the rope round. He holds it by a swivel attached to a rope passing round the body, so that it is stretched strongly to prevent it doubling up and knotting while it is turned. In the lower line are sandal makers, taking a skin from the jar in which it has been soaked; cutting up the leather on a board, into the soles, two of which are above; stitching it by pulling the thread with the teeth; and piercing the loops on the sides of the sole, for attaching the straps, with the cutters and piercers figured above. A pair of sandals, in side view, complete with the straps, is placed over the scene.

137 *Network*. A special art pf leather work in the xviiith dynasty was the cutting of networks, exactly on

the system of the modern expanded metal lattice stamped from one sheet. The leather was cut with rows of slits, breaking joint one with another, so that it could be stretched out into a net (P.A.C. fig. 140). The cutting was extraordinarily delicate, leaving only threads of about 1/30 in. thick; never could a false cut be remedied, and the whole of a network must be faultless in the cutting. Such nets of a coarser kind were worn over linen waistcloths, to take the wear of sitting (P.A.C. fig. 70); finer ones are in University College, and the finest are those from the tomb of Tehutmes IV (Cairo Mus.).

The water skin served as a hieroglyph, being the determinative of the word *shed*, "to save," which was in earlier times a rolled-up skin, that which was saved at the killing of an animal (P.DS. xix).

138. *Coloured work*. Leather was also ornamented, as in the quivers of Maherpara, in the middle of the xviiith dynasty. These were of pink leather embossed by stamps, and patterns of green leather applied on the pink (Cairo). Stamped leather was also placed on the straps of mummies in the xxist-xxiind dynasties. This decoration by applied leather is as old as the iiird dynasty, when it was imitated in the painting of the headband of Nefert, copied from flowers of red leather stitched down on a white band, and with details in black. The great example of such work is in the catafalque of Queen Isimkheb of the xxist dynasty; it is a cubic tent of red leather panels, with elaborate applied detail in green leather. Six vultures cut in leather are spread over it, with the titles and name of the father of the queen, and the sides have a long inscription, and the name of her son, in whose reign she died.

In Roman times, leather was much used for shoes, both red and white, often gilded with stamped patterns; also for belts and leggings (U.C.). Shoes appear to have been developed from the sandal in the xviiith dynasty (P.K.G. 28).

CHAPTER XV

POTTERY

139 *Beginning*. The earliest pottery known in Egypt was the Neolithic and Tasian, followed by the Badarian which began at a high level, apparently due to a developed civilisation entering into the country. The material was not only clay but ground-up basalt, and was wrought to very thin forms entirely by hand. Some bowls show on the lustrous black surface the traces of a diagonal combing in cross directions, which gives the secret of the smooth regularity of the form. There was also brown pottery well finished, with black tops, from being baked mouth down in the ashes. Smooth light brown bowls and globular jars were also handmade, as well as rough brown bowls, and large conical deep pans for storage (see *Badarian Civilisation*, and *P.M.E.* II, 12).

The later types of the Badarian are of red polished ware, with a sharp ridge between the rounded bases and the conical sides. This form passed on into the next civilisation, Amratian, which had little in common with the Badarian. The prominent character of the Amratian is the white-line patterns upon these bowls, and on the inside of open bowls, imitating basketwork (P.M.E. 22). This elementary idea of a clay-covered basket dish, corning after the skilful comb-faced pottery of basalt clay, marks plainly a fresh, and less advanced, culture which disappears by S.D. 34. The red pottery with black top which was only a lesser class of Badarian, was imitated with more open forms by the Amratian. All of this pottery was baked, as is still done in Nubia, by lighting a fire over it. The parts which are exposed to the air retain the original red face of the haematite polish; but where covered with the ash the haematite is reduced to the black magnetic oxide. Any part that rested on the ground, banked over by ashes, is therefore black. There have been theories of a smoke black, or a painted black, but the conclusive evidence is that pots which have fallen accidentally in the baking are black up the side, proving that the colour is due to deoxidation in the ashes. The black magnetite thus formed is rendered the more brilliant when entirely reduced, as in the inside of large pans (baked mouth down), where carbonyl gas was held in and acted as a solvent of the iron, producing a mirror surface (see *Corpus of Prehistoric Pottery*).

The special characteristic of pottery of the Gerzean age was the painting of patterns in red line. These begin with imitation of marbling of stone vases and of the rush covers for their protection. Then boats were depicted, and large galleys, rowed with ten to forty oars and bearing two cabins and the ensign of their port. Wavy-handled jars came in, the first of a long series, and the black incised ware, probably imported.

140. *Handwork and turn-table.* The shaping of the pottery was done entirely by hand, without even a tum-table; the inside was pressed by a stick or by fingers against the palm of the other hand. To this day, a variety of forms of hand-made pottery are made for household use, though not fired. Rows may be seen standing in sheltered places where the sun bakes them hard.

As late as the vth dynasty, deep pots and cups are represented as being made by hand (L.D. ii, 74). The use of a turn-table was frequent in the early dynasties, and can be traced in the Neolithic period; it was rotated by the right hand, in the earliest examples, while the left hand marked the pottery. The form of the alabaster tables in the iind dynasty is linked with this type of raised turn-table which preceded the potter's wheel. The varieties of form are too vast a subject to enter on here, running to several thousand, but they belong to the artistic rather than the technical abilities. Many in the predynastic are not circular, but oval or square, and there are double vases, and animal figures (see *Prehistoric Egypt*).

141. *Slow wheel.* Of the fully developed manufacture, we see all the stages in a scene at Beni Hasan of the xiith dynasty (fig. 94); two men are “beating” or “kneading” the clay with the feet; the next is “mixing” with enough water for a smooth paste; the clay is given as a tall lump to the potters, who model it on raised turntables. In the lower line, a man is smoothing off the pots, with a wet finger; another is polishing or burnishing the dishes; next is the furnace, with the man shading his face with his hand; after this is the “opening of the glare” of the furnace, and taking the pots out; lastly a man is “going to remove” the cups in his slung pans. All of this work was with the slow wheel; but the quick wheel that turned with a good impetus was certainly reached in Roman pottery, as seen by the close lines made by a rapid vibration of an edge against a dish or pot.

Another stage leading to the use of the wheel was making rough pots bedded in a hole in the ground, where they could be turned round. The burnishing of pottery up and down continued till long after it was wheel-made, and this disguises the formation. The wheel was certainly used at the beginning of the lst dynasty, for the great jars of the royal manufacture.

