THE ORGAN OF :: THE ANCIENTS

FROM EASTERN SOURCES

(Hebrew, Syriac and Arabic)

BY

HENRY GEORGE FARMER, M.A., Ph.D.

Carnegie Research Fellow

WITH A FOREWORD BY

The REV. CANON F. W. GALPIN, M.A., F.L.S.

Hon. Freeman of the Worshipful Company of Musicians

WILLIAM REEVES

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Dedicated to

Robert Sangster Rait,
C.B.E., M.A., LL.D.
The Principal and Vice-Chancellor
of the University of Glasgow.

WHEN I was invited by Dr. Farmer to contribute a foreword to his treatise on The Organ of the Ancients, I accepted the offer with great pleasure, partly because I considered it a privilege and also for the reason that I have for a long time been interested in the early history of the instrument, and more especially, in that of the water organ or hydraulis. During the years 1900-4, stimulated by the researches of M. Clément Loret and Dr. Charles Maclean, I was able, through careful retranslations of descriptions given by Heron, Vitruvius and (for the scale an anonymous classical author), to construct a working model of the hydraulis, taking as its design a representation preserved by a small statuette of the early part of the second century A.D. discovered at Carthage. There is no need for me to describe its details here, for illustrations and particulars of this organ have frequently been published, the readiest to hand being those set out under its name in Grove's Dictionary of Music. With the help of the late Mr. C. F. Abdy Williams, a life-long friend and recognised authority on

1 Recherches sur l’orgue hydraulique. (Extr. from Revue archéologique, 1890.)
2 The Principle of the Hydraulic Organ. (In S.I.M.G., vi, 1906.)
3 Anonymi Scriptio de Musica: Ed. Bellermann, pp. 94-5.
Greek music, we were able to give renderings of original Delphic hymns with voice, *kithara* and *hydraulis* at a lecture in the Fishmongers' Hall, London. The organ with its manual of nineteen keys and three stops, came through the ordeal triumphantly, even in the solo work, and we afforded a practical demonstration of its true principles, dispelling some of the ludicrous theories about its construction which were commonly current. And now having reluctantly, but by the author's desire, said thus much about myself, I turn gladly from personalities to the work which Dr. Farmer is presenting to us.

As will have been observed, the writers consulted by me with reference to this once popular form of organ were those living about the commencement of our present era. From that time, or shortly after, there seems to stretch out a vast silence on the subject; the so-called "Dark Ages" rested like a pall over the scene; knowledge was confined to the few; men were fighters rather than thinkers; and though here and there come glimmers, reflected in Greek and Roman carvings and coins focussed for us by M. C.-E. Ruelle, M. H. Leclercq, and other writers in their published researches, they are not sufficiently clear to give the light we need or the guidance we desire on the upward path of the organ. What was happening to it during the eight hundred years and more ere Western Europe woke to new knowledge? What fresh inventions had been thought out? What new improvements added?

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Yet, notwithstanding the devastating havoc of war, many of the records of the past and passing years were preserved for the day, when, in the Land of the Dawn there arose a brilliancy of intellectual power and scientific inquiry unparalleled save by that of our own schoolmen and gildmasters of the later Middle Ages. From the eighth to the thirteenth centuries this rich and refined culture prevailed over Nearer Asia, as indeed it had flourished there in art and handicraft more than four thousand years before. In those far distant days Sumerian and Semite had delighted in the development and consorts of their lyres and harps, flutes and drums, sistra and timbrels; and now, in newly founded Baghdad, their successors devoted their skill to the perfecting of the like art and practice of music and to the systematic translation of the finest treatises of Greek and Syrian writers obtainable.

Thus they built up a literary fame and constructive reputation which spread not only eastward, but westward to the great trade marts of Constantinople and Venice, and through northern Africa, to the shores of Spain, Cordova rivalling Baghdad in educational and technical prowess. In this way, during those years of western obscurity, the discoveries and devices of the centuries as they sped were preserved to us; but unfortunately in languages inaccessible to most. We have had, it is true, peeps behind the scenes. Since Ugolinus gave us his masterly versions in Latin of the writings of Hebrew rabbis, we have received, within the last hundred years, Kosegarten's rendering of the Arabic master Al-Fârâbî, the work of

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6 See *my Notes on a Roman Hydraulus*. (Extr. from *The Beliquary*, 1904, and *The Water-Organ of the Ancients and the Organ of To-day*. In *The Story of English Music*, 1904.)

6 *Diet. des antiquités grecques et romaines*, iii, art. "Hydraulus" (1900).

7 *Diet. d'archéologie chrétienne et de liturgie*, vii (1), art. "Instruments de musique" (1926).
Foreword.

Kiesewetter, with more recent translations by German savants and descriptions by French writers of modern Arab music, which, however, is a different matter. Yet the many wonderful treasures lying behind the curtained door have remained practically untouched. For, in the unveiling of these valuable heirlooms of the art of music, it is not enough that the student should be a sound oriental scholar, well versed in the language of the old schools; he must also have the practised eye and sense of the antiquary and the trained ear and mind of the musician. It is in Dr. Henry George Farmer that we possess these three requisites happily and effectually combined.

I have for a long time been under an obligation to Dr. Farmer; for his first book (on military music), which is a well used volume on my bookshelf; for his later writings and many of his communications to learned societies, which are known far and wide; and, on this occasion, for his latest work, the pages of which he has kindly allowed me to scan.

I am sure that its readers will be most grateful to him for this new instalment of Hebrew, Syriac and Arabic musical lore in so convenient and comprehensive a form. Many will not be able to test his conclusions by their own intimacy with the languages of which he is a ready master: others, after due consideration, may hesitate to endorse in their entirety the deductions and suggestions he has made; but certainly all cannot fail to appreciate his scholarly translations.

When I had my hydraulis, I badly needed wind "regulators" between the bellows and the stabiliser or compressor, which would have prevented the vagaries of an unsteady blower. In the Măriștus treatise here brought forward by Dr. Farmer we have these "regulators."

We are also indebted to him for having traced the genealogy of the myth of the Hărănut al-Rashid organ in Europe, which is shown to have started with De Genlis. It is now as dead as it can be, and I am glad that he has given it the coup de grace. As for William of Malmesbury, Dr. Farmer's new translation is certainly "up to date" in its hydrostatic force (acqua calefacta violentiam), but it is quite legitimate as a derivative from caldus—"active or excited under pressure."

On the one hand thanking him for exposing absurd and untrustworthy statements, and on the other relying on the trustworthiness of his expert research, I wish to this refreshing and informing book, as it goes forth to the light of day, every success and good fortune. 

Naharak sa'did.

FRANCIS W. GALPIN.

Faulkbourne, Essex.
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INTRODUCTION.

"Ghubār ul-'amali khairun min za'farān il-'ufārūlī."

“The dust of labour is better than the saffron of idleness.”—Arabic Proverb.

QUITE a regiment of historians have already paraded before us the alluring and fascinating story of the “King of Instruments,” and one can therefore presage the interrogation being put, “Why add to the file?” The answer is that the present work does not profess to be a history of the organ, but just simply a contribution towards a particular provenance and period of its history, hitherto unwritten or imperfectly known.

Whilst most of the material offered will probably be quite new to the majority of readers, part of the Hebrew-Aramaic data from the Talmud and elsewhere, has long been known to historians. Yet, truth to tell, not since Ugolinus, in the eighteenth century, has any serious attention been paid to this rather important source. Ugolinus collected the most significant writings on the music of the Jews, with Hebrew texts, in his Thesaurus antiquitatum sacrarum (1744-69). Historians have neglected him, or, at any rate, have not taken advantage of his monumental work. Of course, Ugolinus wrote in Latin, and that may have repelled inquirers. For the first time the present work gives those interested in the question an English translation of all the known references to the ancient organ in Hebrew-Aramaic literature.
Introduction.

In regard to Syriac literature, the materials concerning the ancient organ are scanty. These, however, have also been translated into English, as they do not appear to have been known in this way before, if, indeed, they have ever been noticed.

More important is the Arabic literature, together with the few extracts from Persian and Turkish writers. Much of this is from manuscript sources hitherto untouched. One may even make bold to say that some of the data brought forward in the present work ought to make estimable material for future historians of the organ. The primitive pneumatic organ described in the Arabic treatise entitled The Comprehensive Reed-Pipe Organ, attributed to Muristus, is certainly the earliest example of its kind known to us, and historians have hitherto only surmised the existence of such an instrument. In the Arabic treatise on the hydraulis, attributed to Muristus, we have, for the first time, a specification, together with designs, which, with the help of the descriptions of Heron, Vitruvius, and the Carthage model, ought to be of material assistance to the successors of the Rev. Canon Galpin and the late Dr. Charles Maclean, when a real history of the instrument comes to be written.

Indeed, I believe that serious consideration deserves to be given to the opinion, which I have hazarded, that the Muristus treatise on the hydraulis may be the actual work written by Ktesibios, the inventor of the hydraulis, or an adaptation of it.

Grove's Dictionary of Music and Musicians (third edition, iii, 736) says: "The Organ of the Ancients: From Eastern Sources, . . . by Dr. Henry Farmer (in the press, 1926), is looked forward to as an authoritative treatment of the subject." This statement is likely to cause confusion in the future so far as dates are concerned, as may be seen from a question asked in the Musical Times (1928, pp. 735-6, 833), and it seems advisable, therefore, that I should explain why a work that was "in the press in 1926" was not published until 1930.

The present work was completed in 1924, and early in 1925 it passed into the hands of Mr. William Reeves for publication. Shortly after this, I received a letter from Professor Dr. Eilhard Wiedemann, of Erlang University, congratulating me on my Arabian Influence on Musical Theory, which had appeared in the January issue of the Journal of the Royal Asiatic Society. Correspondence followed, in which I informed him that I had completed a book on The Organ of the Ancients: From Eastern Sources, when, to my surprise, I learned from him that the Bani Musâ and Muristus treatises had been translated into German by himself and Professor Dr. Friedrich Hauser in a centenary volume and in a periodical publication respectively.

Although the Muristus translations had been made in 1918, even Baron Carra de Vaux appears to have been unaware of the fact, since, in his work, Les penseurs de l'Islam (1921), he expressed himself as follows about these Muristus documents: "Ces textes évidemment ne sont pas très faciles; et les figures qui les accompagnent dans les manuscrits sont parfois plus décevantes qu'utilites. Ils sont au reste peu nombreux; et il serait désirable de les étudier et les traduire ensemble, afin d'en
Introduction.

It was, indeed, the very words of Baron Carra de Vaux that originally led me to plan the present work, and it came therefore as a great surprise to me when I found that I had been forestalled in the translation of these treatises. It was my intention to immediately withdraw the manuscript of my book from the publishers, but I deferred to the persuasion of two eminent scholars who had read the manuscript, and urged publication because of the other original material brought forward in my book, and because the Banû Mūsâ and Mūrisṭūs documents would be in English translations. In 1926, on the eve practically of the work being sent to the press, I decided not to publish, as, in spite of the labour bestowed on the work, I did not feel the same interest in publishing since I had learned of the German translations above alluded to.

Mentioning the matter one day to Mr. A. S. Fulton, M.A., of the British Museum, to whom I am indebted for many courtesies, I learned that the Museum had acquired an exemplar of the Mūrisṭūs treatises. In my previous work, the Bairût MS. of Mūrisṭūs, as found in the Mashriq, had been used. The texts were faulty, and I was far from being satisfied with the translations. Professor Dr. Wiedemann had the benefit of a Constantinople MS., although not at first hand, as well as the Mashriq text. A perusal of the British Museum copy soon convinced me that, in spite of lacune, this was perhaps the best. This decided me to reconsider the publication of the Banû Mūsâ treatise, I may say that Professor Dr. Wiedemann's work was not a complete translation. Much of it was an abridgment. This was an additional reason for including this treatise in a complete translation.

It is now 1930, and the printing of the book is nearing completion. I have just received through the courtesy of the authoress, Mrs. Helen Robbins Bittermann, of Columbus, Ohio, U.S.A., two articles published by her in 1929 in Speculum, the journal of the Mediaeval Academy of America, on (1) Ḥārūn ar-Rashid's Gift of an Organ to Charlemagne, and (2) The Organ in the Early Middle Ages. The first of these articles reminds me that in 1927 I sent to Mr. O. G. Sonneck, the editor of the American Musical Quarterly, an article entitled The Arabian Organ in Europe, which was, in fact, a résumé of the last chapter of the present book. The article did not appear, and its receipt was not even acknowledged. Had that article appeared, there would have been no necessity for that of Mrs. Bittermann's, since the latter simply traverses the ground which had already been covered by me, and I had already shown in 1926 (Journal, Royal Asiatic Society, p. 496) that the Ḥārūn-Charlemagne organ was a myth which could not be traced beyond Madame De Genlis.

In her first article Mrs. Bittermann quotes from some of my writings, and says (p. 216): "Farmer erroneously assumes that the Arabs reintroduced the organ into my book, and with the British Museum MS., which had not hitherto been used, I was able to go over the ground afresh, and it is from the latter manuscript that the present translations of the Mūrisṭūs treatises have been made.

As for the Banû Mūsâ treatise, I may say that Professor Dr. Wiedemann's work was not a complete translation. Much of it was an abridgment. This was an additional reason for including this treatise in a complete translation.

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Reference to my Arabian Influence on Musical Theory (p. 5), Historical Facts for the Arabian Musical Influence (pp. 295-7), and the present work (p. 154), will establish that it is actually Mrs. Bittermann who has "erroneously assumed." It was revival of interest in the hydraulis, not in the organ (pneumatic organ) in Europe, that I suggested was due to the Arabs. My critic says that the organ was "not indigenous to the Arab," and for authority for her statement she refers her readers to F. Salvador-Daniel's book translated by me under the title of The Music and Musical Instruments of the Arab (1915) and to the article on "Music" in the Encyclopædia of Islam. So far as Salvador-Daniel or myself is concerned, there is no authority for the statement to be gleaned from us. As for her second reference, the article in the Encyclopædia of Islam has not yet appeared!

In concluding this "Foreword" I would like to say that in several places reference is made to the Yônâniyyân and Ram, who have been made to stand for the ancient Greeks and the Byzantines respectively. It ought to be borne in mind, however, that the terms sometimes refer to the Byzantines and Romans respectively.

A verbal translation of the Arabic documents has been aimed at. In some instances it may be considered that the results have been rather too verbal. My desire has been, however, to convey as faithfully as possible not only the style of the original Arabic, but also the processes of Arabian thought.

The transliterations from the Arabic have been made in accordance with the system approved by the Royal Asiatic Society, and now used generally in most English-speaking countries. There are a few modifications, including the omission of the ligature or logotype for "th," "dh," etc. In Hebrew and Syriac, whilst the conventional method has been followed, there are occasional inconsistencies. The quantities and diacritical points have been omitted in these languages. Whenever I have used the name of a musical instrument or a technical word, I have invariably given the Semitic word in parentheses, but in the singular, even when the text demands otherwise, rather than confuse the reader by the use of the dual or plural.

Finally, I have to express thanks and obligations in several quarters. First, there is a debt of gratitude to my old teacher, the late Dr. T. H. Weir, Lecturer in Arabic at Glasgow University, to be acknowledged. The whole of the Hebrew and Syriac translations are practically his, whilst his help in other directions was considerable. I have also to speak of my indebtedness to Professor D. S. Margoliouth, F.B.A., of Oxford, who read my MS. in its earlier form, and encouraged me to publish, in spite of the disappointment already alluded to. To Professor W. B. Stevenson, D.D., and the Rev. Alexander Moffatt, B.D., of Glasgow, I must record my thanks for generously reading my proofs, and offering suggestions, whilst I have also to acknowledge a debt for several kindnesses to Dr. J. M. Clark, M.A., and Mr. Adam Henderson, B.Litt., of Glasgow University. Finally, I would like to mention that I am indebted to the Carnegie Trust for its beneficence in lightening the financial burden which many of us engaged in research of this nature find a serious impediment.

HENRY GEORGE FARMER.

Glasgow, September, 1930.
CHAPTER I.

THE TERM "ORGAN."

"And his brother's name was Jubal; he was the father of all such as handle the harp and organ."—Genesis iv, 21.

The use of the term "organ" in the Bible has, for many centuries, been the cause of much ink being spilt by historians of music. To them, "organ" meant the "mechanically wind-fed instrument," and for the translators of the Bible to equate the Hebrew word 'ugab with the English word "organ," simply meant to the historians that the translators did not know any better, since the 'ugab has generally been recognised as a "pipe" or "wood-wind" instrument. Yet it is quite clear that the translators of the Bible were fully justified in what they did. Ælfric, Wyclif, Tyndale, Coverdale, and the compilers of the "Great Bible," had all written "organ" before the appearance of the authorised version of 1611. The work of these scholars was certainly based on the Latin Vulgate, for the greater part, and in this latter, organum = 'ugab. We must bear in mind, however, that

\[^{1}\text{Genesis iv, 21. Job xxii, 12, xxx, 31. Psalm cl, 4.}\]

\[^{2}\text{In the Greek Septuagint, organon = 'ugab only in Psalm cl. In Genesis and Job, it equates with psalterion (transposed with kithara) and psalmos respectively. The additional Psalm, cl, certainly has organon, but we do not possess the Hebrew of this}\]

\[^{1}\text{1 2}\]
The Organ of the Ancients.

"organ" had stood for a "pipe" in English from Anglo-Saxon times down to the days of Shakespeare and Milton. The usage had come with the Latin tongue, and we find in Quintilianus (d. 118 A.D.) that organum meant a pipe. With the Greeks also, as may be seen in Telestes (d. 400 B.C.), organon had a similar connotation.

In modern Hebrew, the word 'ugab stands for our present organ or piano, but we cannot argue from this that the same meaning was implied in biblical times. In fact, there are reasons for believing that the modern Hebrew connotation is due to the influence of the Septuagint and Vulgate. Admitted that 'ugab equates with hydraulis in the Talmud and in the Targums of the Hagiographa (third to ninth century), yet this scarcely proves anything more than the fact that the Jews of this period knew of the hydraulis.

Returning to the question whether "organ" stood for a "pipe," there is corroboration from Muslim sources that this was accepted in the East. The old Persian lexicon entitled the Burhān-i qašī says:

"Some say organ (urghanun) is a translation of 'pipes' (mizmūr), meaning all instruments of blowing, and as late as the Turkish writer, Evliya Chelebi (d. c. 1679), the word organ (urghanun) is used in this sense.

Besides meaning a "mechanically wind-fed instrument" as well as a "pipe," the term organon or organum stood, with the Greeks and Romans, for an "instrument of many strings," and also for "any musical instrument." As an "instrument of many strings," the term organon is used by Plato (d. 347 B.C.), and Aristoxenos (b. c. 354 B.C.). The oft-quoted passage in the Deipnosophistae of Athénaios (fl. 220 A.D.), in which the chatty author quotes Aristokles asking "whether the hydraulic organ (or hydraulis) is a stringed (literally 'beaten') or a wind instrument," appears to be explicable only by taking cognisance of the wide use of the term organon.

Athénaios says that the master musical theorist did not know of this point. The work of Aristokles has not come down to us, but we know something of the writings of Aristoxenos. Paul Tannery has shown that Aristokles was contemporaneous with Apollodoros, and must therefore be placed in the second century B.C. Aristoxenos however, lived, in all probability, before the hydraulis was invented, so that he could scarcely have been in any dubiety as to its category. We know that in one place Aristoxenos refers to the trigonon ("an instrument of many strings") as an organon, and this might account for

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The Term "Organ."

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Athénaios says that the master musical theorist did not know of this point. The work of Aristokles has not come down to us, but we know something of the writings of Aristoxenos. Paul Tannery has shown that Aristokles was contemporaneous with Apollodoros, and must therefore be placed in the second century B.C. Aristoxenos however, lived, in all probability, before the hydraulis was invented, so that he could scarcely have been in any dubiety as to its category. We know that in one place Aristoxenos refers to the trigonon ("an instrument of many strings") as an organon, and this might account for

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Archiv für Studium der Neueren Sprachen, xcvi, 32, 17. Bibliothek der Angelsächsischen Prosa, iii, 136. Hamlet, iii, 2. Paradise Lost, vii, 596. J. Schwarzstein (Frankfurt a/M., 1886), page 18, and ii of text. Archiv für Studium der Neueren Sprachen, xcvii, 82, 17. Biblilothek der Angelsächsischen Prosa, iii, 136. Quintilianus, 11, 3, 20. Bergk, Poetica Lyrica Graeci. Jewish Encyclopedia, ix, 432. In the same way, psanter stands for "pianoforte," but this does not help us to interpret the instrument in Daniel, iii. Talmud Yerushalmi, Sukkah, v, 6. Jastrow, i, 305. Some commentators say that the words "stringed instruments" and "organs" in Psalm, el, 4 (A.V.), which translate minim and 'ugab, are misplaced, and that minim should more properly translate "organs." In the second introduction to Mendelssohn's translation of the Psalms, this notion is followed.
The Organ of the Ancients.

the query mentioned by Athenaios, who may have had the word *organon* in mind when he wrote the above passage. That Aristokles should ask the question is quite allowable because what he was probably referring to was not the *hydraulis*, but a *hydraulic organ* of a different kind, which made figures play wind, string and percussion instruments.

The term *organum* was understood by mediaeval Latin writers to stand for something similar, since we read: *Psalterium Rotta is genus organi.* According to the Irish glosses, *organa* stood for *timpanum* and *chithara*. Corroboration also comes from Syriac sources since we know from Isho' bar Bahlul (fl. 963) that the term "organ" (*urganun*) was used for two kinds of musical instruments, a "mechanically wind-fed instrument" and an "instrument of many strings." Here is what he says:

"There are two kinds of organ (*urganun*), of which the first has the shape of a weaver's frame, supplied with many strings, and its sounds can be heard seven stadia distant."

Elsewhere we read that this instrument possessed ten strings. From Arabic sources we may quote from the historian, Al-Mas'udi (d. c. 956), who uses material from an earlier writer, Ibn Khurdadhbih (d. c. 912). He speaks of the Byzantine *urghan* as an instrument of "sixteen strings," whilst the "mechanically wind-fed instrument" is termed the *urghanum*. In the eleventh century *Glossarium Latino-Arabicum*, edited by Seybold, the term *organum* equates with "possessed of many strings" (*dhū awwār kathira*), which reminds us of Plato's *organon polychordon*.1

The term *organum*, used in general for "any musical instrument," may be found in Cato (d. 149 B.C.),2 Lucretius (d. c. 50 B.C.),3 Julius Firmicus (fl. 340 A.D.),4 and St. Augustine (d. 340 A.D.).5 The last named says on this point:

"Organa is the word used for all instruments of music. Not only is that called *organum* which is large, and is inflated by means of bellows, but whatever is adapted to singing, and is corporeal, which he who performs uses as an instrument, is called *organum.*"

In another passage the same author says:6

"This instrument to which bellows are applied, is called by the Greeks by another name, and its being called *organum* is rather a conventional Latin usage."

This passage is rather interesting since it might be hazarded that the "other name" used by the Greeks was *hydraulis*. On the other hand there are two passages quoted by Ruelle which supply perhaps a better clue for this "other name." Here are the two passages:7

"(*Organon*), the 'flute-like,' of. brass, which is called the *megistion organon* (greatest organ), *cheirorganon* (hand organ)."

"Those which are called 'organs,' especially with us at present, the ancients called the *plinthion achordon*

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3 Lucretius, 3, 132.
4 Firmicus, 3, 14.
7 Ruelle, 312. See Leclercq, 1177-8.
The Organ of the Ancients.

(stringless plinthion), and the plinthion auletichon (flute-like plinthion)."

It was evidently the plinth-like form of the organ-case, or the pedestal which supported it, which led to this name being given to the organ by the Greeks.

In Western Europe during the Middle Ages, we have the term organum standing for a particular kind of musical composition. On this question the Persian Burhân-i qātī seems to point to a similar procedure:

"Others say that when a thousand men, old and young, all together, with different sounds, sing to one another something, that state of things they call urghanīn."

Whether the term organum, which stood for a certain species of composition, came into use owing to the fact that this kind of music was played on the instrument called the organum, is not easy to say. At the same time, such a procedure obtained, it would seem, in Syria, in regard to the hydraulis. In Syriac, the latter instrument was called the ḥedhrula, and the Syriac lexicographer, Isho' bar Bahlul (fl. 963) says:

"Hydraules are also the tunes played upon them [the hydraulis]." The Arabic commentary on the passage says that the word means, "The music (ghindī) in them [the hydraulis], or the player (mughannī) on them."

Elias bar Shinayā (b. 975) says:

"Hydraules are kinds of playing that the mukhannathan play."

CHAPTER II.

THE INVENTION OF THE ORGAN.

"Some say this and some say that, but Allah alone knows the truth."—Arabic Byword.

The organ that we now have to consider is the instrument which we Westerners of modern times know by this name. It is the "mechanically wind-fed instrument" known in two forms, (1) the pneumatic organ, and (2) the hydraulic organ. This nomenclature is certainly rather misleading, but it has been in use so long that it is scarcely worth while at this time of day to seek more precise terminology. Both organs are, strictly speaking, pneumatic, i.e., they are made to speak by means of air pressure. The real difference between them is in the method by which the wind supply and wind pressure stabilisation are obtained. Further, two principles are involved in the hydraulic organs. In one, the wind supply is furnished by a hydraulic air compressor, as in the Banū Mūsā instrument. In the other, the wind supply comes from bellows or pistons, whilst the water only plays the part of stabilising the pressure. This is a hydraulic pressure stabiliser as in the hydraulis.1

1 Throughout this work, the term pneumatic organ is used in reference to all mechanically wind-fed instruments where the wind supply and wind pressure stabilisation are furnished by bellows or pistons. The term hydraulic organ is used for any instrument...
The Organ of the Ancients.

Some writers look upon the hydraulis as the earlier type, but this theory is wholly untenable, since there cannot be any doubt that the pneumatic organ has the prior claim. How and where this latter originated, have been variously speculated upon. Two names occur in the Bible as "inventors" of the organ. They are Jubal and David. Added to this we have the claim of the Roman Church that St. Cecilia has this honour.

According to Genesis (iv, 21), Jubal "was the father of all such as handle the harp and organ." So runs the English "Authorised Version" and almost every other translation, where "organ" stands for the Hebrew 'ugab, a word which, as we have already seen, represents an instrument of the wood-wind family.

David's claim as an organ inventor has its authority in the additional Psalm cli of the Septuagint. Here we are told that David "fashioned" an organ (organon), but since we have no Hebrew original of this part of this psalm, we cannot say which type of instrument is intended, especially when we take into consideration the various words which organon stands for in the Septuagint. David had an inordinate reputation among the Jews in matters musical, and he was recognised as an inventor of musical instruments quite apart from the testimony of this psalm.

Rabbinical lore has heightened this esteem, and even the Arabs became infatuated with this laudation of his musical gifts. In this connection there is a Muslim tradition which runs:7

"The organ (urghanun) is an old invention, and it is said that formerly David accompanied his psalms with it . . . . David invented this instrument (at Edessa)."

The St. Cecilia claim is almost as legendary. This "Patron Saint of Music" lived in the second century A.D., long after the invention of the organ. Some people have suggested that it is merely the small portable organ that is referred to here. So far the imagined inventors of the organ.

Although history tells us nothing about the inventor of the organ, we can be reasonably sure of the process of its invention. Kathleen Schlesinger, in her Researches into the Origin of the Organs of the Ancients, says that the "essentials" in the instrument are: "(1) a set of reeds or pipes of various lengths; (2) a contrivance for supplying the pipes with wind and thus enabling them to speak; (3) a system for controlling the distribution of the supply of wind separately to each of the several pipes." The first had its prototype in the ordinary reed-pipe and Pan-pipes. The second was suggested by the bagpipe and the bellows. The third was a question of mechanics. All these requisites may be traced back to the very dawn of civilisation in Babylonia-Assyria and Egypt. When it was precisely that the "restless intellect of man" conjured all these "essentials" together in a primitive organ, we do not know. All that we can be sure of is that it was long anterior to the fourth century B.C., a period when

where the wind supply comes from a hydraulic air compressor, whilst the term hydraulis is reserved for the instrument furnished with a hydraulic pressure stabiliser.

6 Qur'an, xxii, 79; xxxiv, 10; xxxviii, 17. Kashf al-mahjub, 402. Al-Tabari, i, 423.
6 Qur'an, xxi, 79; xxxiv, 10; xxxviii, 17. Kashf al-mahjub, 402. Al-Tabari, i, 423.
7 Evliya Chelebi, i, ii, 226. 4 Schlesinger, Researches, 168-70.
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We have definite knowledge of organs in an advanced stage of construction.

