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*Thesis*



# Egyptian Hieroglyphs for Modern Printing Devices

by

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# Egyptian Hieroglyphs for Modern Printing Devices

*An Outline Font of Egyptian Hieroglyphs for PostScript® Printers.*

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1 June 1988

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## Abstract

Students of Egyptian history face economic and technological constraints in the reproduction of hieroglyphs. Ideally, they need a system which provides a collection of professional quality symbols and a means to arrange and integrate them in print. The Apple Macintosh and a laser printer font might offer a reasonable and inexpensive solution. The goal of this project is to develop that font and, in so doing, provide a model for solving similar problems in the reproduction of unusual, non-Latin characters.

## Outline

This paper opens with a discussion and review of the history of hieroglyphs.

Next, the various means of reproducing hieroglyphs are compared.

Third, the project itself is reviewed and discussed. Specifically, early work with the Metafont language and subsequent efforts with PostScript outline fonts are presented.

The paper concludes with an Appendix outlining the methodology in building the font, the programs used, and a user's manual.

## Background

### History

The phrase *hieroglyphs* comes to us from Clement of Alexandria who coined the term (circa 150 AD) in reference to the sacred images carved on temple walls of Egypt. In Greek, *hieros* = sacred and *glupho* = sculptured·[1]

Hieroglyphs are small graphic representations of men, women, gods, animals, plants and other objects. Usually hieroglyphs are arranged in a sentence-like structure--in columns or lines--to record events or to communicate ideas. Hieroglyphs have been found arranged in both vertical columns and horizontal rows and read from either right to left or left to right; right to left is most common, see figure 1. The symbols themselves face in the reading direction; in right to left reading, for example, characters with fronts and backs face right. The arrangement of these symbols in a line or column follows from the Egyptian's strong preference for symmetry and disdain for gaps or spaces.

Hieroglyphs were used in Egypt for three to four thousand years. The earliest inscriptions are dated before 3000 BC, while the most recent hieroglyphic inscriptions can be identified from Philae around 394 AD. Throughout this

[1] Gardiner, *Egyptian Grammar*, p. 9.

period, these symbols underwent changes which can be roughly assigned to different periods or dynasties:

- Old Egyptian, approximately 3180 - 2240 BC.

- Middle Kingdom, approximately 2240 - 1740 BC.

- Late Kingdom, approximately 1573 to 715 BC.

In the oldest documents, hieroglyphic pictures simply represented the object they depicted. Consequently, abstract thought was difficult to express. But as the language evolved, the meaning of existing glyphs changed and more hieroglyphs were added to provide other articles of speech. For example, some symbols stood for the sounds they represented; others acted as classifiers to help clarify ambiguities. In more modern times, hieroglyphs have been used primarily by Egyptologists to document inscriptions, to discuss literature and other writings, or to explain grammar. Other hieroglyph users include researchers, historians, museum curators and interested individuals. The users, however, have a diverse range of needs and, as a result, many means for representing hieroglyphs have emerged through the years.[2]

## Methods of reproducing Egyptian hieroglyphs

There are a variety of ways to capture hieroglyphic symbols. Expense, accuracy, legibility, and expediency often determines the means of representation, but technology is also a factor. For example, in the early 1800's, on-site in Thebes, hand-writing implements were the most practical choice. Here, the hieroglyphs were reproduced as complete drawings or as handwritten symbols.[3] In the 1900's, with the availability of detailed and elegant metal types, hieroglyphs could be reproduced mechanically. While metal type facilitated the reproduction of hieroglyphs, the limited printing of scholarly publications made this technology very costly. Today, the computer may provide an economical means of reproducing hieroglyphs. The various methods of printing hieroglyphs and their advantages and drawbacks are discussed in more detail below.

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[2] The Middle Kingdom has been called the "period of literary renaissance." [Gardiner, Egyptian Grammar, p. 1] In this period, the written hieroglyphic language is most consistent. Many texts and inscriptions from this period have been preserved. For these two reasons, many scholars concentrate on the hieroglyphic symbols of the Middle Kingdom.

[3] Good examples of handwritten hieroglyphs can be found in *Principles Généraux*, the work and writing of J. J. Champollion-Figeac.

*Photography*

Photography is perhaps the most accurate means of recording hieroglyphic inscriptions (figure 2). Odd hieroglyphs, broken areas, texture, and even color can be fully captured with photography. This medium is good for documentation and reference of entire works, but conventional photography is an impractical means to reproduce single hieroglyphs and arrange them within text.

*Drawings*

Drawings can provide clear illustrations of hieroglyphs as they appear in context on walls, documents and carvings (figure 3). Drawings are also an easy means to complete an inscription. Often, portions of inscriptions are missing or damaged, and these sections can be included in drawings. The major disadvantage of drawn representations is that those drawings not done accurately can be misleading. This is particularly disturbing when the drawing is the only record of an eroded or vandalized inscription.

Like photographs, drawn hieroglyphs are not an effective means for representing individual hieroglyphic symbols in analysis, discussions on grammar, and reference.

*Handwritten*

Handwriting is a quick and easy means of creating individual hieroglyphs, requiring only paper and writing tool (figures 4-5). While drawing might be used to depict an actual inscription, handwriting is used to categorize or reproduce inscriptions generically. Handwritten characters can be found where there were no metal fonts available or when cost made publishing text by other means impractical. Unfortunately, the quality of handwritten glyphs depends primarily on the ability and patience of the author; the resulting hieroglyphs can range from beautiful and consistent to illegible and unpredictable (figures 6-7).[4] Moreover, given the labor involved in their creation, handwritten hieroglyphs are not viable when large amounts of text must be represented.

*Metal types*

Metal type consists of rectangular blocks bearing relief characters from which inked prints can be made. A single collection of these blocks is referred to as a font of type. Metal type fonts of Egyptian hieroglyphs were first used in Germany with the creation of the Theinhardt font in 1875 (figure 8). This was

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[4] The tendency in handwriting hieroglyphs with ink on paper is to abbreviate the forms, thus creating a sort of hieroglyphic shorthand. This shape abbreviation began in the Middle Kingdom when hieroglyphs were written quickly on papyrus. These cursive variations were used by priests and later given the name "Hieratic writing," which comes from the Greek work *hieratikos* for priestly.

followed by a font from the Institute Francais d'Archeologie Orientale in 1907 (figure 9). The most popular font was designed in England, in 1927, from the drawings of Norman and Nina de Garis Davies, Egyptological artists working with Sir Alan Gardiner at Oxford. This font is called the Gardiner font (figure 10).

The obvious advantages of metal type include its legibility, elegance, and clarity. An additional advantage is that using metal type, hieroglyphs merge nicely with Roman text. The disadvantages with metal type lie in its flexibility and the ease of reproduction. With metal type, a limited range of type sizes are available and the characters are usually cast facing a direction suited for their use with Roman text. Also, composition of hieroglyphs in print requires a trained typesetter with the patience to locate the correct shapes from a collection of many metal forms and set them correctly. The cost of this highly skilled labor is often beyond the means of academics. Further, there is a loss of control when a document is prepared by a person other than the author. If the typesetting instructions are not clear or if the typesetter is undisciplined, several iterations are needed to produce a final correct page.[5]

*Digital representations: bitmaps*

Computers use digital type to produce printed characters. In digital type, each character is described as a constellation of discrete units or bits arranged in a precise configuration; this configuration is referred to as a *bitmap*. The number of bits per unit of measure determines the resolution. Increasing the resolution improves the quality of character representation, i.e. high resolution fonts are more legible than low resolution fonts. Bitmap representations can be arranged or edited more quickly than metal type and the quality of high resolution bitmaps equals or exceeds that of metal type at small sizes.[6]

In 1983, Oxford University translated the Gardiner font into bitmaps for use on a computer (figure 11).[7] By scanning enlarged photographs of each symbol, they produced eight different point sizes. Unfortunately, computer typesetting with the Gardiner bitmap font requires expensive typesetting equipment. Moreover, the author is still removed from the process. Although a number of different point sizes exist (figure 12), restricting text to these sizes can be a problem.

5 A description of this process can be found in the writing of T.G.H. James, *Computer Printing of Hieroglyphs*, Oxford University Press, Oxford, England.

6 " The resulting forms [ bitmaps] display an unexpected advantage over the old metal versions in possessing a cruspness and clarity which was not always obtainable, particularly with some of the smaller sizes" - T.G.H. James, *Computer Printing of Hieroglyphs at the University Press Oxford*, Oxford University Press, Oxford, England

7 *The Monotype Recorder*, number 4, p. 25 -28.

*Screen fonts*

Screen fonts are bitmap fonts designed for use on a computer screen. These bitmaps are typically of low resolution, consistent with the average computer screen resolution of 72-150 dots per inch.

Screen fonts[8] can be used in many text and graphic programs, thereby increasing the flexibility of their use. For example, some programs allow rotation or scaling font characters, and others allow alteration of designs of the individual symbols. Given the availability and power of personal computers, academics have begun to explore this means of reproducing hieroglyphs. The primary disadvantage, unfortunately large enough to keep many Egyptologists from pursuing such fonts, is the low resolution of these fonts (figure 13).[9]

*Outline fonts*

Another method for representing digital type within a computer is through mathematical descriptions. Instead of defining the precise location of all the discrete bits in a character shape (as in a bitmap), here the computer generates a mathematical description of the character's contour. This contour or master character may be altered by mathematical transformations like scaling, rotating, or obliquing. The resulting outline is ultimately used to create bitmaps at any resolution. Outline fonts are frequently used on laser printers and, because of their flexibility, may be printed on machines of varying resolution.

Currently, no font of Egyptian hieroglyphs exists in this format. The effort required to produce such a font and limitations in the amount of memory in most laser printers has hindered its development. Yet outline fonts may be the means to overcome the resolution problems of bitmap fonts and capture the advantages of computer printing.[10]

*Summary*

It is evident that currently no single approach or font completely satisfies the needs of the Egyptologist. Photography and drawings are useful where faithful reproductions are needed yet are costly and time consuming for use in text.

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*8* In 1986, William Hupper of Linguistic Software developed the first set of hieroglyphic screen fonts for the Macintosh. His effort was based on the Gardiner font. Not long after, Michael Berger of the Oriental Institute in Chicago developed another Macintosh screen font, *ProGlyphs*, based on the Gardiner font.

9 Peter der Manuelian, *Laser Printing Egyptian Hieroglyphs.*

*10* For a discussion on digital type see Peter Karow, *Digital Formats for Typefaces*, 1987, p. 69 - 100, *Digital Typography*, Charles Bigelow, Scientific American, August 1983, p. 106, *The World of Digital Typesetting*, John W. Seybold, 1984.

Handwriting is a quick and inexpensive way to reproduce hieroglyphic forms, but there are problems of inconsistency, legibility and labor intensity. Metal fonts are elegant, legible and easily worked into published pieces, but often the character set is limited and the cost of setting text in this fashion is prohibitive. Digital representations are legible and consistent yet, high resolution bitmaps are too expensive for frequent use. Macintosh screen fonts provide hands-on tools for personal printing but are not publication quality. Finally, outline fonts may meet the user's needs of quality, flexibility, ease of use, and economy but have yet to be developed. It follows that outline fonts deserve further attention.

## The Project

### Purpose

The goal of the project is to provide a collection of professional quality symbols that can be altered and integrated with text or used as graphic illustrations. Specifically, it seeks to introduce a high quality, digital outline or spline font of Egyptian hieroglyphs to the academic community for use on commonly available computer systems.

### Early work with outline fonts: *Metafont*

Initially the outline hieroglyph font was to be completed with a program called *Metafont*. Metafont was designed by Donald Knuth at Stanford University.[11] Knuth looked into the possibility of controlling the descriptions of letterforms with mathematics, creating independent letterform descriptions that could then be broken down into bits for computer-controlled laser printers. To create these letterform descriptions, Knuth developed a programming language he named Metafont.

> "One of the most important factors in my motivation [describing letterforms as mathematical expressions] was the knowledge that the problem would be solved once and for all, if I could find a purely mathematical way to define the letter shapes and convert them to discrete raster patterns.... Although the precision of the raster may change, the letter shapes can stay the same forever, once they are defined in a machine-independent form. My goal was, therefore, to give a precise description of the shapes of all the symbols I would need."[12]

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*11* Knuth was disturbed by the relatively poor quality of mathematical typesetting tools and developed a comprehensive solution to mathematical typesetting and computer text setting in general. His program, TeX [ Knuth, *TeX and Metafont*] quickly became a popular academic tool.

*12* Knuth, *TeX and Metafont*, p. 16, 17.

These letterforms could be used in a text setting program [TeX] and would give control of document preparation to universities. [13]

## Applying Metafont to Hieroglyphs

The philosophy behind Metafont is that letterforms are shapes created by a pen nib traveling along a path, the structure of a particular letter. By changing the nib, various appearances of the letter can be obtained. For example, a nib which is small and round produces a thin, even-weight letterform resembling that created by a ball point pen; a nib which is wide and straight produces a letter that looks much like those common to calligraphy (figure 14).

Metafont also thinks of letterforms as elements of a larger group (a typeface), and typefaces as elements of a still larger group (type families). Metafont recognizes that there are distinct features or characteristics in these collections of letterforms. These features are "design globals" and include shape attributes like serif styles and stroke angles. For example, an attribute of perfect symmetry might be desired in a typeface (where an "o" is perfectly circular); this symmetry can be globally reflected throughout a Metafont typeface, giving it unity (figure 15). Once a typeface is described in Metafont, permutations can be applied to generate different versions, weights or new styles.

At first glance, the hieroglyphic typeface appears to fit the Metafont paradigm nicely. The characters are composed of single-weight lines as if described by a pen nib. Metafont's ability to scale, rotate and stretch shapes allows hieroglyphs to be adapted to the variety of contexts as needed by Egyptologists. Another benefit is that the shapes can be used in the TeX[14] document formatting system which is available to most scholars.

To begin the project, 18 point proofs of the Gardiner font were enlarged to a height of about four inches tall. From these photostats, a path structure could be determined for the Metafont description (figure 16).

In this exercise, it became apparent that there were situations in which a continuous path could not be described (figure 17). Problems in complexity were exaggerated by the lack of repeatable shapes. Although there were

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13 A few years after the introduction of Metafont, Knuth realized that type design was not easy and that the success of Metafont would be greater in the hands of skilled type designers. He collaborated with experts in the field of type design and asked Charles Bigelow, a scholar in the world of typography, to assist him in setting up a degree program with the primary focus to use Metafont. In this degree program, Metafont was to be the backbone for a digital font designing workstation allowing type designers to do design work directly in the medium that would carry the finished product.

14 Knuth, *The TeX Book.*

groups of similar symbols such as the group "Man and His Occupations,"each symbol had a different posture. Therefore, the Metafont notion of global design features did not easily apply to the character set of hieroglyphs. For these reasons, work with the Metafont program was discontinued.

### Turning to the Macintosh laser printer environment

In 1985, it was clear that the *Apple Macintosh* ("Macintosh") might be an appropriate environment for which to develop the font. It was gaining wide acceptance in academic communities. Its affordability and easy-to-use interface had attracted many computer-shy users. In addition, application programs were capable of integrating text and graphic elements, allowing such manipulations as scaling, rotation, and stretching. It was concluded that an outline hieroglyphic font combined with these computer printing capabilities would be a powerful tool for Egyptologists.

## Outline font development

To understand better the next phase of the hieroglyph project, a brief introduction to laser printer outline fonts (as used in the Macintosh environment) and to the *PostScript* programming language follows below.

### Fonts on the Macintosh

In the Macintosh, there are fonts for viewing text on the screen (screen fonts) which can be printed directly to a printer. Their print quality is poor, though, and laser printer fonts are preferred for better quality results. These outline fonts are, like Knuth's Metafont,[15] mathematical descriptions for use by the laser printer. Currently, outline fonts are processed in the laser printer and not viewed on the screen.