Larger pots were made with a fiat bottom which was sliced off the wheel, and with thumb and finger pits at the bottom to handle the pot. Great jars were made in two parts, and joined together afterwards; or made mouth down, drawn in so long as a hand could work inside, and then closed by a lump of clay at the bottom, which was smoothed over outside, but left rough inside. The next stage shown is the drying field, with rows of pots and basins, and the word “turning” indicates the ground where they were turned over and over to dry. For large vessels, and particularly basins, a rough thin cord of palm fibre was passed round them two or three turns, to prevent the clay from falling apart, just as may be seen at any Egyptian pottery now.

The modern kiln in Egypt has a perforated floor halfway up, on which the pots are stacked; the fire is below this, and the baking is done entirely by hot gases. This form is found before the xiith dynasty in Palestine.

142. *Coloured and glazed pottery.* In the xviiith dynasty, the blue painted pottery must have been baked clear of the gases, as they would discolour it. Somewhat the same arrangement as was used for glazed ware must have been adopted for coloured ware. What this was we know from the kilns of early Roman age at Memphis, the only ones that have been fully examined (*Memphis* I, xlix, 1).

The system for firing glazed ware was to build a kiln, square with vertical sides, half underground, with a draught hole at the ground level, facing west or north to catch the main winds. The kiln was 3½ to 7 ft. square inside, and 10 to 15 ft. high, the sides 3 ft. thick. In this were placed piles of saggars, rough cylindrical pans to contain the glazed ware, and protect it from the fuel. Straw was thrown in between the piles of saggars, to burn; no trace of wood charcoal was found. The saggar pots were from 8 to 30 ins. diameter, and 6 to 8 ins. high.

At the bottom of each saggar was laid a ring of pottery, with three points standing up. On this was placed a dish to be glazed, upside down. On the base of it were placed three little cones of pottery, stuck firm by a dab of clay. On these was another inverted dish. Thus dishes were piled in, till the saggar was full. The joints of the saggars, piled one on the other, were closed by a strip of luting clay, smoothly pressed in. When all the piles were thus built up, the firing was done; if it failed, it left a fine series of wasters, which tell the various stages (P.H.S. 34, xviii, xix).

The greatest example of glazing known to us is the votive *uas* sceptre of Amenhetep II (S.K.Museum. P.NQ. lxxviii). The stem of this is 5 ins. diameter and 5 ft. high, covered with a single coat of brilliant blue glaze from top to bottom. The skill required to regulate the temperature for complete fluxing, without softening the basis, proves long practice and ability. The history of glazing and colour making belongs to the Catalogue volume of *Glass and Glazes*, which was stored with other MS. Catalogues in the Collections at University College, and they have now disappeared.

143. *Stone vases.* Stone vases were always made by grinding, never by a circular motion of the vase. The outside is crossed diagonally by the grinder, usually a block of emery; the inside was cut out by a tube drill as wide as the neck, and then widened by putting in grinding blocks of sandstone or emery which were slowly turned by hand under pressure (fig. 95). The test for the age of a stone vase is to spin it round between the fingers; if there is no irregularity it is a modern turned work. The method of grinding by diagonal crossing dates from the earliest Badarian pottery, which was combed over diagonally in alternate directions. For details of stone vases, see *Stone and Metal Vases*, issued in the Catalogue volume of *Funeral Furniture*.

CHAPTER XVI

AGRICULTURE

144. *Origin of the plough.* The one staple crop of Egypt was corn, and no other is generally represented; the beans were only a garden vegetable, and not grown in great crops, as now, for exportation; the cotton was unknown.

The earliest form of hoe was the forked branch (fig. 96), as used in Central Africa still. It continued till the xiith dynasty (P.I.K. vii, 28; P.T.W. lxviii, 57), and appears as a hieroglyph in the iiird (P.MD. xxi, 1st col.). It was made later in two parts, jointed, fig. 97. The next stage was to tie the handle to an animal and guide the point to make a furrow, thus evolving the plough (98, 99). Two handles were soon added, and in the earliest hieroglyph a low, almost horizontal form appears (fig. 100). This low form occasionally survived to the vith dynasty (L.D. ii, 106-7), and it was still rather low in the xiith (N.BH. II, 17). Higher handles were made as early as the iiird dynasty (P.MD. xviii) and, with a turn horizontal for the hand in the vth dynasty (fig. 101), continued in the xiith (L.D. ii, 56, 127), sometimes rising enough for the ploughman to stand as at present (N.BH. I, 11). In the xviiith dynasty, the handles were tall and upright, joined by cross-bars, fig. 102, and ending in loops on the top (P.A. 18; D.NK. xxi). The plough with a single upright post, as in Italy (P.T.W. lxvii, 32, 33) is shown at El Kab in the xiiith dynasty, fig. 103 (T.T.S.x), but it did not continue in use. The share or foot was of wood, down to the xiith dynasty, copied from the blade of a hoe (P. T. W. lxviii, 63); a sock of bronze is of later date (P.T.W. lxxi, G), and one of iron is of the xxvith dynasty (P.T.W. lxvii, 37). In Roman times, a form appeared with two handles converging on the sock (fig. 104), which was of iron sheathing (P.T.W. lxvii, 40). The plough was drawn usually by oxen, but occasionally bulls or cows were used in the vith dynasty (L.D. ii, 106-7; D.S.S. xvi; P.M.E. xliii), and men in the xviiith (L.D. iii, 10); horses appear in the xviiith dynasty. Oxen were yoked by a bar on the horns in the xviiith dynasty (L.D. iii, 10).

An invention of the later Egyptians has been completely lost. In the construction of a pair of steel shears, they had one leg made with hooks and slots to attach it to the spring, so that when the blades were reversed in order, one blade could instantly be detached to allow of grinding or sharpening. This was a valuable invention which never took root in Europe, where the shears had originated (P.T.W. lix, 13, 14).

145. *The hoe and mallet.* The clods were broken up by men with hoes, sometimes double-pointed (L.D. ii, 51,56). The usual hoe was made in two pieces, bound with a tie (P.T.W. lxviii, 59, 62). Mallets were also used in the xviiith dynasty for the tough hard lumps of Nile mud (P.A.18; M.A.F. V, 476, 477).