The late Dr. Charles Maclean, who wrote an able essay on the ancient *hydraulis*, postulates three distinct stages of organ blowing. Under this heading he says: 9

"The first stage in supplying it (the wind) is, when a man either steps on to a blast-bag and so puts his weight, or else applies his hands thereto and so puts his muscular force, to expelling the enclosed air at an increased pressure; he then gives wind directly proceeding from his own exertions, and so varying in pressure, to the speaking pipe. The second stage is when natural inanimate weights are fixed at the summit of the slanting top of a framed blast-bag (diagonal bellows'), and the man's action consists in periodically lifting the weighted frame by lever, pulley, etc., so that the weights can act; here it is a natural inanimate weight which gives unvarying pressure of wind to the speaking pipe, and the only drawback is stoppage of continuity of supply at the moment the weights are raised—which obviated by multiplying and alternating the weighted blast-bags. The third stage is when the weights are placed on the flat top of a separate distensible and collapsible air-reservoir (horizontal bellows'); then the action is as before, only that the feeder being now a distinct apparatus and feeding through a non-return valve, all lack of continuity also is avoided. These three stages have always (? H. G. F.) overlapped, and been thoroughly concurrent with each other."

This classification is, on the whole, fairly satisfactory, but, it has already been pointed out, 10 there may have been an earlier application of the methods of the first stage, where the blast-bag was inflated by the mouth. That this conjecture is correct, will be demonstrated presently from Arabic sources.

About the fourth century B.C., another method of "winding" the organ was introduced. This was the first *hydraulic organ*. In this the air was forced into the sounding-pipes by the flow of water, and it is this instrument that has been confounded with the *hydraulis*, a totally different instrument. Warman, for instance, tells us that Plato is credited with the invention of the *hydraulis*, but that the attribution is false because "this organ (of Plato's) was not a real hydraulic (= *hydraulis*), for the water was employed by Plato to cause its gravitating power to set in motion an ordinary fold-made or pneumatic bellows." 11 This description of Plato's instrument is rather fantastical. Athenaios is the sole authority, and his words imply no such interpretation. Athenaios distinctly states that "Plato had an idea of this type of instrument, since he had made a night timepiece something like a *hydraulis*, being similar to a large *klepsydra*, and the *hydraulis* [i.e., *hydraulic organ*] seems to be a kind of *klepsydra*." 12 The Plato timepiece was clearly a *klepsydra* which sounded the hours by means of a flue-pipe or pipes through the action of hydraulic air compression. 13

The Plato claim for the "invention" of the organ is also to be found in the Persian *Burhan-i qaṭī*'. 11

9 Maclean, 211.
11 Warman, 38.
12 Athenaios, iv, 76.
13 For a discussion on the Plato instrument, see Diels, *Über Platons Nachthyr* (Sitz. der K. P. Akad. der Wiss., 1915, page 82).
14 *Burhan-i qaṭī*, s.v. From Greek sources we know little or nothing of Plato's musical abilities, but from an Arabic author, Ibn al-Qifti, we learn that Plato studied music in his youth and wrote on the subject.
The Organ of the Ancients.

"The organ (urghanun, urghanun) is that instrument which the Europeans (Rumiyan) play, and Plato is the inventor of it."

The authority for this is probably an Arabic one, although I have been unable to trace it. Aristotle (fl. 344 B.C.) is also mentioned as the inventor of the organ, but by Muslim writers, so far as I am aware. The famous scientist, Fakhr al-Din al-Raji (d. 1209) says in his Jam' al-'ulum:

"The world-master Aristotle (Aristatallis) arrives, and the organ (urghanun) is made."

Three hundred years later, the Turkish bibliographer, Hajji Khalifa (d. 1658) tells a similar story in his Kashf al-zunan ("Doubts Cleared up"). He says:

"After him [Pythagoras] other wise philosophers added to what he had invented, until the turn came to Aristotle, and he conceived and constructed the organ."

How Aristatallis, Aristatallis, or Aristu, as he is variously designated by Muslim writers, came to have this "invention" tacked on to his name is not easy to say.27 Classical authors, whose works have come down to us, do not mention it. Aristotle's Mechanika (a pseudograph), known in Arabic as the Kitab al-jiyal, was possibly one of the earliest works on mechanics known to the Arabs. This may have led them to ascribe so novel a contrivance as the organ to the Stagirite. Further, the name Aristu could easily be confused with Aristu (Muriustus), who is claimed to have been the inventor of the organ or a writer on the subject of its construction, as will be shown later.

The Invention of the Organ.

Archimedes (d. 212 B.C.) is mentioned by Tertullian as the inventor of the organum hydraulicum.28 This statement has led Warman to assert that "the first or true inventor of the actual hydraulic organ (= hydraulis) was undoubtedly the celebrated Archimedes."29 The facts of the case are such, however, that this certainty will not bear close scrutiny. One may perhaps say quite safely that the hydraulis can scarcely be older than Archimedes, seeing that he was the creator or systematiser of the science of hydrostatics, but this alone hardly warrants us in concluding that he was the "inventor" of the hydraulis.

Most historians of the organ, from the time of Vossius (1673)30 to Degering (1905),1 have repudiated the Tertullian claim. Probably the repudiation is quite proper, if the hydraulis itself is meant, although it would seem that Archimedes may have some claim as the inventor of another type of hydraulic organ. A Byzantine writer named Zosimos (fl. 408-50 A.D.) has a significant phrase which may be turned to account. It runs: τα πνευματικά 'Αρχιμήδεων.31

The Arab polygraph Al-Jahiz (d. 868) also mentions Archimedes in such a way that might suggest some reason for the claim. He says: "What a distance! Archimedes (Arshakanus) to Muriustus!"32 This Muriustus, as we shall learn presently, was the name of a Greek savant who is claimed in Arabic works to have been the inventor of the hydraulis, and a writer of works on organ construction. Strange to say, Archimedes is credited by the Arabs with the invention of the klepsydra,4 and we have seen that the

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25 Fakhr al-Din al-Razi, folio 154 v. 26 Hajji Khalifa, vi, 288.
27 The klepsydra was certainly known in Aristotle's day. See Problems, xvi, 8.

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18 Tertullian, De anima, xiv. 19 Warman, 38.
20 Vossius, 107. 1 Degering, Die Orgel.
1 Rueff, 312. 5 Al-Jahiz (Cairo edition), 133, 143.
4 Carra de Vaux, Notice sur deux ms. arabes, 295.
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klepsydra has been confused with the hydraulic organ or hydraulis.

There exists in Arabic a treatise attributed to Archimedes which describes a klepsydra in which a small flue-pipe (saffāra) is sounded by hydraulic pressure, whilst another treatise of his deals with an automatic wind instrumentalist (alat al-sāmīr) in which a flue-pipe (saffāra) or reed-pipe (samr) is wound in the same way. These works have only survived in Arabic, and it is highly probable that it was such treatises as these that led to Archimedes being credited with the "invention" of the organum hydraulicum, which is not necessarily the hydraulis.

Apollonios of Perga (fl. 247-205 B.C.), called by the Arabs Abūnīyūs, Abūnīyūs, Balūnīs, and Balūnās, is credited with the authorship of a work on an automatic wind instrumentalist entitled San'at al-zamīr ("Construction of the Wind Instrumentalist"), which has only come down to us in an Arabic version. It may have been translated by one of the Banū Mūsā (Muḥammad, d. 873), Hilāl ibn Abī Hilāl (d. c. 883), or Thābit ibn Qurra (d. 901), who translated his Conic Sections. The instrument described is an hydraulic air compressor. Water pours into a cistern hitherto filled with air. The rising water compresses the air in a wind chest, which makes a sounding pipe (nāy) speak.

In the third century B.C., an improvement was made in stabilising the wind pressure of the ordinary bellows or piston-blown organ. Instead of the pressure stability being maintained by horizontal bellows as in the third stage mentioned by Dr. Maclean, water was used for this purpose, hence the term hydraulis being given to the apparatus. Its inventor is generally supposed to be Ktēsibios (fl. 246-221 B.C.). The claim rests mainly on the testimony of Athēnaios. Paul Tannery has carefully sifted the evidence, and he has demonstrated that Ktēsibios must have lived under Euergetes I (246-221 B.C.), and not under Ptolemy Euergetes II (146-116 B.C.) as Athēnaios thought. Chappell says that not only Athēnaios, "but also Vitruvius before, and Pliny after his time, unite in ascribing it to Ktēsibios, as do all earlier writers." Chappell also alludes to the epigram of Hedylos in which, he says, there is mention of the "hydraulic organ (= hydraulis), and to Ktēsibios as its inventor." The Pliny evidence is scarcely valid, since the writer refers to hydraulic machines in general. The "earlier writers" mentioned by Chappell are Hedylos and Philón, but this evidence is valueless. Hedylos simply tells us that Ktēsibios constructed a rhyton in a temple dedicated to Arsinoe Zephyritis. This rhyton was not an hydraulis, but a cup which emitted a musical sound, probably worked on the principle of the Archimedes organon hydraulikon, which was a hydraulic air compressor, or one of the whistling instruments mentioned and described by Philón and Herōn. Chappell

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5 British Museum MS., Or. Add. 23301, folio 20 v. For a description of another exemplar of the MS. see Carra de Vaux as quoted above, and Wiedemann's Byzantinische u. arabische akustische Instrumente, 145, and his Übr des Archimedes, 109, 104.
6 The first is the form in the British Museum MS. quoted above.
7 It is described by Carra de Vaux, op. cit. above, 307, and Wiedemann, op. cit., 149.
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also says that Philon refers "to several inventions by Ktésibios, and, among them, to the hydraulic organ (= hydraulis)." This is also incorrect. Philon does not mention Ktésibios as the "inventor" of the hydraulis. He only refers to him in respect to what he taught concerning the "nature of air," and the remark is made after a reference to something that Philon himself had written on the hydraulis, yet Ktésibios is not actually mentioned as the inventor, although he probably was.

The first glimpse that we get of the hydraulis is given by Philon, when he speaks of "the syrinx played with the hand called the hydraulis." Philon himself wrote on the hydraulis, but the work has been lost, unless we are to allow, with Baron Carra de Vaux, that the Arabic Miristus treatise is Philon's. This Miristus, Muriștus or Murtus, has however, a claim for an independent existence as the inventor of the hydraulis, and as the author of a treatise on its construction, as well as one on the pneumatic organ.

From the ninth to the fourteenth century A.D., this Muriștus finds a place in Arabic works. Al-Jāḥiẓ (d. 868) speaks of earlier and later Greek theorists in the domain of music thus: "From Pythagoras to Euclid and Muriștus," and then of earlier and later mechanicians thus: "From Archimedes to Muriștus." We know from Ibn al-Nadim (d. c. 995), Ibn al-Qīfṭ (d. 1248), and Abū'l-Fīdaʿ (d. 1331), that a Murtus or Muriștus was the author of treatises on organ construction. Copies of these works have been preserved and may be found in

the British Museum, the library of St. Sophia at Constantinople, and at the Three Moons College of the Greek Orthodox Church at Bairut.

The identity of this Muriștus has already been discussed by Baron Carra de Vaux and the present writer. The former has pointed out that in the Arabic version of Philon's Pneumatics (Kitab fī-l-khyal al-rāhānīyya), the dedicatee is a certain Riştun or Aristun. In the Latin translation derived from the Arabic, the dedicatee is called Marzotom, whilst the same author's Belopoika, and the Treatise on the Klepsydra attributed to Archimedes, also refer to this same person. These facts have led Baron Carra de Vaux to suggest that the Muriștus of the organ treatises is the same person as the Riştun, Aristun, etc., mentioned above, and that all these names are simply malformations of Ariston or Aristos, the friend to whom Philon dedicated his works.

The learned French savant has also very plausibly argued how Muriștus came to be credited with the authorship of the organ treatises. The scribes, he says, misread the Arabic particle li as the genitive instead of the dative, so that instead of "by Muriștus" we ought to read "to Muriștus." Of course, if we accept the Ariston (Muriștus) dedication theory, we must accept the Philon authorship of the organ treatises, together with the Archimedes klepsydra treatise, and Baron Carra de Vaux is practically prepared to urge this.

Yet it is almost impossible to accept the Philon authorship of both the organ treatises. The one on the pneu-

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22 Chappell, 328. 14 Philon, 77. 15 Philon, 77.
16 Carra de Vaux, Philon de Byzance, 38; L'Invention de l'hydraulis, 340.
17 Al-Jāḥiẓ, 133, 143.

18 Studies in Oriental Musical Instruments, 30.
19 Carra de Vaux, Philon de Byzance, 29, 38. L'Invention de l'hydraulis, 338.
20 Cf. his Notes d'histoire des sciences, 449.
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**Pneumatic organ** describes an instrument far too primitive to have been composed by him, whilst even the treatise on the **hydraulis** appears to belong to a period anterior to the Philon of the **Pneumatics**. On the other hand, the latter, as it stands, cannot be the work of an ancient Greek, because the author or compiler relates that he constructed an organ of the type which he describes, for a “King of the Inner Franks,” and he also uses the phrase: “If Allah Wills.” These passages however, may be additions by a copyist, compiler or translator, just as the prefatory Islamic invocation—*Bismi’llahi* (“In the Name of Allah”) is.

A likely elucidation of the enigma of the name **Māriṣṭus** was suggested to me by Professor D. S. Margoliouth, of Oxford, who pointed out that the name Māriṣṭus or Māriṣṭus was evidently intended for **Ameristos** (*Ἀμηρίστος*) the ancient Greek mathematician.

We only know of Ameristos through Proklos on Euklid (i, 65, 11-15) where we read: “Next to Thales, Ameristos, a brother of Stēsichoros, is mentioned as having engaged in the study of geometry; and from what Hippias of Elis says it appears that he acquired a reputation for geometry.” But even his name is uncertain. Suidas (*sub* “Stēsichoros”) has Mamertinos. In Freidlein’s edition of Proklos it is written Mamerkus, whilst in Heiberg’s edition of Heron’s **Definitions** we have Mamertios or Marmetios. As Stēsichoros lived about 630-550 B.C., one might conceivably allow him the authorship of the Māriṣṭus treatise on the pneumatic organ, but hardly the one on the hydraulis, which must be a far later work. In all probability it was the fame of Ameristos that had come down to the Arabs via Proklos (Bruqlus), which led a scribe to write

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The Invention of the Organ.

Māriṣṭus, when he saw a name in his manuscript which looked like it!

It is certainly strange, as Baron Carra de Vaux observes, that Ktesibios should be unknown in Arabic, and yet be of such importance in Greek and Latin literature. Is it not possible, as I pointed out in 1926,* that the name Māriṣṭus is simply a scribal slip which ultimately can be traced back to the form Ktēsibios, or, as it would be written in Arabic—Qatsibiyūs? What strengthens this opinion is the name of the inventor of the hydraulis given in the *Kitāb al-siyāsa* attributed to Aristotle. This work was translated into Arabic from the Greek by Yūhannā ibn al-Batriq (d. 815) and the inventor of the hydraulis is here called Yāyasṭayūs, Thaṣṭiyūs, Thaṣṭiṣūs or Ṭaṣṭiṣūs, in the various copies of this treatise.†

Indeed, when one sees these various names in Arabic, and then conjectures the gradual transformation of the name from Ktēsibios to Māriṣṭus, at the hands of the copyists, in the following way, the opinion put forward by the present writer is not altogether unfeasible.

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1 Heath’s translation.
The Organ of the Ancients.

It will be recognised that the passage from “Mūrisṭūs” (with a long “ā”) to “Mūrisṭūs” (with a short “u”) is simple enough, and is quite a common substitution in foreign names.

Of course it may be argued that we know little of the writings of Kūsibios, since nothing has survived of them. That, however, ought not to prevent us from accepting the Arabic Mūrisṭūs treatise on the hydraulis as the work of Kūsibios, as there are several Greek works that have only survived in Arabic, including the Pneumatics of Philōn, the Mechanics of Herōn, the Conic Sections (Books V to VII) of Apollonios, and the treatises on the Automatic Wind Instrumentalist by Archimedes and Apollonios.

Finally, there is the possibility that Mūrisṭūs may even have a separate existence from either Ameristos, Ariston or Kūsibios, since we have several writers mentioned in Arabic works that appear to be quite unknown in Greek or Latin literature, such as the astronomer Paulisa in Al-Bīrūnī, the musical writer, Fandūrus of Ibn Khurdādhbih, Qāntwān of the Fihrist, and Sā‘ātūs of the Mūrisṭūs treatises.

Needless to say, Kūsibios could scarcely have written the Mūrisṭūs treatise on the rather primitive pneumatic organ.

CHAPTER III.

THE ORGAN FROM HEBREW SOURCES.

“Adoeque, quae de immani sonno Magrephæ narrant, vel fabulosæ esse, vel saltem cum grano salis accipienda.”—Joh. D’Oustrein, De instrumento magrepha.

THE pneumatic organ, as already shown, belongs to a period long anterior to the fourth century B.C., and hydraulic organs can definitely be traced to this date, whilst the hydraulis was certainly known in the third century B.C. Whether the pneumatic organ came from the Greeks, as did the hydraulic organ and the hydraulis, or from Egypt or Babylonia-Assyria, which were the culture-determining forces of pre-Hellenic antiquity, we know not. The probability is that it was known in the Mesopotamian plains before Greece had it. Yet the fact remains that the Assyrian language has not handed down any word that gives a determinate clue that the organ was known in these parts.

The earliest trace of the organ in the literature of the Semitic east comes from Hebrew-Aramaic sources of a much later date. Strangely enough, however, this fount has been neglected by historians of the organ, and with the exception of the savants utilised by Ugolinus in his Thesaurus antiquitatum sacrarium (1744-69), no deep interest has been evinced in this material.
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§ 1.

The oldest Hebrew literature that we have, the Old Testament, does not mention an instrument that we can recognise with any degree of certainty as a "mechanically wind-fed instrument" like our organ. Yet there are writers who are prepared to conclude that the mashroqitha of Daniel, iii, 5, 7, 10, 15, was an early type of pneumatic organ. The cue for this was given by Athanasius Kircher, the learned, though imaginative author of the highly interesting Musurgia Universalis (1650).

Kircher's description of the mashroqitha has been quoted by almost every historian of the organ, and his delineation of the instrument has been reproduced ad nauseam, for the most part erroneously. In view of this, it may be worth while to consider Kircher at first hand.1

The mashroqitha, according to Kircher, comprised a wooden chest, in the top of which were fitted eight pipes of various lengths and diameter. By the manipulation of sliders moved by the fingers, these pipes were made to speak by means of wind supplied by a skin bag within the chest, which was inflated by the mouth, through a pipe which passed along, and entered, the back of the chest.

1 "Masmkitha (- mashroqitha), a sibilo quem faciebat, sic dictum instrumentum erat proclavato: sine multorum calamorum, qui simul ligati & in ligno quodam in formam. Thse adpada gradatim infixi disponebantur, calami vero aperti supra, infra pelis adductione certo quodam ligno obturabatur, etaque in-structum manubrio quodam, a quo dilatae cista paulatim in aux- tum spatum coarctabatur: Instrumentum applicabatur labis & insufflatione facta digitorum foramina e latere nuno claudentum nune aperientium ope varius percipiebatur sonus pro ractive longitudinis, aut latitudinis brevitatique fa-turalum, vel etiam pro insufflationis intentione. Unde colligo hoc instrumentum idem prorsus fuisse cum Syringe sive heptaulo Panos; ut paulo post patebit." Kircher, Musurgia Universalis, i, 53.

The next important stage in organ development was the introduction of bellows, either manual or pedal. We have evidence of an instrument of this sort dating from prior to 200 B.C. in one of the terra cotta objects unearthed by

2 Engel, 286.

3 Schlesinger, Researches, 185. This author says that Kircher calls it "the mashrokitha or magraketha of the Chaldees." The word he uses is masrakitha, with no mention of the "Chaldees."


5 Hawkins, History of Music, i, plate v, reproduces Kircher's design with only seven pipes instead of eight, and with sliders that do not comport with them. These errors have been copied by most of the English writers on the organ, who pretend to take their design direct from Kircher. See Hopkins and Rimbaud, The Organ, 3. Grove's Dict. Mus., iii, 786. Stainer, Music of the Bible, 121. Schlesinger, Researches, 185. Audsley, Art of Organ Building, i, 7.
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W. Burckhardt Barker at Tarsus in Cilicia. "The instrument," says this writer,⁶ "consists of a vertical row of pipes, the length unknown, as the lower portion is wanting; they are inserted into a small air-chest, which appears inflated in the middle part." Commenting on this instrument, Kathleen Schlesinger says that although both drawing and description are somewhat vague, "there is no reason for doubt that this was an organ."⁷ Confirmation comes, although the date is later perhaps, from another terra cotta object preserved in the Louvre. This latter was also discovered at Tarsus, and it shows the rear of an organ with fifteen pipes.⁸ That the organ was known even further East, may possibly be demonstrated from the curious figure discovered on the site of ancient Khotan in Chinese Turkestan by Sir Aurel Stein.⁹

We now come to Jewish sources. Did the Jews possess the organ in common with their neighbours in Asia Minor? Whatever notion the Semitic East had of the organ prior to the Hellenistic period, the new culture forces, dating from the time of Alexander the Great, became most marked from the end of the third century B.C., not merely in political life, as we see in the books of Maccabees, but in art and literature, as we know from Daniel, iii (c. 164 B.C.). Post-biblical literature, as exemplified in the Targumim, Midrashim and Talmud, reveal a weighty impress of later Greek influence.

Since we can match almost every musical instrument of Greece and Rome with one in Syria and Palestine, there is no reason why the pneumatic organ, which must have been known in the former countries, should not have found acceptance in the latter. Yet it has to be acknowledged that there is no mention of the instrument in the Apocrypha (c. second-first century, B.C.), nor in Philo Judaeus (b. ca. 20-10 B.C.), nor in Josephus (b. 37 A.D.). Indeed, it is not until we come to the Talmud that we get anything like evidence for its existence among the Jews, and even this has been challenged. In the Talmud there is mentioned an instrument of the Temple called the magrephah, which is claimed to be a pneumatic organ in the second stage of development,¹⁰ that is to say, with manual or pedal bellows.

The evidence of the Talmud has long been suspect. This has been due, mainly, to the conflicting descriptions of, and references to, this magrephah by the rabbis. But we must remember that after the fall of Jerusalem in 70 A.D., music generally was anathema amongst the Jews.¹¹ Its prohibition was a sign of mourning for the destruction of the Temple, and the interdict has had its influence on Judaism up to comparatively modern times.¹² As a result, it is quite possible that the rabbihood in the Talmudic period was not sufficiently conversant with instruments of music to give precise particulars of such a contrivance as the magrephah.

Before we can deal with the evidence of the Talmud, it seems advisable, for the sake of those readers who may not be acquainted with this literature, to scrutinise the historical aspect of this work, which has been termed "in many respects unique among the literary monuments of the world."¹³

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⁶ Barker, Lores and Penates, 260-1.
⁷ Schlesinger, The Organ, 206.
⁸ Froehner, Les musées de France, pl. xxxii.
⁹ Stein, Ancient Khotan, pl. xliii.
¹¹ Schlesinger, The Organ, 206.
¹³ Abrahams, Jewish Life, 253.
¹⁴ Oesterley and Box, 86.
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There are two great collections of the Oral Law with the Jews—the Palestinian Talmud and the Babylonian Talmud, both of which may be said to have been finally redacted before the year 500 A.D. The Talmud is made up of the Mishnah, in Hebrew, “in the form that was officially sanctioned by Rabbi Yhudah I, about 190 or 200 A.D.” and secondary material called Gmara, for the most part in Aramaic, containing traditions of lesser authority. All this material is interpreted and discussed by the Amoraim or “Speakers” (ca. 220-500), some of whom hand down traditions from the Tannaim or “Teachers” (ca. 10-220), which reach back to the time of the destruction of the Temple.

Among the Amoraim who will be quoted on the question of the magrephah of the Temple are, Rab, Shmuel, Rab Nahman bar Yiḥaq, Rab Mattnah, and Rabbah Shela. Rab, or more properly, Abba Arika (d. ca. 247), was the chief Babylonian Amora, and the founder of the Sura Academy. It was Rab who “determined the form and method of the Babylonian Talmud,” taking the Mishnah of his master, Rabbi Yhudah I, as his basis. Shmuel, or Mar Shmuel (d. ca. 254), a contemporary teacher, was Principal of the Nharde’a Academy. The disputes between Rab and Shmuel “constitute the main body of the Babylonian Talmud.” Rab Nahman bar Yiḥaq (d. 320) was a pupil of Shmuel and he also became Principal of the Nharde’a Academy. Rab Mattnah, or Rabbah ben Mattnah, was a Babylonian Amora of the fourth century, as was Rabbah Shela, the latter being a pupil, probably, of Rab Nahman bar Yiḥaq, whose say-

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ings he transmits. This disposes of the historical aspect of the Talmud, and we can now consider what this work tells us about the instrument called the magrephah.

The instrument called the magrephah, identified by some writers as a pneumatic organ, has been the subject of a two thousand years’ controversy. The instrument is not mentioned in the Mishnah, but only in the Gmara. At the same time, the Palestinian Talmud, tractate Sukkah, v. 4, says:

“The Levites accompanied themselves with lyres (kinnor), harps (nebel), cymbals (miillaim), trumpets (haçoṣeret), and numerous other musical instruments.”

It is quite possible, therefore, that the magrephah may have been counted among the “other musical instruments,” or, if not, it may have been that it was not one of the instruments of praise like the above, but was used for other purposes, as we shall see presently. At any rate, the magrephah is described in both the Palestinian Talmud and Babylonian Talmud, although not in a sufficiently precise way to enable us to be certain of its category.

The tractate Sukkah, v. 6, in the Palestinian Talmud, describes the magrephah thus:

“The magrephah [is described by] Rab and Shmuel. One says that it had ten holes, and each emitted one hundred different sounds (zemar). The other says that it had one hundred holes, and each emitted ten different sounds. Altogether it gave one thousand sounds.”

The tractate ‘Arakin, ii, 6, in the Babylonian Talmud, gives us a little better description of the instrument:

“Rabbah bar Shela said, in the name of Rab Mattnah, in the name of Shmuel, that there was a magrephah in the Temple. It had ten holes, and every hole emitted ten different sounds, so that altogether it emitted one hun-

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18 Oesterley and Box, 82. 19 Rodkinson, x (2), 2.
20 Oesterley and Box, 119. 21 Ibid. 22 Ibid.
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drew different sounds. In a mishnah we have learned that it was 54 cm. (= one ammah) broad, and 54 cm. high. And there was a handle projecting from it on the right side. And it had ten holes, each of which emitted one hundred different sounds, so that altogether it emitted one thousand different sounds. And Rab Nahman bar Yiqaq said, ‘Take note, the mishnah exaggerates.’

The mishnah which ‘exaggerates’ is evidently the one quoted from the Palestinian Talmud, as above, and it may be remarked that the latter is admittedly less authoritative than the Babylonian Talmud, since it was apparently not subjected to a final revision, and has reached us in an incomplete form.

This may partly account for the so-called ‘exaggeration.’ On the other hand, we have already pointed out that the Byzantines seemed to have nicknamed the organ, ‘the instrument of a thousand voices,’ a phrase which may have been borrowed by the Jews, as it was by the Arabs and Persians, and may have contributed to the ‘exaggeration’ concerning the ‘thousand different sounds.’

The tractate Tamid, iii, 8, in the Babylonian Talmud, also tells us that there was a magrephah in the Temple, and that it had a very powerful sound. The passage runs:

“From Jericho they heard the sound of the Great Gate [of the Temple] that was opened. From Jericho they heard the sound of the magrephah. From Jericho they heard the sound of the appurtenance made by the Ben Qattin for the laver. From Jericho they heard the voice of the chief Temple crier. From Jericho they heard the sound of the flute (halil). From Jericho they heard the sound of the bell (celcal). From Jericho they heard the sound of the song (shir). From Jericho they heard the sound of the horn (shophar). From Jericho they heard the voice of the High Priest.”

A similar passage occurs in tractate Sukkah, v. 3, in the Palestinian Talmud.

The most perplexing passage on this question is the one in Tamid, v. 6, in the Babylonian Talmud, and it is this relation that has caused most of the differences of opinion among the commentators on the identity of the magrephah. The passage reads:

“One of them [who served in the Temple] took the magrephah and ‘sounded’ (zaraq) it between the porch and the altar. No one could hear the voice of his neighbour in Jerusalem because of the sound of the magrephah. It was used for three purposes: (1) The priest who heard its sound knew that his brother priests had entered to worship, and he ran and came: (2) The Levite who heard its sound knew that his brother Levites had entered to sing, and he ran and came: (3) The chief of the stationary men (Ma’anadh) placed those that had been unclean at the Nikanor Gate.”

These four extracts comprise all that the Talmud has to tell us about the instrument called the magrephah, and we may proceed to enquire what type of instrument it was.