The digital outlines used by the Macintosh are described with a special programming language called *PostScript*. These PostScript programs express, as mathematical equations, the shape of each letterform[16]. The *Apple LaserWriter* ("LaserWriter") is more than just a printer, it contains a computer that interprets and translates the PostScript programs, ultimately into toner spots on the printed page.

The following example illustrates how an outline font works in the Macintosh environment. If one is printing a resumé, one chooses a font, e.g. Palatino, in a point size, e.g. 10 point. When the document is printed, the entire text file is translated into a PostScript program which is then sent to the printer. The printer, upon receiving this file, interprets the PostScript language. Because

[15] Knuth, *Computer Modern.*

[16] There are many types of equations to describe the curved elements of letterforms; those used by the PostScript language are called Bézier splines. See *PostScript Language Reference Manual* for a description of the béziers used in the PostScript Language.

the Palatino fonts are merely mathematical instructions they are easily scaled to the 10 point size. The LaserWriter determines how best to render the font outlines into a 300 dpi bitmap, the printer's resolution. This final bitmap image is then produced as spots of toner and transferred to a piece of paper.

Getting the artwork of the letterform into the computer to create an outline-master requires some interaction between a designer and the computer. Some programs such as the *Ikarus* program[17] accomplish this with a "digitizing tablet."[18] Other programs have the user scan artwork into the computer and then offer an interactive means of placing key points along the outline of scanned image. As these points are placed, a path is drawn through the points and the resulting shape is displayed on the terminal screen.[19]

## Constructing the font

With the introduction of the LaserWriter and the introduction of PostScript outline fonts, it was possible to proceed with the creation of an outline font of Egyptian hieroglyphs. Such a font would capitalize on the Macintosh environment and allow users to take advantage of the higher resolution printers such as the LaserWriter (300 dots per inch) and Linotype L-300 (1270 dpi & 2540 dpi).

### Tools in font development

A fairly sophisticated program, *Fontographer*, was introduced to create laser printer fonts. With Fontographer, a type designer could create outline type by placing points around a scanned letterform image. Letterform files created in Fontographer are assembled in the predefined font format required by PostScript.[20]

Although it was easy to produce a finished font with Fontographer, there were two disadvantages to using this program for the hieroglyph outlines. First, the graphic interface was cumbersome--detail was hard to obtain with the large icons that were used to indicate points. Second, the resulting font format was restrictive; outlines could only be handled as Fontographer fonts, not as editable graphic elements. Another program, *Adobe Illustrator* ("Illustrator"), overcame some of Fontographer's limitations.

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*17* Peter Karow, *Digital Formats for Typefaces.*

*18* Basically, a digitizing tablet is a surface that contains a precise internal grid. Artwork is placed on the surface and key points are entered with a mouse-like device along the contour of the letter. A program then constructs a curve through these consecutive coordinates.

*19* *Adobe Illustrator,* Adobe Systems Incorporated.

*20* This format is described in the *Language Reference Manual* and the *PostScript Language Tutorial and Cookbook,* Adobe Systems Incorporated, 1985.

Illustrator was intended to be used by graphic designers or illustrators to translate their artwork into PostScript outlines. The interface provided the designer significant control over the resulting shapes. Illustrator drawings were also usable by other programs such as *PageMaker* or *ReadySetGo*. The program, however, did not produce a laser printer font. Producing a laser font from Illustrator files involves writing programs that use the Illustrator files as character shapes and compiling them in the correct PostScript font format.[21]

Given the project goals, a font created by Illustrator had value as both a font and as outlines for the creation of alternate symbols or illustrations. Moreover, Illustrator files were usable in many text setting applications, hieroglyphs could be used as fonts and as alterable shapes.

The project then became an exercise of scanning the outlines from samples of the Gardiner font, curvefitting them with Illustrator, writing and using software to translate the outlines into the correct PostScript font format, and arranging the font for the Macintosh keyboard. The intended product included both a set of font characters for use in Macintosh applications and a complete set of characters as modifiable Illustrator drawings.

### Issues in the font development

In the process of using Illustrator to produce a font, a number of questions and problems arose challenging the nature of digital representations.

*Selection of original artwork*

Selection of a model for each hieroglyph was an early concern. Although Gardiner's font was popular, it could presumably be enhanced by looking at examples from the Egyptian monuments. In the interest of consistency, the Gardiner font simplified many of the hieroglyphic forms. But this simplicity seemed unnecessary in a computer font that was not restricted by limitations of a metal typeface. For example, the lips and eyebrows of men were left off the Gardiner font, yet these details were often present on the carefully carved hieroglyphs (figure 18).

Using photographs from carved inscriptions, enhancements were made on the Gardiner characters. From the experimentation with alternate designs it became apparent that the extra detail was lost when these characters were printed at smaller text sizes at even 1270 dpi. (figures 19-20). Moreover, the added detail increased the memory usage beyond the capacity of the LaserWriter. These experiments suggested that the detail of the Gardiner font was adequate and opened the possibility of new interpretations based on the original carvings and paintings.

[21] For a description of these programs refer to Appendix C.

*Integrity of design representation*

Other questions were raised concerning how best to translate the design intent behind certain Gardiner shapes into the digital medium. For example, the cornered edges of many of the Gardiner shapes appear rounded (figure 21). This is perhaps due to the difficulty of cutting exact square edges in metal and enhanced by the effect of ink spread when an impression of the metal piece is printed. The question arose; if the Gardiner intent was to create a perfect square, yet the technological constraints of metal yielded only a rounded form, should the computer, without such constraints, produce a perfect square or imitate the rounded results of metal? After "squaring" several of the geometric characters, the resulting shapes seemed inconsistent with the other somewhat more natural shapes (figure 22, 22a). Even if the intent had been to make a square square, the accuracy of the computer forced a different style on these symbols. Therefore, it seemed better to follow the idiosyncrasies of the Gardiner font to preserve a consistent style and to consider, as a future project, the design of a new font using shapes easily generated by a computer.

*Side effects of the digital medium*

There were situations where the idiosyncrasies of the Gardiner shapes did not translate acceptably to the digital medium. In such cases a compromise was made favoring the printed result. For example, a vertical character which sits at a slight angle is rendered with a jagged edge in a digital font. In fact, the closer to vertical the angle lies, the worse the jagged edge appears. Because this jagged edge has such visual impact, it distracts from the character shape. In these cases, though the design character of the metal font is lost, a perfectly vertical line seemed preferable. Interestingly, one would think that this problem only occurs in printers of 300 dpi or less, yet the eye can resolve these jagged edges at typesetter resolutions of 1270 dpi (figures 23a, b, c).[22]

*Memory constraints*

The memory capacity of the LaserWriter offered another constraint. There are disk-based printers with more memory than the LaserWriter, but it was less likely that such printers would be available to scholars. The LaserWriter can process a file with fonts of a size up to 200 Kilobytes (K). Typically, fonts use between 30 K and 60 K of memory and present a problem only when many are used by the printer at once. However, the total size of the hieroglyphic font reached 1500 K, more than seven times the available memory. This problem was solved by breaking the font into smaller character sets, and making several smaller fonts. By treating each of the 26 Gardiner categories as a font, the sizes became manageable, from as little as 4K to 150 K. The only exception was the category of Birds which totaled 216 K; this font is broken down to two sections for printing.

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[22] For a thorough discussion on the perception of forms at various resolutions or frequencies see the article "Digital Typography" by Charles Bigelow and Donald Day, *Scientific American*, August 1983.

*PostScript constraints*

Another size limitation problem occurred at the early stages of the project, the number of points in many of the character shapes exceeded the limits for a PostScript procedure body. With a maximum of 500 elements and curves containing six numbers each, no more than about 80 curves could be used. To get around this problem an adjustment had to be made in the mkAIfont program (see Appendix C). Character procedures were subdivided into parts which were then executed consecutively.

*Positioning the font in the Macintosh environment*

Positioning the font in the Macintosh environment is another considerable task without the appropriate software. The Macintosh requires a screen font for use in the WYSIWYG[23] applications. Generally, this screen font is given the same name as the printer font. Printer fonts are also formatted to be sent or downloaded to a printer when selected as a screen font within a document. With Fontographer, this configuration is automatically created, but this is not the case with the Illustrator files. Since it was beyond the scope of the project to write software to create a Macintosh format printer font that would be automatically downloaded to the printer, an application called the Font Downloader was used to send files to the printer. Since the font created from the Illustrator files was a simple PostScript file, it could be sent to the printer with the Font Downloader and the effect of having the font in the printer would be achieved. Although the process is somewhat cumbersome, it allows users to print from the Macintosh.

The original intent was to combine the printer font with an existing screen font. There were two such fonts, *ProGlyph* by DblClick Software, and *Hieroglyphs* by Linguistic Software, each modeled after the Gardiner character set. To utilize these screen fonts, the printer font had to have the same name and the locations of the characters on the keyboard had to be identical. Under this arrangement, one could purchase the screen font programs and use them with the high resolution printer font. The advantages of this approach were that the efforts of building a screen font need not be duplicated and that the user need not learn another keyboard arrangement. Unfortunately, each of the screen font sets grouped the Gardiner categories into larger fonts resulting in a collection of characters too large for a single printer font. Also, discrepancies between screen font characters and printer font characters would make the WYSIWYG paradigm unreliable.

To address the needs of existing laser printer users, a different approach to the font arrangement had to be pursued. Since the printer fonts were already divided into smaller fonts (Gardiner categories), this structure was used for the screen fonts. The remaining issue was to determine where the characters of each font would be located on the keyboard. As the categories of the

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[23] *What You See Is What You Get.*

Gardiner font occurred sequentially, an expedient solution was to arrange the symbols on the keyboard in that same order. Thus, starting with the number "1" on the keyboard, the symbols of each category progress across the keyboard (figure 24).

## Future directions

The exploration of possibilities for printing non-standard fonts with computers and laser printers has only just begun. There is room for development in aspects of translating existing font designs, creating new font styles, and developing better hardware and software to support the use of such fonts.

When characteristics of the computer are brought together with font design the limitations of old technologies give way to new opportunities. For example, the speed and computational power of the computer makes it possible to generate variations on a design; fonts can be made bolder, italicized, filled, or rendered as dotted outlines. These variations may be used in texts to differentiate levels of meaning within an inscription. Stylistic influence of the computer medium like the square shapes of the Gardiner font or the jagged edges of low resolution can be accentuated and used for the development of a modern interpretation. Additionally, the computer's capacity for maintaining data bases may be applied to the font characters, creating entire systems for cataloging and cross referencing inscriptions. The computer may even challenge the traditional notion of font--a set of symbols with common attributes, and incorporate symbols which are scanned from photographs. This would be useful for languages that are still being deciphered, such as the Mayan hieroglyphs. Here, it is important to depict the hieroglyphs as accurately as possible (usually with photography or detailed drawings) both to minimize assumptions made about a character and to provide an actual representation for cataloging the various symbols.

With its accuracy, speed, processing power, high resolution printing capabilities and accessibility to scholars, the computer represents an exciting direction for the study of ancient languages.

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## List of Illustrations

**Figure 12**. Varying point sizes of the bitmap Gardiner font. From the article, Proud Tradition at Oxford Sustained, by William Morgan, The Monotype Recorder, number 4, p. 26, October 1984. Courtesy of The Monotype Corporation.

**Figure 13**. Screen fonts of hieroglyphs developed for the Macintosh. *Top*, characters from a font developed by Michael A. Berger, 1986. *Middle,* characters from a font by William G. Hupper, 1986. *Bottom*, characters from alphabetic characters developed by the author, 1984.

**Figure 14**. Typographic effects on a single letter achieved by varying the parameters given to a Metafont program. Knuth, *Computers and Typesetting / C, The Metafont book*, © 1986, p. 192. Addison-Wesley Publishing Co., Reading, Massachusetts. Reprinted with permission.

**Figure 15**. Typographic effects on entire typefaces achieved with the Metafont program. Knuth, "Lessons Learned from Metafont", *Visible Language*, Volume 19:1, 1985, p. 38-39. Reprinted with the permission of the original publisher, Visible Language.

**Figure 16**. The path that might be used to create a Metafont character. *Top*, a photographic enlargement from a proof of the metal font. *Middle*, an inked interpretation to serve as a model for the final character. *Bottom*, the path that describes the character shape.

**Figure 17**. An example where the "path" model breaks down. Here the outline cannot be easily composed of single weight lines. For instance, *a*, represents a point which is thicker than the stroke that must be used for the rest of the character shape.

**Figure 18**. A photograph illustrating the added detail present on many hieroglyphic inscriptions. This photograph is from the *Zeitschrift für Ägyptische Sprache und Altertumskunde*, Heft 1, Band 109, 1982. p. 74.

**Figure 19**. An example of detail added to the face of *A1*, Man and His Occupations.

**Figure 20**. The *A1* character, with extra facial detail, shown in descending point sizes to illustrate the negative effects of 300 dpi resolution on small sizes.

**Figure 21**. Enlargements of the Gardiner characters to show the rough and rounded quality of the original metal font shapes.

**Figure 22**. A "squared" character introduced to the Gardiner font to demonstrate the inconsistency of geometric shapes among the more natural characters.

**Figure 23a, b, c**. The rope character, *S29*, slanted at different angles in increments of one degree to show the effects caused by the digital medium at various resolutions, (**23a**.,300 dpi, **23b**., 600 dpi, **23c**.,1270 dpi).

**Figure 24**. The keyboard arrangement for the font, *A*, or *Man and His Occupations*. This format, arranging the characters in their Gardiner sequence across the keys of the Macintosh, is used for each of the fonts.

**Figure 25a, b, c, d.** A showing of *Cleo*, the PostScript outline font of Egyptian Hieroglyphs.

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# Appendix A: Methodology

## Project process

*Artwork preparation*

Proofs of the Gardiner font at 18 point size were enlarged 598% (5 times at 143%) on a photocopier.

The photocopies were scanned at 300 dpi with an *Abaton* scanner and the *MicroTech* scanning application and saved as *MacPaint* files.

*Entering the artwork into the computer*

The *MacPaint* files were used as templates in the *Adobe Illustrator* program with which they were drawn as outlines. The outside contours were filled with black and the inside contours filled with white. An origin of 0,0 was placed at the left edge of the shape, and the finished form was saved at its original size and at a size of 290%. The glyphs were named according to the Gardiner classifications plus the suffixes, .ill or .290. (E.g., a10.ill, a10.290, b7.ill, b7.290).

The Illustrator files, scaled to 290% were uploaded with *MacIP*, a Stanford file transfer protocol program, to a *Sun 3/50* workstation running *UNIX 4.2 bsd.*

*Converting the computer representations into a font*

A main directory was created and named **Hieroglyphs**. In the **Hieroglyph** directory subdirectories were created and named after the Gardiner categories (A, B, C, etc.) The uploaded Illustrator files were sent to the correct sub directory and stored in another directory named **ill.**

A UNIX shell script, *drop* was used on the **ill** directory to remove the .290 suffix from the name.

A copy of the **ill** directory was created and named **bez**.

A UNIX shell script, *stripheader* was run on the contents of the **bez** directory. *Stripheader* removed the Adobe Illustrator preface from each file leaving only the outline path description.

For each font, two files were created: **widths.ps** and **encoding.ps**. The file **widths.ps** contained a list of each character in the **bez** directory and a numeric entry for its width. The file **encoding.ps** contained a similar list of characters but assigned each a number according to its keyboard position.

A font building program called *mkAIfont* was then run on the entire **bez** directory. **mkAIfont** incorporated the **encoding.ps** file and the **metrics.ps** files. **mkAIfont** then assembled the **bez** files, **encoding.ps** file and **widths.ps** file producing a PostScript font file called **font.ps**.

