that, in the great mass of stars of the sixth magnitude, the smallest visible to the naked eye, the motion is about three seconds per century. As a measure thus stated does not convey an accurate conception of magnitude to one not practiced in the subject, I would say that, in the heavens, to the ordinary eye, a pair of stars will appear single unless they are separated by a distance of 150 or 200 seconds. Let us then imagine ourselves looking at a star of the sixth magnitude, which is at rest while we are carried past it with the motion of six or eight miles per second which I have described. Mark its position in the heavens as we see it to-day; then let its position again be marked 5000 years hence. A good eye will just be able to perceive that there are two stars marked instead of one. The two would be so close together that no distinct space between them could be perceived by unaided vision. It is due to the magnifying power of the telescope, enlarging such small apparent distances, that the motion has been determined in so small a period as the 150 years during which accurate observations of the stars have been made.

PRIMITIVE METHODS OF DRILLING.

"A STUDY of the Primitive Methods of Drilling" is the title of a monograph by Mr. J. D. McGuire, in the recently-published Report of the United States National Museum (1894). The paper covers 125 pages of the Report, and is fully illustrated, in addition to which there are numerous references to books of travel among peoples living under the most primitive conditions. The author of the paper verified his opinions during the progress of the work by experiments in a laboratory fitted up for the purpose in the United States National Museum.

The paper discusses the various ways by which holes are bored in material, ranging from the softest to the hardest known, with such implements as were possessed by different peoples throughout the age of stone, and well through that of metal. The implements employed in performing the work were chiefly such as are on deposit in the Museum, the collections of which, especially from the North American tribes of Indians, are very rich. Yet the author has not hesitated, where circumstances warranted, to seek further afield for examples, notably in the concluding portion of the paper, where he describes a heretofore unrecognised drill, which frequently appears on the bases of royal seats among Egyptian antiquities. The act of cutting a hole through stone, or other substance, is shown to be a much simpler process than archæologists have heretofore supposed. The author has shown by specimens, and by quotations, that man, from the first time of which we have evidence of his existence, perforated with apparent ease material, such as shell or bone or ivory, and that to do this required nothing more than a stick or a stone with a little sand.

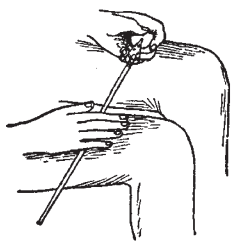

FIG. 1.—Horizontal drilling.

It is shown that early in the Lake period of Switzerland, a hollow cylinder of metal was often employed in boring stone axes, and the same conditions have existed from very early times in the history of the most ancient nations of which we have any records.

The seals of Mesopotamia, as well as the earliest intaglios, it is asserted, were bored with the drill and wheel from a period ante-dating the Christian era by thousands of years. The author shows that the American Indian, at the time of the discovery of the country, employed only the simple shaft-drill revolved between the extended palms of the hands, a method yet in use among the most primitive peoples in producing fire. The same implement, revolved horizontally upon the thigh, is illustrated in Fig. 1, by which means any of the simpler holes found in the earliest antiquities may be readily and quickly reproduced.

The "Bow Drill" (Fig. 2) is represented in the monograph as it has been employed by various races, ancient and modern, showing the manner of working it, and the differences in shape of the bow and shaft of the drill. The author calls attention to Fig. 3, which he says is the drill bow of ancient Egypt carried in sacred processions as an emblem of ceremony.

Fig. 4 is a drill of a complicated character used by certain California tribes, and appears to be an aboriginal American outgrowth of the "Pump Drill," which was imported into the country from Europe or Asia in modern times. The author illustrates what he designates as a "Top Drill" (Fig. 5), worked by means of a single strap and head-piece, which was developed in the course of his experiments. While in itself this drill is not claimed to be of any great value, it did lead to most interesting developments, the principle of which is, among other things, recognised in the Hindu statue of Samudra Mutu (the third incarnation of Vishnu). This again, in its turn, led to the recognition of the "Disc Drill" with double string, shown in Fig. 6, a most common glyph among early and late Egyptian antiquities known as the "S. S. M." or "Sam," which is by some authors thought to be "an altar typical of the Upper and Lower Nile joined under a single Pharaoh." Such a drill was set up in the Museum laboratory, and was found to work with perfect ease, and to be capable of producing any of the holes met with among the bored monumental stones of Egypt. The number of persons who, upon occasion, might be employed at the same time in working this drill, is unlimited; though probably not more than four would be required at any one time.

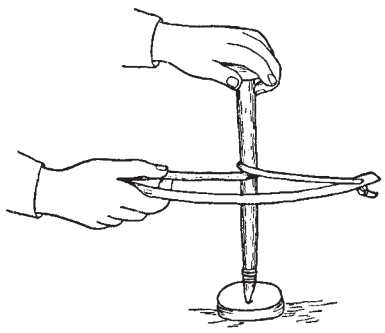

FIG. 2.—Single-handed Bow Drill in use.