Some say that the magrephah was a pneumatic organ, whilst others urge that it was a pulsatile instrument. Commentators hold that both these types were in use, and...
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that both were called by this name magrephah. This has led modern writers from the time of Abraham de Porta Leone (d. 1612) to speak of these instruments respectively as the magrephah of 'Arakin and the magrephah of Tamid.3

The magrephah of 'Arakin (ii, 6) is certainly an instrument which could be likened to some composite woodwind instrument. All that we are told, however, by the Amoraim, is its dimensions, form, and that "it had ten holes, and every hole emitted ten different sounds."4 The famous commentator, Rashi (d. 1105) sought to explain the passage as follows:

"Each hole had a pipe (qaneh) which had ten holes in it, and every hole emitted one sound, so that altogether it [the magrephah] emitted one hundred sounds."

It will have been noticed that there is no mention of the method of inflation of this supposed pneumatic organ or composite wood-wind instrument. One of the later Jewish writers, Abraham de Porta Leone, suggested bellows or bags. This author describes the magrephah at length, drawing freely on his imagination, although making it consistent with the descriptions of the Amoraim and commentators. In consequence of this, his description deserves a place here. Abraham de Porta Leone was an Italian Jew whose Shilte ha-gibborim was published in

3 Abraham de Porta Leone, 37, 41.
4 Miss Schlesinger (The Organ, 266) points to this "description in the Talmud" of the magrephah "with bellows." "The quotation," she says, "as given by Blasius Ugolinus, states that the instrument known as the magrephah of 'Arakin (Treatise xxxiii of Bab. Talmud, see Thesaurus Antiquitatum Sacrarum, xxxii, 11 and 21), consisted, as the Shilte ha-gibborim teaches, of several rows of pipes, and was blown by bellows." The "quotation" is not from the Talmud but from Kircher. Further, 'Arakin is Treatise xxxii, not xxxiii. See "Note" on p. 44.

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Hebrew at Mantua in 1612, the same year as the author's death. Here is his description of the magrephah of 'Arakin.5

"The magrephah was like a box of wood . . . disposed in the likeness of the shovel of the bakers, closed in, above and below, and on all its sides, and completely hollow within. Its length was about 135 cm. (= 2½ ammakh), and [in shape] bent. Its width about 54 cm. (= 1 ammakh), and its height the same. Within it were enclosed ten reed-pipes, with ten holes in them, some of the reed-pipes being long and thick, and others short and thin. They were fixed horizontally and not vertically, and the holes of the reed-pipes, which were in an even row, were turned and arranged so as to face the bottom part of the box and not the top part. And in the two sides of the box, i.e., the North and South of it, were bellows. And in the East of the box were the heads of the ten reed-pipes, joined to it, at a distance from the bottom of the box by about 27 cm. (= ½ ammakh). And in the West side of the box there protruded the ends of the ten reed-pipes, open and empty, a short distance from the ten holes in them, so that the sounds of the reed-pipes could be heard distinctly, and not die inside the instrument . . . . And in this instrument were placed one hundred bags, ten for each reed-pipe, one for every hole. And in the end of the bags towards the inside, were upright irons, with a little lid on the head [of each] in such a way that they could manage to close on (lit. 'strike') and stop up, with those little lids, the holes of all the reed-pipes, by tapping the keys which were on the side [of the instrument], until, by the closing of the lids upon the holes, and the driving of the

5 Abraham de Porta Leone, 47, et seq., Hebrew text with Latin translation in Ugolinus, xxxii.
wind into the reed-pipes with force, there were produced
in them the sounds, varied and pleasant, like those which
are produced in the flutes (halit) by the closing of a man's
fingers upon them, when they blow into them. So the
magrephah emitted, quite conveniently, all the hundred
sounds of which our rabbis speak, distinct from one an­
other, due to thickness and fineness and length and short­
ness of the reed pipes, and the distance of the holes in
them from the first hole to the tenth. And he who played
upon this instrument was one man and no more. Thus I
imagine the form of the magrephah and its function. If
you are satisfied, then so am I. If not, then choose an­
other opinion which may be more correct."

Kircher, in his Musurgia Universalis (1650), although he
set great store by Abraham de Porta Leone, differed from
the latter in his conception of the magrephah. According
to Kircher, the magrephah was “similar to our church or­
gans,” and although he quotes from the Shilte ha-gibborim
as one of his authorities, he depicts the instrument as an
oblong box in which are fixed, vertically, thirteen
pipes, which appear to answer to “slides” placed in front
of the box, whilst at the back are two bellows. The pipes
of Kircher are not furnished with “mouths” as to-day.
Printz, in his Historische Beschreibung der edelen Sing
und Kling-kunst (1690) sought to remedy this by adding
“mouths,” quoting a certain Johannes Schütterus as his
authority for the deviation. In this design Ugolinus fol­

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copists, mostly professing to reproduce Kircher, really
borrow from Hawkins.10

Kircher’s design, in spite of the fact that it has become
almost a “hardy annual” with historians of music, is not
even consistent with the description in the Talmud, let
alone the Shilte ha-gibborim, which he put such trust in.
Whatever reservation we may allow in regard to Abraham
de Porta Leone, we can afford to dismiss the magrephah
of Kircher once and for all.

It must be acknowledged that the naïveté of Abraham
de Porta Leone in the coda of his description, disarms all
criticism. He admits that he has no authority for positing
the bellows or even the organ case, although he argues
with congruity that the holes in the reed pipes could
scarcely have been manipulated by the digits of the hands.
Yet it is remarkable that he should have failed to notice
the “handle” which is so distinctly mentioned in the Tal­
mud as projecting from the side of the instrument. This
would have given grounds of justification for his intro­
ducing a mode of inflation, since this “handle” might
very well have been the lever which worked circular bel­
lows or pistons, a principle often depicted in the mechani­
ism of organs in mediaeval MSS.11

Abraham de Porta Leone considered that the organ case
was curved “in the form of the bow of the arrows,” con­
cave in front and convex at the back. When the “handle”
was added to the side of this, one can appreciate why the
instrument was called a magrephah, because it would re­
semble “a shovel,” as the commentators tell us.12 Although

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6 Kircher, i, 54.
7 Note the title of this book of Schütterus as quoted by Prints
and Hawkins.
8 Ugolinus, xxxii, 371. 9 Hawkins, i, 256-7, pl. v.
10 See Stainer, Music of the Bible, 122. Grove’s Dict. Mus.,
iii, 736. Schlesinger, Researches, 200.
12 Maimonides and Abraham de Porta Leone.
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this appears to be a reasonable explanation for the word being used, there may be a more likely origin. The root of magrephah is garaph, a word which means: (1) “to carry, snatch away, sweep away,” and (2) “to grasp.” Hence magrephah means “a ladle, shovel, etc.” whilst eghroph means “a fist.” This secondary meaning prompts the suggestion that the name magrephah for a pneumatic organ or composite wood wind instrument, was given because it “comprised, embodied, embraced or enclosed” within itself, a number of different sounds. The Arabs had a similar mode of expression in jama’a, which means “to collect, include,” hence jum’—“a fist.” They called the pneumatic organ the urghanun al-jama’i or “comprehensive organ.” So far the magrephah of ‘Arakin, ii, 6, which has been considered to be a pneumatic organ.

The magrephah of Tamid (iii, 8; v, 6) has been generally understood by later commentators to refer to a different instrument from the magrephah of ‘Arakin (ii, 6). Rashi (d. 1105), however, only recognises one species of musical instrument called magrephah, since he says: “There are two sorts of magrephoth, one for the ashes [the shovel], and one for music.” Maimonides (d. 1204) commenting on Tamid, iii, 8, refers us to ‘Arakin, ii, 6, which shows that he considered the magrephah in the former to be identical with that in the latter. The instrument in Tamid, iii, 8, is said to have possessed so powerful a tone as to be heard at Jericho, which was nine or ten miles distant. The learned Lightfoot says that we cannot plead the literal truth of this statement, “seeing it is apparent that it is uttered by way of hyperbole: only it may not be improper to observe, how common the phrase was: ‘From Jerusalem to Jericho,’ which is also used in Luke, x, 30.” On the other hand, we have an account of the Marisius hydraulis, the sound of which could be heard sixty miles. Further, the reputed “Letter to Dardanus” of St. Jerome (d. 430) tells of an organ at Jerusalem which could be heard at the Mount of Olives, quite a mile distant. At any rate, there are no particularly valid reasons for regarding the instrument in Tamid, iii, 8, as being different from that of ‘Arakin, ii, 6.

It is, however, the magrephah mentioned in Tamid, v, 6, that has been regarded as so radically different from that mentioned elsewhere. A gloss on this passage says that this magrephah was a great vessel which was rung so as to make a sound, whilst another opinion is that it merely refers to the shovel of the altar which, being large, and of brass, made a loud sound when it was either rung or thrown on the floor of the Temple. We find therefore in the Tosaphoth Yom Tob that three distinct objects carried the name magrephah—the altar shovel and two musical instruments. Another commentator, Obadya de Bertinoro (d. 1510) is inclined to a similar view.

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What led the commentators and other writers to discriminate between the magrephah in Tamid, v, 6, and the instrument mentioned elsewhere, was the use of the word sarag which has been translated on page 29 as "sounded." Most of the old Latin translators made sarag equate with projicio, because the literal meaning of sarag was "to sprinkle, cast, throw, scatter." In the face of this it was difficult to link up this word with the instrument mentioned in 'Arakin, ii, 6, and therefore another instrument or appurtenance had to be imagined. Abraham de Porta Leone supposed a pulsatile instrument, although he confessed that he could not describe it. Later writers, such as Kircher, and Lightfoot, fancied that it was a bell, an opinion which Hawkins gave acquiescence to. Pfeiffer conceived a kettledrum, whilst Saalschütz favoured the altar shovel. The latest opinion, that of the lexicographer, Marcus Jastrow, is that it was "a sort of tympanum." There is still the possibility however, that the magrephah of Tamid (v, 6) was the same instrument as the magrephah of 'Arakin (ii, 6). Why should sarag not be used in a figurative sense in the same way as we speak of "throwing the voice"? Sarag has a figurative meaning elsewhere, although not with the latter meaning. In Latin, there is a metaphorical use of the word projicio, where it means "to expel, drive out, obtrude, utter.

Still, whatever type of instrument the magrephah of Tamid (v, 6), was, we can perhaps accept the magrephah

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of 'Arakin (ii, 6) as a pneumatic organ or composite woodwind instrument, as most writers have done since the time of Abraham de Porta Leone, although the latest Talmudic lexicographer, Marcus Jastrow, prefers a non-committal definition of the instrument as "a musical instrument of the Temple." It has been mentioned that the pneumatic organ was known to Greece and Rome, and in view of the close musical connection between all the countries of the ancient world, there is no reason why the Jews should not have possessed the instrument, which the description in the Talmud seems to suggest. If we may accept the Talmud evidence, this latter will be the earliest literary reference that we have to the pneumatic organ, since earlier Greek, Roman and Byzantine writers only advert to the hydraulis

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[Footnotes]

5 Braunius, cap. ix. Ugolinus, xxxii, 38.
6 Abraham de Porta Leone, 37.
7 Kircher, i, 52.
8 Lightfoot, Temple Service, ix, 6.
9 Hawkins, i, 256-7.
10 Pfeiffer, 52.
11 Saalschütz, 131.
12 Jastrow, s.v.
13 Hoseo, vii, 9.
14 Jastrow, s.v. I take this opportunity of quoting the opinion of Professor D. S. Margoliouth, which he was good enough to express to me after he had read the MS. of the present work. He says: "In the matter of the magrephah, it would appear that the notion of its being a musical instrument is later than Rashi (d. 1105) and the author of the 'Aruch (c. 1100). Tamid, v, 6, deals with the removal of refuse from the Temple, and the magrephah is clearly an instrument or vessel in which such refuse is collected. In the passage of 'Arakin, Rashi is clear that the same instrument is meant, and adds the French riddle, which is now used for 'jagging iron,' but probably, in Rashi's time, meant something different. He says that it is exactly the shape of a hand, i.e., a pan with a number of spouts. These spouts he supposes furnished with holes somewhat similar to the mechanism of the silencer of a motor-car. The supercommentary called Tosaphoth finds fault with Rashi's view, and supposes that a musical instrument is meant, and it is true that the context here deals with musical instruments. The discursive nature of the Gmara renders this argument of little weight. According to Rashi, the music will have been accidental, and it may be suspected that the source of the whole story was Psalm xlii, 8 (7), 'Deep calleth unto deep at the noise of thy water-spouts.'"
15 Abdy Williams, Aristoxenian Theory of Musical Rhythm, 9. The Talmud tells us that the Jews had their Temple instruments of music repaired in Egypt, the home of the hydraulis and other instruments.
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or hydraulic organ. Apart from the Talmud, the earliest reference to the pneumatic organ is that of Julian the Apostate (d. 363 A.D.).

§ 2.

Whilst there is no evidence that the pneumatic organ, i.e., the magrephah, was used by the Jews after the destruction of the Temple at Jerusalem (70 A.D.), there are a number of references to the hydraidis, which was known to the Jews as the idrablis or hirdaulis; words perspicuously derived from the Greek. This instrument, as we have already apprehended, was of colonial Greek origin, and it (or some type of hydraulic organ) is mentioned by Greek and Latin writers such as Philon (fl. 150 B.C.), Cicero (d. 43 B.C.), Severus (fl. 10 B.C.), Petronius (fl. 66 A.D.), Vitruvius (fl. 70 A.D.), Pliny the Elder (d. 79 A.D.), Suetonius (fl. 116 A.D.), Nikomachos (fl. 138), Heron (fl. 150), Julius Pollux (fl. 180), Athenaios (fl. 220), Tertullian (d. c. 222), and Obtanian (fl. 324), whilst the art remains which cover this period, the hydral...
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pressure stabiliser. Vitruvius describes the *hydraulis* at length, although, strange to say, he does not explain the function of the water. First there was a cistern or *ara* containing the water. In this cistern there was an inverted funnel (*infundibulum inversum* = *pigneus*) standing on three legs on the bottom of the cistern, so as to allow room for the water underneath. From the side of the inverted funnel there were pipes through which the wind was forced by pistons into the inverted funnel, both the pipes and the pistons having valves to prevent the return of the wind. From the neck (*cervicula*) of the inverted funnel there was a pipe which conducted to a wind chest (*arcula*), which fed the organ pipes, via cross channels (*canales*) controlled by stopcocks. In the organ pipes were the "sliders" called *plinths*, which were connected with a lever mechanism not unlike our modern organ key action.\(^{24}\)

Heron tells us much about the same as Vitruvius, save that the key action is fully described, and, above all, the function of the water as a pressure stabiliser is explained. When superabundant wind was forced into the *pigneus* or inverted funnel, the water within the latter was forced down, whilst the water without was forced up. It was the gravitating power of water seeking its own level that supplied a constant wind-pressure.\(^{29}\)

Julius Pollux defined the *hydraulis* as a *syrinx* of bronze, but blown from underneath instead of from the top of the pipes. The wind was supplied by bellows, whilst water gave stabilisation to the wind pressure. Athenaeus also explains that the organ-pipes sounded on account of the water being disturbed [from its level].

Such was the instrument known in the Byzantine and Roman Empires, and, considering the influence of Egypt (the home of the *hydraulis*) over Jewry,\(^{20}\) we may surmise that this instrument was fairly well known to the Jews in the early centuries of the Christian era, if not earlier.

The earliest mention of the *hydraulis* by Jewish writers is in the Babylonian Talmud tractate, 'Arakin, ii, and in a tosepheta to 'Arakin (i, 13), as follows:

"And* Rabbi Shim'on ben Gamaliel says that the *hydraulis* (*hirdabulis*, *hirdaulis*) was not in the Temple. What is the *hydraulis*? Abaye says it is a musical instrument (*tabla*) like the organ (*gurgrana*).\(^{29}\)

The name of Shim'on ben Gamaliel (fl. 135 A.D.) is of importance in this connection, as it has been said that "his decisions are founded on . . . an intimate acquaintance with the subject."\(^{3}\) He was a Tanna of the fourth generation and Principal of the Usha Academy. He belonged to an illustrious family of Tannaim, the first of whom was Rabban Gamaliel the Elder, whose son, Rabbi Yhudah I, was the compiler of the Mishnah.

Abaye, surnamed Nahmani (d. 338) was a Babylonian

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\(^{24}\) For a complete English translation of this section of Vitruvius, see Gwilt, 237, and Maclean, 221. For a design of the instrument, see Vossius, 100, which must be used critically. Maclean says: "Except for short extracts, the dissertation [of Vossius] on the Water Organ has never yet been reproduced in original." This is incorrect. It was reproduced in original by Ugolinus, Thes. ant. mer., xxxii.

\(^{29}\) For English translations see Greenwood and Maclean. For designs see Maclean, 223, and Chappell, 340.

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Amora and Principal of the Pumbeditha Academy. His arguments with Rabbah bar Huna are considered of importance.

In the Palestinian Talmud, tractate Sukkah, v. 6, a similar passage to the above occurs as follows:

"It is handed down by Rabban [Rabbi] Shim'on ben Gamaliel,4 that there was no hydraulis (irdablis) used [in the Temple] at Jerusalem, because it interfered with the music (nimah)."

"Enthusiasts are not wanting," says the late Dr. Stainer, "who would make us believe that this instrument [the hydraulis] was among those known and used by the Jews in their Temple." We are not told who these enthusiasts are, but it is quite certain that the Jews did know of the hydraulis. As for its use in the Temple, we have it denied by the two eminent authorities who have been quoted above. It happens, however, that the word hydraulis equates with 'ugab in one place, and this may have prompted the idea that the Temple possessed the instrument. We read, for instance, in the Babylonian Talmud, tractate Sukkah, v. 6:

"Rabbi Shim'on ben Laqish says that the 'ugab was the hydraulis (irdablis)."

Again, in the Targums of the Hagiographa (seventh-eighth century) the word hydraulis (hirdaulis)8 stands for 'ugab in Psalm cl. 4, probably in conformity with Ben Laqish or the Septuagint organon.

The opinion is obviously erroneous. Shim'on ben Laqish (d. 275) was one of the earliest Palestinian Amoraim. In his younger days he had been a gladiator in the circus, and it was here, probably, that he became acquainted with the hydraulis, which was one of the special appendages of the spectacle.7 It is likely, however, that his opinion was coloured by the Septuagint, and on a false inference that as 'ugab = organon, and hydraulis = organon, therefore 'ugab = hydraulis.

A very interesting reference to the hydraulis occurs (if it is to be trusted) in the great Midrash on Genesis called Bereshith Rabbah, a work "which occupies the first position among the Midrashim in virtue of its age and importance."9 Rabbi Hosha'yah (fl. 219) is generally credited with the authorship of the work in its original form, although the final redaction probably dates from the fifth century. The passage in Bereshith Rabbah runs:

"There are hydraulis players (idrablin) and flute players (korablin) in the land, and such a land should be destroyed."9

From this midrash it appears that the hydraulis was common in secular life among the Jews, just as it was in Colonial Greece and Rome. Here we have the condemnation of instruments of music, especially those linked up with the vanities of the world. This was due to the wave of asceticism that swept over Judaism after the fall of Jerusalem. The connection of the hydraulis players with the circus, and the unsavoury reputation of flute-players, especially female performers, seem to have aroused the ire.

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4 Daremberg et Saglio, ii, 1504. 5Jew. Ency., viii, 557. 6 Korablin is Jastrow's reading, and it equates with the Greek chorai. It appears in corrupted forms as sorbalin and borbalin. Jastrow also suggests that idrablin and korablin may stand for the instruments themselves and not the players, and may be read organ and cymbals (κρυμβαλα). See Bartoloccio, 479.

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42 Cf. Jastrow, s.v.
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of the rabbis. The name zimri (wood-wind player) came to stand for a "lewd person," just as in Arabic during the early days of Islam the term zamíra (female zamir player) came to be a euphemism for courtesan. It was precisely the same sort of thing that operated in Western Europe when Christianity frowned on musical instruments.

Elias bar Shinaya (b. 975), the Syriac lexicographer, tells us that the type of music which the mukhannathun played was called hydraulis (hedhrula). The mukhannathun among the Arabs were a shunned class, and the drum called the kuba, used by them in their orgies, became anathema. It would seem, therefore, that these mukhannathun used the hydraulis, a circumstance which would lead to the condemnation in the above midrash.

NOTE.—Concerning the Magrephah of 'Arakin, Kathleen Schlesinger (Researches, 202) says that the only available translation, that of Moise Schwab, of the passage in the Talmud concerning this instrument was so obscure that she had to fall back on the description by Kircher. The passage cannot have been obscure because the tractate 'Arakin does not appear in the Palestinian or Jerusalem Talmud which Schwab translated. It is only to be found in the Babylonian Talmud, which was available in a translation by Dr. August Wünsche (Der Babylonische Talmud, Leipzig, 1886-8; Berlin, 1894). Of course, Ugolinus had already given a Latin translation of all the passages on the magrephah in the Talmud.

CHAPTER IV.

THE ORGAN FROM SYRIAC SOURCES.

"En dehors de ces trois grandes orgues, on en fabriquait de petites, portatives, introduites en Occident sous le règne de Charlemagne par les ambassades byzantines. Il parait même hors de doute que les facteurs des premières grandes orgues d'Occident, au 1er siècle, étaient des Grecs ou des Syriens."—Amédée Gastoué, La musique byzantine.

In spite of the mediocrity which Renan said was characteristic of the Syrians, it is to these people that we owe the passing on of the learning of ancient Greece to the Arabs of the Middle Ages, who, in turn, were to light the torch of civilisation anew for Europe. In music, at any rate, the comment of Renan is not altogether just. The Greeks of old borrowed many of the ideas of their instruments of music from the Syrians, and in a similar way the Romans were also indebted to these Semites. The influence of the Syrian cities of Antioch and Edessa, and of the Syrian poets, Synesius and Ephraem, on the early Christian Church, cannot be ignored, because of an epigram of Renan. Nor can we forget that Porphyry, Iamblichos and Theodoret came from Syria.

It was the Syrians who kept many of the ancient Greek sciences alive until the days of Islam. It was then that
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many of the ancient writings on the mechanical arts, including those on organ construction, were turned into Arabic by Syrian and Arab translators. Indeed, that there were books on the *hydrælis* in Syriac, appears to be hinted at by the ninth century Syriac lexicographer, Isho' bar ‘Ali.4

§ 1.

Whatever the *magrephah* of the Jews was like, we probably get some idea of the pneumatic organ of the early Christian era in the oft-quoted Obelisk of Theodosius (d. 395),8 and the portable in the Orange medallion.6 Descriptions of the instruments are given by Julian the Apostate (d. 363),9 St. Augustine (d. 430),8 Theodoret (d. 457), and Cassiodorus (d. 585).10 Julian tells us of metal pipes, bull's hide bellows, and "sliders." St. Augustine depicts an instrument that is "large, and inflated by means of bellows." Theodoret (a Syrian) specifies metal pipes, leather bellows, and the fingers for playing. Cassiodorus speaks of pipes, bellows, "sliders" (*linguae*), and the fingers, for playing.

4 Payne Smith, 977.
6 See the instrument delineated by Hopkins and Rimbault (The Organ: Its History and Construction, p. 16), Chappell, Hist. of Music, p. 373. Naumann, Hist. of Music, i, 194. Grove's Dict. of Music, iii, 727. Cf. Didron, Annales archéologiques, iii, 277. Reinach, Bibl. des monum., i, 127. Kathleen Schlesinger (The Organ, 267) considers the instrument of the Church of St. Paul at Rome (fourth-fifth cent.) to be a pneumatic organ, but there is no reason why it should be thus designated.
8 Kathleen Schlesinger classes this as a pneumatic organ, although others say that it is an *hydrælis*. Dict. d'arch. chrét., vii, i, 1180. See also De Caylus, Recueil d'antiquités, ii, 14.
9 Brunck, Analecta, ii, 402.
12 Migne, Patr. Lat., iv, 590.
16 Migne, Patr. Lat., lxx, 1032.

The Organ from Syriac Sources.

We frequently read of organs in Byzantium, where we know, from Syriac sources, that they were used by the emperors at their festivities,11 and Justinian II (d. 711) is said to have been cured of his madness by the soothing effects of the organ.12 In 757, the Emperor Constantine Copronymus presented Pépin, King of the Franks, with an organ.13 Wonderful organs of silver and gold are mentioned in the accounts of the festivities during the visit of the Arab ambassadors to the Byzantine court of Constantine Porphyrogenitus (d. 959),14 and it is an instrument of this period that is described by the Syrian author named Isho' bar Bahlul (fl. 965). Here is his description of the pneumatic organ:

This organ (*urganun*) "consists of two columns, hollow and slender; beautifully made of marble. And these stand upright, closely united in a skilful way. Below are bellows similar to those which a blacksmith uses, although not so large, but small and elegant. The organist sits above, and those who perform the song, whatever it may be, stand on the right and left, and sweet music (*zemara*) is heard, to which there is nothing similar in creation. They say that such [an organ] is in that church [St. Sophia] in Byzantium [Constantinople]."

Some of the above details are interesting. Whilst there is no reference to the pipes, the mention of the two marble columns leads one to suppose that these were the pillars which supported the organ-case.15 This appears to be...
The only Syriac reference to the pneumatic organ in the Middle Ages, although we have occasional mention of the *hydraulis*, and to this instrument we now turn.

§ 2.

In spite of the *anathema* hurled against the *hydraulis* by Judaism and Christianity, the instrument found favour until the fifth-sixth century. In the West, it is referred to by Claudianus (fl. 395 A.D.), Martianus Capella (fl. 480), and Apollinarus Sidonius (d. ca. 483). An important reference to the *hydraulis* is to be found in a Syriac author of the fifth century named Isaac of Antioch (d. ca. 460). He was "one of the stars of Syriac literature," who lived at Antioch as a priest and abbot until 459. His works have been published in Syriac with a Latin translation by Gustavus Bickell, and among them is a poem which introduces the *hydraulis*. It is of sufficient interest to be quoted at length.

"A wave of meditation rushed in upon me, and threw me from place to place, even now to that island of dry land which is situated in a sea of sand, yea, even to the lovely city of the Greeks, which I entered, having set out from the East to the Western Sea.

"During the month of Kanun, which, by music, is depriving the inhabitants of sleep, I was hearing every night the sounds of citharas (*qithara*), *hydraules* (*hedhrula*), symphonias (*cphunutha*), which resounded before the palaces of the princes.

"The whole city was like a tavern, and, with the musical plays, they changed night into day. Everyone devised and learned melodies on every scheme, so that each was pleased with his own voice, and was delighting himself with his singing. The mouths of the shepherds vied with the citharas, and the voices of the tragedians strove to overcome the lyres (*kennara*).

"This month of Kanun again reminded the city of the different ranks in it, for on none of the nights was music neglected under the windows of the judges, or before the gates of the princes. Every night, instruments, musical feasts, as it were, were set out in order. Nothing fails with a *hydraulis* if there be a performer. With mere rational speech, man overcomes the cithara. Musical instruments are like men without speech or reason. Their strings are compressed as if they were eager to speak; nay, rather, if they are played by persons that can speak, they also receive a certain kind of speech or reason. They wish to utter prompt oratory, but the tongue is deficient in articulation. Their voices are like the voice of a man who wishes to tell a story conceived in the mind, but is abandoned by the lips and tongue.

"In this way, the destitute, anticipating the dawn, sing before the palaces of the rich, and spend tiresome watches so as to flatter the proud. Tongue is joined with reed-pipe (*abbuba*), and the lips of the *hydraulis* with its low
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sound, sustains the soft voices, and, united with them, the singing can reach to the top of the palaces. It [instrument] the mute, is joined with the articulate [man], whose voice is heard far and wide. The sweet concord which I then heard was wonderful. Moreover, on a certain day there, when we were immersed in slumber, the hydraulis sounded loudly, so that being terrified on hearing it, I awoke. Then my brethren who were with me, and I, arose straightway to perform our duty, and a psalm which best suited the occasion occurred to us.”

This narration is quite an important adjunct to the historical literature of the hydraulis, since it tells us more than any of the Greek or Latin authors do of the intimate part which this instrument played in the lives of the people.

After this reference by Isaac of Antioch (d. ca. 460) and that of the Talmud, nothing is heard of the hydraulis in the East for over three centuries. The same thing occurs in the West, where, after Apollinarus Sidonius (d. ca. 483), we have silence concerning this instrument until the ninth century. It may therefore be assumed with a tolerable degree of certainty, that the hydraulis had disappeared in the interim.

The disuse of the hydraulis appears to have been due to three factors: (1) the triumph of the barbarians; (2) the rise of Christianity and of a puritanical Judaism; and (3) the greater simplicity in construction of the pneumatic organ. Whilst Gaul and Italy experienced the barbarian devastations which materially contributed to what has been termed the “Dark Ages,” Byzantium was not so badly exposed, and here, probably, only the second and third causes operated. That the arts and sciences, including music, were held in contempt by the early Christians, is testified by many authorities, but there is an interesting confirmation from a Muslim source. It occurs in the Muruj al-dhahab of Al-Mas'udi (d. c. 956), where we are told as follows. In the days of the ancient Greeks, and in the first period of the Kingdom of Byzantium, science was developed, and scholars were honoured. . . . Then came the Christian religion, which became fatal to scientific knowledge, since it destroyed and blotted out the teaching of science. All that the ancient Greeks had placed before the world vanished or was distorted. Among the noble sciences which were thrown aside with the advent of Christianity was the science of music.