146. *Sowing and reaping.* Sowing was always broadcast, as at present in Egypt. The sack of grain, with the corn measure upon it, stood in the field (N.BH. I, xi); in the iiird dynasty the sower had a bag slung round his neck, and scattered the seed with his right hand, while he drove before him the sheep to tread it in (P.MD. xxviii); afterward the sowing was separate from the driving, and the seed bag carried in the left hand (W.M.C. 469).

The grain was trodden in by driving flocks of long-horned sheep over the ground (L.D. ii, 51, 106), and pigs were used similarly in the xviiith dynasty (Thebes; N.T.N. xiii), as later described by Aelian. Rakes cut out of wood, with triangular teeth, and fitted to a long handle (fig. 105), were used in the xiith dynasty (P.T.W. lxxix, 74-5).

For driving off bird from the crops, boys were employed with slings, in the xviiith dynasty and onwards (W.M.C. 156).

Reaping was done with the sickle, which appears in the hieroglyphs of the 1st dynasty (P.TR. I, xxxi, 18), and in scenes of the vth (fig. 166) and vith dynasties (fig. 107). The actual sickle found in the xiith dynasty (P.K.G. ix, 22; P.T.W. lv, 7) was carved in wood (fig. 108), with a groove in which flint saws were inserted with glue and mud setting. The form is for a sawing cut swung around the wrist; it is so nearly the form of an ox jaw that it seems to be derived from that. A more complex handle (N.BH. xxv), for direct sawing motion, also belongs to the xiith dynasty (fig. 109). The same composite idea was kept up to Roman times, when an iron sickle had a groove in which a strip of steel with saw teeth was inserted (P.T.W. lv, 27, 28). The curve of the sickle varies in the figures; sometimes it has but one bend, with the handle square with the blade (L.D. ii, 47, 80); others have the handle almost in line with the blade (ii, 106-7); more completely there is a double bend, so as to bring the hand near the centre of curvature (P.DS. xxiii: N.BH. IV, xxv). An approach to a scythe, worked by both hands, with a blade at right angles, was used for flax, as well as the usual sickle (R.C. 36). When ears were cut close they were placed in a linen bag on the hips (P.MD. xxviii, 6), or in a bag slung by a band passing round the head.

The straw was usually cut about half-way up, or higher, leaving enough straw to grasp the ears by. There was no attempt to keep the straws whole and long, as they were not required for thatching. All the straw was chopped up to serve for cattle food during the inundation, there not being any grass or hay in the land. In the xviiith dynasty, the ears were sometimes cut off close (W.M.C. 471), perhaps when the straw was wanted for plaiting.

147 *Storage.* The ears with half the straw were done up in bundles, with ears at both ends (L.D. ii, 106-7); and these were stacked together into a tall pile (L.D. ii, 47; W.M.C. 476), which was put on an ass, and secured from tipping to and fro by cords passing round the ass's neck and crupper (D.P.A. II, vii). Otherwise the ears were done up in large bundles, apparently in a sheet, and lashed on to an ass by two bands, one round the neck, the other under the belly (L.D. ii, 43). More usually they were put into baskets or bags upon asses (L.D. ii, 80, 106). Wide panniers were also in use, made in pairs, joined (L.D. ii, 127; N.BH. I, 11). In the xviiith dynasty, crates were used, carried slung from a pole between two men (W.M.C. 471; T.T.P. iii; P.A. 18).

Gleaning was done by children, usually (P.A. 18; P.A.C. 69); also by men with two scrapers (W.M.C. 471), and by girls with a bag (474; P.M.E. lxxviii, 2). The threshing floor was trampled by oxen (L.D. ii, 106, 127) or by asses (L.D. ii, 43, 106; P.DS. xxiii). It was doubtless a smooth beaten surface of hard mud, as in Egypt now; in Palestine the floor is usually of rock.

Winnowing was done by sifting in wide sieves, usually by women (L.D. ii, 9, 47, 71) who sometimes wear a waistcloth, as a long skirt was awkward (71, 80). It was also done by men or women who scraped up the corn and chaff with two pieces of stick (L.D. ii, 47, 71), or by means of broad boards with curved backs (W.M.C. 475; T.T.P. iii). Such winnowing boards (fig. 110) were made in pairs with a rounded back edge to hold (P.T.W. lxviii, 65-6), and sometimes with the round equally on both sides, so as to be held in either hand (67). The corn was put into baskets or bags (W.M.C. 142, 474 left), and carried off to the granary. The chaff was scraped up and turned with long forked sticks, at first carved as a hand at the end (L.D. ii, 47), or with naturally branching twigs (71); or made as a regular trident (80, 127), which form continued to the xviiith dynasty (W.M.C. 475).

148. *Granaries.* The granaries were of two kinds: (l) Conical holders (fig. 111), open at the top, into which whole sheaves were thrown until the threshing; such are usually represented (L.D. ii, 9, 51, 56, 80, 127), and are found in towns of the xiith and xviiith dynasties (P.K.G. xv; P.NQ. lxxxv). In order to prevent burrowing by rats, a bed of limestone chips was laid down beneath the granary (Kahun). (2) Upright holders for grain were built in rows with arched tops (L.D. ii, 103; P.DS. xxiii: N.BH. II, xvii). The earlier form (fig. 112) was a plain cylinder with top contracted but yet open, and a little door at the side which is seen in all these granaries for withdrawing the grain (see models P.R.T. I, xliii, 117-8; Q.K. vi, 2); the cylinders were either domed, or arched butting one on the other. Tall cylinders had a ladder up the side for the ascent of the man carrying the grain (M.A.F. V, 293). The large groups of granaries (fig. 113), built together, had steps leading up to a platform on the top (W.M.C. 141), or else ladders up the side (142). The base of two great granaries with long stairway to the top, 26 and 29 ft. diameter, was found at Tell el Amarna (P.T.A. xli). The great Indian granary at Bankipur is about 90 ft. diameter and 70 ft. high, with a spiral stairway around the outside, but it has never been used (A.H.L. Fraser, *Among Indian Rajahs and Ryots*). The corn measures are noticed under *Woodwork.*

149. *Parching corn*. Corn was parched in deep conical

pottery pans as kilns, sunk in the ground in rows, round which a slow fire was placed; this system has only been found at the beginning of the dynasties (P.C.A. III, 4). It is well known that when moisture is dried out of grain it is not liable to attack by weevil, and the preservation of it was probably the reason for drying it, without necessarily browning it to prepare it for food. It was usual for storage in Palestine, see Ruth ii. 14; 1 Sam. xvii. 17; xxv. 18.