*Proofing and testing the resulting fonts*

To test these fonts, another UNIX shell script called **printall** was used. **printall** was run from the main or Hieroglyph directory and expected the name of the directory(s) that were going to be printed. (e.g. **printall A B C**). **printall** appended the **font.ps** files for each directory specified as an argument to **printall**.

*Linking the font to the Macintosh environment*

To make the outline font more useful in the Macintosh environment, it was necessary to create a set of screen fonts. These screen fonts were given the same name as the laser font so that there would be a link between the WYSIWYG application and the printer font.

For a detailed explanation of each of these programs see Appendix C.

# Appendix B: Results/User Manual

The final project consists of three sets of disks;

The first set contains:

-Printer font (font.ps) files for each category of the Gardiner classification.

-The *FontDownloader* program for sending the PostScript files to the printer.

Set two contains:

-The screen fonts in 12, 18, and 24 point sizes for use with the printer font.

-*Font/DA Mover* for installing the screen fonts on the Macintosh.

-Keyboard charts for each font.

Set three contains:

-Illustrator documents for each hieroglyph for use as modifiable graphic elements.

# User Manual

"Cleo" is a font of Egyptian hieroglyphs based on the font created by Sir Alan H. Gardiner. *Cleo* is a PostScript outline font available in public domain from Stanford University for use on laser printers supporting PostScript. It is intended to address the printing needs of students and scholars of Egyptology as a high quality and versatile font. *Cleo* (approx. 800 characters) is organized as a series of smaller or sub fonts following the categorization scheme laid out by Alan Gardiner. There are accompanying screen fonts for use in WYSIWYG applications. The size of each sub printer fonts ranges from 9 Kilobytes (K) to 216 K. These printer fonts may be stored to disk (ROM) on disk-based printers or stored as needed in the memory of the laser printer (RAM). In general, to use *Cleo* most efficiently, the screen fonts for all the sub fonts should be installed in the system of the Macintosh and each sub printer font should be stored or downloaded to a laser printer with disk. The font is then accessible by all application programs supporting screen and printer fonts by a simple keyboard arrangement based on the Gardiner arrangement. Key position charts are provided with the fonts. The details for using *Cleo* are outlined below.

### Using *Cleo* with disk-based laser printers.

equipment: MacPlus, 20 megabyte hard disk, AppleTalk, disk-based laser printer

Given the large size of the entire *Cleo* font, over 1500 K and the wide range of characters necessary in many hieroglyphic transcriptions, it is most practical to store the entire font on a laser printer disk. The alternative, necessary in printers with less available memory, is to download the fonts as needed. This method will work if the total number of fonts needed by one document does not exceed the printer's memory. The following instructions assume working knowledge of the Macintosh available in the *Introduction to Macintosh* book and cassette tape. The user should also be familiar with a word processing program such as *MacWrite*.

*Installing* Cleo *screen fonts.*

First install the screen fonts into the system folder by inserting the screen font disk and opening the *Font D/A Mover*. Two scrolling windows appear, one listing the fonts already present in the Macintosh system, the other, blank. Below the blank window select the **open** button. If the resulting dialog box is not labeled with the name of the hieroglyph screen fonts disk then select the **drive** button until the name appears. Now select **open** and the hieroglyphs screen fonts should then appear in the window that was previously blank. Holding down the mouse button, select all the screen fonts in the window. They will be highlighted with black (monochromatic screen) and two new button choices will appear between the windows. Choose **copy** and the entire set will be copied into the Macintosh system. You will now be able to scroll through the system window and the hieroglyphs names will be present. Select the **quit** button to exit the *Font D/A Mover* program. Eject the hieroglyph screen fonts disk.

*Downloading* Cleo *printer fonts*

Next, install the printer fonts in the laser printer. This is done with the *FontDownloader* located on each of the printer font disks. The font downloader was designed to be used to send both *Adobe* fonts and regular PostScript files to PostScript laser printers. Since the font is not an *Adobe* font it will be treated as a PostScript file when using this program.[24]

Insert the first hieroglyph printer files disk and using **chooser**, available from the apple icon menu, select the name of the disk-based laser printer. This creates a link between the Macintosh and the laser printer.

Open the *FontDownloader* and pull down the **File** menu that appears. In this menu, select **Download PostScript® File**. A dialog box with a scrolling window will appear and should contain the names of the printer font files. Again, if this is not the case, select the button marked **Drive** until the name of the hieroglyph printer font is labeled over the window. Select (highlight) the

---

[24] It is important to remember this distinction mainly because the tendency is to use the *FontDownloader* for fonts, not PostScript files.

first printer font and select the **Download** button. A warning dialog box will verify the download; select **OK**. A new dialog box is then presented with a choice of downloading the files to disk or memory; choose **Disk**. Next a dialog box reporting the progress of the downloading process will appear. When the downloading is complete, a message will appear informing you that the download was successful. Repeat this procedure for each of the font files.

To check the contents of the printer disk, use the **Special** menu of the *FontDownloader* and choose **Printer Font Directory**. Choose **Screen** when asked where to send the directory. In a scrolling window, the fonts available on the printer will appear. Those loaded to disk will be labeled (DISK).

*Using* Cleo *in programs*

When both the screen fonts and printer fonts are installed, *Cleo* may be used within any application supporting printer fonts. For more information about font selection refer to the Macintosh user manual or the individual application user manuals.

Accessing *Cleo* from the keyboard may be done in two ways; using the keyboard layout charts provided with the font, or using the *keycaps* desk accessory utility. The appropriate font must be selected for each symbol. It is recommended that a palètte or dedicated file be created with the most commonly used hieroglyphs from which the user may cut and paste the symbols into a text document. This arrangement will reduce the time involved with font selection.

*Editable hieroglyphs files*

Provided with the *Cleo* screen and printer fonts is an entire collection of modifiable Adobe Illustrator files to be used in the creation of new or combined shapes. To modify these files, the Adobe Illustrator may be used. A thorough tutorial is provided with the program. Illustrator files may be saved as *Executable PostScript Files* (EPSF) making it possible to incorporate and use them in a growing number of text and graphics programs that support EPSF.

# Appendix C: UNIX shell scripts and files used

**HeaderAI**: a dictionary of definitions for the Illustrator files.
This file is used by the *mkAIfont* script.

```
%Header dictionary definitions for illustrator files.

/HeaderDict 30 dict def
HeaderDict begin
/bdef {bind def} bind def
/ldef {load def} bdef
/xdef {exch def} bdef

/PaintType where {
  pop PaintType 0 eq {
        /FILL /eofill ldef
  }{
        /FILL /stroke ldef
  } ifelse
}{
  /FILL /eofill ldef
} ifelse

/_R {.25 sub round .25 add} bdef
/_r {transform _R exch _R exch itransform} bdef
/c {_r curveto} bdef
/C /c ldef
/v {currentpoint 6 2 roll _r curveto} bdef
/V /v ldef
/y {_r 2 copy curveto} bdef
/Y /y ldef
/l {_r lineto} bdef
/L /l ldef
/m {_r moveto} bdef
% do-nothing operators
/J /pop ldef
/j /pop ldef
/w /pop ldef
/u {} def
/U {} def
/i /pop ldef
% path painting operators
/n /newpath ldef
/N /n ldef
/F /closepath ldef
/g /pop ldef
/f /closepath ldef
/s /closepath ldef
/B {FILL} bdef
/b /closepath ldef
%end definitions

end % HeaderDict
```

**BuildCharAI.ps**: a procedure that is used by the mkfont script.
%% BuildChar procedure for use with makefont

```
/BuildChar {% fontdict charcode
  exch begin
        Encoding exch get% /charname is on stack
        dup Metrics exch get aload pop
        setcachedevice
        HeaderDict begin
           CharProcs exch get
           exec
        end
  end
} bind def
```

**stripheader**: a shell script to remove the Illustrator header.

```
#!/bin/sh
#
# stripheader Sat Jun 20 14:18:18 1987
#
# This program will pull the "header" off an Adobe Illustrator file
# (and translate all stray carriage returns into line feeds).  It is
# mainly useful for making fonts out of Illustrator files.

for char in $*
do
  mv $char $char.BAK
  echo -n "$char ... "
  cat $char.BAK | tr '\015' '\012' |\
  cgrep '+/%%Trailer' "%%Note:" > $char
  echo "done."
done
```

**mkfont**: the program that assembles the Illustrator paths into a font of user defined format

```
#!/bin/sh
#
# mkfont                    huggins Sun Feb 1 13:16:57 1987
#

# This program will build a PostScript font from a directory of
# illustrator files.
#

font="font.ps"
buildchar="/user/huggins/bin/BuildCharAI.ps"
header="/user/huggins/bin/HeaderAI"

# build header on font file:
echo -n "building header ... "
echo "%!" > $font
echo "%%CreationDate: `date`
/setpacking where { pop true setpacking } if
25 dict begin" >> $font
# temporary hack to fix flattenpath
echo "/flattenpath {currentflat dup 3 add setflat flattenpath setflat}
   bind def" >> $font

# add encoding and prologue fields:
cat encoding.ps >> $font

# add the Metrics dictionary (if it exists):
if [ -f "metrics.ps" ]; then
   cat metrics.ps >> $font
else
   echo "/Metrics 256 dict def" >> $font
   echo "Metrics begin Encoding { %forall" >> $font
   echo "   [0 0 1500 1500 0 1500] def" >> $font
   echo "} forall end" >> $font
fi
# add BuildChar routine:
cat $buildchar >> $font

# add illustrator definitions:
cat $header >> $font
echo "done."# "building header ... "

# add add char strings:
echo -n "counting chars ... "
cd bez
  rm *.BAK *.CKP > /dev/null 2>&1
  count=`ls | wc -l`
cd ..
echo "$count."# "counting chars ... "

echo "creating CharProcs dictionary:"
echo "/CharProcs $count 1 add dict dup begin
```

```
/.notdef { } def" >> $font

# loop through bez here
cd bez
  for name in *
  do
       echo -n " $name"
       length=`cat $name | wc -w`# how many "words" in file?
       if [ $length -lt 485 ]; then# normal case (no "subrs")
         echo "/$name { " >> ../$font
         cat $name >> ../$font
         echo " FILL } readonly def % $name" >> ../$font
       else                     # break up into pieces ("subrs")
         /bin/rm -f x??
         echo -n "/$name [ " >> ../$font
         split -60 $name# makes files like "xaa" "xab"...
         echo -n "("
         for chunk in x??# loop through "split" files
         do
             echo -n "$chunk "
             echo -n "{" >> ../$font
             cat $chunk  >> ../$font
             echo "}/exec load" >> ../$font
         done
         echo " { FILL } /exec load" >> ../$font
         echo -n ")"
         echo " ] cvx readonly def % $name" >> ../$font
         /bin/rm -f x??
       fi
  done
cd ..
echo "end def" >> $font#match CharProcs
echo "
done."   # "building CharProcs ... "

# add the "definefont" line and finish:
echo "currentdict end dup /FontName get exch definefont pop" >> $font
echo "/setpacking where { pop false setpacking } if" >> $font
```

**www**: a shell script that corrects the widths of the characters by checking for the actual size of each character and adding a fixed amount of space. This script creates a dictionary called *metrics.ps*.

```
#!/bin/sh
#
# wwwgreid Tue Apr 26 20:27:26 1988
#
# generates a widths file from a "font.ps" file....

out="metrics.ps"
prog="/user/huggins/bin/www.ps"
tmp="/tmp/www.$$"
font="${1-font.ps}"
sidebearingvalue="75"

trap "rm -f $tmp; exit" 0 1 2 15

fontname=`awk '/FontName/ { print $2; exit }' $font`

cp $font $tmp
echo "/fontname $fontname def" >> $tmp
echo "/outfile ($out) def" >> $tmp
echo "/sidebearing $sidebearingvalue def" >> $tmp
cat $prog >> $tmp
echo "bye" >> $tmp

echo "($tmp) run" | PS

count=`grep " /" $out | wc -l`
sed -e "s/XcountX/$count/" $out > $tmp ; mv $tmp $out
```