Puritanical Judaism was equally contemptuous of instrumental music, as we have seen. The hydraulis, above all other instruments, savoured of the circus, the spectacle, and all the so-called orgies of Paganism, against which the Christian Fathers and Jewish Rabbis alike had sternly set their faces. When next we read of the organ, it is no longer of the hydraulis, but of the pneumatic organ.

Probably the art of constructing the hydraulis was lost in the barbarian destruction of the writings of antiquity, and also by reason of the ignorance of the Christian monks. Vossius opined that the barbarians tried unsuccessfully to make the hydraulis, but had to remain content with the pneumatic organ, which was more easily constructed. On the other hand, it may have been that the latter instrument was free from anathema. Certainly, it was much easier to make and less liable to get out of order.

After the world-wide Arab conquests of the seventh-eighth centuries, and the consequent revival of learning,
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we read once more of the hydraulis in Syriac writings. This occurs first of all in the lexicographer, Isho' bar 'Ali, who is said to have been a pupil of Ḥunain ibn Ishāq (d. 873), a Christian Arab of Al-Hira, and one of the savants of the Bait al-hikma (College of Science) in Baghdād. Isho' flourished at Baghdād, where his father and uncle were in charge of the college in the Mar Pethion Convent in 832-6. Isho' defines the hydraulis (hedhrula) thus:

"[It is] the organ (urghanun) ... skins, on which they play."

The Arabic commentary on this passage says:

"[It is] the organ (urghanun, urghanun) on which one plays."

Another Syriac lexicographer, Bar Saroshwai (early tenth century) says:

"Hydraules are instruments of music on which one plays, such as reeds (one MS. has 'skins') which men work."

The more celebrated Isho' bar Bahlul (fl. 963) describes the hydraulis a little closer:

"The hydraulis of brass is explained as a certain oven (tannur)."

The Arabic commentary on the passage runs:

"[It is] the musical skin (bag), the organ (urghanun)."

Payne Smith, the famous Syriac scholar, thought that this mention of the tannur (oven) was an error. It is not, since this same word is mentioned in the Muristus Arabic treatise on the hydraulis, and equates with the bömischos of Heron and the ar[x]a of Vitruvius.

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The Organ from Syriac Sources.

Elias bar Shinaya, of Nisibis (b. 975) says:8

"Hydraules are instruments which they play like reeds and what resembles these."

The Arabic commentary runs:

"[It is] the musical skin (bag), like the flutes (shabab) and wooden contrivances (manjar), and the like."

These later notices anent the hydraulis from Syriac sources are probably too fragmentary to be of much use to historians of music, but at least they enable us to recognise that the Syrians knew of the instrument in the ninth-tenth centuries, and we must remember that the famous Utrecht Psalter, which gives us the first pictorial evidence of the hydraulis since the fifth century, was probably inspired by Syrian art or artists. Further, it was in Syria that Arabs were constructing organs in the twelfth century.9

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5 Meaning the "bellows."
6 Payne Smith, loc. cit.
7 Payne Smith, loc. cit.
8 Ibid.
9 Ibn Abi Uṣaibi'a, ii, 155, 163.
CHAPTER V.
THE ORGAN FROM ARABIC SOURCES.
(The Pneumatic Organ.)

"Harp and Tambourine and Organ, dulcimer-like sweet resound,
For the sigh of Flutes is Frankland all a wail, in verity."
Prince Jem of Turkey (d. 1495).

In the Muslim conquests of Persian and Byzantine lands in the seventh-eighth centuries, we see that first harbinger of the dawn whose meridian was the Renaissance. In the fourth century B.C., Greek science had marched with Alexander the Great into Syria, Mesopotamia and Persia, where it subsisted even down to the Christian era in important culture centres like Edessa, Harran and Jundeshapur. Yet, it was not until the Arabian khalifs took Greek science under their protection that it came to flourish in the Middle Ages. The Umayyads (661-750) were certainly interested in the question, but it was reserved for the 'Abbâsids (750-1258), beginning with Khalif Al-Manṣûr (754-75), to rescue the learning of the Ancients from the oblivion engendered by the Dark Ages.

The libraries of Byzantium were searched for the sciences of the Greeks, and a host of treatises were translated from the Greek into Arabic, many, if not most of them, via Syriac. Works on the propædeutic or mathematical sciences ('ulām riyāḍīyya), which comprised arithmetic, geometry, music and astronomy, may be traced in Arabic to the eighth century, when we have the 'Ard miftâh al-nujm of Hermes being translated into Arabic (dated 743). It was, however, the Baghdad College of Science (Bait al-ḥikma), founded by Khalif Al-Ma'mûn (813-33) that speeded the work of translation, and it was here that one at least of the works on organ construction which has come down to us, that of the Banû Miisa, was produced. Baron Carra de Vaux is of opinion that the mechanics of the Greeks, as well as their music, was studied, first of all, on Persian territory, before it passed into the hands of the Arabs. Certainly, the number of Persian technical words which are to be found in the Arabic works on mechanics and similar sciences, are considerable, although both Aramaic and Syriac are well represented.

Concerning the present subject we find that there were Arabic translations of the Pneumatics of Philôn (Kitâb Filân fil-hiyal al-râhâniyya wa miḥāniqa al-mâ'), the Mechanics of Herôn (Kitâb al-hiyal al-râhâniyya), and the Automatic Wind-Instrumentalist (Ṣaw'at al-ul al-sânîr) of Archimedes and Apollonius of Perga. These works show us that the Arabs were fairly well acquainted with these departments of science, and especially with the production of musical sounds from flue and reed-pipes by means of hydraulic action.

In all probability, these translations were done in the ninth century. Philôn's Mechanics was probably trans-
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lated in the time of Al-Ma’mūn (813-33). The Heron treatise came from the hand of Qūṣṭa ibn Lūqā, and was written for Khalīf Al-Musta’in (862-66). The translation of Apollonius of Perga may be due to Hilāl ibn Abī Hilāl (d. c. 882) or Thābit ibn Qurra (d. 901).

As for the organ proper, we have evidence that it was in use by the Arabs in 813-25, as we shall see presently. Yet precisely how it came to be adopted by them we do not know. In Syria, and in Byzantine lands, the Arabs would have come in contact with the pneumatic organ as early as the seventh century, when they conquered Syria and a portion of Asia Minor. In the eighth century, several mechanical contrivances of the Byzantines and Ancient Greeks were adopted by the Arabs, and the pneumatic organ may have been one of them. It is more likely, however, that it was not until the Syro-Arabian school of translators began to work on the ancient Greek treatises on organ construction, that the Arabian mechanicians themselves began to produce this instrument for the khālīfate court and nobility, who were always interested in musical and mechanical novelties. At any rate, it is fairly certain that the hydraulis made its appearance in this way, that is to say, that it was not until the ancient Greek works on the hydraulis became known to the Arabs, that the instrument was revived anew, after having been neglected for two or three centuries.

The earliest technical documents dealing with organ construction in Arabic are those attributed to a certain Murīṣūs, to whom we have already referred. That these are translations or compilations from Greek documents, there is every reason to believe. We do not know, how-

The Organ (Pneumatic) from Arabic Sources.

ever, the precise date of their transmission. Assuredly, they were known to the polygraph, Al-Jāḥīṣ (d. 868). Père Cheikho suggests that the translation or compilation was done by one of the Banū Mūsā (Muḥammad died in 873), or by Ḥunain ibn Ishāq (d. 873). Yet since the organ was known to Al-Mahdī’s daughter ‘Ulayya (d. 825), an earlier date is almost incumbent upon us, if we are to accept the suggestion that the organ was introduced to the Arabs via the literary contact.

We can now deal with the various types of mechanically wind-fed instruments that were known to the Arabs. (1) the Pneumatic Organ, (2) the Hydraulic Organ (hydraulic air compressor), and (3) the Hydraulis (hydraulic pressure stabiliser).

§ 1.

The earliest definite reference to the word organ in Arabic is to be found in the famous Kitāb al-āghānī, or “Book of Songs,” by Abūl-Faraj al-Iṣfahānī (d. 967), who quotes a story about Khalīf Al-Ma’mūn, Isma‘īl ibn Al-Hādī, and ‘Ulayya, the daughter of Al-Mahdī. Since Al-Ma’mūn became khālīf in 813, and ‘Ulayya died in 825, the incident must have taken place between these dates. Although the organ is merely mentioned, the story is too good to be passed over, and we therefore give it:

“There informed me Muḥammad ibn Yahyā, on the authority of ‘Awn ibn Muḥammad, on the authority of Abī Aḥmad ibn al-Rašīd, and [in addition] I copied the story from a book by Muḥammad ibn al-Ḥasan, who got it from ‘Awn ibn Muḥammad, who got it from Abī Aḥmad ibn al-Rašīd, the following: He [Muḥammad

\[\text{\footnotesize Citations: Carra de Vaux, loc cit.} \quad \text{\footnotesize See the Fihrist, 267, 285.} \quad \text{\footnotesize Al-Jāḥīṣ, 133, 143.} \quad \text{\footnotesize Kitāb al-āghānī, ix, 90 (Sāṣi edit.).} \]
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Ibn Yahya said, Isma'il ibn al-Hadi entered one day into the presence of Al-Ma'mun, when he heard music (ghind') which diverted his attention. Then Al-Ma'mun said to him, 'What ails you?' He replied, 'I have heard something that has bewildered me, and yet I have been the most strenuous in denying that the Byzantine organ (urghan al-rum) killed with delight, but now I declare that to be true.' He [Al-Ma'mun] said, 'Do you not know what this is [that you have heard]? He [Isma'il] replied, 'No, by Allah.' He [Al-Ma'mun] said, 'It is your aunt Ulayya, who is teaching your uncle Ibrahim [ibn al-Mahdi] to sing a melody from her repertory.'

The Arab historian, Al-Mas'udi (d. c. 956) has an interesting passage on Byzantine musical instruments in his Muruj al-dhahab, which mentions the organ. The passage is actually a citation from an oration by Ibn Khurdadhbih (d. 912) before Khalif Al-Mu'tamid (870-93). This Ibn Khurdadhbih had some reputation as an authority on musical instruments, and was the author of two books on music, a Kitab adab al-samd' ("Book of Liberal Education in Music") and a Kitab al-lahw wa'l-malalh ("Book of Diversion and Musical Instruments"). In his oration, Ibn Khurdadhbih says:

"And they [the Byzantines] had the urghanun possessing bellows and iron work."

A more precise description of the Byzantine organ is given by an Arab-Persian scholar named Ibn Rusta, who lived at Isfahan in the ninth-tenth century. Particulars of his life are wanting, but we know that he was at Al-Medinah in 903, and that about the same time he wrote a work entitled the Kitab al-alag al-nafta, the geographical portion of which has survived. Ibn Rusta describes an organ at Constantinople as follows:

"Then there is brought a thing called an organ (urqanda), and it is made of a square [case of] wood, in the shape of a wine-press (ma'sara), and this latter is covered with strong skin. Then there are made in it sixty pipes of brass, the heads of which, as far as the middle, project above the case. These pipes are covered with gold above the case, with the exception of a small portion, in proportion to their sizes, one longer than the other.

"At the side of this square thing [the case] are holes in which are fixed the bellows (minfakh), which resemble the blacksmith's bellows (kar). Then there are brought three crosses (salban); two are placed on the ends, and one in the middle. Then they press the bellows with the feet, and the organist (ustadh) stands and plays (kasaba) upon these pipes, and each pipe he makes to speak in turn, according to what he [the organist] plays."

Another description of the Byzantine organ is given in the encyclopaedia known as the Majati al-ulam, or "Keys of the Sciences," written by Muhammed ibn Ahmad al-Khwarzimih about the middle of the tenth century. In the section on "Musical Instruments" we are told:

"The organ (urqanun) is an instrument of the Greeks (Yananiyyan) and Byzantines (Rum). It is made of..."
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three large bags of buffalo skins, one being joined to another. And there is mounted upon the head of the middle bag, a large skin. Then there are mounted upon this skin, brass pipes having holes upon recognised ratios, from which proceed beautiful sounds, pleasing or melancholy, according to what the player desires."

The "large skin" upon which the brass pipes were mounted would appear to have been used for the same purpose as our modern horizontal bellows.

It is in the ninth century that we first hear of the name of Mūristus from Arabic sources. This was the supposed inventor of the organ, and/or the author of works on organ construction. He is mentioned by the famous polygraph, Al-Jāḥiẓ (c. 773-868), the companion of Ibn al-Zayyāt, the wāiz of Khalīf Al-Wāthiq. The first actual reference to the titles of the works of Mūristus, however, occurs in the Fihrist of Ibn al-Nadīm, written in the year 988. This writer says: "Mūrūs or Mūristus. And among his books are, Book on the Musical Instruments called the Flue-pipe Organ (urghanun al-buql) and the Reed-pipe Organ (urghanun al-zāmir); Book on the Musical Instrument which may be heard Sixty Miles." A similar passage occurs in the Taʾrikh al-ḥukamaʾ of Ibn al-Qīṭṭī (d. 1248): "Mūrūs or Mūristus, a Greek sage, skilled and ingenious. And among his literary works is a Book on the Musical Instrument called the Organ (urghan), and it is the instrument which may be heard Sixty Miles."

Lastly, the passage may be found, with a slight variation, in the Taʾrikh mukhtaṣar al-bašar of Abūʾl-Fidāʾ (d. 1331): "And among them [the Greeks] was Mūrūs or Mūristus, a Greek sage, skilled and ingenious. And he composed a Book on the Instrument called the Organ (urghan), and it is the instrument which may be heard Sixty Miles."

This Mūrūs or Mūristus, was also the author of a Kitāb ṣaʿāt al-juljul ("Book on the Construction of the Chime"), the Arabic text of which has been printed in the Mashriq. In this work we read of a certain Šāʾūṭ as a constructor of this chime. He is also mentioned in the Fihrist as the author of a Kitāb al-juljul al-ṣīyyāḥ ("Book of the Octave Chime"), and he is another Greek or Byzantine writer, whose work, although unknown in Greek, has been preserved in Arabic.

Returning to Mūristus, it is not improbable that three other works mentioned in the Fihrist may be attributed to him. They are: a Kitāb al-lat al-zāmr al-buqlī ("Book on the Trumpet-like Reed-pipe"), a Kitāb al-zāmr al-riḥī ("Book on the Æolian Reed-pipe"), and a Kitāb al-dawalib ("Book on Water-wheels").

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23 Abūʾl-Fidāʾ, 156.
24 The Bairūt text has suffa, but the Catalogue of the MSS. in the Université de Beyrouth in the Mélanges de la Faculté orientale (vii, 280) has the word ṣaʿāt, as in the British Museum MS. Cf. Mashriq, ix, 19.
25 For a German translation of this see Wiedemann's Byzantinische u. arabische akustische Instrumente, 164.
26 The Bairūt text has Šāʾūṭ, but the British Museum and Constantinople MSS. have Šāʾūṭ.
27 It may be read ṣaʿādūṯ ("clamorous").
28 At Ṣanʿa in Al-Yaman there were statues that were made to sound by means of pipes through which the wind passed. (Yaḡūṭ, iii, 811.)
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It may be safely conjectured that Ibn al-Qifti derived his information from Ibn al-Nadim, or else that both depended on a common source. At the same time it must be noticed that Ibn al-Nadim refers to two books whilst Ibn al-Qifti and Abu'l-Fida' only mention one. Further, Ibn al-Nadim refers to two distinct instruments, a Flue-pipe organ and a Reed-pipe organ, whilst the others speak of a single instrument combining both types of pipe. Such contrariety, however, may be due to the carelessness of copyists, and we certainly have no other evidence of the combined instrument.

It has already been pointed out that there are several specimens of the Muristus MSS. on the pneumatic organ and hydraulis. In the British Museum (Or. 9649) these are entitled: (a) Risâla li-Muristus san'at al-urghin al-baqt ("Treatise by Muristus on the Construction of the Flue-pipe Organ"), and (b) Risâlat ukhra li-Muristus san'at al-urghin al-zamir ("Treatise also by Muristus on the Construction of the Reed-pipe Organ"). The Constantinople MSS., which are preserved in the Library of St. Sophia (Nos. 2755, iii and iv) have similar titles except that the phrase al-hakim (the sage) is added to the name Muristus. The copies (No. 224) at the Catholic University of Beirut appear to be copies of the Constantinople MSS., and they are included in the one title: Risâlat an li-Muristus fl' l-urghanun (Two Treatises by Muristus on the Organ). Perhaps the oldest copies (No. 364) are those preserved at the Three Moons College of the Greek

The Organ (Pneumatic) from Arabic Sources.

Orthodox Church at Bâirût. Here, the works are called: (a) 'Amal al-alat illati ittakhadhahâ Muristus yaddhabu sawiyka sittan milan ("Making of the Instrument which Muristus Invented, the Sound of which Travels Sixty Miles"), and (b) San'at al-urghan al-jami' li-jami' al-ajwab ("Construction of the Comprehensive Organ for all the Sounds"). This is the only copy of the Arabic work on the hydraulis which expressly mentions Muristus as the "inventor."

For the present, however, we are concerned with the pneumatic organ, and the Muristus MS. deals with a type of instrument much earlier than anything hitherto known to us. Although the Arabic texts of the Bâirût Muristus MSS. have been printed in the Mashriq, they are faulty, and the present translation is based on the British Museum MS. which has not hitherto been used. At the same time, both the Mashriq texts and Professor Wiedemann's German translation have been used in collating the British Museum text for the purpose of the present translation.

"TREATISE ALSO BY MURISTUS ON THE CONSTRUCTION OF THE COMPREHENSIVE REED-PIPE ORGAN FOR ALL THE WONDERFUL SOUNDS.

"And it is that which makes you hear a wonderful sound, causing you to weep violently: And makes you hear a sound compelling sleep, for he who hears it sleeps where he stands: [And makes you hear a sound so as to grieve and divert:] And makes you hear a sound so as
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to be merry and to dance: So when you wish to make this instrument, take three skins (ziqq) tanned well and soft, each of them separately, and do not let bitumen (zift) come near them. Then, sew up the heads of two of these skins thoroughly, so that they are air-tight, and leave the third skin with its head unsewn. Then put the skin that has its head unsewn in the middle, and each of the other two skins on the right and left of it. Then, perforate the [inner] side of each skin that is on the right and left of the middle skin with four holes, and similarly perforate the middle skin on its two sides with four holes exactly opposite to the holes of the two skins on either side of it. Then these three skins are marked: A, B and J. And the middle skin is B.

Then take pipes (unbāb) of strong brass (nahās), about the thickness of a [big] tube (qaṣib) the length of each pipe being 54 cm. (= 1 dhīra'). Then, let them be joined from skin to skin. And these pipes are called 'the passages of the wind.' And let these holes and these pipes be of different size in their measure and arrangement, according to ratio, and according to what I shall describe.

"Let the first hole of the right [skin] which is opposite the breast (sadr) of the middle skin, be measured according to what we wish of the dimension of width. And if the width of the first hole of the [left] skin [be like] the width of the first hole of the first skin on the right, then likewise the ratios of the remainder. And if you make the width of the first hole of the left skin half the width of the first hole of the right skin, then similarly you will make the ratios of the remaining holes of the left skin. And if you make the first hole of the left skin wider than the first hole of the right skin, then similarly you make the ratios of the remainder [of the holes] of the left skin.

"The sense of this is that for these pipes D and K we posit fixed widths, just as we wish, either equal or unequal. Then we make the ratio of the pipe H to pipe D in proportion as 2 is to 1, and likewise we make the ratio of pipe Y to pipe K. Then we make the ratio of pipe W to pipe D in proportion as 3 is to 1, and likewise we make the ratio of pipe T to pipe K. And we make the ratio of pipe Z to pipe D in proportion as 4 is to 1, and likewise we make the ratio of pipe H to pipe K. And this
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is the ratio of the pipes which are called 'the passages of the wind.'

"Then mount upon the mouth (? head) of the middle skin a pipe, its length 54 cm. (= 1 dhinda'), projecting by itself. And its width is the width of a dirham. Then fix it so that there is no vent-hole, and it is the pipe B-L.

"Then perforate in the chest of each skin four holes, and let the distance between the holes be exactly equal. And let these holes be in the size, and width, and measure, according to the size of the pipes [called] 'the passages of the wind,' and according to their ratios. Then mount upon these holes pipes of brass, of which the width and ratio are according to the size of the holes. And let the length of each pipe be 54 cm. (= 1 dhinda'). Then let these pipes stand vertically, projecting from the chests of the skins. And they number twelve pipes. And those in the A skin on the right are marked M, N, S and X: and those in the B skin in the middle [are marked] F, S, Q, and R: and those in the J skin on the left [are marked] Sh, T, Th and Kh.

"Then mount with a firm arrangement upon every one of these pipes, at its extremity, a 'sound-box' (sha'rat al-mizmar), and you will get twelve sounds. Then, for these twelve vertical pipes in which are the 'sound-boxes' from which the sounds proceed, you insert (itakhadhka), in the middle of them, 'stoppers' (bathin), firm and dry.

The Organ (Pneumatic) from Arabic Sources.

which are shut and opened in order to change the sounds. And this is the chief requisite in the making [of this instrument]. So understand that.

"Then to return to the pipe which was in the chest (? head) of the [middle] skin, it is B-L, and it is the place of blowing and the entering of the wind. Then mount upon it a small skin, firmly fixed to the extreme end L, and it is the skin marked D (Dh). Then insert in this skin four pipes, the length of each pipe being 81 cm. (= 3 shibr), and the width of each pipe being of a convenient size for the lips [of the blowers]. And the pipes are marked D, Z, Gh and S.

"Then place the whole of this instrument upon a framework (sarlir), and prepare places for the seating of the men who blow. Then, if you wish to play sorrowful music (lahn), close all the 'stoppers' (bathin) which are in the pipes, and do not press out from them any air, except [from the hole of the second pipe of the second contrivance (? skin), the upper one of the first skin, and the hole which is in the fourth pipe of the second skin and it is opposite the upper pipe of the third skin, and it is half of the upper, which means that you close all the 'stoppers' except N, Z (sic), and T. Then when they blow, let their blowing be gentle, moderate in degree, for nobody is
cock, tap." The Banu Musa and the Arabic Kitab al-hiyal of Philon have bathin, whilst Badi' al-Zaman has fitthin, and the Apollonios and Archimedes treatises have both bathin and bathyn.

7 Elsewhere called the "mouth." 8 Not in the Mashriq text.

9 The Mashriq text reads, "the width being according to what the 'sound-box' is joined to."
The Organ of the Ancients.

able to hear this sound except that grief enters into him, and his temperament is quieted, and sleep so overcomes him that he sleeps where he stands.

"And if you wish that you should play music (laḥn) which will conduce to wakefulness and courage, then blow the hole of the first pipe which is the upper one of the first skin [A], and the second hole of the second skin,\(^{22}\) and it is an upper one also, and the third hole of the third skin,\(^{23}\) which means that you open the 'stopper's' M, S and Th. Then the blowing will be with violence, for the sound has to produce what is conducive to courage and wakefulness.

"And if you wish to produce delight and activity in the temperament of man, until his senses are carried away, and he continues weeping and moaning, then blow the hole of the second upper pipes, and the third upper [pipes] of all the skins, which means that the 'stopper's' N, S and T and Sh (? S), Q, Th, are opened. Then regulate the sound,\(^{24}\) and let the blowing be with moderation. Then upon that there appears in man [the mediator of] joy and gladness, and depression of the intelligence. And he weeps without knowing why he weeps.\(^{25}\)

"And if you wish to perplex the listeners until their souls become flaccid and the bodies weak, then open the holes of the upper pipes of the three skins and the holes of the pipes opposite the upper pipes, and they are the low [sounds], which means that the man opens the 'stopper's'

\(^{11}\) Meaning, "the hole of the second pipe of the second skin."

\(^{12}\) Meaning, "the hole of the third pipe of the third skin."

\(^{13}\) This phrase, by a copyist's error, comes before the notation, in the British Museum MS., but I have transposed it.

\(^{14}\) Not in the Mashriq text.

\(^{15}\) The Mashriq text differs somewhat from the British Museum MS. here.

The Organ (Pneumatic) from Arabic Sources.

M, F and Sh, the high [sounds] and the 'stopper's' X, D\(^{26}\) and Kh, the low [sounds]. Then you will see a marvel, because this 'compound' (tarkhā) is alien (lit. 'external') to the temperament of man, because a man does not comprehend upon hearing it what we have mentioned.

"And the ears of those who blow will be stopped in order that there may not affect them what affects the hearers, otherwise their work would be useless.

"And it will be more effective for the increase of the sound, and its strength and length and duration, that those who blow should be twelve according to the number of pipes. Then if you desire that, let there be inserted in the small skin, twelve pipes for twelve men.

"Then let those who blow be clever and experienced in the art concerning singing (ghind') and the scansion of melody (laḥn), because it may be necessary for them to play melody (laḥn) for the notes (nagham) of regular poetry, just as the player of the mizār al-wāḥid which is called the surnāy (reed-pipe) and the nāy (flute) makes melody (laḥn). And let their larynxes (lit., 'the instrument of their throats') be wide and sounding.

"And we can only compare this instrument [the Comprehensive Reed-pipe Organ] to the disposition which is to be found in the composition of man. It [the organ] is one of the best composite productions (mizāj) among the instruments of sound, with its manifold means of use, sounding all the sounds that one desires, in all the languages of land and water animals. And no one will be able to construct these instruments, which are adapted to man, in such a way that the sound is produced as we have

\(^{16}\) The design has R, and Wiedemann says R.
The Organ of the Ancients.

mentioned, except in the manner in which this instrument has been described."

This document describes a pneumatic organ of a type anterior to anything that we know of in Byzantium or Western Europe. It is certainly much earlier than the instrument depicted on the Obelisk of Theodosius (died 393), the fourth-fifth century Roman instrument, the Stuttgart codex (tenth century), the descriptions of Bernelius (c. 990) or Pseudo-Bernelinus, Notker Labeo (d. 1022), Eberhard of Freising (eleventh century), Theophilus (eleventh century), or the Pommersfelden codex (eleventh century).

In both the British Museum and Constantinople MSS. the instrument is termed a “Reed-pipe Organ.” This is borne out by the description of the instrument which specifies pipes of the same length. The diagrams in the various MSS. give us merely a “bird's eye view” of the instrument, which, save for the mere suggestion of a framework in the Bairut MS. (see frontispiece), shows nothing in the nature of an organ case. The three skins or wind chests seem to have served, by reason of the weight of the pipes, as pressure-stabilising bellows at the same time.

The blast-bag (i.e., the “small skin” mentioned in the text), with its four insufflation pipes for the mouths of the

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27 In the Mashriq text there is no clue for the elucidation of the notation in the design. (See frontispiece.) Further, parts of the text dealing with the tarkibat (sing. tarkib) have got badly mixed, which even the learned Père Cheikho was unable to rectify. Even the Constantinople MS., as translated by Professor Dr. Wiedemann, does not conform strictly to the British Museum MS.

28 See ante pp. 39, 46. 29 See ante pp. 46.


1 Gerbert, Scriptores, i, 318, 325. 2 Ibid, i, 1000.

3 Ibid, ii, 279. 4 Theophilus, iii, 81-4.


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FIG. 1.—THE MURISTUS PNEUMATIC ORGAN.

(Al-arqhin al-zamri.)

British Museum MS., Or. 0649.
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blowers, is the only example that has come down to us from antiquity of this primitive method of organ blowing. Further, as has already been pointed out, it justifies the contention of other writers that in the earliest attempts the supply of wind was furnished by the mouth.  

There is no keyboard such as we know of by that name. In the Bairüt MS. (see frontispiece) the btihanat (sing. btihan), or "stoppers" as I have called them, have the form of "sliders" not unlike the appliances delineated in European MSS. which contain designs of organs. In the Bairüt MS. these "sliders" are mentioned as being fixed in the middle of the pipes. In the British Museum and Constantinople MSS., these "stoppers" are given the form of a tap or stopcock, and they are shown inserted not in the middle, but in various places.