150. *Flax.* Flax was an important crop, as being the principal material for clothing. The pulling of it is often represented (L.D. ii, 107; W.M.C. 478-9 misnamed), and the stripping of the seed, by means of a fork held down by the foot (L.D. iii, 10, best; P.M.E. lxxviii). A fork of this kind, and a tray to catch the seed, were found at Lahun (P.L. II).

151. *Grapes and wine*. Grapes were the most important fruit, and were cultivated from prehistoric times. An offering chamber of the 1st dynasty had a layer of small dried grapes, 10 ins. deep (P.R.T. I, 15). In the iiird dynasty, trellis-vines are figured as the hieroglyph of a vineyard (P.M.E. li, 3). In the ivth-vith dynasties, a regular scene in the tombs is the great trellis of vines, with men gathering grapes (L.D. ii, 53, 111), continued in the xiith dynasty (127), and the xviiith (L.D. iii, 11; M.A.F. V, 332, 480, 579 iv).

Bunches of grapes are often figured in piles of offerings, but the main use of them was for wine. They were carried in baskets to the wine press, a shallow tank, with a spout for the juice to flow out. Over it was a horizontal pole (fig. 114), supported on a frame (L.D. ii, 96), or columns (111), or palm trees (C. 35); the men who trampled the grapes in the tank held on to the pole, or to cords hanging from it (M.A.F. V, 332, 480). After the finest juice had thus flowed freely, the skins were collected and placed in a cloth, which was then twisted together and violently strained (fig. 115). The cloth was passed at the ends round two poles, and a pair of men at each pole twisted them in opposite ways. As the poles tended to draw together, a man got between them to force them apart, and thus stretch the cloth tighter. This scene is very usual (L.D. ii, 53, 96), but how it was actually worked is not clear; the poles appear upright and the cloth stretched in air between them, yet a man could scarcely be supported by thrusting between the poles. It would seem that the scene is a diagram, in which, for clearness, space is left between the cloth and the vessel below, which caught the juice; if the twist of cloth rested on the vessel and the man lay over it, the action would be possible. This awkward method was superseded by a vertical frame, the cloth being secured to a swivel passing through the uprights; this appears (figs. 116-117) in the xiith dynasty (N.BH. II, vi; C.5A) and the xixth (C.T.K. xx). A hieroglyph (fig. 118) in the 1st dynasty seems to show that the invention is as early as that (P.R.T. I, xxiii, 37); if this be so, the figures of men in the later scene (115) may have been only a picturesque artistic survival.

In rare cases, some of the must was boiled, as in the Greek manner (R.C. 38), probably to ensure its keeping well. Usually the juice was stored in large wine jars (L.D. ii, 13, 49, 53, 96, 111) which were inscribed with the year. These jar inscriptions are a valuable aid to chronology; one of Amenhetep II guarantees his reign of 26 years, though only 5 years are otherwise dated; those of Akhenaten give every year from his 4th to 17th; those at the Ramesseum indicate that Sety I began that building for his own temple, and was ousted by his successor. The other principal fruits were figs of the sycamore tree, which grows wild; they are found dried and strung together in the 1st dynasty (L.D. ii, 106-7, 127). See also dates (L.D. ii, 126), and pomegranates (L.D. ii, 53, 61, 103).

152. *Papyrus*. An important harvest was that of the papyrus plant used for boat building, matting, boxes, and writing material. The gathering, bundling and transport are shown in the vth dynasty (Q.R.P. xxxiii). For splitting the concentric layers of the papyrus apart, to produce thin sheets, a very long narrow knife was needed, described as a “needle” by Pliny; such knives are found, up to 10 ins. long and a fifth of an inch wide, with a sharp cutter at the butt to sever hard fibres (P.T.W. lxv, 58-9). Two layers were placed together with the fibres crossing, moistened with gum water, pressed, dried, and burnished, to make the large smooth sheets used for writing. Such material, no thicker than our writing paper, has survived for 5,000 years, and is still smooth and pliable.

153. *Watering*. The watering of crops was done on a large scale by the *shaduf*, as in present times. In the xviiith dynasty, it is shown with the swinging lever hung by a rope from a beam overhead; and the long vertical rod attached by another rope to the lever, and with a hook at the lower end to carry a skin bucket. The bucket ends in a point, so as to catch it and tip it up to empty the water (M.A.F. V, 612, i). Otherwise the lever was swung on two pillars (figs. 119, 120), which is the usual support in the modern form (W.M.C. 93, 94). The *saqieh*, or wheel with band of buckets, was used in Roman times, as proved by the *qadūs* pots found in that period, but not before. Another form of water-raiser was the wheel with buckets on the edge, worked by a man treading on steps upon it, like a treadmill. This is known by a pottery model (Brit. Mus.) in which the man (misnamed gardener) holds on by a vine trellis as he walks up the wheel (Vit. x, 9). The great undershot wheels for raising water by means of a running stream, are used

in the Fayum now, and may well have been known there in Roman times, as they are described by Vitruvius (Vit. x, 10). The Archimedean screw for raising water was also used in Roman times in Egypt (Str. xvii, 30), and is common now in the Delta. Athenaeus knew it (v, 43), and Vitruvius describes the details of construction (x, 11). All of these rotary machines seem to be western inventions, brought into Egypt in the Greek period.

For detailed watering, the Egyptian used globular pots, slung from the ends of a yoke (L.D. ii, 127; W.M.C. 95, 144). One of these yokes with straps is preserved in the British Museum (W.M.C. 145).

For a list of 150 plants grown by the Egyptians, see Petrie, *Descriptive Sociology*, 145-6.

CHAPTER XVII

TRANSPORT

For the development and forms of Egyptian shipping, see *Anc. Eg.* 1933, 1, 65.

154. *Floats*. The earliest conveyance was that by reed floats on the Nile, named in the pyramid texts of Unas and Pepy, evidently belonging to an age before boats were known. The craft formed of two bundles of reeds, lashed together, is in use in Nubia to this day (B.D.R. 108), and the four sons of Horus were said to “bind together the two floats for this king Pepy,” and “two floats of the sky are placed for Ra that he may ferry over with them to the horizon.” Neither Ra, the sun god, nor man had anything better than reed floats before the early prehistoric civilisation.