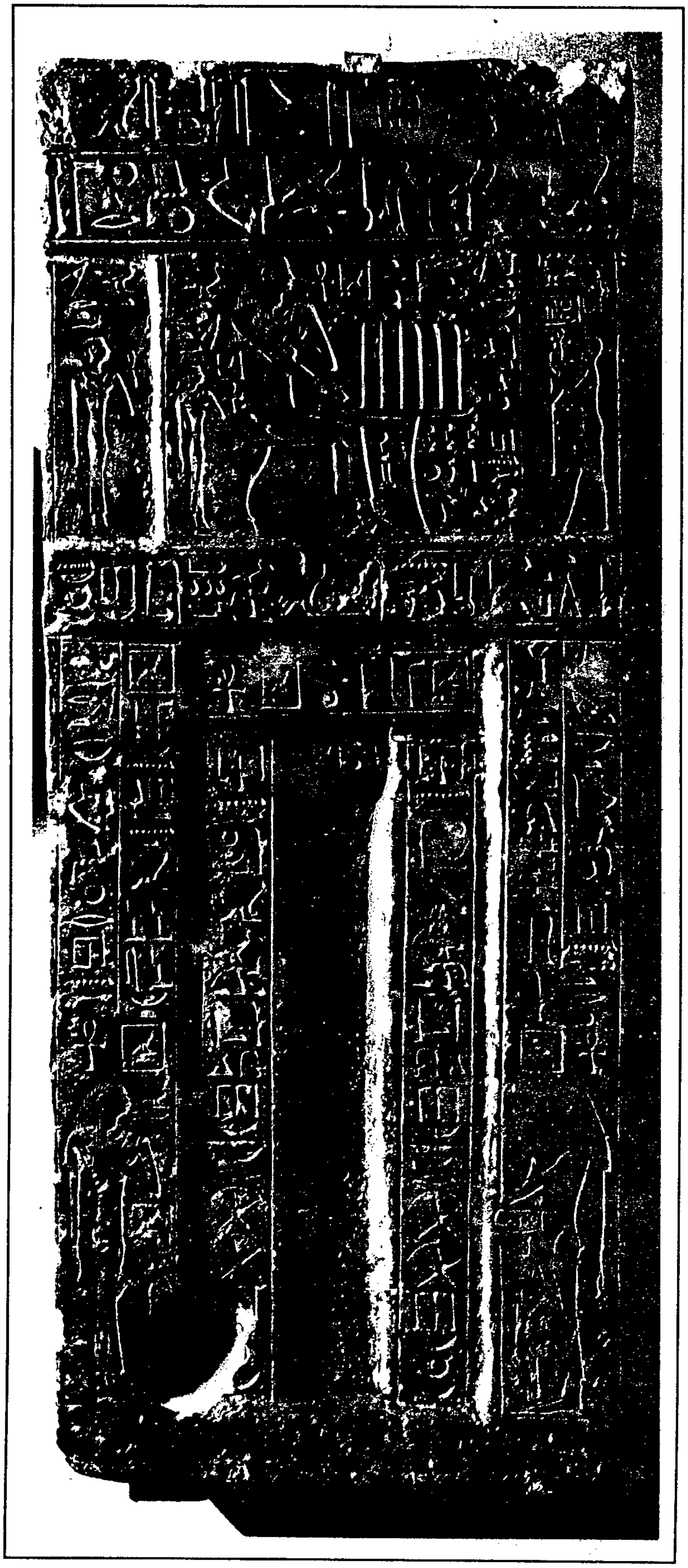


**Figure 1.**

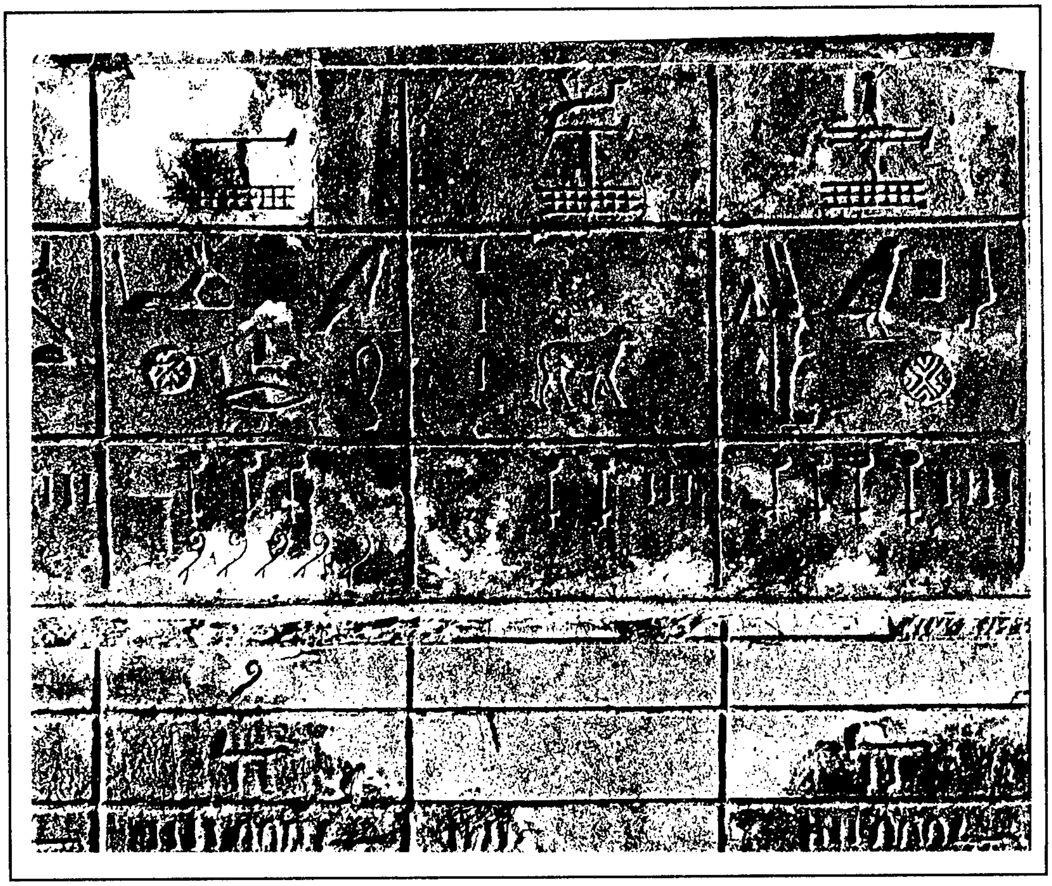


**Figure 2.**

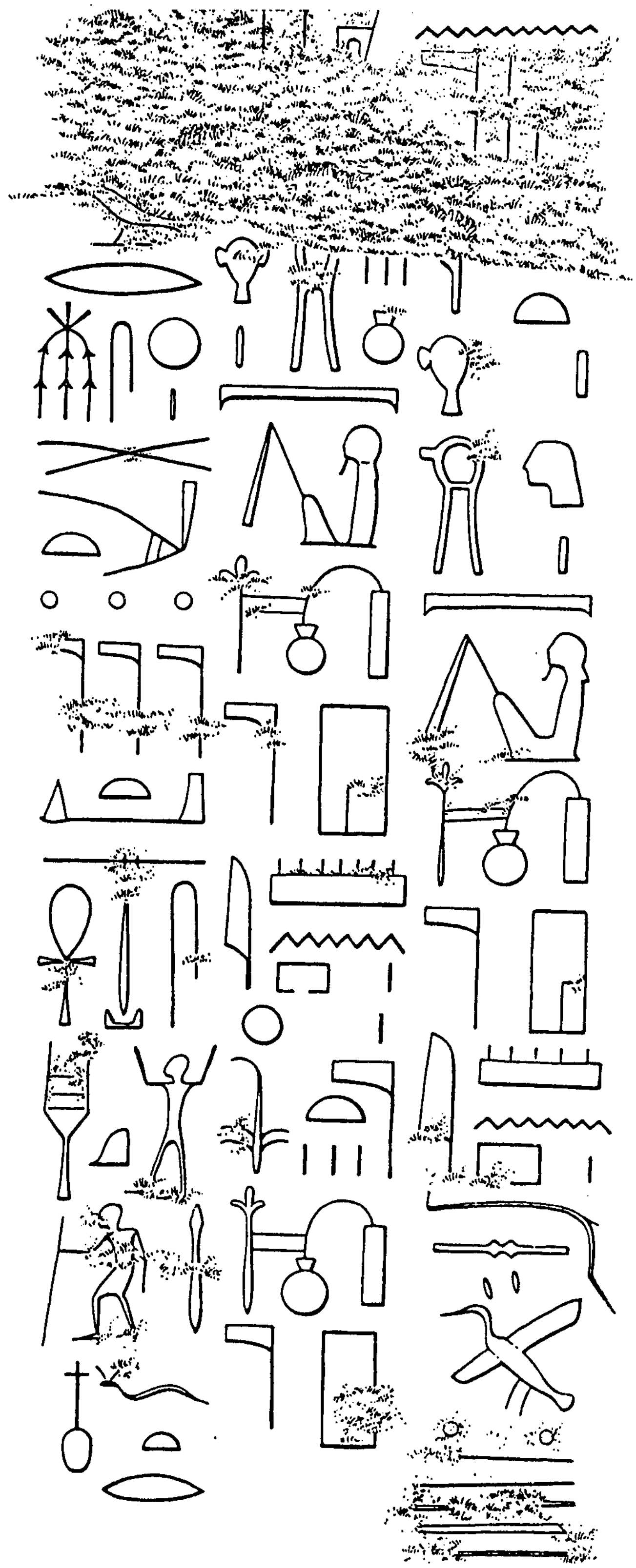


**Figure 3.**

## APPENDIX III: CALLIGRAPHY

The student may be perplexed as to how the hieroglyphs should be written, and persons unfamiliar with drawing may be daunted by the elaborate forms of many of the signs. The subject is not however so formidable as it first appears. Before showing the method of writing for some of the more frequent forms, I should like to draw attention to the following:

1. Everyone should develop their own handwriting which, provided it is legible, expresses their own personality as in other handwritings.

2. Improvement of the handwriting depends very much on practice and imitation of good examples. In any case, my own writing is a choice of individual signs from those of Sethe, Fairman, Mrs Smither, Faulkner, Erichsen and the forms used by the printed founts.

3. Generally speaking, signs are (a) narrow, tall, or low, as , ; (b) broad low signs, such as ; and (c) signs that may be written roughly within a square, such as , .

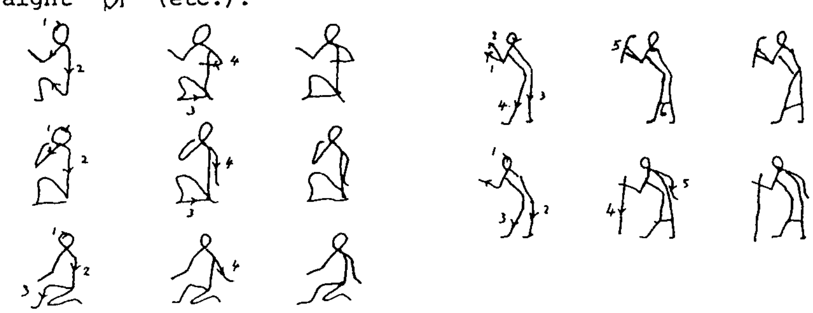
4. The Egyptians hated leaving blank spaces, and liked symmetrical appearance. However, in writing this present book, this rule has not been strictly followed, because of practical reasons in the production.

5. Train your hand to write from left to right and *vice versa*.

6. This Appendix is only intended to show the method of writing the most recurring signs, and the guiding rules for writing.

Now I present my general remarks.

A. *Men*: note first how the hands are engaged and in what position, such as the seated man , man with hand to mouth , tired man , man striking with stick . Then note the position of the body, leaning or straight (etc.).



B. *Gods*: the most characteristic features are the body and the beard; details in connexion with crowns, etc., of the king can be added afterwards.