The question of the tarkib or "compound" of notes produced by the Comprehensive Organ of Māriṣṭus is of considerable interest. When I wrote my Historical Facts for the Arabian Musical Influence I only had the Bairüt Māriṣṭus as a guide. In this MS., as may be seen from the design, each "stopper" or pipe is marked with an Arabic letter (see frontispiece). This notation being similar to a musical notation given by a certain Arab theorist of music named Ibn Zaila (d. 1048), led me to say in the book mentioned above, that "if we may assume that these symbols [on the Māriṣṭus organ pipes] have the same pitch values" as the notation of Ibn Zaila, we could find out what these tarkibat were. On this assumption, purely tentative, I gave some examples of these tarkibat or "compounds" of notes (i.e., chords). The recent acquisition by the British Museum of an exemplar of the Māriṣṭus treatise, and the fresh light thrown by the Constantinople MS., show that the suggestion cannot be insisted on. Of course, the scale assumed in these works may indeed be the one actually used. It is a lute scale. On the other hand it may have been built on a semitonic scale seeing that there were twelve pipes. At any rate, it is now quite clear that none of the MSS. give a definite clue to the actual notes given by the twelve pipes, other than that the lowest row of pipes (X, R, Kh) gave the low notes, and the highest row (M, F, Sh) the high notes.

It is a pity that the great Arabian musical theorists, Al-Kindi (d. c. 874) and Al-Fārābī (d. 950) did not deal with the organ in their treatises. The important Kitāb al-mūsāq al-kabīr of the latter was compiled in Syria, a land which was evidently well acquainted with the organ, and a line on the organ from the master hand of its author, would have been an invaluable guide in this inquiry. Ibn Sīnā (d. 1037), the famous successor of Al-Fārābī in the Arabian world of science and philosophy, has merely mentioned the organ en passant in his Kitāb al-shifā. He says:

"And sometimes there are made instruments that are blown into, of composite structure, when we get the like of the Byzantine instrument known as the organ."  

In another work attributed to Ibn Sīnā, entitled Rasā'il fi'l-hikma, there is this passage:

"Among the appendages to the science of music, is the
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construction of marvellous, extraordinary instruments, such as the organ (urghan)\(^{11}\) and what resembles it. Ibn Sinâ's disciple, Al-Ḥusain ibn Zaila (d. 1048), was the author of a rare work named the *Kitâb al-kâfî fi'l-mûsâqî, now in the British Museum. In this work there is a passage similar to that in the *Shîfiya:

"And sometimes there are made instruments that are blown into, of composite structure, when we get the like of the organ (urghanun), and other than this."

It will be noticed that nearly all these writers refer to the Byzantine or Greek organ. This does not mean that it was not used by the Arabs, but merely that it was of Byzantine or Greek origin. Arabic authors frequently name their instruments after their place of origin or provenance, just as we read in the *Alf laila wa laila ("Thousand and One Nights") of the Damascus lute (‘ud jilliql), the Persian harp (jank ‘ajamî), the Tartar flute (nay tatari), the Egyptian psaltery (qanun mîsâl).\(^{13}\)

We know from the Murîsûs documents and from Ibn Abî Uṣâibi‘a, that the Arabs were not only interested in, but were actually constructing organs between the ninth and twelfth centuries.\(^{14}\) The manner in which the Ikhwan al-Ṣâfâ (tenth century), include organs in a long list of indigenous musical instruments seems a point in favour of this view.\(^{12}\) Al-Ḥusain ibn Zaila (d. 1048), who quotes Ibn Sinâ almost verbatim, dispenses with the qualification "Byzantine," which may have been deliberate.

How far the pneumatic organ was favoured by the Arabs is difficult to determine. Perhaps it was only taken kindly to in Syria, where we know that it continued in favour until the twelfth century at least, since Arab constructors are mentioned at this period. Two of these organ builders are signalised by Ibn Abî Uṣâibi‘a (d. 1270) in his *Uyun al-anbâ, and they are Abû’l-Majd Muḥammad ibn Abîl-Ḥakam and Abû Zakariyyâ Yahyâ al-Bayâsî. Abû’l-Majd (d. 1180) was a physician, scientist and musician, who was in the service of the Zangid atâbag Nûr al-Dîn (1146-74) at Damascus. His biographer says:

"Abû’l-Majd had knowledge of the science of music (mûsâqî) and played the lute (‘ad); excelled in the song (ghinda), the rhythms (tîqa[‘ad]), the reed-pipe (samar), and other instruments. And he constructed an organ (urghan) in which he attained perfection."

Abû Zakariyyâ was an Andalusian Arab by birth, but he spent most of his life in Egypt and Syria in the service of the Ayyûbid sultan Sâlâh al-Dîn (1169-93), otherwise known as Saladin. He too was both a musician and scientist. Of him it is said:

"Abû Zakariyyâ . . . made for Ibn al-Naqâsîh many instruments of a composite nature, which he derived from engineering (handasa), . . . was an excellent player on the lute (‘ad), and he constructed an organ (urghan), and sought by artful contrivance the playing of it."

When Baghdâd was captured in 1258 by the Mughal hordes of Hulâgû, the Khalifate proper came to an end,

\(^{11}\) Ibn Abî Uṣâibi‘a, ii, 155. \(^{12}\) Ibn Abî Uṣâibi‘a, ii, 163.
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and with it much of what counted for culture in the Near East. It was due to the Mughals however that the organ was introduced into China. We have the event and the instrument described in a Chinese document, the *Yüan shih*, where the organ is called the *hsing lung shén*. We are told that this organ was "presented by the Muslim kingdoms in Chung-t'ung (1260-64)." In another work, the *Wang chung wén kung chi*, we have the information that the instrument was "an offering from the lands of the West," and that the Emperor Khubilai himself "added improvements to it." We may suppose that this organ actually came as a present from Hülagü to Khubilai, who was his kinsman, and probably it was made in Syria.\(^1\)

After this, the organ passed out of use in Muslim lands, and was only recognised as an "instrument of the Europeans." In Persia, however, the organ appears to have had some vogue even up to the time of Hāfiz the poet (d. 1380), since the organ (*urghanūn*) is enumerated among the instruments of music in use in his *Mughannī nāma*.\(^2\)

The famous Perso-Arab musical theorist, 'Abd al-Qādir ibn Ghaibī (d. 1435), whose holograph MS. of the *Kitāb jāmī al-alḥān* is preserved in the Bodleian Library says:\(^3\)

The Organ (Pneumatic) from Arabic Sources.

"The organ (*urghanūn*) is much used by Europeans. It is constructed of pipes arranged in a row. Behind them are arranged bellows from which the wind goes into the pipes. . . . And with the left hand they move the bellows, and with the fingers of the right hand they play. And the notes are in its pipes, and to every pipe there is a 'pallet' (lit. 'screen') in the form of a . . . . (?). . . . which, when pressed down, opens a passage (into the pipe) and its voice is heard."

The mention of the bellows being worked by the left hand, and the pallets by the right hand, shows that the writer had a small portative organ in mind.

In the sixteenth century, the organ was still a "foreign" instrument to the Persians, since it is mentioned in the *Burhānī qātī*, thus:

"The organ (*urghanūn*) is that instrument which the Europeans (*Rumiyān*) play."

The last references to the organ that are of interest are those by Tashkopri-Zade (d. 1560),\(^4\) Hājji Khalīfa (d. 1658)\(^5\) and Evliya Chelebi (d. c. 1679). Tashkopri-Zade refers to the organ in such a way that it is quite clear that the instrument was alien to the Turks in his day. He says:

"I saw and heard the organ frequently, but the sight and impression only increased my awe and my confusion."

Hājji Khalīfa, however, writes about the instrument not from personal experience, but after consulting an older authority, probably Al-Khwārizmī (tenth century), and practically in the same words. He says:

"After him (Pythagoras), other wise philosophers added to what he had invented, until the turn came to Aristotle, and he conceived and constructed the organ, and it is an

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\(^{1}\) *Miftāḥ al-sa‘ādat.*

\(^{2}\) *Hājji Khalīfa,* i, 399, vi, 258.
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instrument of the Greeks (Yünâniyyûn), made of three large bags of buffalo skins, one being joined to the other. And there is mounted upon the head of the middle bag another large bag. Then there are mounted upon these bags, pipes having holes upon recognised ratios, from which proceed beautiful sounds, fine and pleasant, according to the wish of him who uses them. These are all Turkish writers, but the first two wrote in Arabic. The famous English organ builder, Thomas Dallam, constructed a mechanical clock-organ for the Sultan of Turkey in 1599-1600, and installed the instrument personally.

The mention of the European organ by Evliya Chelebi, in his chatty Siyâhat nâmâ, deserves to be reproduced here:

"The organ (urghanûn) ... is generally found in the country of the Franks. There you will find in every convent and church, a large organ with three hundred pipes, with two pairs of bellows, each moved by ten monks, and touched with the fingers. And when it begins to sound in a mournful tune like that called rahâwî, the monks sing to it the verses of the psalter. They are in the habit of castrating boys in order to preserve their voices. These boys are made to stand on the upper part of the bellows, with which they rise and descend, singing the verses of the psalter to a mournful tune, rahâwî, so that the hearers are all enraptured. ... This tune is so called from the town of Raha (Edessa), where David invented this instrument, which absolutely must be heard to have an adequate idea of it."

2a See ante, p. 59-60.

2 English Historical Review, v, 656. A full account of it is given in a MS. in the British Museum.

3 Evliya Efendi, Travels, i, ii, 226.

CHAPTER VI.

THE ORGAN FROM ARABIC SOURCES.

(HYDRAULIC ORGANS.)

"The power then passed to the Greeks (Rûm). It is to these people that the savants belong who have dealt with astronomy, geometry, medicine, arithmetic, music, magic glasses, talismans, pneumatic and hydraulic machines, and all the sciences."—Mukhtarî al-najâb (tenth cent., ?).

FROM such works as the Arabic versions of Pseudo-Aristotle's Kitâb al-siyāsâ (Secretum secretorum), Philon's Pneumatics and Heron's Pneumatics, it is evident that from the late eighth and early ninth century the Arabs were conversant with several devices for the production of sound by means of hydraulic action, whilst the treatises on the klepsydra and the Automatic Wind Instrumentalist attributed to Archimedes and Apollonios of Perga, reveal that they were acquainted with types of hydraulic air compressors connected with flue and reed pipes. These instruments, as well as an automatic wind instrument designed by the Bani Mûsâ in the ninth century, have been included in this chapter under the label of hydraulic organs, so as to distinguish them from the hydraulis which is a hydraulic pressure stabiliser.

The simplest examples of pipes being made to speak by means of hydraulic pressure are the whistling instruments
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mentioned in the *Pneumatics* of Philon, and the *Pneumatics* of Heron already mentioned. The musical tree that was erected in the palace of Khalif Al-Muqtadir (908-32) was constructed on these principles, and the design for such a tree may be seen in a MS. in the British Museum. More elaborate were some of the instruments attributed to Archimedes (Arshimidis) and Apollonios (Ablünstus). These were worked much in the same way as their *klepsydras*, which were known to the Arabs as early as Khalif Harûn al-Rashid (786-809) who presented one to the Emperor Charlemagne in 807. A somewhat similar appliance was installed in the mosque of the Banû Umayya at Damascus. One type of *klepsydra* announced the hours of the day, not by a *cymbalum* as in the Charlemagne instrument, but by a *flue pipe*.

In a treatise attributed to Archimedes on the *Automatic Wind Instrumentalist* (*dlat al-zâmir*), we have the figure of a wind instrumentalist holding a flute (*nây*) or reed pipe (*zamr*) which is made to sound by air being forced through it by the fall of water into a cistern (Fig. 2).

The Apollonios instrument, as set down in the *San'at al-zâmir* (*Construction of the Wind Instrumentalist*), is

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1 See Carra de Vaux, *Philon de Byzance*, for a complete Arabic text and French translation of the *Pneumatics*.
2 Schmidt and Nix have made a German translation of the *Pneumatics* from the Greek and the *Mechanics* from the Greek and Arabic.
3 *Journal, Royal Asiatic Society* (1897), 40, 42.
6 Ibn Baṭṭūta, i, 209.
8 This is the title in the Brit. Mus. MS. The Bairût MS. is entitled *'Amal dlat al-zamr* ("The Making of the Wind Instrument"). There is no particular reason for supposing that these
The Organ (Hydraulic) from Arabic Sources.

quite an elaborate affair. It is made of three compensating cisterns, one on top of the other, the bottom one having two divisions. The top cistern (khasanat al-md) A, supplied the water, which flowed from it through a channel (mi'zab) B, on to a water wheel (dالاب) C, emptying itself into the cistern X. On the axis of the water wheel there was a cogwheel (dd'ira) D, which interlocked with another cogwheel which worked on a vertical axis ('amad), E, at the bottom of which there was a disc (nusf dd'ira) F, with a portion of it cut out, G. This disc, in

works "attributed" to Archimedes and Apollonios are not genuine. We certainly do not possess Greek originals, but we have several works by these authors that have survived in Arabic only, viz., three books of the Conics and the Sectio Rationis of Apollonios, and the Liber Assumptorum of Archimedes (?).

9 The Roman letters that I have added to the designs so as to elucidate the text do not correspond with the Arabic notation.
rotating, lifted alternately, two rods (*qadib*) H, which opened and closed alternately two valves (*bab*) J, in the bottom of the cistern X.

Above is the Arab artist's design of the mechanism of the two upper cisterns (Fig. 3).

This design is not drawn to scale, nor is it even in perspective, but reference to the complete design of the instrument based on a reconstruction made by Wiedermann, will serve as a corrective. See Fig. 7. It will be noticed that one of the two divisions of the lowest cistern K, has been squeezed into the left-hand corner of Fig. 3 so as to show how the disc F lifted the rod H and the valve J. A better idea of these rods and valves is given by the artist in Fig. 4.
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In each of the two divisions of the bottom cistern K, there was a lever working on a fulcrum M, one end having a cup N, and the other end having a counterweight (rum-mana) O. This lever moved up and down according to whichever end had the preponderance. When the water poured through the valve J into one of the divisions K, it fell into the cup N, which, when filled, had the preponderance, and descended. It closed the valve P at the bottom of the division in its descent, through which air had passed previously into the division. Here is the artist's design of the bottom cistern K with its two divisions.

The water gradually accumulated in the division, and, as it rose, the air that was already in this division was driven out through a wind-pipe (unbāb al-rāh) Q, equipped with a non-return valve (bāb midhāf) R, into a wind-chest (the rukba of the Banū Mūsā) S, and from there it passed into a sound-box (ḥabba) T, eventually sounding the flue-pipe (nāy).

Fig. 7 shows the composite instrument reconstructed.

The Organ (Hydraulic) from Arabic Sources.

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Fig. 7 shows the composite instrument reconstructed.
tusammir binafsihā). The three “Sons of Mūsā” (Banū Mūsā) were named Muḥammad (d. 873), Ḥaḍād, and Al-Ḥasan. They were probably the most celebrated Arab scientists of their day. Khalīf al-Ma‘mūn (813-33), the great patron of learning, gave them positions at the Bait al-hikma (“House of Wisdom”), the College of Science at Baghdād, together with Yaḥyā ibn Abī Maṣṣūr (d. 831) and other scientists. They “attracted translators from other countries,” and many Greek treatises were translated there which “revealed the marvels of science” to the Eastern world, and later to the West.19

The author of the Fihrist (d. 995-6) says that the favourite sciences of the Banū Mūsā were geometry, mechanics, music, and astronomy.20 Ibn Khallikān (d. 1284) also assures us that music and mechanics were among their accomplishments.21 Yet not a solitary work on music is mentioned under their names in the Fihrist nor by Ibn al-Qiftī, unless the Kitāb al-urghanun (Book of the Organ) mentioned in another part of the Fihrist may be counted as theirs.22 Ḥaḍād, we know, was the author of the Kitāb al-hiyal (Book of Mechanics). The treatise on The Instrument which Plays by Itself that has come down to us under the name of the Banū Mūsā may possibly have come from the hand of Ḥaḍād.

This treatise, which is to be found in the library of the Three Moons College of the Orthodox Greek Church at Bairūt, Syria, appears to be a solitary exemplar. The copy dates from the twelfth century, and the Arabic text

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19 Fihrist, 43. 20 Ibid. 21 Ibn Khallikān, ii, 315. 22 Fihrist, 285. Collangettes (Etude sur la musique arabe, 392) mentions a work on music by the Banū Mūsā. The authority was probably Casiri (i, 418). It is erroneous. What the latter translates as a Liber de musica is, in the text, a Kitāb al-qarafān. See my Hist. of Arab. Music, 128.
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has been printed in the Mashriq with an introduction and explanatory notes by the late Reverend Professor Maurice Collangettes. The work is of such great interest, that a complete translation is given here. Throughout the treatise, references are made to diagrams which would explain the figures (alphabetical) used. Unfortunately, not a solitary diagram has been preserved in the Baitrût MS., and even the figures mentioned are not always correct.

"THE INSTRUMENT WHICH PLAYS BY ITSELF."

"We wish to explain how an instrument (âla) is made which plays by itself continuously in whatever melody (lahn) we wish, sometimes in a slow rhythm (iqâ' thaqîf) and sometimes in a quick rhythm (iqâ' khaffî), and also that we may change from melody to melody when we so desire. And because the perpetual organ (samr) is only played by means of a perpetual wind, we will first begin to explain how an instrument is made from which a perpetual wind supply arises.

"We make a vessel (ind') of this kind. Its length 108 cm. (≈ 2 dhirâ'), by a breadth of 108 cm., by a height of 108 cm., and we mark upon it A B J D. And we divide it into two halves by the surface (sath), H Z and K L. In one of the two divisions (qism), in this case it is the division A J Z H, there is a cup (hand) H T, mounted upon the line (satr) T Y, working upon the axis U Mashriq, ix, 444-58.

11 I have endeavoured to correct these in brackets.
16 In all the figures given in this treatise, the recognised equivalents are used with the exception of the 'ain, for which X is substituted.
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reason there is need of the division H Z D B, which is similar to it. And in it also are some of the devices (ala) which we have described, and will describe in what follows, like those which are in the division A J Z H, in order that the two of them may be compensative until, when the exit of the air from the pipe M N is cut off on the filling the division A J Z H with water, the air goes out continuously from the pipe S X, which is mounted upon the surface Z D, which is the cover of the division upon which is H Z D B. So, as long as the water continues pouring into the division H Z D B, then the air goes out into the pipe S X.

And we shall describe the arrangement in which there is the cutting off of the water from the division which is filled first, and comes to the last empty division. When the water is cut off from one of the two divisions, and in this case it is the division A J Z H, the cup H T empties itself from a small hole in the bottom of it at T. Then, when the water empties from it, the weight which is at K [?] descends, and the cup H T ascends, and draws the valve [L] and opens it. Then the water which is in the division A J Z H goes out from the valve Y [?] until none of it remains.

And the air is compelled to succeed the water which goes out from A J Z H, and it has no way to enter into it except by the valve K [?] L. Yet since water goes out sometimes and goes in sometimes (just as happens to vessels which are narrow of mouth, when we turn them upside down in order that the water may be emptied from them), it occasionally happens in this state that the exit of the water from the division A J Z H is retarded. And there is no way to make the air enter into this division from the pipe M N, because it is imperative that the air should not return through the pipe M N into the division A J Z H. For that reason we make a thin pipe mounted on the surface J Z, upon which is F $, its end, upon which is F (and it is the upper end) is fixed to the surface J Z, and the end $, which is the lower end, is in contact with the bottom of the cup H T, which was empty. Then the supply (madda) of the air comes to this division on the going out of the water from it.

And we also make another pipe, like the pipe F $, mounted on the surface Z D of the division H Z D B, like what we have described of the structure of the pipe F $, in order that it may act when the water goes out from the division H Z D B by its valve which is in the bottom of it, and it is like the valve K [?] in the division A J Z H. Then if we explain that the water does not cease flowing into one or other of the two divisions continually, according to the arrangement which we said we would describe, it is necessary that it [the water] should go out, and the air also, from the division into which the water pours through one of the two pipes M N and S X. And it is not possible that it should return by the other one of the two divisions on account of what we will describe also.

But the air comes to a place sharing the two ends M [?] X of the two pipes M N and S X, and it is the kurra (sphere) N X Q, and this also has a neck (unq) upon which Q, which enters into a specific junction (rukba ma'mula) upon which is R S [?] T, as we have drawn, fixed symmetrically in it by a paste (lajan) or glue (lisag). And only the end of the 'organ-pipe'

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27 There is something wrong with the text here. The water could not have entered by these pipes, which merely carried the air to the kurra.

28 The text has lajan, butajan is evidently intended.
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The 'sound-box' (habbat al-musawwita), is entering into the junction R S [? Sh] T, arranged in it, as we have drawn, in order that the air may collect and be compressed continually in the kurra N X Q, and in the junction R S [? Sh] T, and there will not be an outlet to it except from the head of the sounding-reed upon which is B [? Th]. And for that reason the sound becomes continuous, not intermittent.

"And as for the reason why the air does not return by either of the two pipes M N and S X into the two divisions A J Z H and H Z D B, then that is because of our fixing two small valves, which are mounted upon the two ends Z [? N] X of the two pipes M N and S X, in order that their opening shall be in the interior of the kurra N X Q. The result is that when the air goes out from the two divisions [? division] A J Z H by the pipe M N into the kurra N X Q, the valve which is at the end N is opened by the air forcing it, and the other valve which is at the end X is closed because the air forces it also and shuts it, so that none of it [the air] returns by the pipe X S into the division A J Z H. And similarly, it happens to both [valves?] when the air goes out from the division H Z D B by the pipe S X into the kurra N X Q. Then it is clear that the water, if it were continually flowing into one of the two divisions, the air would be continually going out from the 'sound-box' upon which is B [? Th], so that there would result from this a continuous sound in the 'organ-pipe' (surnāy) upon which is L [? Th] H [? Kh].

"And it is only the arrangement which is in it that makes the water which is in it, continually flowing, at one time into the division A J Z H, and at another time into the division H Z D B, and it [the arrangement] is what we shall describe.

"We make a large cistern (haud), its length 108 cm. (= 2 dhira'), by a breadth of 67.5 cm. (= 1½ dhira'), by a height of 27 cm. (= ½ dhira'). And upon it is a wide pipe, its diameter 5.625 cm. (= 2½ isba'). Then its lower end is fixed to the bottom of this large cistern and is projecting from it to the outside of the bottom about 4.5 cm. (= 2 isba'). Then it stands up to nearly two-thirds the height of the cistern in its inside. Then it is bent until its end comes nearly one-third of the height of the cistern. Upon it is A B J. And we mount upon its end, upon which is H, a valve, its diameter 5.625 cm. (= 2½ isba'), and we fix upon the male plug (dhakar) of it, a rod, so that it works freely, the male plug being covered by the female (unthā).

"And we make also a large tap (bhīhan), for the passage of the water, its diameter, 5.25 cm. (= 2½ isba'), and upon it is A D. And its end upon which is H, a valve, its diameter 5.625 cm. (= 2½ isba'), and we fix upon the male plug (dhakar) of it, a rod, so that it works freely, the male plug being covered by the female (unthā).

"And we make also a large tap (bhīhan), for the passage of the water, its diameter, 5.25 cm. (= 2½ isba'), and upon it is A D. And its end upon which is A, is mounted in the inside of the end A of the pipe A B J, and the end D penetrates the surface J R [? Z] and comes near to the bottom of the cup H T which is in the division A J Z H, but fixed to the surface J Z with a firm sure fixing.

"And we make also a small cup of the height of 9 cm. (= 4 isba'). Upon it is D, and it comprises the end D of the tap (bhīhan) A D. And let its width be according to what would break the strength of the water which empties into it from the tap A D, in order that the air may be able to go out by the tap D A. At the bottom of it is also a
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nail (mismār). When the cup [H T] [in division A J Z H] begins to empty, the nail enters into the hole T of the cup H T, in order that the hole T may not be blocked by any foreign matter (askyada') that may be in the water.

"So when this small cup is full, it overflows quickly. Then the cup H T [which is underneath it] fills and descends, and the valve K [L] is closed. And the cup H T also overflows and the water collects in the division A J Z H, and the air goes out from it by the pipe M N until it comes to the 'organ-pipe' (mizmār) upon which is Th, as we have explained. Then the sound is produced also.

"Then as for the pipe F S, which is in the cup H T, the water flows from it into the outside of the division because the end S is immersed in the water which is in the cup H T, and for that reason the air does not go out from it. And it has been in our power to make it only when required in emptying the division, and none of it [the air] goes out otherwise. But we have left it in this state, on account of its usefulness in making the air uniform which goes out by the 'organ-pipe' (mizmār), because the air, when it is strong against the 'organ pipe' to an intense degree, it possibly shuts it, and no sound arises from it. But when the pipe F S is open, the water goes out by it from the cup H T, flowing with considerable egress into the outside of the division. So it breaks the strength of the air on account of that, until it is strong enough to wind (atbaq) the 'sound box' (habba) of the 'organ-pipe' (mizmār).

"And similarly, we make in the head T X of the [large] cistern D S T X and the division H Z D B, a thing like what we have made in the other head, I mean, like the small cup H [J] D A [J], and the tap (bithān) D A, and the bent pipe A B J [which is attached to it], and the valve J [H] which is mounted on the end H [J] of the bent pipe A B J.

"Then we make a half-disc (nusf halqa) the breadth of which is 4.5 cm. (= 2 isba'), and its thickness a uniform one, but its diameter according to what is between the valve H and its like, upon which is Z H T, and upon its diameter R B Q. And the centre of its circle is Y, and it is parallel to the bottom of the cistern, and nearly touching the valve H, and its parallel also is the horizon. And it [the half-disc] turns round under these two valves, upon a [vertical] pillar (ʻamad) K Y L, and let the mounting of this pillar in the straight side (qitr) be firm.

"Then when this half-disc turns round under one of the two valves, the rod which is upon the male plug of the valve rises up, and the valve is opened, and the water which is in the cistern DSTX enters through this opened valve, because we always make this cistern full of water. Then it flows through the large bent pipe, and through the large tap (bithān), until it comes to the division upon which it is mounted. And the other like valve will be closed [and] no water will enter through it, nor does the water cease going down into that division until it [the rod] reaches the end of the arc (qaus), and the straight side upon which is T, as far as the male plug (dhākar) of the valve A B J, then it lifts (lit. 'pushes') it, and the valve J is opened, until the water flows into the division A J Z H. And in order that the supply of the air may be cut off from the 'organ-pipe' (mizmār) at any time, it is necessary that the valve (which is like the valve J) should not..."
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be shut, but that the two will be open until the water collects in the division A J Z H, and the water [air] goes out from the two pipes M N and N X together into the 'organ-pipe' (*misehr*). Then when the air which goes out through the pipe M N, is strong upon that, the end of the arc (*qaus*) and the straight side (*qitr*) upon which is Z, [and] the rod which adheres to the male plug (*dhakar*) of the like valve, separate. Then, upon that, it [the valve] is closed, and the water is cut off from the division H Z D B, and by that the water is emptied from the division H Z D B, as we have explained before in regard to the division A J Z H. So it will be clear from what we have described, that if the turning of the half-disc be continuous, then the water comes constantly into one of the two divisions for a long time, or in both of them for a short time. Then for that reason, the going out of the air by one of the two pipes M N and N X, or by both of them for a short time, is not cut off, and it reaches the 'organ-pipe' (*misehr*) so long as the large cistern is full of water, and the half-disc turns round under the two valves.

"Next, we make the ends of this [vertical] pillar ('amad), fixing that end which is in the straight side of the half-disc upon which is K (and it is the lower end), goes round in a hole in a block (*libna*) mounted on the bottom of the large cistern, and the other end is that which goes round in the cross-beam upon the end of which is M N. And these two ends are mounted upon the two ends of the two columns (*ustuwan*) mounted upon the end of the large cistern upon which are M S [and] N X. Next, we make a little wheel (*da'ira*) furnished with cogs (da'ira), and a compartment (*bait*), in the midst of which is a pillar ('amad) K Y L, with angles (*sa'iviya*) as we have drawn them, in order that it [the little wheel] may go round with the turning of the pillar K Y L.

"And we make also, another strong pillar ('amad) of which the ends go round in the two columns (*ustuwan*) M S [and] N X, in the two holes S Z [? Q]. And it passes alongside of the inside of the wheel F furnished with cogs. And we make in the pillar where it touched the wheel, a screw (*laulab*), upon which is D [? R], meeting the cogs of the wheel [F] so that when the screw goes round it makes the wheel F [with the cogs] go round with its turning.

"And we make a water-wheel (*dulab*) having six float-boards (*burda*), upon which is S [Sh] B [? T]. And it is fixed in the middle of the pillar upon which is S W [? Q], on angles (*sa'iviya*) arising from the middle of the water-wheel S [Sh] B [T].

"Next, we make two long supports (*ustuwan*), mounting their gear (*udda*) upon the ends of the large cistern upon which is R [? D] S X [? H], and we make them removable if we wish that. Upon them is D S X and T D. And if the need compels us we make four supports. Next, we mount upon them the cistern H D [and] S T, and we make its length 67.5 cm. (= ½ dhird') and its breadth 67.5 cm., and its height 27 cm. (= ½ dhird). And there goes out from the bottom of this cistern a long tap (*bithin*) upon one of the two ends which is X. And we attach it to the bottom of the cistern, and upon the

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30 A Persian word, perhaps from the Greek *dud*.

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1 From the Persian *danda* = "a tooth."