155. *Ships*. In the early Amratian class of prehistoric pottery-the white line patterns-the representation of the ship comes in (P.P.E. xxiii; P.M.E. xxxvi), and it was developed into a sea-going galley in the Gerzean prehistoric age. The sizes of these vessels may be seen by the cabins upon them in the drawings (P.P.E. xix-xxii); these are not likely to have been less than eight ft. long probably more-and the vessel would therefore be over a hundred ft. in length; as it has even as many as sixty oars, at least this size would be implied. For ship-building, see under *Woodwork*. The prehistoric trade in gold, emery, and obsidian from the Aegean accords with this growth of shipping. The two cabins shown on the earliest ship, S.D. 33 (fig. 121) were continued on the ship shown usually on vases (fig. 122) about S.D. 50. Later,

on the tomb painting (S.D. 63) an upper shelter appears on the aft cabin (fig. 123). This is the main feature on the summary rendering of the ship on the ivory knife handle (fig. 124). The high-prow ship is painted black in the tomb painting (fig. 125), and is evidently similar to the second type of ship on the knife handle (fig. 126). These belonged to the race, probably the dynastic people, who were attacking Egypt in the late prehistoric age (for detail, see *A.E.* 1917, 35; *P.M.E.* 71, 72).

Coming down to historic times, the small fragment of the Annals that remains to us, states how Sneferu, at the close of the iiird dynasty, in one year made a ship 170 ft. long, and 60 ships of 100 ft. long, and in the next year three more ships of 170 ft. Throughout the pyramid age every noble seems to have had his ships on the Nile, some with as many as 23 oars on a side and five steering paddles (L.D. ii, 45). The next great vessels recorded are those for transporting the obelisks in the xviiith dynasty. The figures of these are much shortened up (N.D.B. civ), but the two obelisks were each about 70 or 80 ft. long, and even longer, so the ships must have exceeded l50 ft. As the section of the largest obelisk averages 50 square ft., it would not need more than 180 square ft. section of clear space to float the obelisk, probably by two vessels lashed side by side.

The ships of the Ptolemies are described as being of thirty banks of oars; and the greatest, of Philopator, was of forty banks of oars, 420 ft. long, 57 ft. beam, 72 ft. high, with four rudders; it held 4,000 rowers (or fifty a side), and 2,850 marines, besides many sailors. He also built a State barge on the Nile 300 ft. long and 45 beam, 60 ft. high, gorgeously decorated (P. Ath. v, 37-39). The later removal of obelisks to Rome was by Egyptian vessels which “excited the greatest admiration… …Augustus consecrated the one which brought over the first obelisk, as a lasting memorial of this marvellous undertaking"; the vessel used by Caligula was "looked on as the most wonderful construction ever beheld upon the seas" (P.N.H. xxxvi, 14). Thus the Egyptian skill in shipping surpassed all that the Romans knew. Under Arab dominion, Egypt in 880 A.D. had 100 ships of war; in 919 there was a fleet of 85 ships; in 975, 600 ships were built, some of 275 ft. long and 110 beam; in 990 another 600 are stated to have been built; in 1080 the fleet numbered 95 vessels.

156. *The ass*. The ass was the usual animal for transport in historic times, but there does not seem to be any trace of it before the dynasties. Asses occur in the earliest spoils taken from the Libyans (C.D.A. fig. 159); they may have first come from Assyria, where they were hunted by the kings, and may still be met with in wild herds (L.N. 49, 324). The earliest remains of the ass in Egypt is of the earlier half of the 1st dynasty, when a great noble had the graves of three asses placed in the court of his great mastaba tomb (P. TR. II, xviii, xix). The ass was greatly used from the pyramid times onward; 760 asses are stated to be the property of a noble, Khafra-onkh. Yet the ass is seldom named among the captured cattle from neighbouring countries, which implies that it did not come from a distance. In the captures by Tehutmes III in Syria, 1470 B.C., the asses-about 200-are only a small fraction of all the cattle taken. In the expeditions of the xiith dynasty in Sinai, 500 asses were employed; most of them probably for bringing food supplies up from the coast, and others for water. Asses are also mentioned for the transport of goods from the Red Sea to Koptos, and for mining at Ataka by Rameses III. The use of asses is continually referred to in the papyri of Roman age, and they have continued to be the principal light transport of Egypt to the present time. The double pannier sacks used on asses are shown on the pylon of the Ramesseum (L.D. iii, 155).

157. *The camel*. The use of the camel is a difficult subject. The entire absence of camels in the sculptures and paintings has led to supposing it unknown to the Egyptians. Yet, at about the 1st dynasty, two heads of camels modelled in pottery were found (P.A. II, x, 224; Q.HP. lxii, misnamed donkey). Of the xixth dynasty is a pottery figure of a camel with large jars (P.G.R. p. 23, xxvii). A glazed figure of a camel from Benha is attributed to the xixth dynasty, and the camel was used in the Delta about 700 B.C. (P.S.H. III, 323). Of the Roman age, pottery figures of camels with jars are sometimes found. It seems, then, that the camel was always on the borders of Egypt, but never settled there till Arab times, when it became the sole carrier of heavy burdens.

158. *The ox*. The ox was not used for draught as much as in the west. Three pairs of oxen are figured drawing a heavy stone upon a sledge, at the beginning of the xviiith dynasty (L.D. iii, 3); oxen were used for military wagons in the xixth (L.D. iii, 155); and they drew the carts of the nomadic Zakary people in the xxth (W.M.C. fig. 80). Ploughing was always done by oxen.