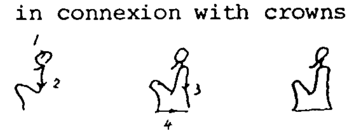


**Figure 4.**

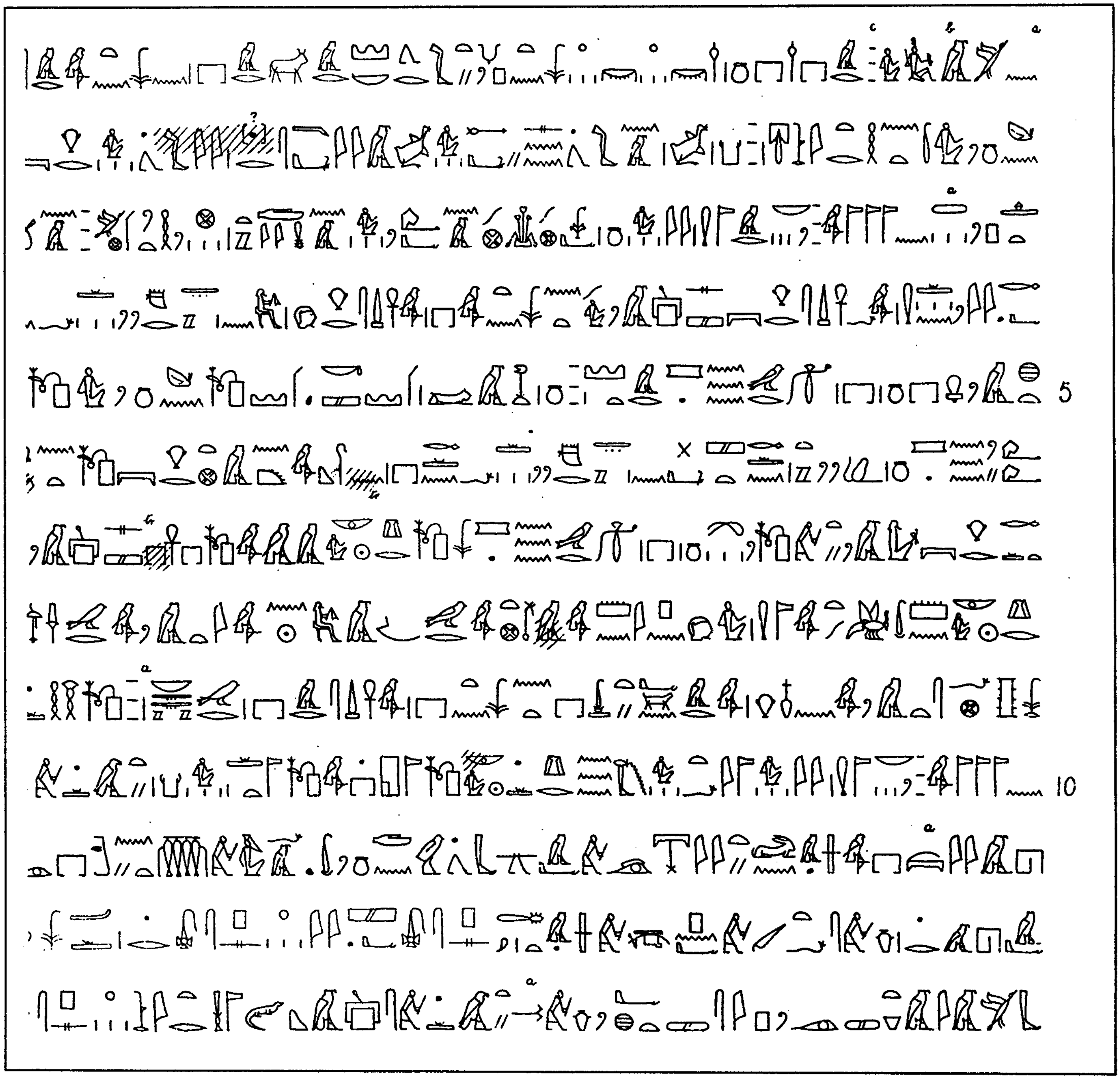


**Figure 5.**

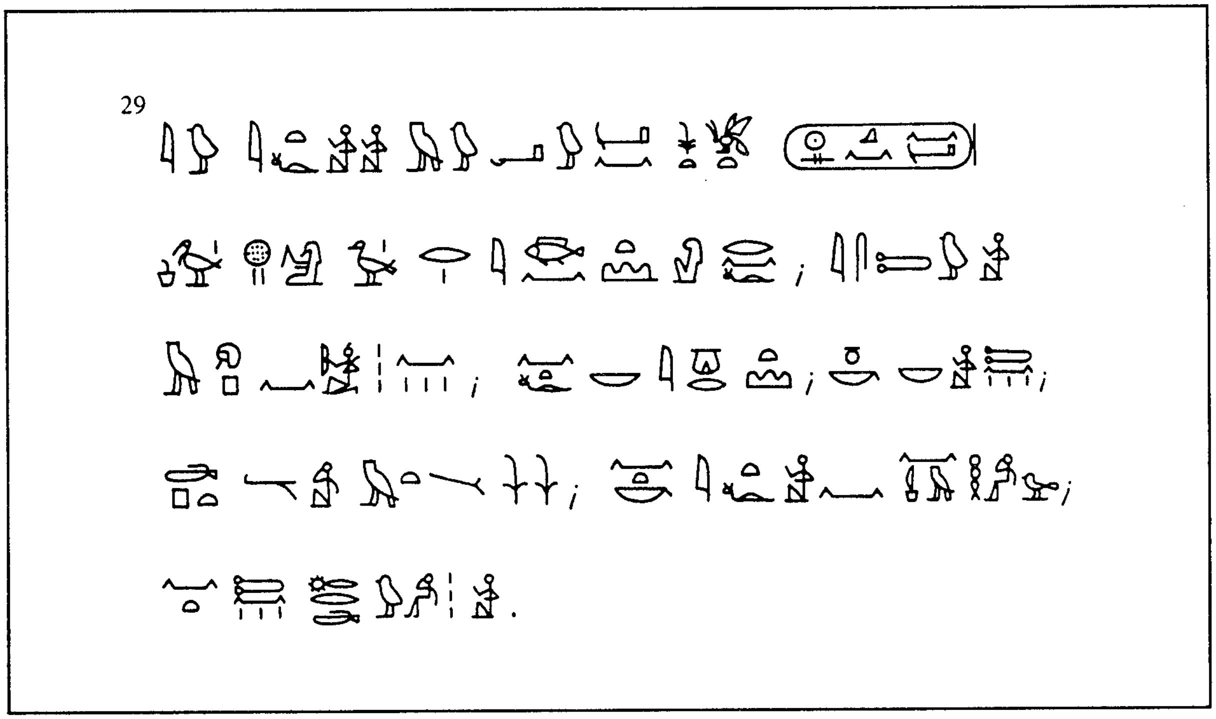



**Figure 6.**

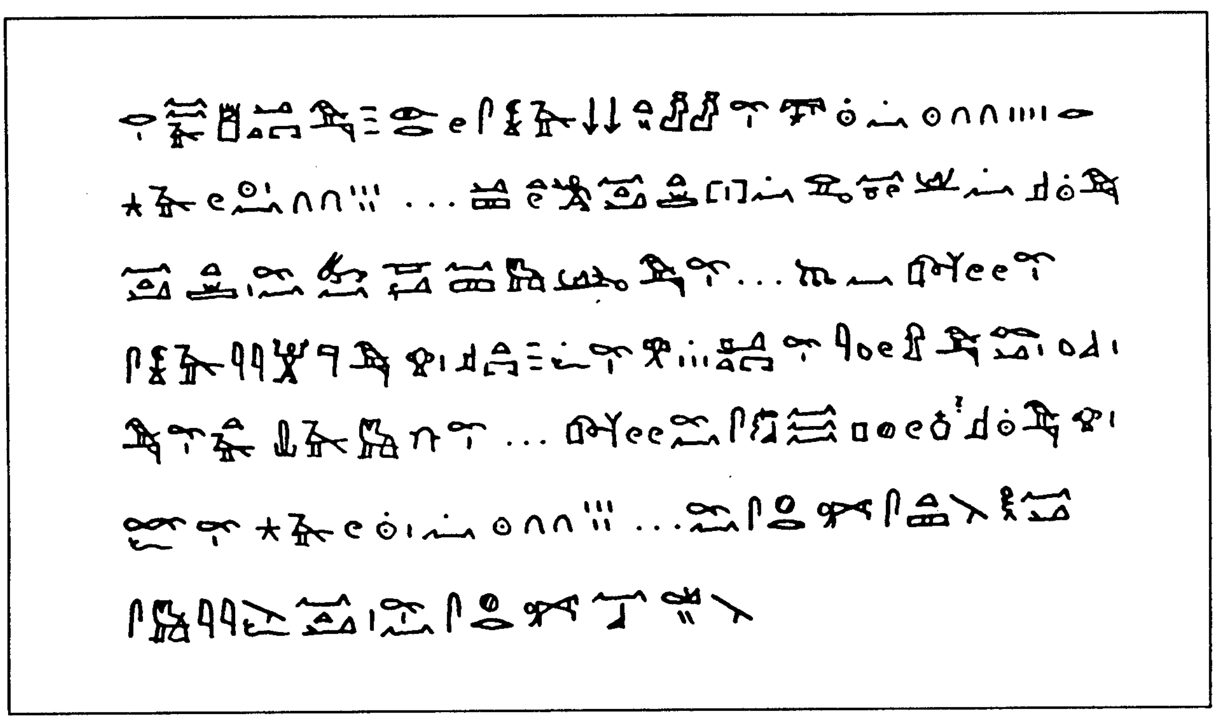


**Figure 7.**

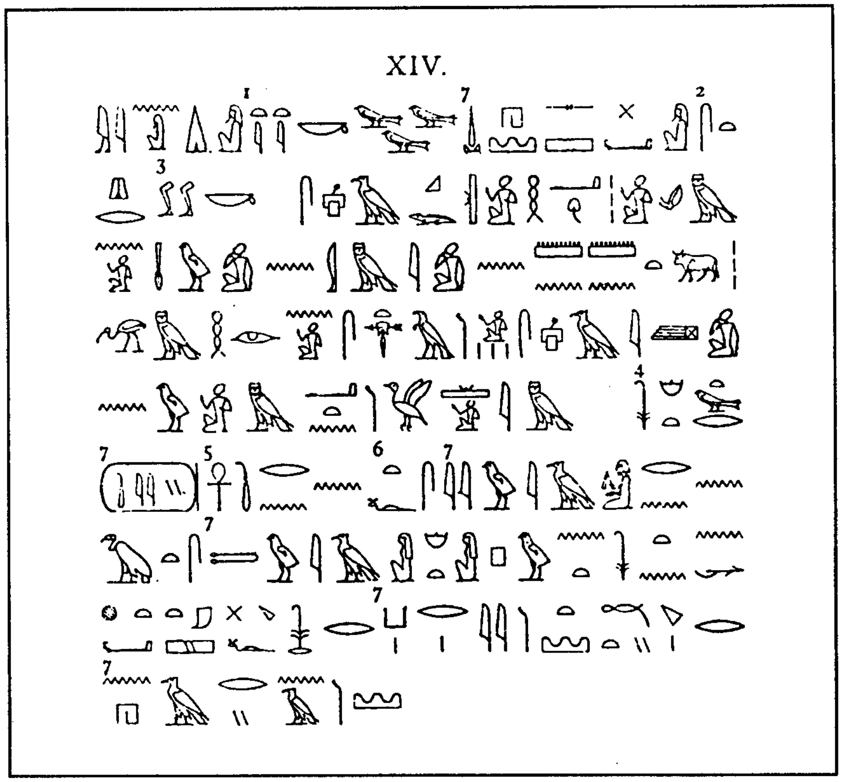



**Figure 8.**

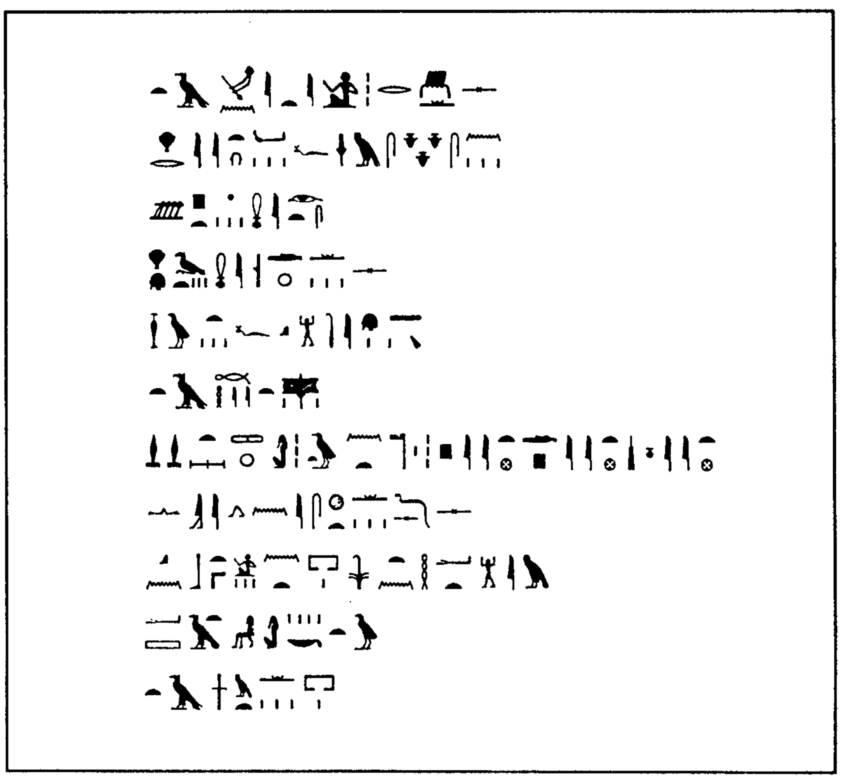


**Figure 9.**

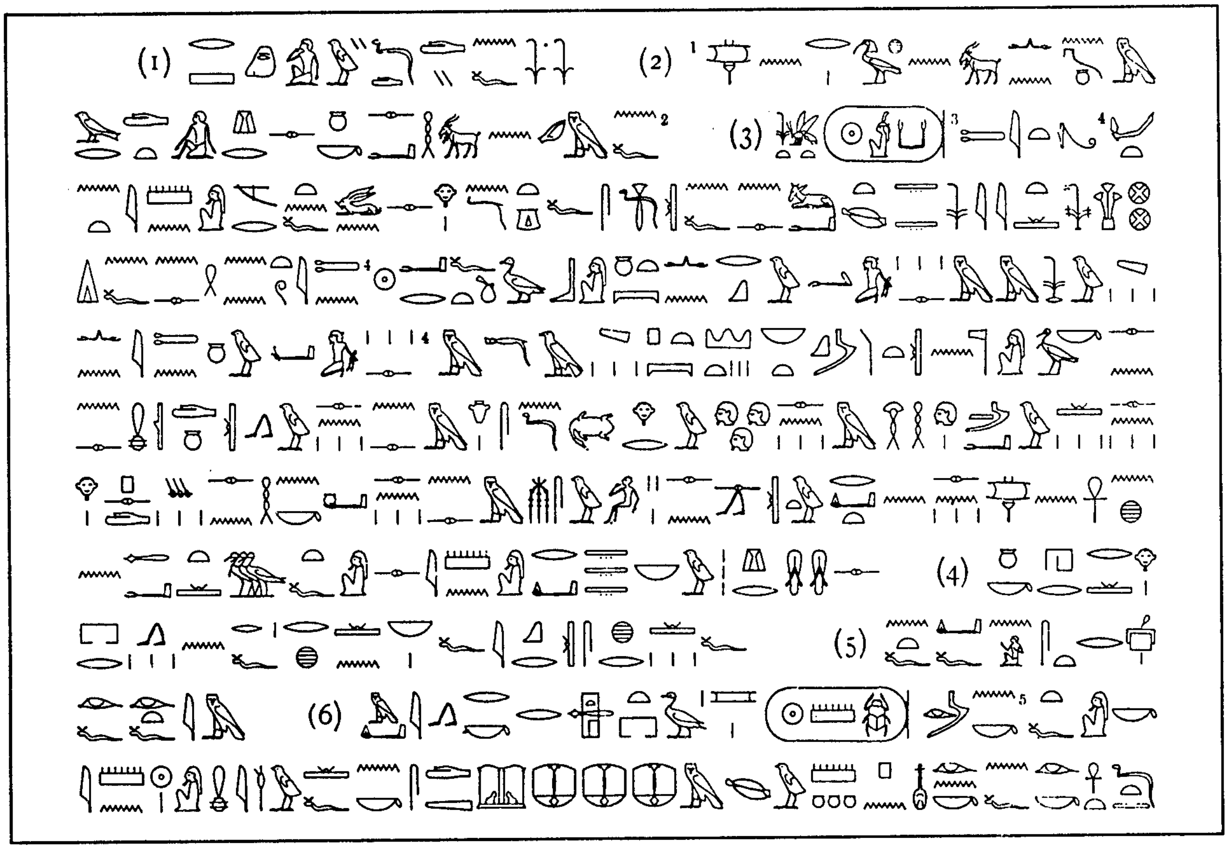


**Figure 10.**

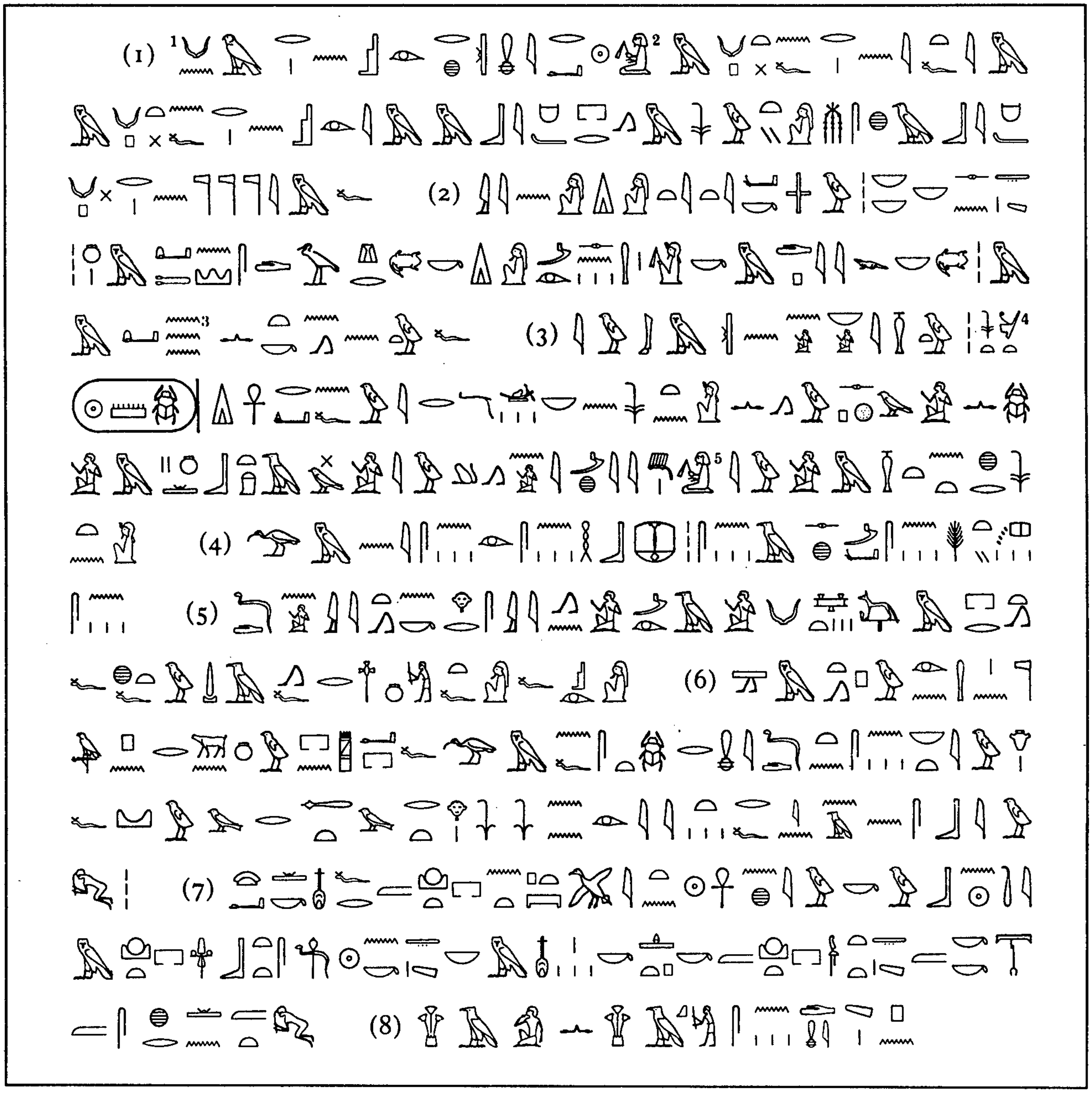
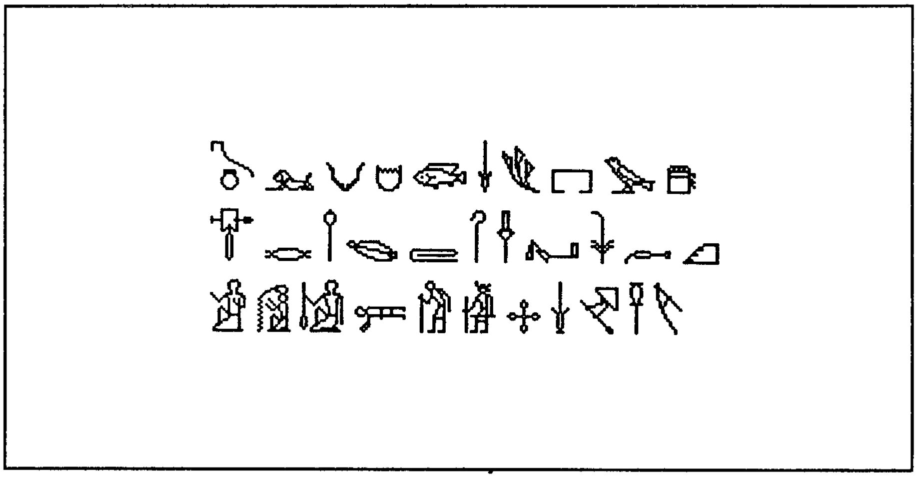
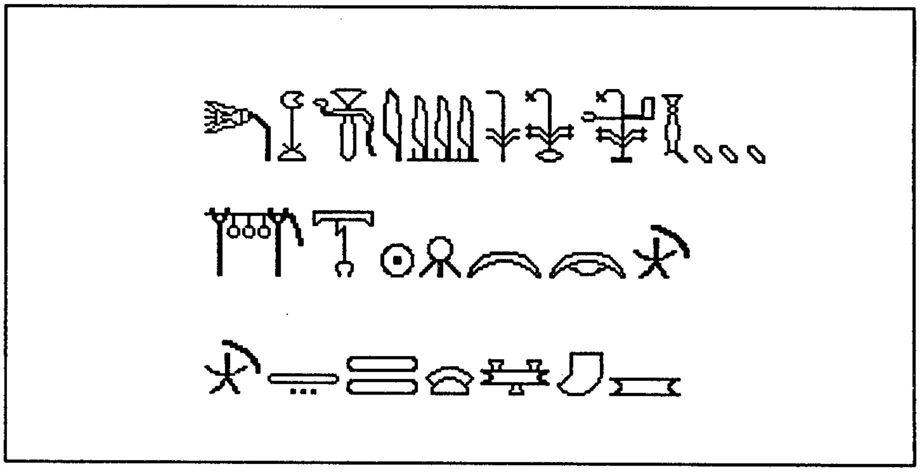