2 Meaning the angles of a quadrangular pillar.

3 A Persian word.

4 The text has *narda*.

5 These letters cannot be correct.
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other end, and it is that which ends at the water-wheel S B [? Sh T]. And it is possible that we may make the flow of water into the cistern H D S T from a river or from a reservoir in which there is water, in order that this cistern may always be full. Then it is clear that the water, when it goes down from the cistern H D S T, through the tap X A, flows upon the water-wheel S B [? Sh T]. This water-wheel goes round, and with its turning there goes round the screw (laulab) upon which is Z [? R], because they are upon one beam (sahm), and it is S F [? Q]. So when the screw goes round, the wheel (da'ira) upon which is F goes round (and in it are the cogs). And there goes round with them the half-disc (nusf halqa) upon which is Z H T in the large cistern, because these two are upon one pillar, and it is L B [? Y] K.

"And it has been explained that when the half-disc upon which is Z H T, is continuous of revolution, the water is continuous of descent into one of the two divisions A ] Z H and H Z D B, or into both of them for a short space during the time of the removal when the tap (bithân) A D and its like are opened."

Up to this point the Banu Musa are describing the wind-producing part of the apparatus, and a design of this is given here which is based on details supplied by the late Professor Dr. Wiedemann (Fig. 8).

The Banu Musa then proceed to describe the "organ-pipe," and the automatic arrangement by which it was played.

"Then we make upon every one of the holes of the 'organ-pipe' (surndy) 6 B H [? Th Kh] up to eight [holes],

Fig. 8.—THE BANû MUSA AUTOMATIC HYDRAULIC ORGAN. (Reconstructed.)

Showing the three cisterns, (a) The water-cistern, (b) The water-wheel and valves cistern, (c) The air-compressing cisterns, open and shut.

6The author here drops the term mizâdr and returns to the term surndy.
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a 'pallet' (bab ma'than), the width of which is according to the width of the hole. And we do not make for the ninth hole a 'pallet' because if these eight are shut, the ninth hole gives its note, and there is no need to close it afterwards. And we fix the 'pull-downs' (farkh) of the 'pallets,' I mean the male plugs (dhakar), upon the ends of levers (maṣṭara). But in every one of the levers is a pin (miḥwar), which makes the lever work as we have drawn it. Nevertheless we make in the middle of the levers near the bridges (majāz) the sign J. And we make the end of every lever upon which the male plug of the 'pallet' is fixed, heavier than the end upon which is D, so that the 'pallet' may close securely by itself. And the end D, when it is touched (ghamanā) upon, goes down, and the 'pallet' (tabaq al-bab) goes up along with the end of the lever upon which is B, which is placed upon it. And when the hole is opened it gives the note which belongs to this hole. And when the end D of the lever is free and is not being touched, the 'pallet' is closed, and there does not go out from this hole any sound at all. And in this fashion the eight holes are opened and closed.

"And as for our composing the notes of the melodies (laḥn) which we wish [to be played], it is according to what we shall describe. We make a cylinder (barbakh),

round, closed at the two heads, its length being according to the distance in which are the eight holes in the 'organ-pipe' (surnāy) or rather greater. And the diameter is 27 cm. (= 1 shibr) or a little more. Upon it is H W. And we mount in the middle of it a pillar ('amud) or square

rod (qaḍīb mu'rabba') of brass, upon which is R (Z) H.

and it will project from its head [both heads] so that it reaches to the two columns (ustuwān) R (Z) H and T F (Y) or to the two other columns if there be not these two. And we make its two ends go round in them

in the two holes R J (Z H). And we prescribe upon the surface (qahr) of this cylinder (barbakh) eight discs (da'ira), upon an axis R (T) Y and R (Z) H, opposite to the eight levers, by the ends of which we open and close the holes which are in the 'organ-pipe' (surnāy) as we have mentioned. And we set up upon every one of

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Fig. 9.—THE BANU MUSA AUTOMATIC HYDRAULIC ORGAN. (Reconstructed.)

Showing the way in which the teeth of the cylinder or recording barrel opened the holes of the horizontal organ-pipe by means of pallets.

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^ Here the nomenclature of organ builders is used, so as to make the description more intelligible.

^ The editor of the text says that the barbakh is like the unbab or qaṣṭal (a pipe).
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these discs which are upon the surface of this cylinder, small teeth (shaqiyya), their rims (harf) being true arcs of a circle. And we put a number of these teeth in one disc which goes round opposite a hole [of the surndy] according to the number of what is desired for which that note is employed which goes out from that hole in that melody in one turn (daura) of it [the disc]. And we make the length of this arc (qaus), I mean the teeth (shaqiyya) mounted upon the disc (dd'ira) which is opposite that hole, like the space in which that note is employed in that from that melodic scheme (daur).\(^9\)

So when we set up these teeth upon each of these discs which are upon the cylinder, as we have described, then the cylinder turns, as we shall describe, [so] that the teeth meet the ends of the nails (mismdr) upon which are D B H, in the first place. Then, when the one end of it is touched, the hole upon which the other end falls does not cease being opened, and the note goes out from the ‘organ-pipe’ (surndy), until the tooth (shaqiyya) passes the end of the lever. Then, that hole closes and another tooth begins to touch the end of another lever, which makes the note which follows it [the previous note] in that melody, go out, whether it be higher or lower than it, and it continues according to the space which that note needs in the melody. And so the one note does not cease going out from the opened hole, and the remaining seven are silent because their ‘pallets’ (bab) are closed. And that is because the surface of the cylinder does not touch the ends of the levers, for it is only the arcs (I mean the teeth mounted upon the discs which are upon the surface of the cylinder) that touch them, until the space of that note comes to an end, and that which follows it begins, according to the composition of the melody, until the melody is finished with every note and rhythm. And that is [accomplished] in one-third or in half a turn with which the cylinder goes round, if the melody be short. Or, if the melody be long, with one complete turn. Then the melody returns to the beginning.

\(9\) Any complete melodic or rhythmic sequence is a daur.
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§ is a weight. When it [the weight] descends, the cup § X ascends until the lever reaches the horizontal, when the cup is empty. Then when we open the tap upon which is W, the water flows from the cistern [?] T H D, descends through it into the cup § X, until it is nearly full, when it descends from its position, and the [other] end of the lever upon which is §, ascends along with the weight suspended from it. Then it opens the valve W [?] in the bottom of the cistern [?] T H D. Then the water pours from it upon the great water-wheel T Y. Then its [the cylinder] turning becomes swift through that, because the water pours upon it from two places, from the tap N, and from the valve W. And for that reason the melody becomes a quick scheme (daur) and continues so until the cup S X is empty through the water pouring out of it through the hole S which is in the bottom of it. Then after that, the weight which is suspended at the end § of the lever descends and the valve W shuts, so that no water flows from it upon the great water-wheel T Y. And upon that it slackens the speed of its turning, and the melody returns to its first state, and by reason of that the melody is slow, and it continues so until the cup S X is filled, and descends and opens the valve W, when the quick scheme (daur) returns as we have described.

Then, if we wish to change this organ (samur) so as to play a melody other than that which it already plays, then that may be done by enlarging the cylinder (barbakh) H W, until half a revolution of the cylinder gives the melody twice or thrice, and in the other half of the revolution, another melody is given twice, thrice, or more. Then the rule in the second revolution of the cylinder will be like the first, I mean that the first melody will repeat, and the other melody will follow it, and so on ad infinitum. And in proportion as we enlarge the cylinder (barbakh) H W, it becomes more possible to us that we should make it in more than two melodies, so that one of them follows the other, then repeats, and so on.

And if we wish that we should have this [instrument] in the form of a man who plays, then we will make all of the instrument concealed inside the body of an image, or in another place. And the reed-pipe (surnay) will be shown, inserted in the mouth of the image. And we make those levers (maṣṭara) upon the ends of which are the ‘pallets’ (and they are those which shut and open the eight holes of the reed-pipe) the fingers of the image. And we join the ends of the levers D to the inside of the two forearms of the image, until the teeth which are set upon the cylinder H W end in the inside of the image, so that nothing may appear of any part of the instrument except the reed-pipe (surnay), and the fingers of the image which are formed by the fingers [? levers]. Then we free the water in the instrument, and make the ‘wind-chest’ in the mouth of the image, and it (the wind) issues through the ‘sound-box’ (habba) and produces the sound in the reed-pipe (surnay), then the fingers move on the reed-pipe as we have described. Then the image plays those melodies which we have composed, just as the wind-instrumentalist plays them, and quickens the rhythm (iqa') of the melody and makes it slow as above, and changes from melody to melody as described. And that is what we wish to explain.

And sometimes it is permissible that we should make the instrument changing from one melody to another, not as we have already described, but by another method.
The Organ of the Ancients.

And that is, that we fashion in the cylinder which produces (qata'a) the melodies, an extension of length beyond the eight holes which are in the reed-pipe (surndy), so that when the cylinder turns, the melody may be complete, and shifts from its position towards the direction of its beam (sahm) upon which is the axis B [? W] H, by the measure of 27 cm. (= 1 shibr) until it agrees with what we have mounted upon the cylinder for another melody. Then there begins the other melody. Then it returns to the first melody. And when we desire, according to this model, that we should change to three or four melodies, and the system proceed, we do so.

"And as for the contrivance in the shifting of the cylinder upon the direction of its beam and its axis, it is quite easy in a number of ways. And one way is that we make the two columns (ustuwn) in which are the two holes in which the axis of the cylinder goes round, mounted on two pulleys (bakra) like wheels ('ajala). And it is worked by a floating vessel (dabba) which continually ascends and descends, or by a cup (hauš) which is filled and emptied, and ascends when empty and descends when full. And it works by itself [i.e., automatically] like the *surūq* which is free of itself. And from different kinds of contrivances made at one time and another we can change this [arrangement].


11 The *surūq* are the two pillars at the mouth of a well which support the axis of the drum, or the cross-piece (na'āma) to which the pulley is attached. It is an Aramaic word, says Baron Carra de Vaux, which in the generic sense means a tube, and is the Greek *oikýz* = "a flute." See Carra de Vaux, *Philon de Byzance*, 232.

The Organ (Hydraulic) from Arabic Sources.

"And sometimes it is also equipped so that there happens in their change from one melody to another, the choice of these directions which we have mentioned, in that we increase the flow of the water or diminish it, so that he who is present does not see or perceive anything of the instrument [doing this], and it seems to the people that the image has commanded that it should change the melody, and that it obeys him, or else that he commands it to play a well-known melody and it plays it. And by such an arrangement we make the instrument for the turning on of the water, and also with skins (siqq) filled with wind and emptied, or with what takes the place of skins in making the wind go out, as it is wanted evenly.

"And so that the playing be continuous, it is proper also that we should work the organ (dlat al-sa'm) by means of a donkey or mule that goes round, just as happens in the mills which grind. But that which revolves by means of water, as in the 'araba, or else what takes the place of the 'araba in ships, or elsewhere, is better for making a continuous playing [of the 'organ'] evenly, than that which is contrived by means of animals or by the wind, in any of the devices.

"And according to this same method, it is sometimes proper that we should make an image which plays (lit. beats) on the lute ('ud), or on an instrument of strings like psalteries (plur. ma'dzif). Then each of the two images conforms to the other, for the 'organ' (sa'm) conforms to the string [instrument], and the string [instrument] conforms to the 'organ.' And it is also possible..."
The Organ of the Ancients.

that we should make figures of images which dance and follow this 'organ' and these strings. And the contrivance in all this is like the contrivance of the 'organ,' so that every note of the strings corresponds with every note of the 'organ' to the end of the piece of music (nauba).

"And we do not trouble ourselves in this discourse with the construction of the lute and stringed instruments, which we construct according to the melody we want. And if there be in what we have explained a sufficiency to him who has studied geometry (handasa) and mechanics (kiyal), without its being clear in regard to what follows by a clear proof, we take this and make for it a figure as we have done in the organ.

"And as for the contrivance by which the image succeeds in playing any melody we wish, we make that in two ways. One of them is that we count the beats of the strings in proportion to the duration of the note. Then if the organ be made upon a definite sound (saut) and beating (darb), we preserve what is in that sound of the beating of the strings in each note successively which is upon it. Next, according to the duration of every note we mount upon the cylinder (barbakh) opposite that hole in the 'organ-pipe' (surndy), a tooth (shaqiyya), of which the size of the whole of the scheme (daur) of the melody is in proportion to the number of the beatings of that note from the whole of the beats of the scheme (daur) of the melody. Then if it happens that its particular scheme of the melody is in proportion to the [one] revolution of the cylinder exactly, then it is all right. If not, then it is permissible that we should make its scheme (daur) more than the melody when we do not use the whole of the revolution of the cylinder, but only a half of its revolution, or a third, or a quarter, or any part.

The Organ (Hydraulic) from Arabic Sources.

"And as for the other way, we take a large wheel (da'ira) of wood or brass, and let its diameter be 108 cm. (= 2 dhira) and three (fingers ? = 6.75 cm.) more than that. And we put it on the ring (balqa) of the large 'drums' (bakra) with which the oxen draw water in the large buckets and receptacles according to custom, only that we make the diameter much greater than that. And we smear upon the place which takes the place of the spot where the rope goes round in those drums, black wax like that which the Byzantines (Rūm) make, and which they smear upon the slates in the elementary schools, in order that everything that is marked in it may be impressed upon it with a trace which will remain upon it.

"Next, this large drum (bakra) is contrived so that the water makes it turn with an even, regular turning, not very swift nor very slow, and that the turning of the drum will be uniform. Then there is mounted above the drum without touching it, an 'organ-pipe' (surnāy). And there is mounted above every hole of the 'organ-pipe,' to the extent of 9 cm. (= 4 isba'), a lever proportionate in length. And we make the eight levers which are opposite the eight holes which are in the 'organ-pipe,' go up and down (lit. 'go round') upon the pins (mihwar) in the direction of one straight line. And their ends, from one side, will fall upon the surface of the drum (bakra) on which is the black wax, from that direction, and their other ends, opposite the holes of the 'organ-pipe,' we suspend with strings, tying every string to that finger of the player (zāmir) which is over that hole opposite the lever, in order that when the player raises one of his fingers from any hole of the reed-pipe (surnāy) the lever which ties that finger falls upon the drum (bakra). And the drum con-
The Organ of the Ancients.

continues going round evenly as we have said, and that lever impresses the value of that note on the wax on the surface of the drum (bakra).

"Then, if the player plays from the scheme (daur) of that melody (lahn), we look at the impressions of each lever upon the wax on the surface of the drum (bakra), and we know by that the duration (mudda) of each note in succession until we can appreciate how each conforms to its original. Next, we make the cylinder, which was made in order to produce [lit. 'cut'] the notes, note for note, as we have described, in accordance with the impressions on the wax. And that is what we wish to explain.

"And there is incumbent upon us in regard to the organ that we should explain the state of the notes which are in the flute (nay) and in the lute ('ud), and which note of the flute corresponds with the note of the lute in the consonance (iltafdq), that is, in equality (musawat). And they correspond in the octave (dēf) and in the remaining ones in the consonances. So we begin and say,—Verily, in every flute (nay) and reed-pipe (surnāy) also, are nine notes whose outlet is from nine holes which are in it. And the custom has been that eight of these holes should be closed by the fingers and opened by the fingers. And the ninth hole is always left open, and it is that which is at the end of the flute or reed-pipe. And the note from this ninth hole sounds only [lit. 'appears'] whenever the eight holes which are higher than it, are closed. And similarly, every other hole [sounds only] when it is opened, and when the holes higher than it towards the mouthpiece are shut. Then the note goes out from it [the first open hole] and belongs to it.

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The Organ (Hydraulic) from Arabic Sources.

"And if the whole of the holes which are after it are open, then the note of the 1st hole, and it is that which is next to the mouthpiece [Here, says the editor, a line has been missed out in the text, and it should run,—'And the 1st hole is equal to the sound which goes from under the 4th finger [g] on the Zlr string [c], and [double of] the open string of the Mathnā string [G]. And the 2nd hole is equal to the 4th finger [f] of the Zlr string, and double of the 2nd finger [F] of the Mathlath string [D]. And the 3rd hole of the flute is equal to the 3rd finger [e] of the Zlr string, and double of the 1st finger [E] of the Mathlath string. And the 4th hole is equal to the 1st finger [d] of the Zlr string and double of the open Mathlath string [D]. And the fifth hole is equal to the [open note of the] Zlr string [c], and double the 2nd finger [C] of the Bamm string [A]. And the 6th hole is equal to the 3rd finger [g] of the Mathnā string [G] and double the 1st finger [B] of the Bamm string [A], and I have found it softened (bil-mihna) as the 2nd finger [F] of the Mathlath string. And the 7th hole is equal to the 1st finger [a] of the Mathnā string, and double the open Bamm string [A]. And the 8th [hole] is equal to the open Mathnā string [G], and it is also half the note of the 1st hole [g]. And the 9th hole is like the 2nd finger [F] of the Mathlath string [E]."

12 Under the fourth finger means the fret lower down (towards the bridge) on the fingerboard.
13 The Arabs refer in all their musical theory to their lute, just as the Greeks used the kithara. The four strings of the lute were, A (Bamm), D (Mathlath), G (Mathnā), and C (Zlr).
14 Double = octave.
The Organ of the Ancients.

...string, and half the note of the 2nd hole, which note is like the 4th finger of the Zir string, just as we have explained. 28

"And it is proper that we should examine in the organ, the valves (bab) and fingers, to see that they close properly for the production of the notes. And we should inspect the inside of the 'organ-pipe' (surnay) so that there may not be in it any dust, or anything that would spoil the tone. And the organ-pipe should be softened with oil, and there should be put upon the valves which take the place of the fingers, Chinese fat, or thick fat, so that they may close [properly] in the production of the notes, and not leak. And we should inspect the fixing-place of the 'sound-box' (habba) upon the mouth of the 'organ-pipe' (surnay), in order that there may not be a leakage from its sides. And we should inspect the 'plug' (simam) in the

[Table]

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<tr>
<td>Khinšir.</td>
<td>D</td>
<td>G</td>
<td>c</td>
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28 Here is the fretting and accordatura of the lute.
The Organ of the Ancients.

is not in it a hair or particle of dust, which would spoil it, so that they are entirely subservient (мафтах) to the two houses [= divisions]. And we must inspect the air-pipe [which enters] the house [= division] into which the water pours, so that it may be open when the water is being poured into its house [= division]. And we examine the revolution of the water-wheel (дальаб) which turns the wheel (дд’ир) in order that it may open the two valves, so that it may not be too swift nor too slow. For if it were slow, it would result that one of the two houses [= divisions] would be filled with water, and the valve of the other house would not have been opened, nor would there have entered into it the water. So the air would be cut off by that from the 'organ' (мишар), and the house also will have been filled with water, and its lower valve will not open unless one opens it with his hand and empty it, because the little cup which opens the lower valve will not open if the house be filled with water.

"The [description of the] instrument is finished with the power and strength of Allah."

This automatic hydraulic organ of the Banu Musa is a most interesting instrument, for whilst the principle of the wind supply is little different from that of the automatic wind-instrumentalist of Apollonios, as found in Arabic documents, yet it is an improvement, and the remaining part of the apparatus is certainly quite novel.

The Reverend Professor Maurice Collangettes suggests that the instrument delineated by Kircher in his "Musurgia Universalis" (1650) resembled in every way the instrument which the Banu Musa describe. This is not quite correct.¹ The principle of the wind supply was different. In the Banu Musa instrument, as in the Apollonios instrument, the wind supply was obtained by means of compensating water cisterns called divisions in the text. Each of these cisterns alternately, was filled with air through a valve at the bottom. When the water flowed upon a movable cup in a cistern, the cup descended and closed the valve. The water pouring into the cup, overflowed, and accumulated in the cistern, thus driving the air out of the cistern into the compartment called the kurra, which fed the wind-chest and so the "organ-pipe."

The kurra in the Banu Musa instrument served the part purpose of the πνίγευς of Heron and the infundibulum inversum of Vitruvius; that is to say, the air was compressed in these contrivances, although the function of the water in the two instruments was different. In the Banu Musa instrument we have a hydraulic air compressor, whilst in the Heron-Vitruvius instrument we have a hydraulic pressure stabiliser. Passing from the kurra through the ‘унг (= cervicula of Vitruvius), the wind reached the rukba or wind-chest, which was the solcu plagion of Heron and the arcula of Vitruvius.

That part of the apparatus which "cut" the melody, as the Banu Musa say, is also clearly described. Here we have a cylinder furnished with teeth (шия) arranged according to the needs of the melody, as in the modern barrel-organ. These teeth touched the ends of levers (мастара) that moved "pallets" which opened or closed the holes of the "organ-pipe" (сунай).

Clearly, this organ did not possess a number of pipes

¹ See Appendix III for Kircher's instrument.

¹¹¹ Mashriq, ix, 457.
²²² Iconismus, xxii. See, however, the instrument on p. 334 (Machinamentum, ii).
The Organ of the Ancients.

as in the case of the ordinary organ. Only one pipe was used, and this was pierced with a number of holes, in precisely the same way as a flute or reed-pipe. These holes were covered with keys called "pallets" which were opened and closed by the action of levers (see Fig. 9).

As for the class of organ-pipe, we are left in some dubiety as to whether it was a flue-pipe or a reed-pipe. On account of the use of the word *surndy*, one might conclude that it was a reed-pipe. On the other hand, that part of the instrument which has been named the "sound-box" is termed the *habbat al-muṣawwita* ("the sounding habba"), and because of this, a flue-pipe suggests itself. A *habba* is "a grain," and in one of the designs of the Apollonios instrument, the "sound-box" or *maudā' habba* is delineated with a number of grains in the box, which would operate in the same way as the grain does in our modern whistles. At the same time, the term *habba* has a wider meaning, and stands for "the core of a thing," hence "that which is needful or requisite," which would simply mean that the "sound-box" was so named because it was "the principal part of the instrument."

Curiously enough, another term for the same part of the instrument is *sha'ṭra*, and this also means "a grain." This word is used by Al-Farabi (d. c. 950) for the head of the *suryānai* ("*surnāy"), which is the place of blowing. Muhammad ibn Aḥmad al-Khwārizmī (fl. 976-97) says that the *sha'ṭra* of the *miṣmār* is its head, and it is that by which it is made narrow and wide (in compass).

Happily, the scale of the Banū Mūsā "organ" has been preserved for us. Here it is:

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<td>1200</td>
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Notes. F. G. a. (by), b. c. d. e. f. g.

Cents. O. 204, 408, 498, 612, 702, 906, 1110, 1200, 1404.

In the treatise entitled the *Mafāṭīḥ al-ʿulūm*, by Al-Khwārizmī, a writer mentioned above, certain "instruments of motion" (*dālāt al-ḥarakāt*) called *ḥannānāt* (sing. *ḥannānā*) are included. They are described as instruments that make a plaintive sound like the sound of psalteries or barbitons (*miṣʿaṭa, miṣʿaṭ*), and reed-pipes (*miṣmār*), and flutes-a-bec (*ṣaffāra*). Does this refer to automatic instruments of the Banū Mūsā type? Ordinarily, the *ḥannānā* was a hydraulic wheel, and it was probably given this name by reason of the sound that it made (*√ḥanu = "the twang of a bow"). The music of water-wheels captured the fancy of the Arabs, and we often read of them sitting enjoying their music. Even Burton, on his pilgrimage to Mecca and Al-Medina, was so captivated by the delightful music that the whistling water-wheel made at Quba' that he left off praying. It is not improbable, therefore, that the description of Al-Khwārizmī is merely fanciful. On the other hand, the *ḥannānāt* described in the Arabic version of Philon's *Pneumatics* were constructed so as to produce a whistling sound.

We have already mentioned a certain Abū Zakariyyā Yaḥyā al-Bayāṣī (late twelfth cent.), who constructed an organ (*urghan*) "and sought by artful contrivance the playing of it." This may have been a similar sort of instrument to that described by the Banū Mūsā. We know

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*Notes:*

1. ibid., 254.
2. Al-Maqṣari, i, 62.
5. See ante p. 75.
The Organ of the Ancients.

from the writings of Bādīʿ al-Zamān al-Āsturlābī (d. 1139-1140), and Bādīʿ al-Zamān al-Jazārī (fl. 1205), who were in the service of the Saljuq sultans and Urtuqid rulers respectively, that mechanical instruments of this type were still in favour.

CHAPTER VII.

THE ORGAN FROM ARABIC SOURCES.

(THE HYDRAULIS.)

"The revival of interest in the hydraulis in Europe appears to have been due to the Arabs. From the sixth to the ninth century there is no mention of the ancient hydraulis in Europe, but in the ninth-twelfth century the Arabs were actually constructing both the pneumatic and the hydraulic organ."—Farmer, The Arabian Influence on Musical Theory.

The hydraulis proper, that is to say, the apparatus that gave us an hydraulic pressure stabiliser, such as we find in Heron and Vitruvius, was also known to the Arabs from an early period. The earliest reference in Arabic to an instrument of this type is to be found in a work entitled the Kitāb al-siyāsa, attributed to Aristotle, where a large hydraulis is mentioned as being used in times of war.

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1 I quote this passage from my brochure because my conclusion have been challenged by Miss Kathleen Schlesinger in a "reply" entitled Is European Musical Theory Indebted to the Arabs? My critic says: "Mr. Farmer will find a record of a fine hydraulic organ constructed in the palace of Louis le Débonnaire." This organum hydraulicum was constructed in 826 or 828, and it was on that account that I introduced the words "ninth century." When I said "from the sixth to the ninth century" I meant "from the close of the sixth century to the opening of the ninth century."

2 British Museum MSS., Or. 3118 and Or. 6121. John Rylands' Library, Arab., 456.
The Organ of the Ancients.

This warlike hydraulis is said to have been used by Alexander the Great (356-323 B.C.), but the story probably belongs to the mythopoeic period of the third century A.D., when most of the other legendary Alexander material arose. The immediate authority for the statement, however, is the Arabic treatise entitled the Kitab al-siyasa ("Book on Government"), which claims to be a translation from the Greek, via the Syriac, made by Yūḥannā ibn al-Baṭriq (d. 815). The translator’s preface informs us that this book was composed by Aristotle for his pupil, Alexander the Great! No Greek original is known, and no Syriac version has yet come to light. Mr. Robert Steele, the editor of Roger Bacon's Secretum Secretorum, which was derived from the Arabic Kitab al-siyasa, opines that the work, as it stands, can scarcely be of Greek origin, although Greek treatises have found a place therein. "The texture itself of the original work," says Mr. Steele, "is oriental, not western. I believe it to have had its origin in the interaction between Persian and Syriac ideas which took place in the seventh to ninth centuries of our era."

The Kitab al-siyasa is not mentioned in the Fihrist (written 988), nor by Ibn al-Qifti (d. 1248), although it is mentioned by Ibn Khaldūn (d. 1406) and Hajji Khalifa (d. 1658). Yet we have evidence of its existence in the twelfth century, since it was translated into Latin from the Arabic by Johannes Hispalensis (c. 1135), whilst a Hebrew version was made shortly afterwards by Judah al-Harizi (fl. 1190-1218). Another Latin translation from the Arabic was done by Philip of Tripoli (c. 1243), a version which is reflected in the Secretum Secretorum of Roger Bacon (d. c. 1294).

The Arabic texts disclose two distinct recensions, now distinguished as the Eastern and Western texts. That portion of the Arabic Kitab al-siyasa which deals with the hydraulis is of sufficient interest to be quoted here:

"And it is necessary that there should be with thee the instrument which Yāyaštayûs invented for warning (people). And it is a pneumatic instrument used for various purposes, because it enables you to warn all your country, and prepare the troops the same day for advancing or retiring, or any other purpose necessary in a mighty army. And its sound will be heard sixty miles."

Another passage reads:

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7 Steinschneider, Jüdische Uebersetzer des Mittelalters, 981. The text is given in H. Suchier's Denkmäler provenzalischer Literatur und Sprache (1888), 472 et seq.
9 I have edited the text in my Studies in Oriental Musical Instruments, p. 28. The text is based on two British Museum MSS. Or. 3118 (called "C"), and Or. 6421 (called "D"), as well as on the John Rylands Library MS., Arab., 465.
11 Roger Bacon has ad nocendum, which Steele suggests is a mistake for adcoecandum, as in the Holkham Hall MS.
12 MS. "C" has nafira'a ("terrifying"), which agrees with the word in Roger Bacon's version. MS. "D" has mufarrigha ("pneumatic").
13 Steele, p. 248. Mr. Fulton's translation.
The Organ of the Ancients.