159. *The horse*. The horse is not represented in Egypt before the xviiith dynasty, though it was brought in by the Hyksos (P.A.G. I, viii). It was at first used in chariots, and there is no scene of making a wheel or chariot before the xviiith dynasty. Yet in that dynasty, large numbers of horses were taken as spoil from Syria. Thus the horse was brought into both Egypt and Syria shortly before the xviiith dynasty by the Hyksos migration from Asia. The horse is only figured twice as being ridden; once by a Syrian sideways (L.D. iii, 145), and once probably by a foreigner (R.C. 120); it is shown in Roman times at Esneh and Edfu (W.M.C. fig. 17), and the Syrian goddess Anaitis is figured as riding a horse (L.D. iii, 138; U.C.). Otherwise it is regularly employed

for chariots by the Egyptians, and also by the Hittites and Amorites (L.D. iii, 154-166). All these people harnessed the horse in exactly the same fashion, two abreast with a yoke padded with leather flaps on the base of the neck, and with a broad chest-band or, earlier, two bands, and a loose belly-band; the reins ran through the ends of the yoke, to the bit. The horse is rarely figured early in the xviiith dynasty; a pair of white horses, brought in as tribute from Syria, is depicted in the tomb of Rekh-ma-ra (Tehutmes III); private chariots of Kha-em-hat (Amenhetep III) are drawn by horses; the earliest abundant use of horses is shown in scenes under Akhenaten. Great numbers were used on both sides in the Syrian wars of the xixth dynasty. By the xxiind dynasty, Egypt had become a breeding ground for Syria, the trade being in Solomon's hands; a horse cost 150 shekels, and a chariot 600 (P.I.K. x, 29).

The wheel is not represented as made in the xiith dynasty; but rollers or wheels are shown under a sledge in the xiiith dynasty (T.T.S. ii).

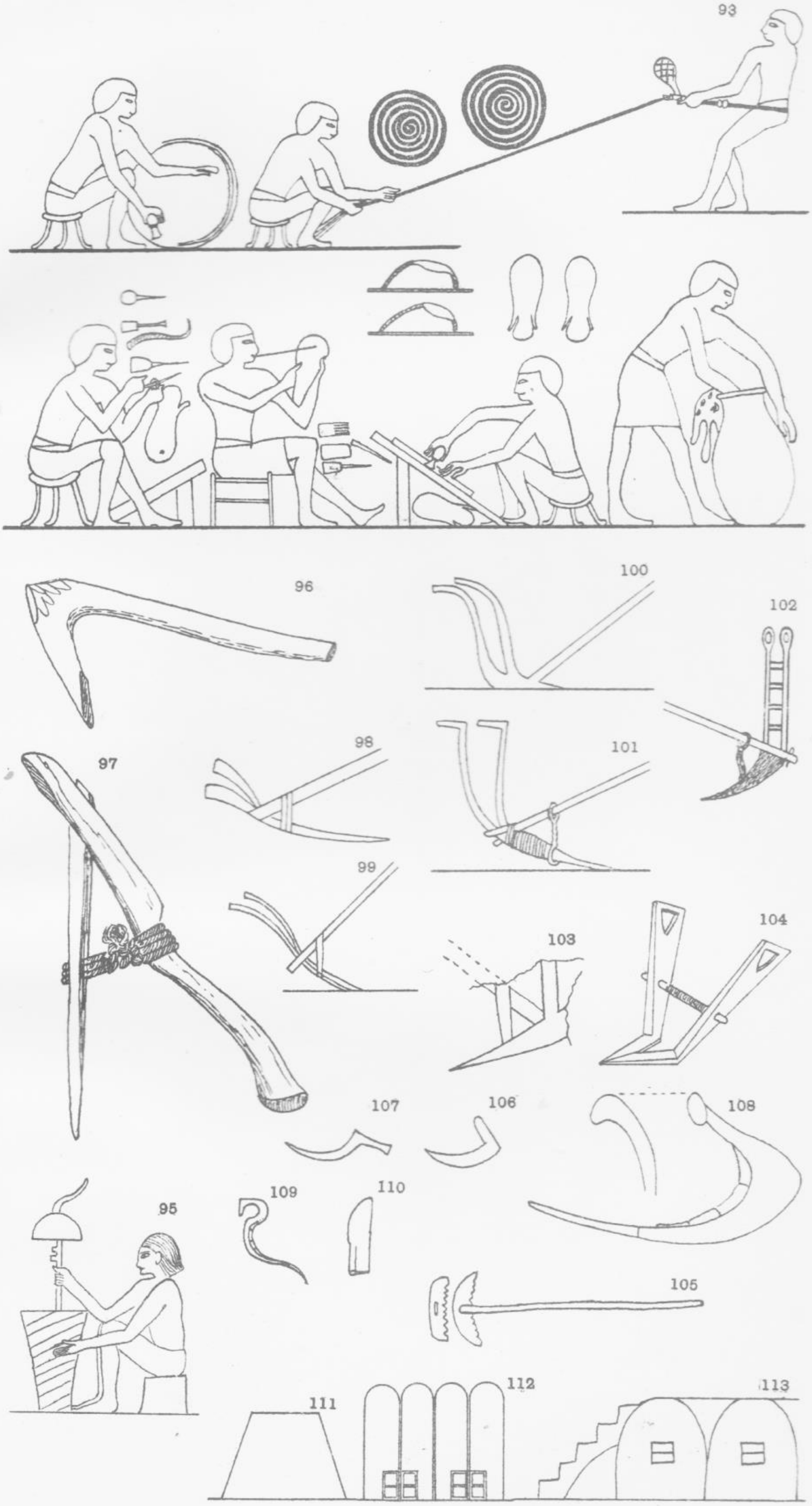
160. *Chariots*. The chariots always had a single pole with two horses, harnessed by a yoke attached to the pole. The body of the chariot was open behind, and low in front and at the sides. A much higher body is seen in the Ethiopian chariot drawn by oxen, of the xviiith dynasty (L.D. iii, 117); this also has a more solid wheel than the Egyptian, with a bronze hub, and bronze jointing at the tyre for the six spokes. The wheel of the Egyptian chariot for war always had six spokes; private chariots might have four or eight spokes (Kha-em-hat, P.A. 18, 19). The chariots remaining to us (Turin, Cairo Mus.) are surprisingly light and springy; it might be thought that they were only funerary copies, but the figures in the sculptures show equal scantiness. The designers trusted rather to yielding to the shocks of driving by elasticity than to rigid framing. The dryness

of Egypt, and of Syria in the campaigning season, favoured this type. by allowing the free use of glued jointing.