**Figure 11.**

| Hiero. No. | Oxford Code | | 18pt | 15pt | 12pt | 10pt | 9pt | 8pt | 7pt | 5pt |
|---|---|---|---|---|---|---|---|---|---|---|
| E20* | 10/83 | S | | | | | | | | |
| E21 | 7/109 | m | | | | | | | | |
| E22 | 8/116 | t | | | | | | | | |
| E23 | 6/73 | I | | | | | | | | |
| E24 | 10/84 | T | | | | | | | | |
| E25 | 10/85 | U | | | | | | | | |
| E26 | 10/86 | V | | | | | | | | |
| E27 | 10/87 | W | | | | | | | | |
| E28 | 10/88 | X | | | | | | | | |
| E28* | 10/89 | Y | | | | | | | | |
| E29 | 7/110 | n | | | | | | | | |

**Figure 12.**





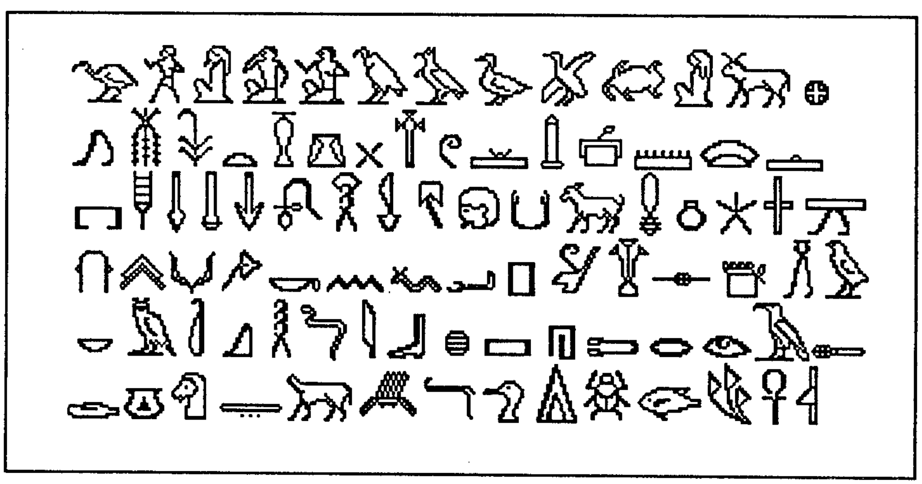


**Figure 13.**

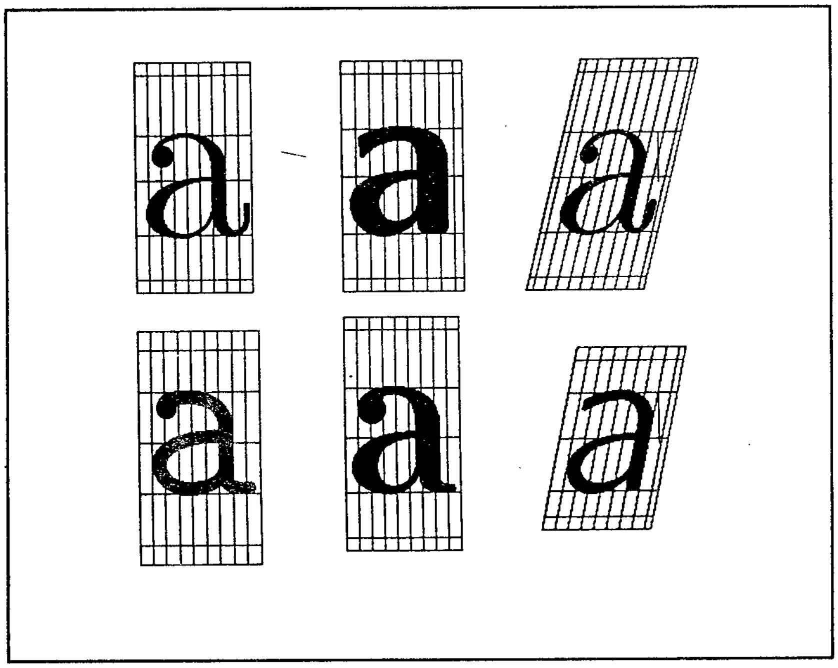


**Figure 14.**

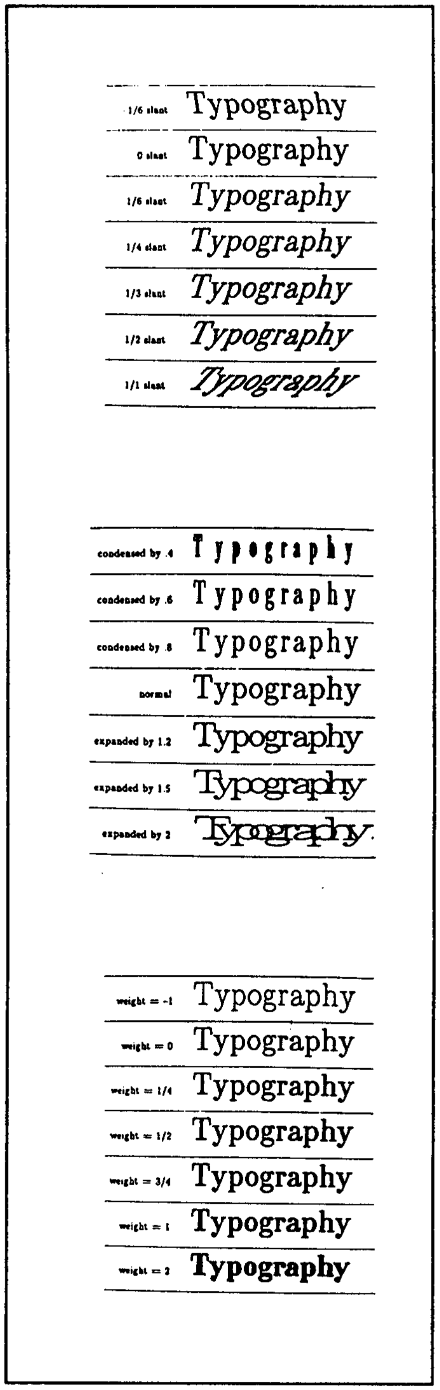

-1/6 slant Typography
0 slant Typography
1/6 slant Typography
1/4 slant Typography
1/3 slant Typography
1/2 slant Typography
1/1 slant Typography
condensed by .4 Typography
condensed by .6 Typography
condensed by .8 Typography
normal Typography
expanded by 1.2 Typography
expanded by 1.5 Typography
expanded by 2 Typography
weight = -1 Typography
weight = 0 Typography
weight = 1/4 Typography
weight = 1/2 Typography
weight = 3/4 Typography
weight = 1 Typography
weight = 2 Typography

**Figure 15.**

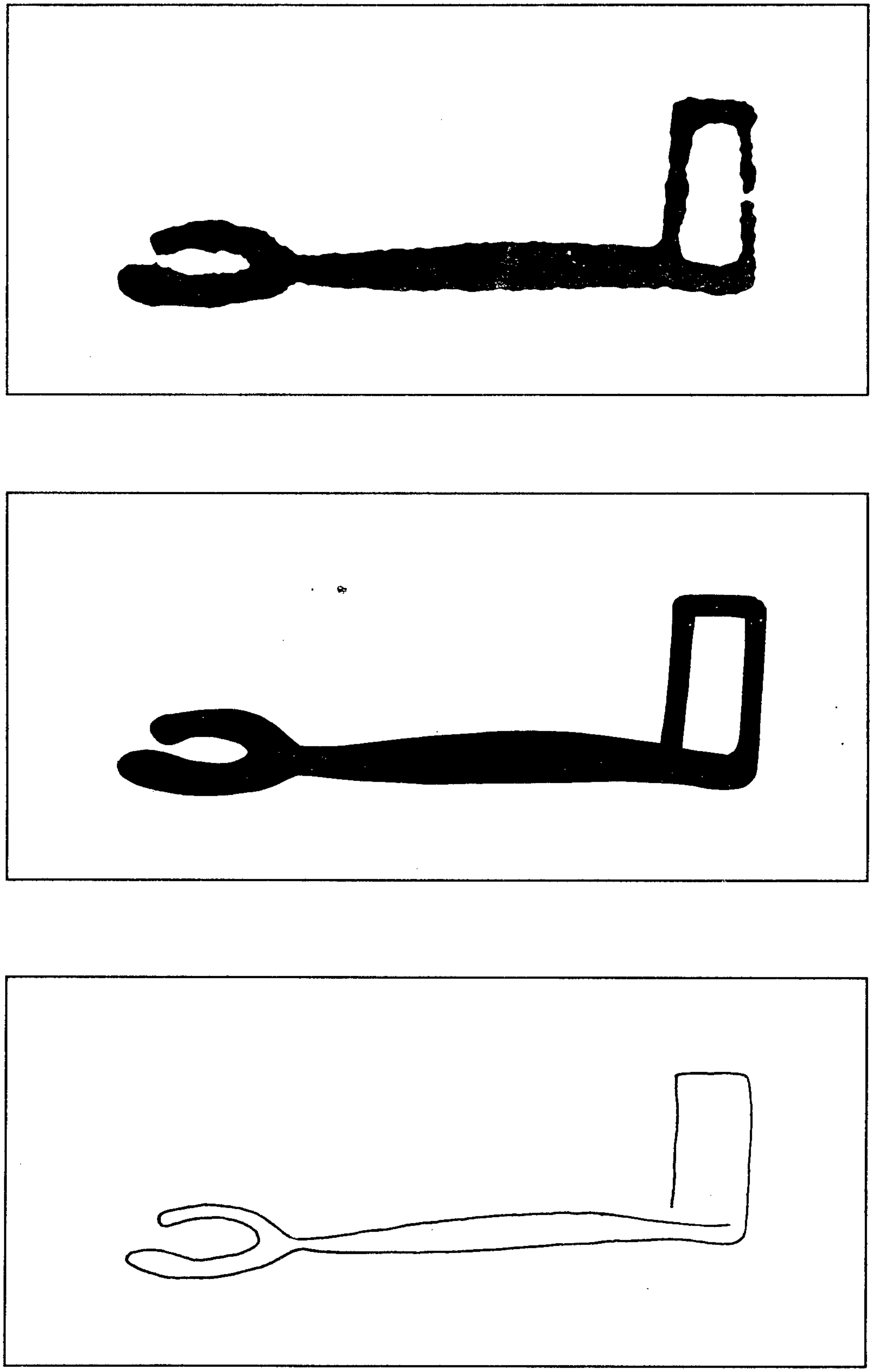


**Figure 16.**

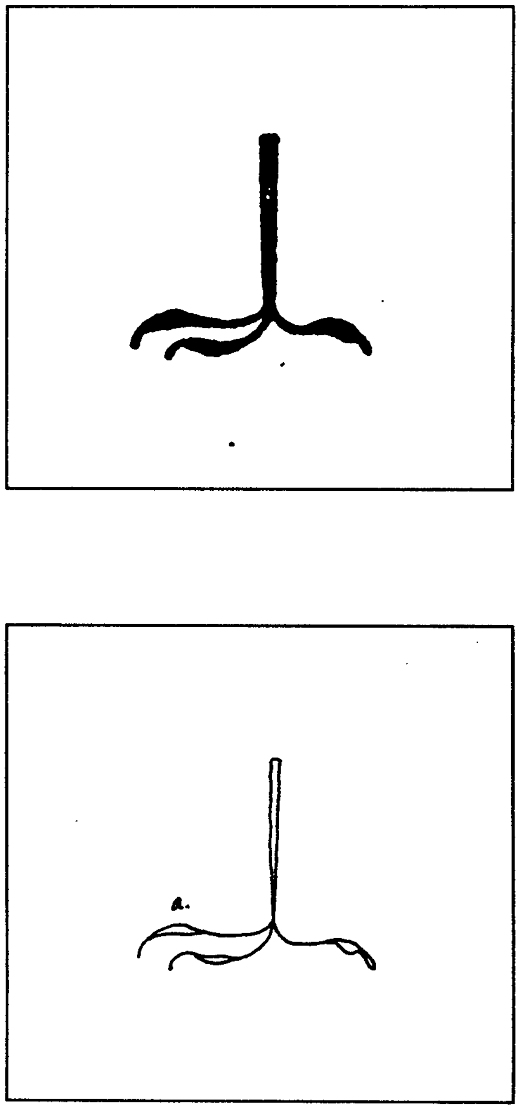



Figure 17.

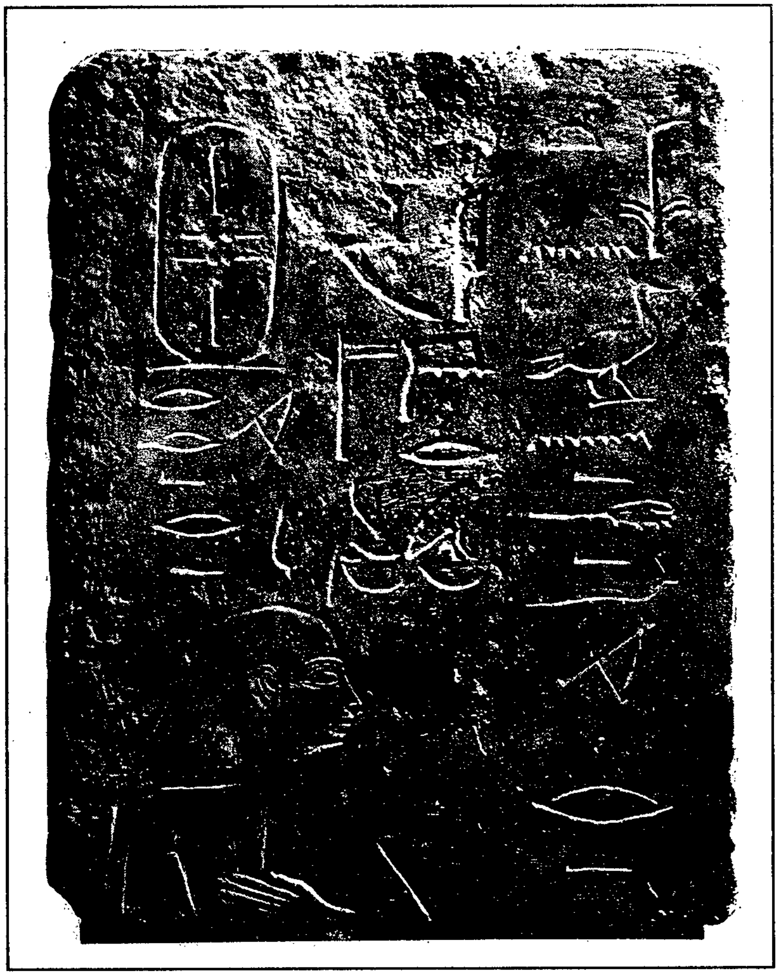


Figure 18.