"And let there be plenty of frightening and terrific sound-producing instruments, for verily they will inspire thy men with courage and those of thy enemy with fear."14

The Hebrew version closely resembles the Western Arabic text, and it was obviously made from it, as was the Latin version of Johannes Hispalensis. Philip of Tripoli used the Eastern text. In the Hebrew version we are specifically informed that they were "hydraulic instruments." The Hebrew text says:

"Provide [thyself with] ... terrifying instruments which make horrible noises, for thereby thou wilt encourage thy army and strengthen their souls, and thou wilt frighten those with whom thou wagieth war, and dread will enter their souls. . . . And thou shalt dispose thy army. . . . On the left . . . those hydraulic instruments which cause dread and trembling, which I have made for thee when thou didst engage with B.l.h.h the Indian. When they heard those frightful noises their hearts quaked, the horses ran away, and thy victory was due to the large number of these instruments which I have mentioned."

Curiously enough, however, it is the Latin version of Roger Bacon, which appears to give a reading more like what, it may be presumed, the original Arabic was. It is as follows:15

The Organ from Arabic Sources (The Hydraulis).

"Et oportet te tecum habere illud instrumentum quod fecit Temistius ad opus excercitus ad nocendum, et est instrumentum terribile quod dividitur multis modis, quia forte oportebit te vocare totam provinciam tuam et regnum tuum, et congregare subito proceres tuos bellatores tuos in eadem die vel cius, vel aliquo modo prout indiget excercitus magnus et numerosus, nam hujus instrumenti sonus auditur per miliaria sexaginta. Hoc est cornu eneum artificii mirabilis fabricatum, quo ex. lx. miliaris tempore bellis suum excercitum convocabat, et regebatur cornu sexaginta hominius propter sua magnitudinem et inestimabilem artificium, et verisimile est quod multa metallorum resonancium genera in ejus composicione concurrebant, et hec est forma cornu."

The form is not given in the Bacon MSS. Mr. Steele says that "no Latin MS. is known in which there is a figure of the horn, with the exception of that in Holkham

14 The Western Arabic text reads: "Instruments which cause dread and trembling, which I made for thee when thou didst engage in battle against Nahela the Indian. When they heard those frightful noises their hearts quaked, the horses ran away, and thy victory was due to this." The Western version may be seen in Land Or. 210, Bodleian Library.
15 Steele, op. cit., 151. Quoted verbatim.
The Organ of the Ancients.

Hall, in the borders of which an entirely fanciful instrument is depicted." As Professor Lynn Thorndike points out, however, that a figure may be found in a Munich MS. (2574b, fol. 69v). Achillini, in his 1501 and 1516 editions of the Secretum Secretorum, gives a woodcut of the instrument, which is, however, purely imaginary. This design was clumsily reproduced by Kircher in his Ars magna (1646), and also in his Phonurgia nova (1674). Kircher records the diameter of the horn as five cubits, and the distance at which it could be heard as one hundred stadia, but he does not declare his authority for these statements.

The Holkham Hall design, which has been reproduced in the facsimile of the De secretis secretorum Aristotelis issued by the Roxburghe Club, is not so "entirely fanciful" as Mr. Steele suggests. Clearly, the artist must have had some "authority" for his conception of the "Horn of Temistius" as an organ. It is almost inconceivable that he merely guessed it. Failing a design in a MS. from which the text was copied, the artist may have been prompted by the reference to "hydraulic instruments," such as we read about in the Hebrew version, which may have also occurred in some Latin version.

The question of the name Temistius in the Latin, and Yayastayus in the Arabic version, has considerable interest. Mr. Steele suggests that "the name Temistius or Themistius . . . . seems to be taken from The Book of

\[\text{FIG. 10.—THE "KITAB AL-SIYASA" HYDRAULIS.}
\]

\[\text{British Museum MS., Or. 3118.}\]

From the descriptions in the Kitâb al-siyâsa and the Secretum Secretorum alone it would not have been possible to have identified the instrument they mention as the

\[\text{Fig. 10.—THE "KITAB AL-SIYASA" HYDRAULIS.}
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\[\text{British Museum MS., Or. 3118.}\]

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\[\text{\textsuperscript{9} Op. cit., lvi.}\]

\[\text{\textsuperscript{10} Thorndyke, A History of Magic and Experimental Science, ii, 265.}\]

\[\text{\textsuperscript{11} Page 140.}\]

\[\text{\textsuperscript{12} Page 192.}\]

\[\text{\textsuperscript{13} The Treatise of Walter de Milemete . . . et De secretis secretorum Aristotelis. Edited by M. R. James. Printed by the Roxburghe Club, 1913, pl. 151.}\]

\[\text{\textsuperscript{14} The Organ from Arabic Sources (The Hydraulis).}\]

\[\text{Astamatis described by Al-Makin.}\]

\[\text{I believe that a more likely solution may be found elsewhere, as has already been hinted.}\]
The Organ of the Ancients.

*hydraulis*, had it not been for the designs of the instrument which appear in the former MS. and the mention of its sound being heard “sixty miles.” Figs. 10, 11 and 12 show the three designs in the Arabic manuscripts mentioned.

These designs are rather crude, but in Fig. 10 we have the *infundibulum inversum* of Vitruvius (= πυργός of Heron and the *unbāb* of Muristus) set within the *aer[c]a* of Vitruvius (= βουλόριον of Heron, and the *ala* of Muristus). The former lacks the water space at the bottom, but otherwise it is a fairly correct design. The cylindrical bellows shown on either side, called by Muristus the *ziqq rumt*, equates with the πυργός of Heron and the *modiolus* of Vitruvius. Two of the figures also delineate the water funnel.

It is in the Mūristus documents, however, that we get a full description of the *hydraulis*. Already it has been pointed out that we have copies of the Mūristus treatises in the British Museum, Constantinople, and Bairūt libraries, the last copy dating from the twelfth century, whilst the works themselves can be traced to the tenth century, and probably to the ninth century.

In the Bairūt copy of the treatise on the *hydraulis*, the actual invention of the *hydraulis* is credited to Mūristus. The treatise is entitled, 'Amal al-alai illatit ittakhadhaha Mūristus yadhhabu sawtuha sitttīn mlīn ("Construction of the Instrument which Mūristus Invented, the Sound of which Travels Sixty Miles"). The title of the British Museum and Constantinople copies runs, Risāla il-Mūristus ṣan'at al-urğhīn al-baği ("Treatise by Mūristus on..."

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1 See my *Studies in Oriental Musical Instruments*, p. 30.
2 See *ante*, p. 16 et seq. Gastoué (L’orgue en France, p. 30) says “eighth century.”
The Organ of the Ancients.

the Construction of the Flue-pipe Organ”). This treatise describes a type of *hydraulis* far earlier than those of Heron and Vitruvius, and whether this is actually the original work of Ktesibios, as suggested, or not, it is a most interesting addition to the literature of the *hydraulis*. For that reason a complete translation of the treatise is given herewith.

THIS IS THE TREATISE OF MURISTUS ON THE CONSTRUCTION OF THE FLUE-PIPE ORGAN, THE SOUND OF WHICH CARRIED SIXTY MILES.

Muristus says: This instrument was carried with them [the Greeks] in their wars because their country had enemies on all sides. And when they were needing that they should warn their fellows or ask for assistance in the wars, to send them the cavalry and succour, or warn the people of the capital of the kingdom or any territory whatever, they sounded upon (lit. blew in) this instrument. And it is the Great Organ, nicknamed ‘The Capacious Mouth with the Loud Voice.’ And that is because its sound
d carries sixty miles.

Then in order to make it, one takes an apparatus (ala) of brass according to the distance that one requires the carrying-power of the sound to be, greater than we state, or less. Then, as for that which I personally made for the King of the Inner Franks (Afranjat al-dakhila) it was the distance that I mentioned. And its capacity was

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4The Mashriq text has a wrong word here. “Sound” (ṣaut) is the word intended, which is clearly borne out by the other texts.
The Organ from Arabic Sources (The Hydraulis).

1,000 qist$^2$ and its height 648 cm. (≈ 12 dhirā'), and the circumference of its base 945 cm. (≈ 35 shibr). And let its base be broad, and as it rises to its top, it gets narrower, until the opening at its head becomes the amount of 81 cm. (≈ 3 shibr), like the form of the oven (tannūr). And it is roofed, that is to say covered. And it is perforated in its upper part, in that place 27 cm. (≈ 1 shibr) below its head, with three holes. And these holes are in a triangle. And between the holes there is an equal distance, a third of the circumference of the apparatus.

Then take three skins (ziqq), each of a large buffalo hide, and tan them well. And the excellence of the tanning will be that it is soft, thin, compact. Let there be inserted into the mouth of each skin, a pipe of brass, the same length as the apparatus, in such a way that if the end of the pipe which is in the skin$^6$ be put in the head it would nearly reach to the bottom of the apparatus. And these pipes will be made flexible (laina),$^7$ broad at the bottom, and in proportion as they rise they get narrower, until they get to a size which I shall describe.

And thus the head of the pipe which is upon the head of the apparatus has an opening of 2.25 cm.

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$^2$ The British Museum text has musht, but the other texts have qist. A qist, according to the Arabic lexicons, is a "bushel," but the above dimensions would seem to show that the Greek ἕρρος (≈ "pint") is intended. See Carra de Vaux, L'Invention de l'Hydraulis, p. 334.

$^6$ The British Museum MS. has 30 shibr, but both the Mashriq and Constantinople texts have 35 shibr.

$^7$ Meaning an equilateral triangle.

$^6$ The Brit. Mus. MS. has "hole" (thaqb) instead of "skin," as in the other texts.

$^7$ The Brit. Mus. MS. has "pipes" instead of "bottom," as in the other texts.

$^9$ The Brit. Mus. MS. and the Constantinople text have "also" (aidan) instead of "flexible" (laina).
The Organ of the Ancients.

(= 1 'aqd), and the head of the pipe at the bottom of the apparatus has an opening of 27 cm. (= 4 iṣba' maftūḥ). And likewise the size of the holes [in the apparatus] which take these pipes.

And let the broad ends of these three pipes enter the holes of the apparatus which are at its head, each pipe projecting the measure of 40.5 cm. (= 1 ½ shibr). Then take [each of] the three skins, and let its mouth, and it is its head, be tied over every one of these pipes [going out] from the head of the apparatus, so that it is fixed securely so that there is not to it an escape of wind in the slightest degree.

[And the apparatus is marked by A B J D. And the lid is that which has A B upon it. And the bottom is that which has J D upon it. As the design is a plane and not a body, we show, instead of the three holes in a triangle, only two holes, R and H. And of the three skins we show only two skins, and they are Y and K. And of the three pipes we show only two pipes, and they are L H and M W. And the two ends H and W penetrate the apparatus, and the two ends M and L are in the head of the skins, and they are K and Y.]

Then we pierce in every skin at its back, two wide holes, the width of each being 27 cm. (= 4 iṣba' maftūḥ) or 18 cm. (= 4 iṣba' maḏmūn). And let there be mounted upon each hole a pipe, the length of each pipe being 40.5 cm. (= 1 ½ shibr). And the ends of the pipes outside shall be narrow, the size of 2.25 cm. (= 1 'aqd) each, and these pipes shall be fixed in their places with a firm fixing in order that the wind may not escape from them. And let there be taken for each of these pipes, a Greek bellows (ziqq Rūm) [and it is the cylindrical bellows which the goldsmiths blow who make seals]. And mount these [bellows] upon the ends of the small pipes which are in the back of the skins. And this is the place for the driving of the wind into the skins [and] then into the apparatus. Understand that.

And the two holes which are in the skin Y are F and X, and the two in the skin K are N and S. Then the pipes fastened to these holes are marked, S-Q F-X, Z-N S-Sh. [And the Greek bellows are marked A B J D.] Know that.

Then take a receptacle (lit. pipe) exactly after the form of the particular make of the apparatus (aleza). And let the width of its lowest part be 40.5 cm. (= 1 ½ shibr), and the width of its head 18 cm. (= 4 iṣba' maḏmūn). And let the length of this receptacle be the amount of a third in excess of the height of the apparatus. Then pierce the head of the apparatus with a hole and insert in it this receptacle, and there will be of its length outside the head of the apparatus the amount of 27 cm. (= 1 shibr).

The Organ from Arabic Sources (The Hydraulis).
The Organ of the Ancients.

Then let the soldering of that be made firm with lead, so that no air will get out at all. And let the bottom of this apparatus be solid.

Then mark the 'hole upon the head of the apparatus T, and mark Th-Kh upon the receptacle which resembles the apparatus, and it is inserted in this hole. And the end Th enters almost to one-third of the apparatus, and the end Kh projects out of the hole T to the extent of 27 cm. (= 1 shibr). 6

Then pierce a hole below the head of this apparatus [A. B. J. D.] at a distance of 54 cm. (= 1 dhird) from the head, and mount upon it a strong stopper (blthun), upon the head of which is a funnel (qam') for the pouring in of the water. And in the bottom of the apparatus also there is a stopper for the flowing out of the water. Then the hole for the pouring in of the water is marked Dh, and the funnel D, and the hole for the pouring out of the water at the bottom of the apparatus Z, and the stopper Gh. 7

Then let water be poured into the funnel D, and it flows out of the hole Dh into the apparatus [A B J D] until the water level reaches the face of the upright receptacle in it, 8 that is to say until it reaches the opening Th of the receptacle marked Th-Kh, and it is from this that the sound [? the wind] goes out. Then close the stopper Dh-D. 9

6 This paragraph is not in the Mashriq.
7 Only in the Constantinople MS.
8 Marked § in the Brit. Mus. design.
9 Marked T in the Brit. Mus. text.
10 Marked X in both text and design, but it is Gh in the Constantinople text.
11 The Mashriq text adds "in the middle."
12 The Mashriq text does not contain any of these notations.

The Organ from Arabic Sources (The Hydraulis).

Then if you wish to make a sound 12 let there be taken pedestals (kurrit), and let them be placed around the apparatus. And let their elevation be to the place of the skins, in order that the skins may be placed on the pedestals. And let there be to them a width to the amount of the width of the couches (sartr) in order that the men [who work the bellows] may stand upon them. And attach the [Greek] 2 blast skins [? bellows] to their pipes [and they are the skins [? bellows] A B J D]. 13

Then they blow the skins until they are full of wind [and they are the skins Y and K]. 12 Then the wind enters [the receptacle] as far as the water, and it moves (thara) it, and disturbs (haja) it [from its level], and circulates, and goes round in it [the receptacle], and seeks the outlet. Then it escapes at the head of the receptacle with a loud, terrifying sound. It has strength and terror, and affrights (lit. splits) the hearts [of those who hear], and is heard the distance that we have mentioned.

And the men who blow will have their ears stuffed with cotton, and covered over with wax, in order that their senses may not depart and that they may not be injured in the ears.

And further to this there need not be only one sound [but there may be different sounds. I will mention them one by one, Please Allah]. 17 And that is because there may be mounted upon the receptacle from which the wind goes out three or four pipes, upon each of which there is a sound-box (sha'irat al-mizmar). Then there will be produced other wonderful sounds.

12 The Mashriq text says "hear a sound."
13 Not in the Mashriq text. 16 Not in the Mashriq text.
17 Not in the Mashriq text.
16 This passage is not in the Brit. Mus. MS.
And likewise, if they intensify the blowing, the wind is strengthened, or if they diminish it, it is weakened. Then according to that, various kinds of sound are produced—pleasant, diverting, or otherwise. But the original purpose for which this apparatus was made is the carrying of the sound to a distance. Then understand that, if Allah wills."

The author of this treatise clearly shows us an apparatus or cistern (ala) which is identical with the bumiskos of Heron and the ar[ε]a of Vitruvius. In spite of the evidence of the design in the Bairut manuscript, as given above, this cistern was not rectangular nor cylindrical, since its circumference is described as being broader at its base than at its summit, which is proper since the very word bumiskos stands for "a wedge-shaped body." It is described as having the form of an "oven" (tannur), the Arabic word being identical with the Syriac. The design in the British Museum MS. is more in accordance with the texts. At the same time, the receptacle (unbub = pnigeus) appears to be more properly represented in the Bairut design.

So far, the description of the Mārisṭūs instrument is quite clear. The author does not, however, actually tell us that the wind-pipes that conveyed the wind from the bellows passed through the apparatus (ala = ar[ε]a) or cistern into the receptacle (unbub = pnigeus). The Bairut diagram rightly shows them passing into the receptacle, which agrees with Heron and Vitruvius, but in the British Museum and Constantinople MSS. these pipes...
The Organ from Arabic Sources (The Hydraulis).

have their ends in the apparatus. It was evidently the absence of this instruction from the text that led Baron Carra de Vaux to adopt a novel scheme for the hydraulic principle, which he committed to a design. This latter shows the wind-pipes from the bellows turned down immediately they enter the apparatus or cistern without entering the receptacle or pnigeus. The pipes enter the water and reach a point lower than the bottom of the receptacle or pnigeus, and are then turned upwards towards the inside of the receptacle or pnigeus. By this principle the wind is supposed to be forced through the water into the pnigeus. This design also shows a rectangular apparatus, which is quite opposed to the text, and its capacity is wrongly given as 9,000 qist instead of 1,000.

The method of the wind supply in the Mārisṭus instrument is rather anterior to the hydraulis that we know of from other sources. The bellows were the collapsible cylindrical bellows known to the Arabs as the siqq rāmi or siqq saqti. There were six of these bellows, two for each of the three large skins in which the air was stored and compressed as in the modern weighted horizontal bellows.

Unfortunately we are told absolutely nothing of the principle of the sound-box (sha'rat al-mizmdr), but as this instrument was furnished with flue-pipes, we know to some extent what the sound-box was like, although the term sha'rat may be rather puzzling. We do not even know the way in which the pipes were made to sound, whether by sliders, stoppers, or a key-action.

The Organ of the Ancients.

The question of the Greeks using the hydraulis in their wars, as mentioned in the Kitāb al-siyasa and the Mārisṭus treatise, is referred to by the Ikhwān al-Ṣafā' (tenth century). The “Brethren” were an association of philosophers of ultra-Shī‘ī views, whose centre was at Al-Baṣra on the Euphrates. In discussing the influence of sound on the temperament of man, they say:

"The great, terrible sounds, out of proportion with one another, when they fall on the ears suddenly, corrupt the temperament, drive it from moderation, and cause violent death. And these [sounds] are found in an artificial instrument called the organ (urghan). And the Greeks (Yūnāniyun) used to employ it in the wars, in order to terrify the souls of the enemy. And they stopped their own ears when they used it and played (lit. blew) it."

Here we find the general term organ used, but undoubtedly it is the large hydraulis that is described. Elsewhere the “Brethren,” speaking about musical instruments in general, refer to organs in the plural, as though they included several types of organs.

We read of organs being employed in Western Europe in warfare, and perhaps the custom came from the East.

Indeed, it has been suggested that the horn of Roland at Roncevalles was a hydraulis, and, strange to say, the instrument described in the Kitāb al-siyasa was known in Latin literature as the Horn of Alexander.

5 Ikhwān al-Ṣafā’, i, 92. 6 Ibid., i, 97.
7 The hydraulis in the Utrecht Psalter belongs to a military scene.
8 Wiedemann, Byzantinische u. arabische akustische Instrumente, 155.
9 Steele, Roger Bacon’s Secretum secretorum.
The Organ from Arabic Sources (The Hydraulis).

It is also interesting to note the similarity of expressions 'twixt East and West regarding organs. In the well-known poem of Wulstan (d. 963) on the Winchester organ, we are told that "everyone stops with his hand his gaping ears, being in no wise able to draw near and hear the sound," whilst its nickname, "The Ruler of Thunder," reminds us of the Arabic name, "The Capacious Mouth with the Striking Voice." In his poem, *De Laudibus Virginum* Aldhelm (d. 709), describes an organ with a thousand pipes, which reminds one of the thousand notes of the Hebrew magrepha and the thousand voices of the Syriac urghanum.

At what period the hydraulis ceased to interest the Arabs we do not know. That the Muristus document at Bairut dates from the twelfth century is certainly some sort of evidence, but, taken by itself, it may only mean that the Arabs were still interested in collecting books on music or on the sciences. At the same time, the testimony of Ibn Abi Uṣaibī'a that there were Arab organ constructors in the twelfth century, is not to be overlooked, and since organs were being constructed, one being presented to Khubilai Khān, it is quite certain that such a mechanical novelty as the hydraulis is almost certain to have found favour with the Arabs.

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CHAPTER VIII.

THE ARABIAN ORGAN IN EUROPE.

"Toute certitude qui n'est pas démonstration mathématique n'est qu'une extrême probabilité; il n'y a pas d'autre certitude historique."—Voltaire, *Dictionnaire Philosophique*.

Historians claim that the first organ known in Europe was introduced by the Arabs! This is stated in the *Histoire littéraire de la France* in the following terms:1

"On sait que les premières orgues connues en France vers la fin du IXè siècle passaient pour présent du Khalif Harūn."2

The statement made by the authors of the *Histoire littéraire de la France* actually follows a description of a marvellous "organ" in the palace of the Saracen Amirs of Babylon which occurs in a twelfth century chanson de geste called *Aymeri de Narbonne*, written by Bertrand de Bar-sur-Aube. This "organ" was simply the "musical tree" which has already been referred to.3 The learned editor of Bertrand's poem, L. Demaison, says that the

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1 *Histoire littéraire de la France*, xxii, 467.
2 To prevent confusion, I adopt Harūn, the modern way of writing the name in English, instead of the various forms, Aroun, Aaron and Haroun, which are used in the works quoted here.
3 See ante, p. 80.
author borrowed his notion of this “musical tree” from Constantinople, and shows that a Byzantine instrument is mentioned in the ninth century. It is far more likely, however, that Bertrand borrowed his notion of this Saracen instrument from the Arabs of Spain, who were his neighbours, seeing that the Arabs also possessed the instrument in the tenth century. Indeed, this chanson, like all the chansons de geste of the so-called Guillaume cycle, is based on local colour.

In Grove's Dictionary of Music and Musicians we have details of an organ said to have been presented by Khalif Harūn early in the ninth century.3

"In 822 or 826 an organ was sent to Charlemagne by the Khalif Harūn al-Rashid, constructed by an Arabian maker of the name of Ja'far, which was placed in a church at Aix-la-Chapelle. It was a pneumatic organ of extraordinarily soft tone."

When statements such as these are made in what are generally considered to be authoritative works, one naturally concludes that there must be substantial evidence for them. No authority is quoted in either of these works, and indeed the present writer has been unable to find any. Yet, in spite of the absence of authority, the story threatens to become established in our histories of music. The French account is given recognition in Le grande dictionnaire of Larousse, and by Henri Quittard in La grande encyclopédie. In English works the story has passed through three editions of Hopkins and Rimbault's The Organ, its History and Construction, and three editions of Grove's Dictionary of Music. It has found an echo in the Smith-Cheetham Dictionary of the Bible, in Audsley's Art of Organ Building, and even in the Arabic journal, Al-Mashriq (ix, 20). In justice to all concerned, and to prevent fixity attaching itself to a statement of dubious origin, it seems advisable that the authenticity of these statements should be tested.

Search made in published historical documents has not revealed the authority. Western chroniclers certainly mention embassies passing between the French and the Arabian court at Baghdađ, and presents being made. As early as the year 762, Pépin sent an envoy to Khalif Al-Manṣūr. He returned three years later, accompanied by an envoy from the Baghdađ potentate. There were presents on both sides, but no organ is mentioned. More important were the Charlemagne-Harūn missions.

In 797, Charlemagne dispatched an embassy to Khalif Harūn, "the Persian king," as he is erroneously designated by the chroniclers. It arrived back at the French court in 801, attended by the Khalif's envoys, who brought "splendid gifts," including an elephant, but no organ is mentioned. In 802 another embassy set out for the Khalif's court from Charlemagne. It returned in 807, with envoys from the Khalif, among whom were two monks from Jerusalem named Georgius and Felix, the former being an abbot of a monastery on the Mount of

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3 Domaison, Aymeri de Narbonne, i, cl. Liutprand, De rebus gestis, vi, ii. See also Annales archéologique, vii, 293-4; viii, 91: xxi, 313-14.
4 See ante, p. 80. This “musical tree” is also introduced into Wolfram von Eschenbach's Titurel (twelfth-thirteenth century). See also the Chanson du pelerinage de Charlemagne (Romania, ix, 11).
5 Grove (second edition), iii, 517. The third edition says, "Shortly after the year 800."
6 Ja'far = Giafar.
The Arabian Organ in Europe.

Olives. The Khalif's envoys were laden with presents for Charlemagne, including a magnificent tent, robes of silk, perfumes, balms, rare animals, and a wonderful clock which struck the hours. Yet there is still no mention of an organ. This mission is mentioned by several Western chroniclers, although we have not the slightest mention of any of these events in Arabic works. Indeed, the Western accounts are suspect in the eyes of some Orientalists.

Since the documents fail us, we are compelled to work back from the *Histoire littéraire de la France* and Grove's *Dictionary*. In the first place, it is quite clear that organs were known in France long before the "end of the ninth century," as the *Histoire littéraire* states. The author of the passage in Grove's *Dictionary* was Dr. E. J. Hopkins, and he had previously collaborated with Dr. E. F. Rimbault in a work entitled *The Organ, its History and Construction*. In this latter work we have the following passage:

"It also appears that an organ, constructed by an Arabian, named Ja'far, was sent to Charlemagne by the renowned 'Commander of the Faithful,' the Khalif Harun al-Rashid—an incident introduced with considerable effect by Madame De Genlis, in her romance, *Les Chevaliers du Cygne*. This was the instrument, in all probability, which Walafrid Strabo described as existing in the ninth century in a church at Aix-la-Chapelle."

Comparing this passage with the account given in Grove's *Dictionary*, it is obvious that Hopkins, the author, was partly repeating what had been written in the Hopkins-Rimbault book. At the same time it will be noticed that there is a wide difference between the two in another respect. In the Hopkins-Rimbault book we have such phrases as "it also appears" and "in all probability." In Grove's *Dictionary* these apparencies and probabilities become transformed into actual historical events, whilst the De Genlis reference is ignored, and the instrument is gratuitously stated to be a pneumatic organ.

Among the additions of Hopkins to the Hopkins-Rimbault narrative are the dates for the presumed Harun present of the organ to Charlemagne. Two are given, "822 or 826." These dates were evidently derived from Seidel's book on *The Organ and its Construction*. We cannot trace where Seidel got the first of these dates from, unless it is a slip for 802, when the presents of the first embassy actually arrived at Aix-la-Chapelle. The year 826 is the date when Louis le Debonnaire had an hydraulis (organum hydraulicum) constructed for himself by Georgius Veneticus. On the other hand, Seidel and Hopkins say that the instrument was a pneumatic organ, which shows that they had in mind the organ made for Charlemagne at the time of the Byzantine embassy in

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8 Clément Huart, *Histoire des Arabes*, ii, 107, includes "instruments de musique" among the presents. There is no foundation for the statement. Perhaps this writer was misled by the account of the clock which sounded the hours on a bell (cymbalium). Heyd, *Hist. du Commerce du Levant*, i, 90, has a similar statement.
10 Hopkins-Rimbault, 14.
11 The *Organ and its Construction* (1855), p. 15. There were two English translations (1852 and 1855) of Seidel's *Die Orgel und ihr Bau*.
12 The chroniclers give two dates—826 and 828. This may partly account for Hopkins's two dates.
At any rate, both the dates of Seidel and Hopkins are too late, since Harun died in 809, and Charlemagne in 814.

Prima facie, the Grove's Dictionary account is based on the Hopkins-Rimbault narrative, but what was the latter's source of information? Was it any other than De Genlis? Anyone reading the "Notes" with which Madame De Genlis furnished her work, is almost bound to conclude that this was the source of information, or else, that both De Genlis and Hopkins-Rimbault borrowed from a common source.

In her chapter on the "Origin of the Organ," Madame De Genlis introduces us to a certain Ja'far (Giafar), who is made out to be, for the sake of the story, a European born in Persia. This Ja'far, and his three brothers, who were all musicians, came to Baghdad, and, being Christians, they met each Sunday in worship to the accompaniment of musical instruments. The Khalif, however had forbidden Christians to worship in this manner, and the prohibition led Ja'far to seek for some device whereby he might evade the Khalif's edict, and then De Genlis makes Ja'far speak thus:

"I had a strong mechanical turn; and, after some reflection, I conceived the idea of contriving an instrument, which would imitate those already known, and even the human voice. At the same time, I wanted it to produce a sound that resembled a concert of various tones. I applied myself night and day, and, in less than six months, formed an instrument of enormous bulk, which I named an organ."

Of the later history of this organ we are informed in the words of Ja'far as follows:

"He [the Khalif] disposed . . . . of my organ in a manner which highly gratified me. The ambassadors of Charlemagne were then at his court; and the Khalif included the instrument in the number of the presents with which he charged them for their master."

In her Notes to this chapter (xiv) De Genlis says:

"It is known that the first organ which was seen in Europe was sent to Charlemagne by the Khalif Harun [Aaron]. I have only superadded the origin of that instrument, which is entirely unknown to us."

Our author distinctly says that the story of the first organ in Europe being a gift from Harun was already known! That sentence and the one in the Histoire littéraire de la France are so perilously akin, that the former appears suspiciously like its authority. It is certainly not a commonplace in French history, and although it appears in both Forkel and Mendel, they both quote De Genlis.