161. *Carrying-chair*. An older mode of transport was by a carrying-chair. In the beginning of the 1st dynasty, the royal children are represented seated in low chairs with arched awnings, which were probably carried (Q.H. xxvi, B). In the close of the iiird dynasty, Nefermaat is shown seated on a high chair, carried by poles in the hands of six (or twelve?) men (P.MD. xxi); in the time of Khufu there was the splendid camp furniture of Hetep-hers, with a carrying-chair all of wood heavily plated with gold. In the vth dynasty the nobles were carried, squatting in a chair, which was strapped on the backs of asses (L.D. ii, 43), or borne on the shoulders of six men; or seated in a high chair (fig. 127) on the shoulders of thirteen men (L.D. ii, 50, 78). In the xiith dynasty a light carrying-chair was used, with the man's legs boxed round (fig. 128), borne by four men (L.D. ii, 126; N.BS. I, xiii, xxix). The royal chairs of the xviiith dynasty had a large lion figure at the sides, and the bearing poles were at the seat level, borne by eight men or by ten or twelve men (L.D. iii, 2, 100, 121). Rameses II represents himself in a high throne borne by Horus and Set (scarabs, Brit. Mus., Turin). The papal *sella gestatoria* is the last survival of such transport on high.

In this short review of some of the more important sciences known in Ancient Egypt, we have tried to see life as the Egyptians saw it, piecing similar things together, but taking no interest in their absolute relation. Not looking for any principles in the world, they were content with the appearance of things, and only considered the practical uses of all they saw around them. So far as we can judge, they did not see the need for theories as to what underlay these things.

This limited view has some value to us now, as showing how the majority of races still feel about the problems of living, and ignore higher issues. Such a purely utilitarian view gave no incentive for understanding the causes below the surface. The races successively occupying the Nile valley showed, however, a facility for ingenious adaptations. From a very early period they excelled in the variety of mechanical arts, and attainments, which formed a part of the Wisdom of the Egyptians.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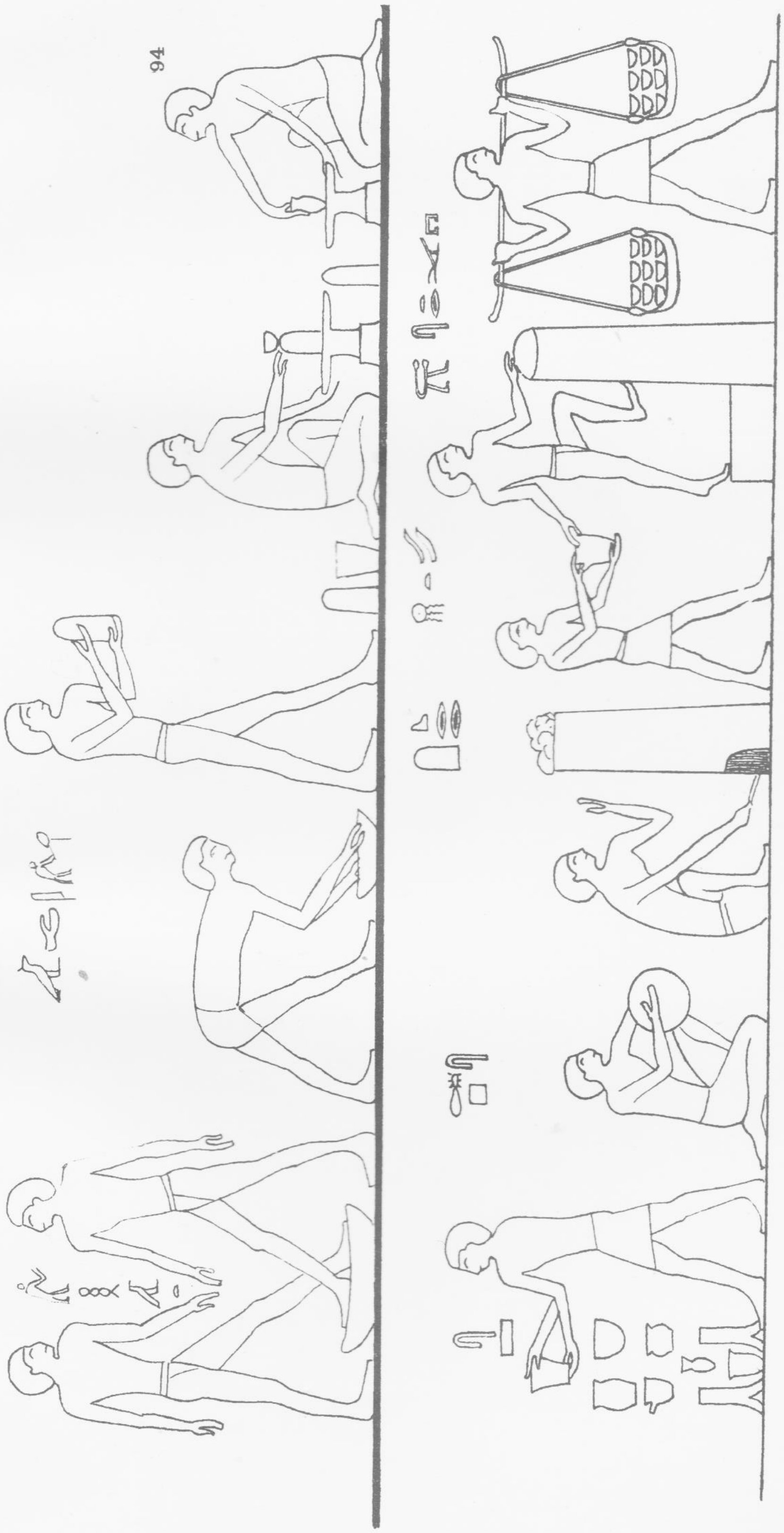
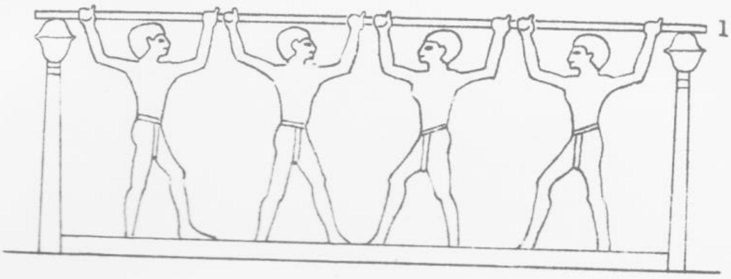
STAGES OF POT MAKING