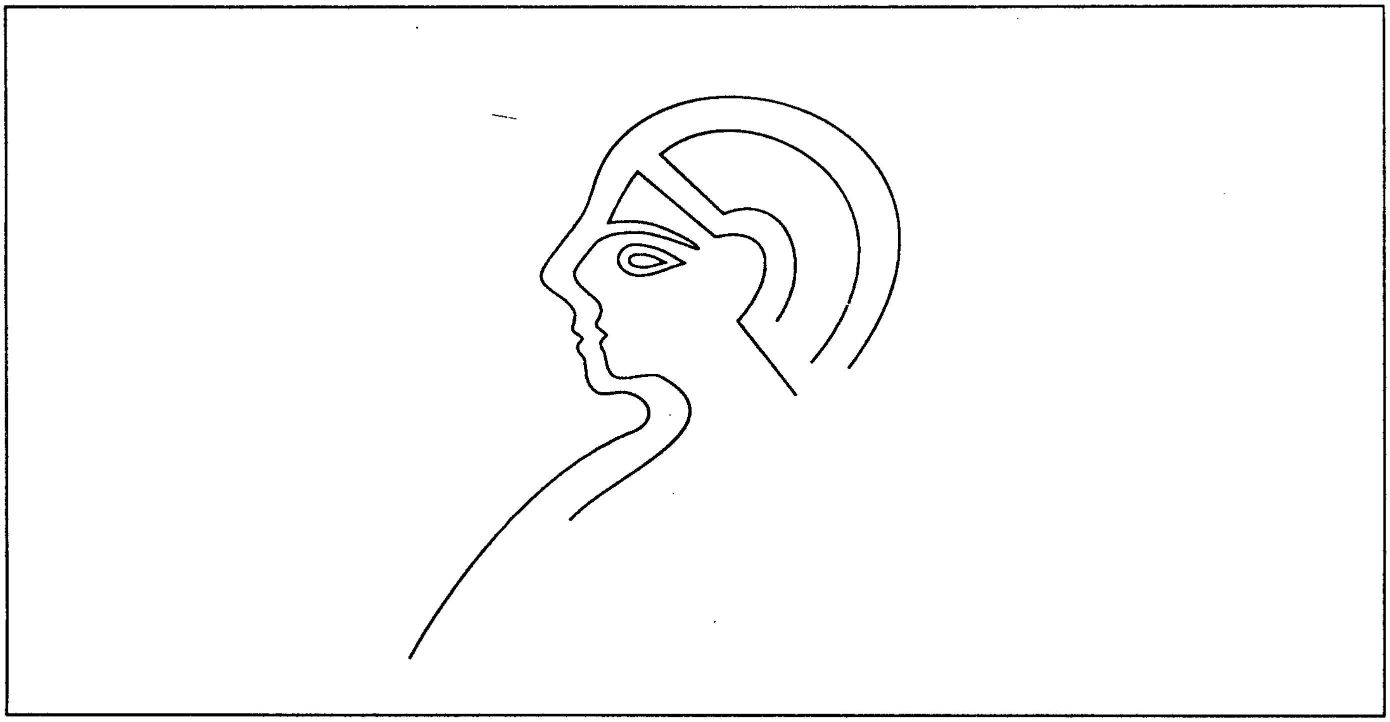


**Figure 19.**

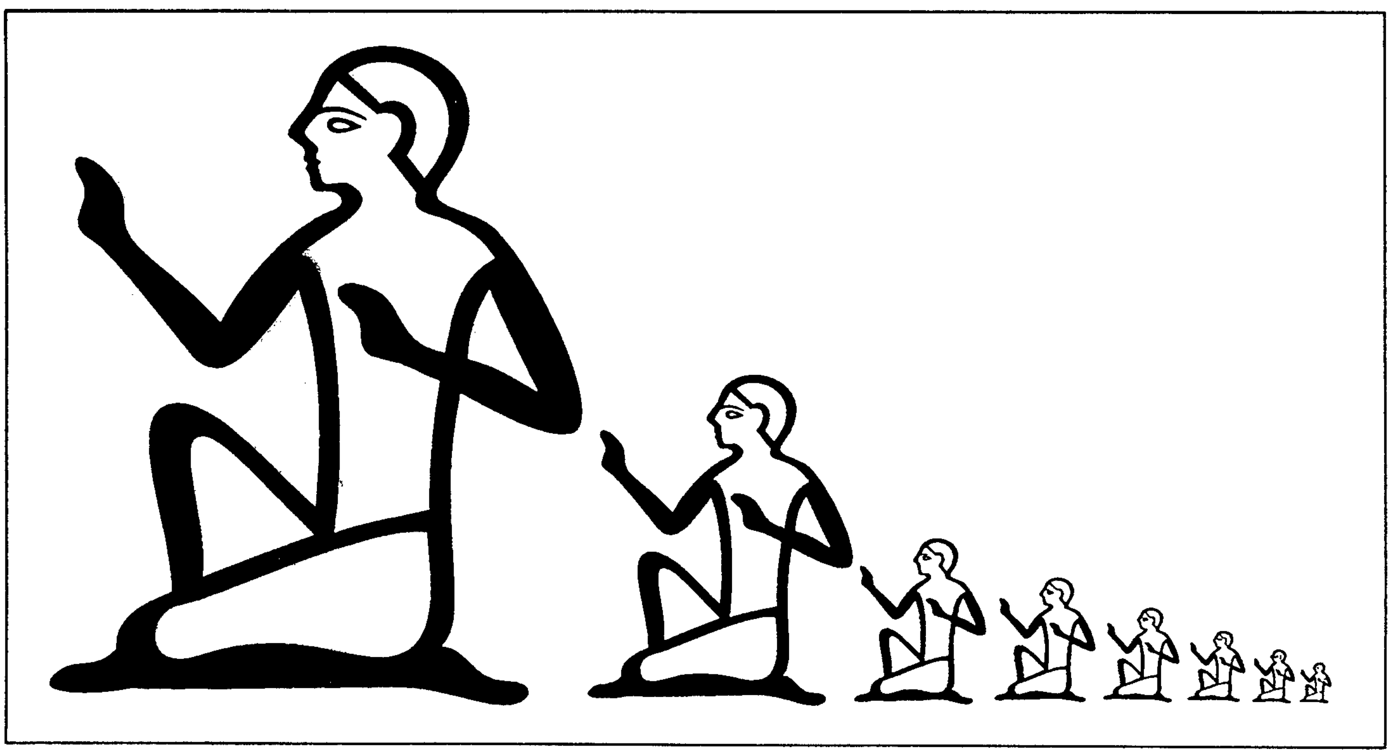


**Figure 20.**

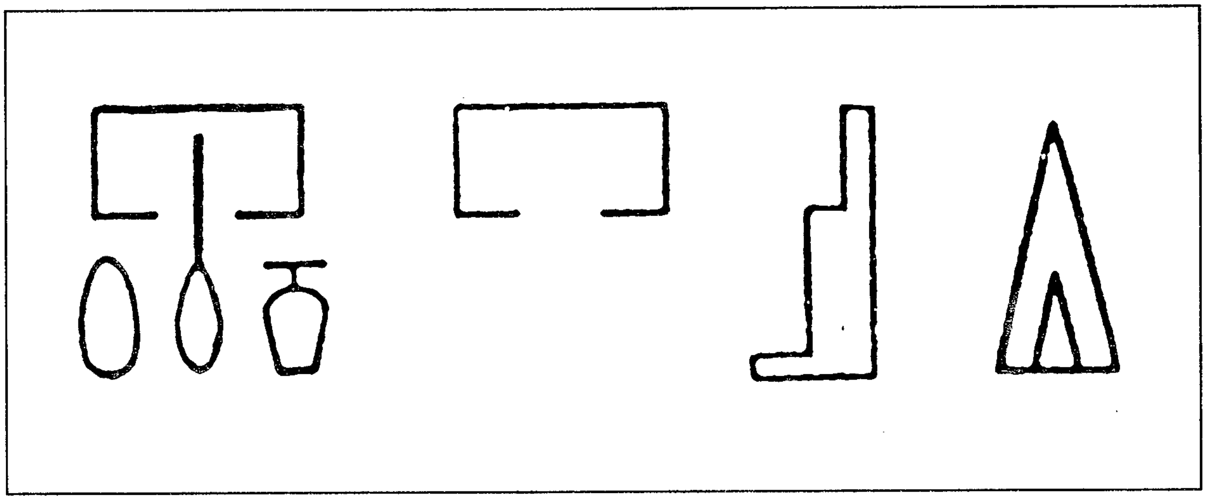


Figure 21.

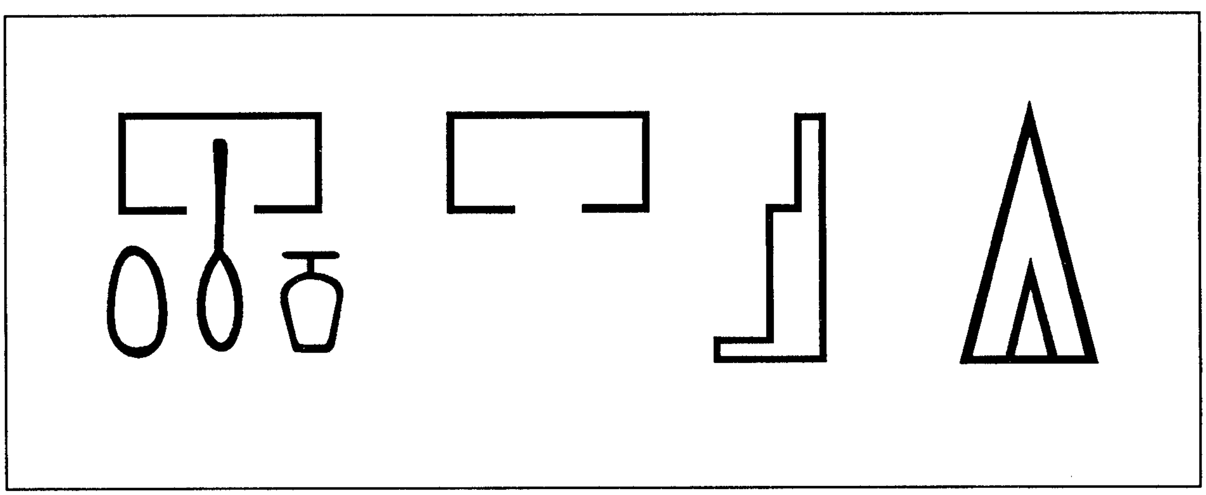


Figure 22.

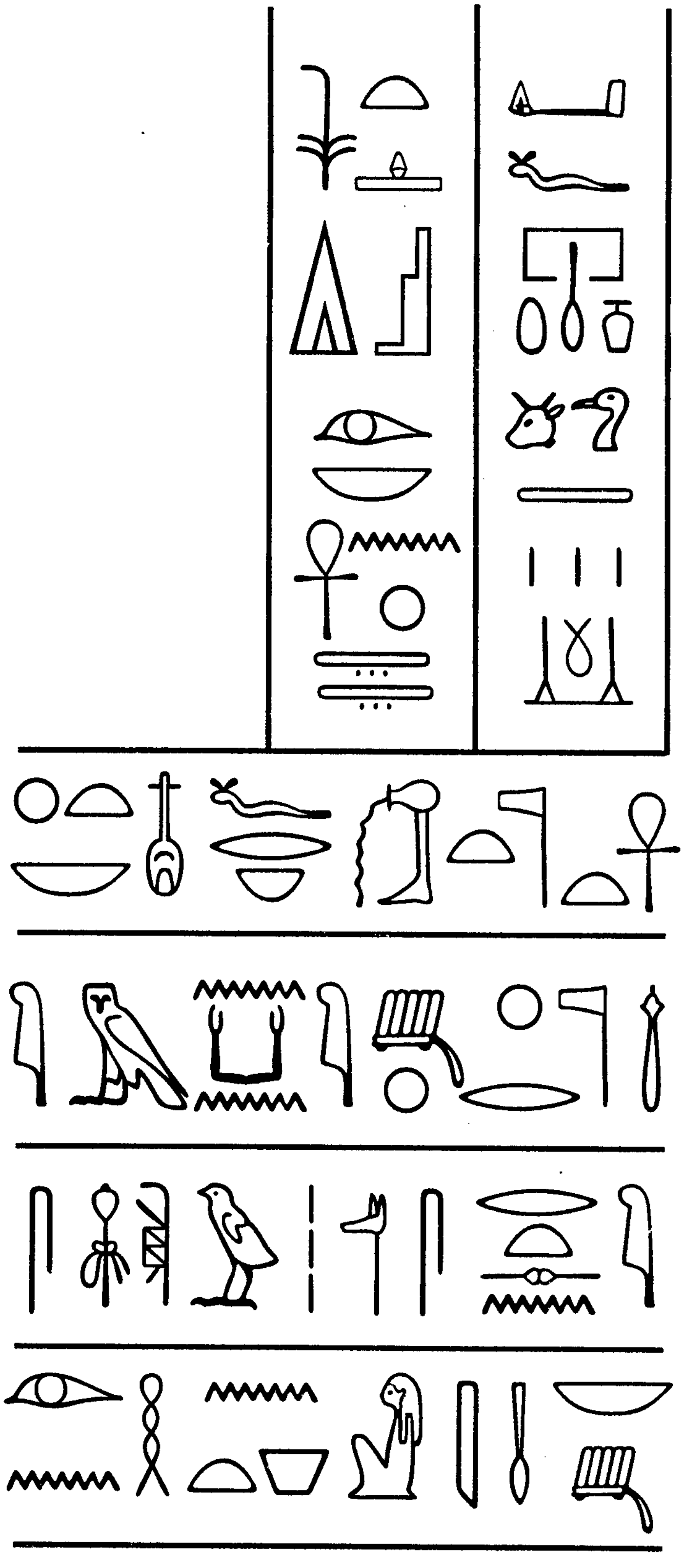


**Figure 22a.**

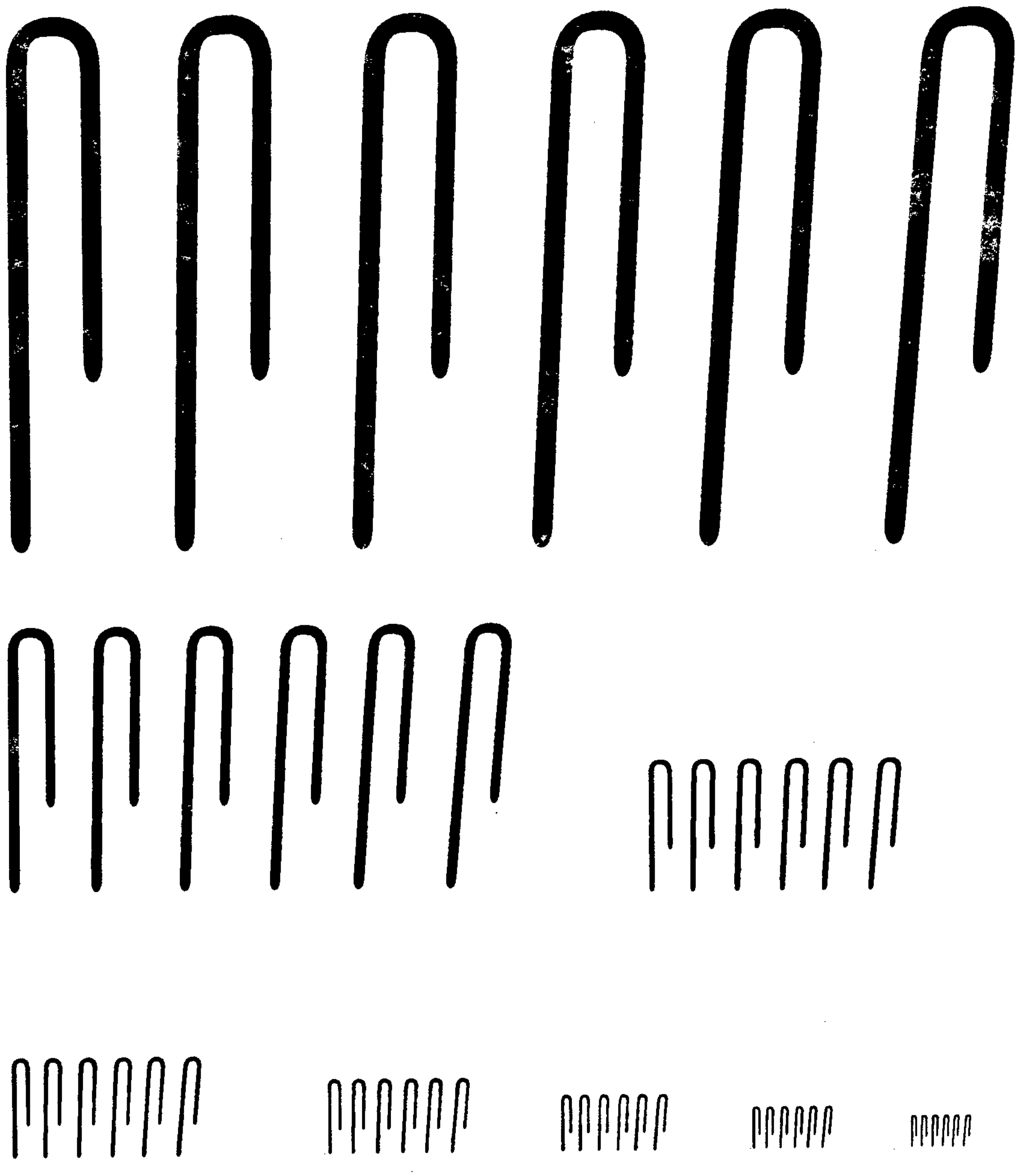


Figure 23a.