Of course, De Genlis says that her account of the origin of the organ "is entirely unknown to us." Did she mean by this that she was tapping a hitherto unknown source of information, or is it to be implied that the story was chimerical, imaginary? One thing is quite certain, and that is that the organ of Ja'far, as described by Madame De Genlis, was unheard of in the ninth century. It is represented as being something like a bureau that could be opened or shut, and played by one person who

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sat in front of the instrument. The author evidently had in mind (in spite of the "enormous bulk" in her description of the instrument) a type similar to the large regal of comparatively modern times.

The upshot of this inquiry is that the statement in Grove's Dictionary is to be traced apparently through Hopkins-Rimbault and the Histoire littéraire de la France to De Genlis.

Strange to say, however, there does appear to be a well evidenced claim for the Arabian influence in the introduction or reintroduction of the hydraulis into Western Europe, which has not been recognised hitherto. The credit of having introduced or reintroduced the organ into Western Europe belongs to the Byzantine Emperor Constantine Copronymus, who, we know, presented an instrument of this sort to King Pépin in 757. Whether the pneumatic organ ever actually disappeared in the Dark Ages or not, we may assume with some degree of certainty that it fell into desuetude only in the West but not in the East. Not so the more complex and anathematised hydraulis, which, we may take for granted, ceased to exist after the fifth century in both the East and West through causes already specified.1

The hydraulis does not reappear in the West until the opening of the ninth century when several Latin chroniclers tell us under the year 826 (or 828) that a certain presbyter, Georgius Veneticus, constructed an instrument of this type for Louis le Débonnaire.2 This reference to the hydraulis is the first in the West since the time of Apollinaris Sidonius (c. 483), and in the East since Isaac of Antioch (B. 459) and the Talmud (c. 500). In the claims for the reintroduction of the hydraulis into the West, we can consider three distinct media—the Occidental, the Byzantine and the Arabian or Syro-Arabian.

The Occidental claim is based on the assumption that the hydraulis never really fell into disuse. It was put forward by J. F. Rowbotham, the brilliant and learned, though not wholly reliable, historian of music. He firmly believed that Georgius of Venice brought the art of organ construction in general to France from Italy, where it had subsisted since classical times.3 If it be true that in 826

1 See ante, p. 60, also 25, 43, 48. See my Historical Facts for the Arabian Musical Influence, 295-7.

2 Mon. Germ. Hist., i, 359. "Georgius quidam presbyter de Venetia, cum Baldrico comite Foroiulense veniens, organum hydraulicum Aquigrani fecit." xv, 293. "Hie est Georgius Veneticus, qui de patria sua ad imperatorem venit et in Aquense palatio organum, quod grecce hydraulica vocatur, mirificae arte composuit." Here the date is given as 828.

3 Rowbotham, iii, 299, 261-2, 365. Of course we have the statement that the (pneumatic) organ was introduced into the Church by Pope Vitalian (c. 660), (Joannes Diaconis Vita S. Gregori), but this has been rejected. Buhle, 61. The Roman singers, Theodore and Bennet, who entered France c. 787, are said to have taught organ playing to the French. Mon. Germ. Hist., 1, 170. Even this event is suspect. The use of the word "organ" (organum, organa) by mediaeval writers still implies in many instances a general term for "a musical instrument." Isidore (ii, 20) says: "Organum voculum generale." Amalarius (De eccles. off., i, 3) says: "Organum vocabulum est generale vasorum omnium musicorum." Papias (Vocab.) says: "Organum generalis nomen." The word organa (plur.) in Fortunatus (Garmina, i, 9) bears this reading, and similarly that in Amalarius (De eccles. off., iii, 32), although when the latter wrote (ninth century) the pneumatic organ was already known in France. As for Aldhelm, his reference to the organ in his Riddles certainly applies to "a musical instrument," which is the general Anglo-Saxon connotation of the word. (See Archiv. für das Studium der Neueren Sprachen, xxvi, 32; Bibl. der Angelsächsischen Pros, iii, 130.) In De laudibus 147.
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(828), Italy was still the “home of organ building,” as Rowbotham says, it is certainly strange that half a century later, Pope John VIII (872-82) should be constrained to appeal to Bishop Anno in Germany saying: “Send me the best organ that you can obtain, together with a player [?], as we have none here.”

Another well known writer, who holds a brief for Italy, says: “Venice seems to have been famed for its organ builders during the ninth century, for Louis le Debonnaire sent there, it is recorded, for a certain monk, Georgius Benevento, to construct a hydraulic organ for his palace at Aix-la-Chapelle.” It is not recorded that Louis sent to Venice for Georgius. All that we are told is that he came in the suite of Count Baldric. Further, his name was not Georgius Benevento, but Georgius Veneticus.

This Georgius Veneticus constructed an hydraulis for Louis le Débonnaire, and we read that the king gave instructions for the necessary materials to be supplied. Coupled with this we have the claim that Eginhard (d. c. 840), who was the biographer of Charlemagne and Louis le Débonnaire, and Minister of Public Works, preserved for posterity, the famous book, De architectura, of Vitruvius, which contains the only Latin description of the hydraulis and its construction in the Middle Ages.

These facts, placed side by side, would rather appear to enhance the Occidental claim for the reintroduction of the hydraulis, at least circumstantially. In reality, however, the Vitruvius reference contributes no evidence, for this reason. Whatever guidance the presbyter Georgius Veneticus may have had in constructing his hydraulis, it was certainly not from the book of Vitruvius, even though we may have a copy dating from this very century. In spite of Seidel’s opinion to the contrary, the work of Vitruvius as we know it, contains no diagrams, and, above all else, it tells us absolutely nothing about the hydraulic principle, the most essential factor of all. Indeed, many scholars, some of whom have had Heron’s more detailed work to refer to, have been baffled about the hydraulic principle of the instrument for four hundred years.

The Byzantine claim for the reintroduction of the hydraulis is based on a rather doubtful assumption that artist craftsmen, “Greeks of the Christian East,” “were dispatched to various parts of Europe to instal the hydraulic and the pneumatic organ in palaces, theatres, churches and amphitheatres.” I am not aware that there is any authority for so wide a statement. That the Byzantine Emperor Constantine Copronymus sent the French King Pépin an organ in 757, and that Charlemagne had another made after a Byzantine model in 812, may readily be allowed. But that is not evidence of Byzantine craftsmen being sent to “various parts of Europe” to instal organs in palaces, theatres, churches and amphitheatres.

As for the hydraulis built for Louis le Débonnaire in...
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826 (828), there is no mention of Byzantine craftsmen.\(^{12}\) What is actually stated is that Georgius Veneticus himself constructed the instrument after the Greek manner,\(^{13}\) which does not necessarily mean that the model was borrowed immediately from the Byzantines, but that the hydraulis was an instrument invented and given its name by the Greeks.\(^{14}\) That Georgius borrowed from an existing Byzantine model does not even quadrate with history since we cannot trace any mention of the hydraulis among the Byzantines during the sixth, seventh and eighth centuries.\(^{15}\) a period which coincides with a similar gap in Western Europe.

The evidence for the Arabian claim for the reintroduction of the hydraulis, is not to be sought in the doubtful material that we have already had under consideration, but in Arabic sources. In the Arabic treatise on the construction of the hydraulis, attributed to Mūriṣṭūs, it is positively stated that the translator or adaptor (scarcely the author) had constructed an hydraulis for the “King of the Inner Franks.”\(^{16}\) This MS. was copied in the twelfth century, but we can be certain that the work was known in the tenth century, and possibly in the ninth century, or even the eighth century, as we have already indicated.\(^{17}\)

It must be recognised that the revival of the hydraulis synchronises with the revival of the arts and sciences of antiquity by the Arabs. Further, we cannot ignore the fact that many if not most of these arts and sciences fil-

\(^{13}\) Mon. Germ. Hist., ii, 629. “Qui se promitterat organum more posse componere Græcorum.”
\(^{15}\) Gastoué, 571-2. \(^{16}\) See ante, p. 128. \(^{17}\) See ante, pp. 60, 127.

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tered into Europe via the Arabian culture-contact, and we have definite clues that Arabian musical instruments and practices were finding their way into Europe at this time.\(^{18}\)

Among the sciences which are intimately connected with the hydraulis are hydrostatics and pneumatics, and seeing that both Philon and Heron were translated from Greek into Arabic, and then from Arabic into Latin, it is not perhaps too much to assume that a work or works on the construction of the hydraulis may also have been translated from Arabic into Latin. Indeed, Kircher, who deals with several instruments of these types, may have had documents rather than actual specimens as his authority.

As to the identity of the “King of the Inner Franks” for whom the author (but more probably the compiler) of the Mūriṣṭūs treatise made a hydraulis, Hartwig Dernbourg, commenting on the opinion of Père Cheikho,\(^{19}\) says that it was the Frankish king Pēpin.\(^{20}\) The instrument, however, that was presented by the Byzantine emperor to Pēpin in 757 is generally supposed to have been a pneumatic organ, although we have no definite indication that it was such an instrument.

The term “Inner Franks” (Afranjat al-dakhila) means the Franks furthest away from the borders of the Khalifate. We find a similar expression being used by Al-Qazwini who refers to the “Inner Byzantines” (bāštīn al-Rām) in the same sense.\(^{21}\) Professor Dr. Wiedemann was

\(^{18}\) On the whole question see my Arabian Influence on Musical Theory (1925) and Historical Facts for the Arabian Musical Influence (1930).
\(^{19}\) Mashriq, ix.
\(^{20}\) Revue Musicale, 6e année, Nos. 8-9, p. 103.
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of opinion that if one of the German emperors were intended it must have been one of the Carolingian or Saxon emperors. It has also been suggested, as we have seen, that the Horn of Roland at Roncesvalles was a *hydraulis,* and colour is lent to the suggestion by reason of the *hydraulis* being actually known as the “Horn of Alexander the Great.”

It is also not improbable that Georgius Veneticus, who constructed the 826 (828) *hydraulis,* may have learned about the instrument from Arabian or Syro-Arabian constructors. It happens that Georgius was the name of one of the envoys that came with Khalif Harûn’s embassy to Charlemagne in 807, carrying presents for the Frankish emperor. He was a monk of Jerusalem, which for two centuries had been in Arab hands. Some of the Khalif’s envoys appear to have stayed at Charlemagne’s court for a considerable time, since we read of their presence there in 812. Perhaps Georgius was one of the original envoys of 807, but being a Frank by nationality, he may have been desirous of staying in the West, and may have settled at Venice. If so, this may be the same Georgius, now surnamed Veneticus, who came with Count Baldric of the Marches of Pannonia, to the court of Charlemagne in 826 (828) promising to construct an *hydraulis.* Venice was in political and commercial contact with both Syria and Egypt at this time, and it was the most important European port for the Levantine trade. Here, the services of Georgius Monachus of Jerusalem, who was *au fait* with the languages and customs of the peoples of the Khalifate, would be invaluable. At any rate, Georgius Veneticus was afterwards given the post of abbe of the monastery of S. Sauve le Martyr in Valenciennes.

Whether we grant that the “King of the Inner Franks” was Pépin, or recognise the identity of the two Georges or not, it still remains fairly certain that the ninth century *hydraulis* of Western Europe came from the Orient. Amédée Gastoué, the historian of Byzantine music, says that whilst the small portatives were introduced into the Occident by Byzantine envoys to Charlemagne’s court, it appears that “the makers of the first large organs [positives] in the Occident in the ninth century, were, without doubt, either Greeks or Syrians.” Since Gastoué gives his opinions elsewhere that the *hydraulis* had died out by this time amongst the Greeks, the greater probability rests with the Syrians. Yet the Syrians were only prompted to this work by reason of the Arabian culture movement. Until the days of Islam, the Syrians showed scarcely any interest in the arts and sciences.

In Byzantium, the idea of a *hydraulic pressure stabiliser* as in the *hydraulis,* had been superseded by the barystathmic principle of the weighted blast-bag. In the face of this there seems to be no reason why a return to the old system should have been made by them without some external prompting. On the other hand the Arabs did not

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*Wiedemann, *Byz. u. arab. akustische Instrumente,* 155.


*Steule, Roger Bacon’s Secretum Secretorum.*

*The Frankish envoys stayed for about three years in Baghdad.*

*Pompeo Molmenti, Venice. *The Middle Ages,* ii, 162, says that this Georgius came from the island of S. Georgio in Alga [sic]. I do not know the authority for this statement.

*After the rebellion of 746, when Marwân razed the walls of Jerusalem, it is probable that the relations between Muslims and Christians were strained.*
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possess any type of organ, at any rate not the hydraulis, until the Syro-Arabian school of translators revealed the treatises on organ construction written by the Greeks of old. When, at the close of the eighth or beginning of the ninth century, the Arabs began to build the hydraulis, after the manner of the Ancients, it is highly probable that the Byzantines, who had discarded the instrument some centuries before, and had lost all knowledge of its actual construction, readily adopted the hydraulis anew under the impulse of the Arabian culture movement.

The artistic, literary and scientific impetus given to Byzantium by this movement at the beginning of the ninth century, is well attested. We see it in architecture, and in the industrial arts most markedly. That scientific and classical studies began to be revived in Byzantium precisely at this period, is strangely coincident. The evidence of the Utrecht Psalter, which especially concerns our subject, is not inconsiderable. This production is said to date from the ninth century, and from the testimony of the palæographers and other experts, we are led to conclude that the designs reveal Oriental influences, probably Syrian, or perhaps Byzantine under Syro-Arabian urge. It is in the Utrecht Psalter that we get our first pictorial representation of the hydraulis in the Middle Ages.

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A final word concerning the later history of the hydraulis may not be out of place here. Dr. Maclean says: "Water organs [i.e., hydraulis] hardly existed after the ninth century." Further, the year 850 is assumed by him as the date when they died out. I believe that it can be demonstrated that the hydraulis existed at a much later date. It is certainly mentioned by Isho' bar 'Ali (ninth century), Aurelianus Recomensis (fl. 890), Hucbald (d. c. 930), or Pseudo-Hucbald, Bar Saroshwai (tenth century), Isho' bar Bahlul (fl. 963), Elias bar Shinaya (b. 975), the Ikhwan al-Şafa' [?], and Gerbert (d. 1003). Possibly, the instrument cannot be traced later than Jerome of Moravia (thirteenth century), and the opinion of Warman that it existed until the seventeenth century, is probably due to his confusing the hydraulis with other hydraulic organs of the "air compressor" type.

Gerbert, who later became Pope Silvester II, is claimed to have studied under Arabian masters. Certainly, he was deeply influenced by Arabian learning, and is credited with having introduced several "Arabian sciences" into Europe, including the Arabic numerals. He was highly skilled in music and was probably "beyond his age in
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this science, seeing that both France and Italy were in a parlous state in this respect. In his letters there are many references to the organ, and he is said to have constructed an hydraulis whilst he was at Rheims about the year 976, and certainly before 980.

The description of this hydraulis by William of Malmesbury in his Gesta rerum Anglorum has given rise to quite a crop of misconceptions. Here is the passage together with a fresh translation which probably gives a correct explication of the much contorted phrase per aquae calefactae violentiam:

"Extant apud illam ecclesiam doctrinae ipsius documenta: horologium arte mechanica compositum; organa hydraulica, ubi mirum in modum, per aquae calefactae violentiam, ventus emergens implet concavitatem barbiti, et per multi foratiles tractus aereae fisticulae modulatos clamores emittunt."

"In that church [Rheims] are still extant proofs of his science; a clock constructed on mechanical principles, and an hydraulis in which the air, in an extraordinary manner, by hydrostatic force, fills the cavity of the instrument, and through numerous apertures, the brazen pipes emit harmonious sounds."

It was the phrase, "per aquae calefactae violentiam," that gave rise to the fables in our histories about the "steam organ." Calefacio, in its figurative sense, means "to disturb, excite," so as to give power. Water disturbed from its level in the arca of the hydraulis, becomes a static force.

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From whence did Gerbert derive his "invention"? It is highly probable that the Arab Umayyads of Al-Andalus had klepsydras from an early date (see ante, p. 80). Toledo had a famous water-clock (bankam) designed by Al-Zarkâli in the eleventh century. (Al-Maqqari, Moh. Dyn., i, 81-3, 385). It has already been shown that the organ was probably known to the Arabs of Spain. The poet Ibn Ḥazm (d. 1064) speaks of it among a number of Arab musical instruments:

"And the duff, the ḫūbūr, and the múzmar, Likewise the ṣūḥān and the ṣubāḥa, And the ṣaḫrūd, and the ṣubabūba."

At the same time it ought to be pointed out that the conclusions adopted by M. Soriano-Fuertes on this question are certainly unwarrantable. He has stated that the múzmar was an hydraulic organ, and that the ṣḥāhrūd was a clavier-organ. His sources, Al-Fārābī and Al-Shālabī (= Kitāb al-imtā') do not contain any statements that warrant such affirmations being made.

What ultimately contributed to the disuse of the hydraulis in Western Europe was precisely the same factor that had led to its supersession after the fifth century, that is to say, the improvement in the weighted blast-bag of the pneumatic organ, which provided a more convenient force of stabilisation of the wind pressure, than that involved in the hydraulis.
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APPENDIX I.

SCALE OF ARABIC MEASUREMENTS USED IN THE PRESENT WORK.

1 Digit = 1 ʻisba' or 'aqd 1 .......................... 2.25 cm.
1 Shut Digit = 1 ʻisba' madmum ................... 4.5 cm.
1 Open Digit = 1 ʻisba' maftuh ..................... 6.75 cm.
1 Span = 1 skibr .................................... 27 cm.
1 Cubit = 1 dhira' (= 1 Hebrew ammah) ... 54 cm.

1 According to Baron Carra de Vaux (Journal Asiatique, Mars-Avr., 1891, p. 319) an 'aqd is a smaller measure than an ʻisba'. See also Der Islam, viii (1918), p. 56.

APPENDIX II.

HERON'S HYRAULIS.

HERON'S Mechanics has come down to us in an Arabic version practically complete, whilst only fragments of the original Greek have been preserved. Unfortunately for our present studies, the Pneumatics has only survived in Greek, although we know that it existed in Arabic. As Heron's hydraulis is much later than the instrument described in the Arabic Muristus treatise, it is essential perhaps that Heron's description should be included here.

The translation is that made by J. G. Greenwood, Professor of Greek and Latin at Owen's College, Manchester, and Bennet Woodcroft, Professor of Machinery in the University College, London. Other translations have been made both before and since, but this translation is just as suitable for the present purpose as a fresh translation based on the textual emendations of Schmidt would be. Here and there, however, slight changes have

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been made in the terms used, but in each case the original words of Greenwood and Woodcroft are given in the footnotes.

Heron describes how the cylindrical pumps of this hydraulis, instead of being worked by hand, may be worked by a wind-mill. The Banu Musa also devise the wind-mill among their automatic appliances for working their "organ."

"THE CONSTRUCTION OF AN HYDRAULIS (ORGANON HYDRAULIKON)."

"Let A B C D be a cistern (bomiskos) of bronze containing water. In the water invert a hollow hemisphere, called a pnigeus, E F G H, which will allow of the passage of the water at the bottom. From the top of this let two tubes ascend above the cistern; one of them, G K L M, bent without the cistern and communicating with a cylinder, N X O P, inverted, and having its inner surface made perfectly level to fit a piston. Into this cylinder let the piston R S be accurately fitted, that no air may enter by its side; and to the piston attach a rod, T U, of great strength. Again, attach to the piston rod another rod, U Q, moving about a pin at U, and also working like the beam of a lever on the upright rod W Y, which must be well secured. On the inverted bottom of the cylinder N X O P let another smaller cylinder Z, rest, communicating with N X O P and closed by a lid above: in the lid is a hole through which the air will enter the cylinder. Place a thin plate under the hole in the lid to close it, upheld by means of four pins passing

through holes in the plate, and furnished with heads so that the plate cannot fall off: such a plate is called a valve.

"Again, let another tube, F I, ascend from F G, communicating with a transverse wind-chest J V, on which rest the organ-pipes (auloi) a a a, communicating with the transverse wind-chest, and having at the lower extremities small boxes (glässokoma) . . . . ; these boxes communicate with the organ-pipes, and their orifices b b b, must be open. Across these orifices let perforated sliders' move, so that, when the sliders are pushed home, the holes in them coincide with the holes in the organ-pipes, but, when the sliders are drawn outwards, the connection is broken and the organ-pipes are closed.

"Now, if the transverse beam U Q be depressed at Q, the piston R S will rise and force out the air in the cylinder N X O P; the air will close the aperture in the small cylinder Z by means of the valve described above, and pass along the tube M L K G into the hemisphere: again it will pass out of the hemisphere along the tube F I into the transverse wind-chest J V, and out of the transverse wind-chest into the organ-pipes, if the apertures in the organ-pipes and the sliders coincide, that is, if the sliders, either all, or some of them, have been pushed home.

"In order that, when we wish any of the organ-pipes to sound, the corresponding holes may be opened, and closed again when we wish the sound to cease, we may employ the following contrivance. Imagine one of the boxes at the extremities of the organ-pipe, c d, to be isolated, d being its orifice, e the communicating organ-

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5 "Small altar."
6 "Box."
7 "Tube."
8 "Pipes."
9 "Lids."
10 "Box."
11 "Tube."
12 "Pipes."
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Fig. 14.—The Heron Hydraulis.


Pipe, \( r s \) the slider fitted to it, and \( g \) the hole in the slider not coinciding with the organ-pipe \( e \). Take three jointed bars \( f h, h m, m o \), of which the bar \( f h \) is attached to the slider \( s f \), while the whole moves about a pin at \( n \).

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Now, if we depress, with the hand, the extremity \( o \) towards \( d \), the orifice of the box, we shall push the slider inwards, and, when it is in, the aperture in it will coincide with that in the organ-pipe.\(^6\) That, when we withdraw the hand the slider may be spontaneously drawn out and close the communication, the following means may be employed. Underneath the boxes let a rod, \( p q \), run, equal and parallel to the transverse wind-chest \( j \), and fix to this slips of horn, elastic and curved, of which \( t \), lying opposite \( e d \), is one. A string fastened to the extremity of the slip of horn, is carried round the extremity \( k \), so that, when the slider is pushed out, the string is tightened; if, therefore, we depress the extremity \( o \) and drive the slider inwards, the string will forcibly pull the piece of horn and straighten it, but, when the hand is withdrawn, the horn will return again to its original position and draw away the slider from the orifice, so as to destroy the correspondence between the holes. This contrivance having been applied to the box of each pipe, when we require any of the organ-pipes to sound we must depress the corresponding key with the fingers; and when we require any of the sounds to cease, remove the fingers, whereupon the sliders will be drawn out and the organ-pipes will cease to sound.

"The water is poured into the cistern that the super-abundant air (I mean, of course, that which is thrust out of the cylinder and forces the water upwards), may be confined in the hemisphere, so that the organ-pipes which are free to sound may always have a supply. The piston \( R S \), when raised, drives the air out of the cylinder into the hemisphere, as has been explained; and when de-

\(^6\) "Tube."
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pressed, opens the valve in the small cylinder Z. By this means the cylinder is filled with air from without, which the piston, when forced up again, will again drive into the hemisphere. It would be better that the rod T U. should move about a pivot at T also, by means of a loop9 R, which may be fitted into the bottom of the piston, and through which the pivot must pass, that the piston may not be drawn aside, but rise and fall vertically.”

9 "Single [loop,]."
A THANASIUS KIRCHER (1602-80), the author of "Musurgia Universalis" (1650 et seq.), describes, in this work, an automatic hydraulic organ, which is somewhat similar to the instrument designed by the Banū Māsā. The wind supply is slightly different. Instead of the one horizontal pipe of the latter, Kircher has eleven or more vertical pipes.

Here is the main part of Kircher's description translated from the Latin into English for the first time.

"HOW TO CONSTRUCT AN AUTOMATIC HYDRAULIC ORGAN."

"For an hydraulic organ, three things are necessary: water, air, and a recording barrel (rota phonotactica). First of all there must be flowing water; air as wind for the organ; and a recording barrel as the instrument of automatic sound.

"You proceed in this way: An organ having been arranged for in a suitable place, in accordance with given designs, you first of all construct a wind 'feeder' (camera aeria), as already described in Pragmatia II."
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So let there be a 'feeder' \( V X Y R \), five palms in height, and three and a half palms in width, with diaphragms perforated in the form of a sieve, and provided with two pipes, of which the larger, \( T S \), will supply fresh water with a stop cock (\textit{epistomium}) at \( T \) for stopping the flow when required. This pipe will be diverted within the vessel (= 'feeder'). Above this vessel there is another pipe, \( V Z \), which conveys the wind blast to the 'wind-chest,' i.e., into the anemotheca, of the organ. The water, rushing through the pipe \( T S \) with great force into the vessel (= 'feeder') at \( R \), puts in constant motion not only the wind already there, but other wind generated afresh. And the air, compelled by the density of the moisture, seeking expansion through the perforated or carded diaphragms, and unable to find it, will escape through \( V Z \) into the 'wind-chest.'

"Further, the water, escaping with great force through the opening \( R \), turns the water-wheel (\textit{rota}) \( M R \), and will turn the cog-wheel (\textit{vertebra}) \( L \), and the cylinder or recording barrel \( H K \). This [recording barrel], with its teeth regularly disposed on the surface, in accordance with the designs given, will touch each of the levers (\textit{spatulae}) working on a steel rod \( A B \). The levers, being caught by the teeth of the recording barrel, will pull down the 'pallets' (\textit{palmulae}) of the abacus claviarius or 'keys' (\textit{tasti} [= \textit{tacti}]) \( E F \), to which they are joined. These being pulled down open 'valves' (\textit{platismatia}), or as the Italians call them, \textit{battiventi}, and thus the wind, forced violently into the 'wind-chest' through the open 'valves,' will enter the organ pipes, and the desired harmony will finally be obtained. . . . .

"This automatic construction can be applied not only to organs but also to stringed instruments."
Appendix III.

This last paragraph is strangely reminiscent of the Banū Mūsā, who tell us that their instrument could be applied to "the lute or instruments of strings like psalters." Kircher also describes more elaborate instruments with dancing figures and wing-flapping birds. A design of one of these instruments is given here (Fig. 15), but it is taken from a certain Gaspar Schott, a cool imitator of Kircher, whose work deserves remembrance on this account.²

The Banū Mūsā, like Kircher, also allow for "figures which dance and follow this organ," and, strange to say, the Chinese organ "presented by the Muslim kingdoms," "as an offering from the lands of the West," presumably by Hulāgū to Khubilāi (ca. 1260-64), had figures of peacocks on the instruments which "flapped their wings and danced in time with the music."³

Fig. 16: THE SCHOTT AUTOMATIC HYDRAULIC ORGAN.

1 Schott, G., Magiae universalis naturae et artis, pars II. Acustica (1657).
2 Journal, Royal Asiatic Society, April, 1926, p. 193, et seq.
3
The Organ of the Ancients.

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Mafdtlh al-’ulum. See Al-Khwarizmi.

Mashriq, Al., See Machriq, Al.


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- before a name or work stands for Ab.

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ERRATA.

Page 23, line 35.—For “The Organ, 3” read “The Organ, 4.”
24, 35.—For “reveal” read “reveals.”
34, 31.—After “(d. 1200)” add “Idelsohn (Jewish Music, 496) says,—Magrephah is derived from grophith reed.”
38, 1.—For “or hydraulic organ” read “or to the hydraulic organ.”
48, 1.—For “Apollinarus” read “Apollinarius.”
50, 21.—After “century” add “There is the well-known diptych of Anastasius of Constantinople (a.d. 517), which may represent an hydraulis, but we cannot be sure that these diptychs represent contemporary manners and customs. As in the contorniates, there is a tendency to copy earlier designs.”
55, 24.—For “Apollonius” read “Apollonios.”
56, 2.—For “Qusta” read “Qustā.”
56, 4.—For “Apollonius” read “Apollonios.”
64, 28.—For “ibn Muṣaffar” read “ibn al-Muṣaffar.”
70, 9.—For “Bernelius” read “Bernelinus.”
73, 21.—After “enquiry” add “In the section on mechanical instruments in his Iḥāṣ al-walām, known in Europe as De scientiis, Al-Fārābī refers to mechanical instruments of music, which would include the various kinds of organs.”
76, 33.—For “138” read “157.”
83, 13.—For “Wiedermann” read “Wiedemann.”
116, 15.—After “with” add “what appear to be.”
117, 6.—Delete bracket after “ḥannāndt.”
118, 1.—For “Aṣṭurāblā” read “Aṣṭurāblā.”
124, 25.—For “has” read “have.”
136, 14.—For “qisṭ” read “aqāṭ (sing. qisṭ).”
142, 38.—For “14” read “13.”
143, 29.—For “translations” read “editions.”
161, 6.—After “that” add “works by.”
169, 25 and 27.—For “Evliyya” read “Evliya.”
BY THE SAME AUTHOR.

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