XXII





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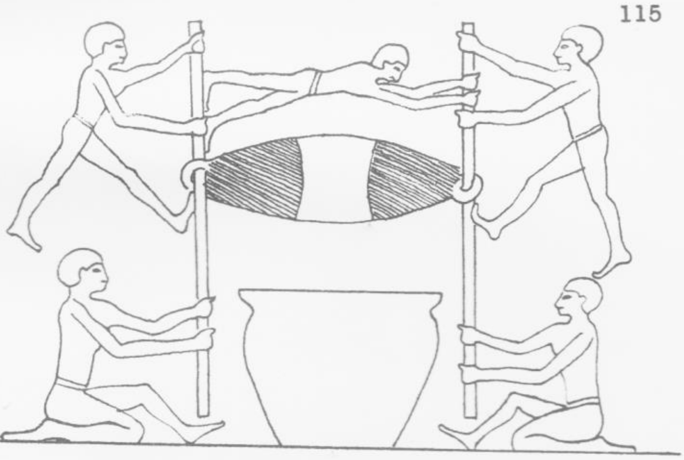

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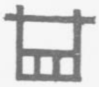
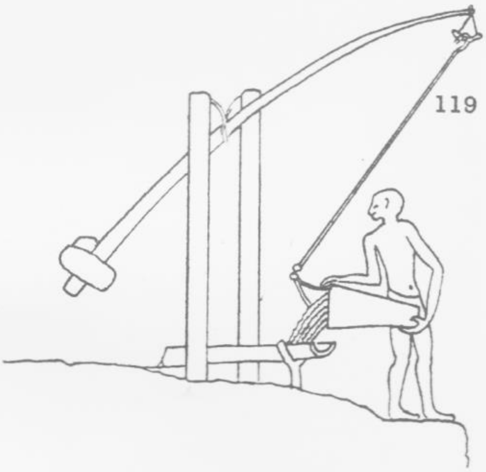
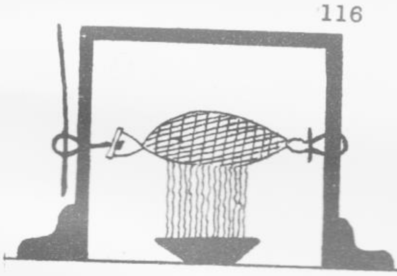


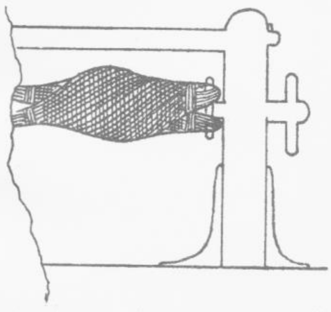
118



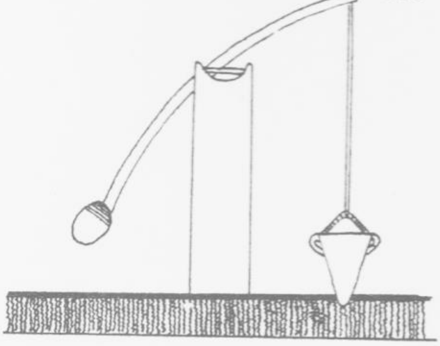
119



116



117

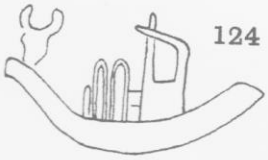


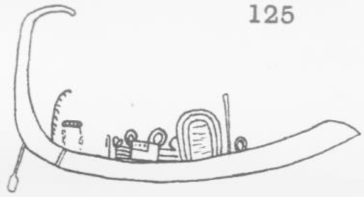
120

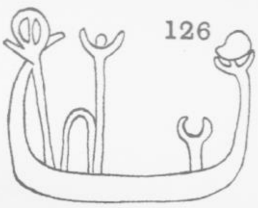
121

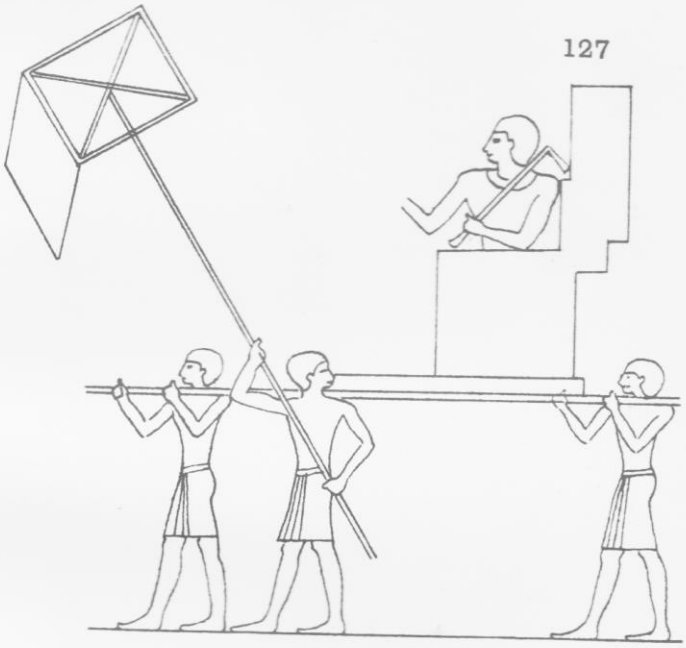

122


123


124


125


126


127


128


BRITISH SCHOOL OF EGYPTIAN ARCHAEOLOGY

THE activities of the School last year were limited to the preparation of the final volume on Gaza and the publication of several smaller works of individual research.

The preliminary arrangements for putting an Expedition in the field were made that year, and again last autumn for the following season, but lack of security in Palestine and the demolition of our camp and, since then, the world menace, have stopped all digging.

Whole-time work remains, in getting forward with publication. We now anticipate the issue of finished volumes on researches at Petra and in Syria. Short writings on the Roman age have also been prepared, and a Corpus of Proto-dynastic Pottery is nearly ready.

The present volume on the Science of the Egyptians is a companion volume to *Egyptian Architecture*, already issued (7s. 6d.), with 155 figures. It will be followed by *Lone Syrian Shore*, with 65 illustrations (10s. 6d.), an account of our two months' caravan tour.

It is earnestly hoped that donors will renew their assistance to the School, as always, in view of the continuance of work which will go forward without diminution, until field work can be resumed in this or an adjacent country.

HILDA PETRIE,
Hon. Assist. Director,
Jerusalem,
Palestine.

Address, for donations:
Miss Bonar, 6 Charlbert St.,
St. John's Wood, London, N.W.8.
Pri 1461 (for duration of war).

INDEX (pp. 155-162).

A

II*

B

F

G

H

I

J

N

O

P

Q

R

S

T

V

W

Y

Z

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