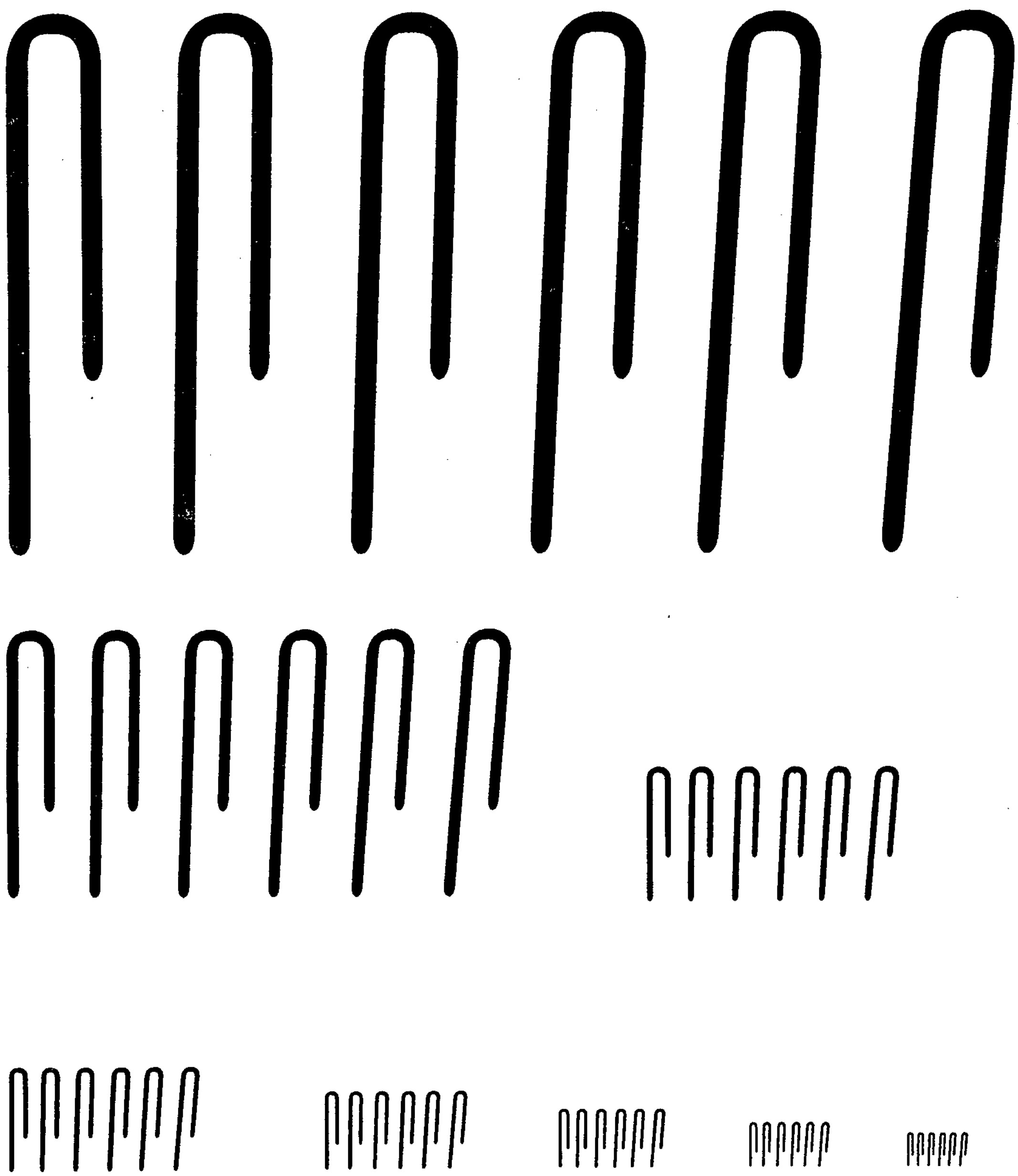


Figure 23b.

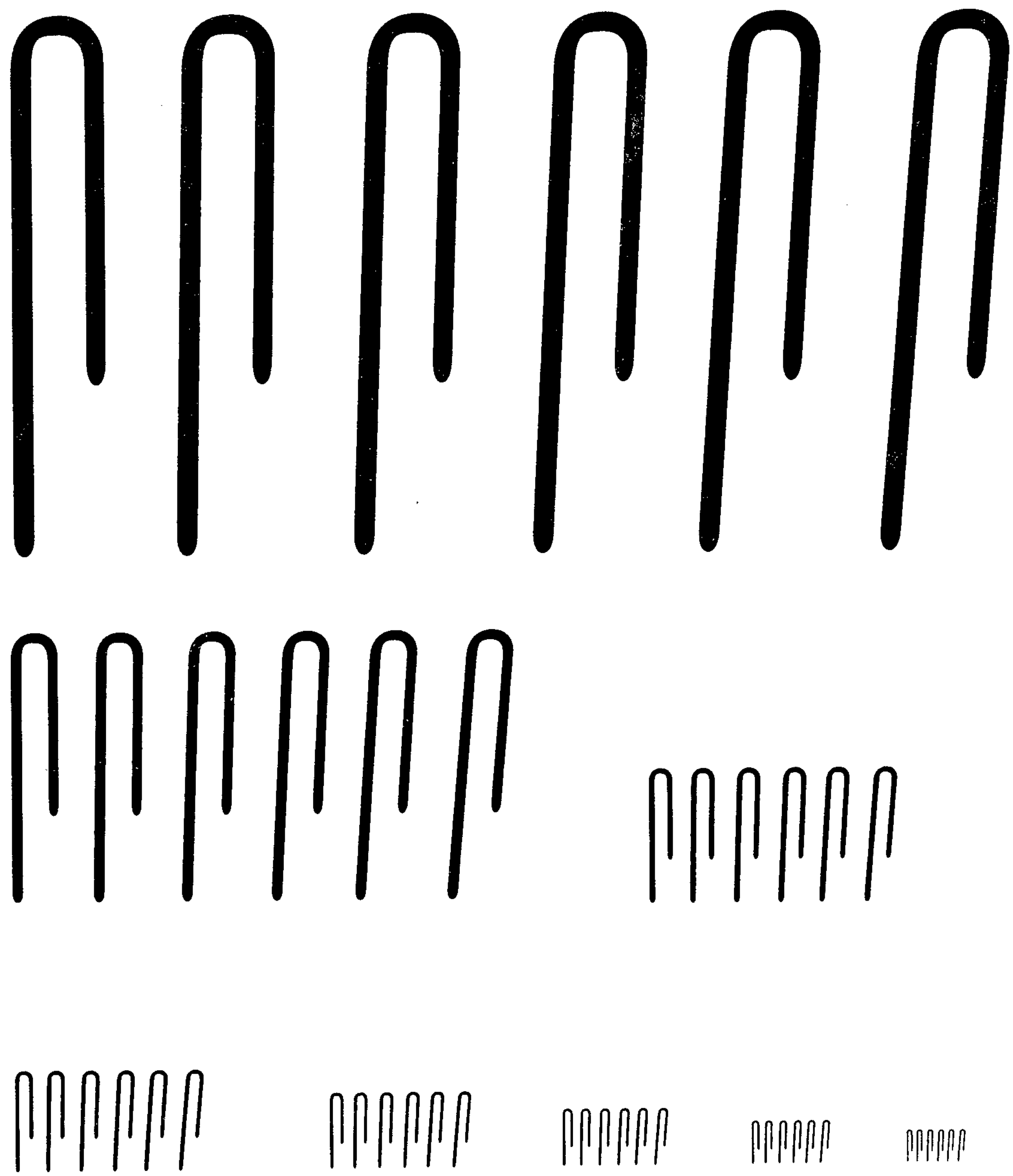


Figure 23c.

# A - Man and His Occupations

| ~ ` | ! 1 | @ 2 | # 3 | $ 4 | % 5 | ^ 6 | & 7 | * 8 | ( 9 | ) 0 | _ - | + = |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | A5 | A6 | A7 | A8 | A9 | A10 | | |

| Q | W | E | R | T | Y | U | I | O | P | { [ | } ] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A11 | A12 | A13 | A14 | A14star | A15 | A16 | A17 | A17star | A18 | | |

| A | S | D | F | G | H | J | K | L | : ; | " ' |
|---|---|---|---|---|---|---|---|---|---|---|
| A19 | A20 | A21 | A22 | A23 | A24 | A25 | A26 | A27 | | |

| Z | X | C | V | B | N | M | < , | > . | ? / | \| \ |
|---|---|---|---|---|---|---|---|---|---|---|
| A28 | A29 | A30 | A31 | A32 | A33 | A34 | | | | |

Shift keys

| ~ ` | ! 1 | @ 2 | # 3 | $ 4 | % 5 | ^ 6 | & 7 | * 8 | ( 9 | ) 0 | _ - | + = |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A35 | A36 | A37 | A38 | A39 | A40 | A41 | A42 | A43 | A44 | | |

| Q | W | E | R | T | Y | U | I | O | P | { [ | } ] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| A45 | A46 | A47 | A48 | A49 | A50 | A51 | A52 | A53 | A54 | | |

| A | S | D | F | G | H | J | K | L | : ; | " ' |
|---|---|---|---|---|---|---|---|---|---|---|
| A55 | A59 | | | | | | | | | |

| Z | X | C | V | B | N | M | < , | > . | ? / | \| \ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

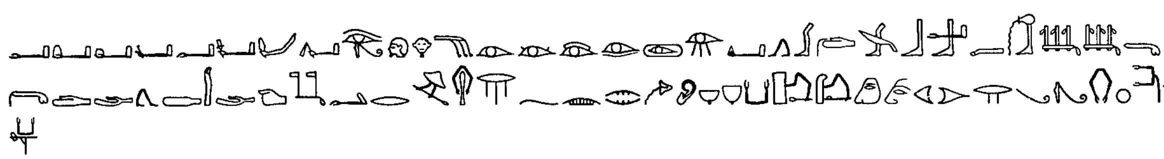
Figure 24.

*Hieroglyphs-A*

*Hieroglyphs-B*

*Hieroglyphs-C*

*Hieroglyphs-D*

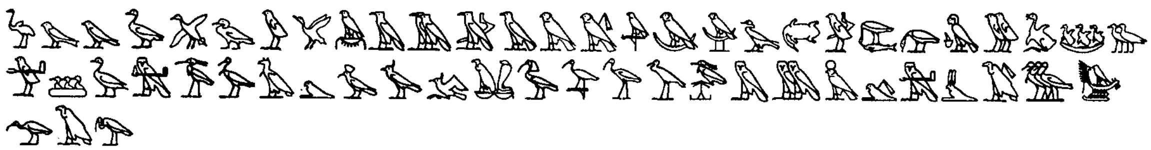


*Hieroglyphs-E*

*Hieroglyphs-F*

**Figure 25a.**

*Hieroglyphs-G*



*Hieroglyphs-H*

*Hieroglyphs-I*

*Hieroglyphs-K*

*Hieroglyphs-L*

*Hieroglyphs-M*

*Hieroglyphs-N*

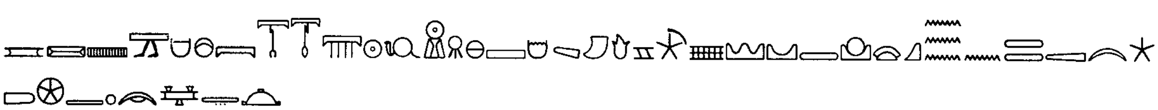
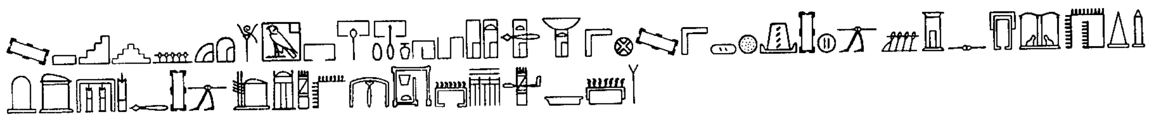


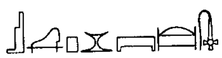
**Figure 25b.**

*Hieroglyphs-O*

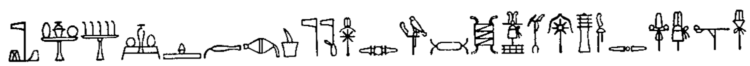


*Hieroglyphs-P*

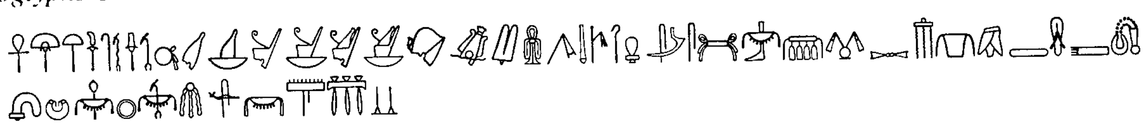
*Hieroglyphs-Q*



*Hieroglyphs-R*



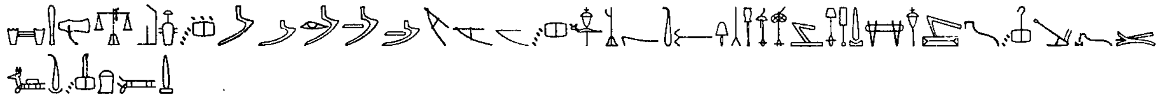
*Hieroglyphs-S*



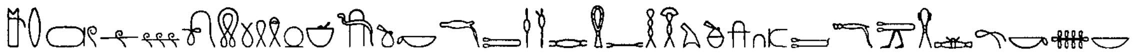
*Hieroglyphs-T*

**Figure 25c.**

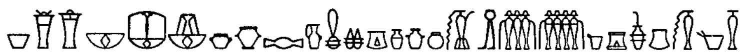
*Hieroglyphs-U*



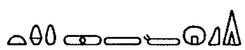
*Hieroglyphs-V*



*Hieroglyphs-W*

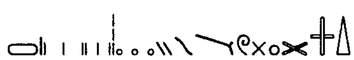


*Hieroglyphs-X*



*Hieroglyphs-Y*

*Hieroglyphs-Z*



*Hieroglyphs-AA*

**Figure 25d.**