FIG. 3.—Ancient Egyptian Drill Bow.

The author not only tested the different stone points employed in boring stone and softer substances, but used the stone points themselves with sands of differing hardness upon different stones. Metal points to drills, as well as metal cylinders, were tested as to their cutting properties. Points of all kinds were experimented with, demonstrating that the sharp sand and wood points are capable of cutting a hole through any material, provided it was not harder than the sand. The paper shows the different characters of holes met with in objects of a prehistoric period, or by people in a low stage of mechanical development, and describes how such holes were made.

In most instances the exact number of revolutions per minute of each separate drill was recorded, and the character of cutting material was noted; the results were in every instance uniform. The velocity of revolution and hardness of the sand determined with mathematical accuracy the time required to drill a hole through any given material.

The striæ noticed upon the cores left in some holes bored in stone in Egypt had led distinguished Egyptologists to believe that the Egyptians possessed the diamond drill, with diamonds not only set in the lower edge of the cylinder, but on the outer and inner sides as well. Mr. McGuire's experiments have demonstrated that with such a drill as represented in Fig. 6, a hole of almost any diameter may be made through the hardest stone, and that the marks left on the interior of the drill-hole, or exterior of the core in the hole, is governed entirely by the hardness of the sand and size of its grains. The time requisite to perforate any material is shown to be but a fraction of what has been heretofore supposed necessary.

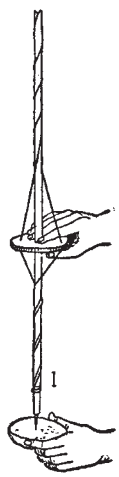

FIG. 4.—Disc Drill (California).

The paper proves the value of a study of the technology of archæology, and its necessity in any intelligent study of primitive implements. The manufacture of any product of ancient man

carries additional information to that which may be gathered merely from the shape of the article. Crushing stone, hammering or breaking it, by heat or cold, by pressure applied in any of the many known ways, each and every item of personal work has its value, and no one can say in advance to what its inspection may lead. We gather here, if the author be correct in his claims, data which no one could have anticipated in advance of experiments.

The long-stone drill points are found unsuited to boring substances which wood and dry sand will cut with ease. Soft wood is shown to be as unsuited as is hard wood for drill shafts. The hard stone point is found to cut steatite or wood quite

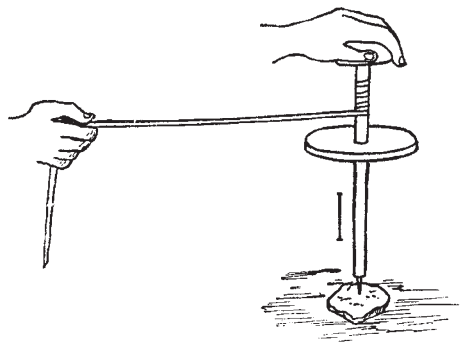

FIG 5.—Top Drill

readily, but is easily broken if it is attempted to bore hard stone with it. The study has been a careful one, has extended over a long period, and no known source of information has been intentionally neglected. Personal acquaintance with drills and their workings, as developed in the paper, is calculated to familiarise one with the Australian or American producing fire with the plain shaft-drill. It enables us to see in a new light Ulysses and his companions boring the eye from the Cyclops king. It gives a new interpretation to one of the incarnations of Vishnu. The remark of the latter, that their foes "should share their toil," suggests further, that instead of the "Nile gods" being

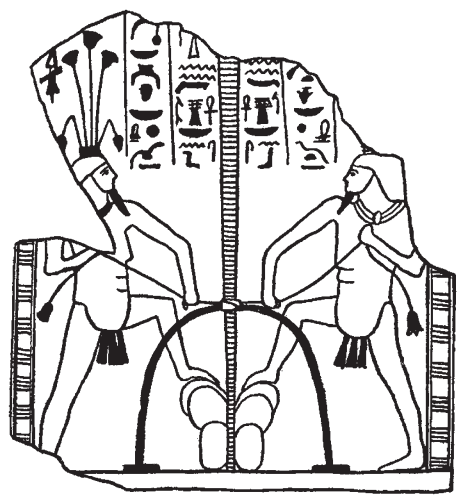

FIG. 6.—Disc Drill on Base of Statue of Amennemhat.

shown in Fig. 6, we see the citizens of a subjugated territory performing ordinary menial labour. The so-called "gods" themselves are usually females, Negro or Asiatic, who hold the straps of the drill. It will be interesting to inquire whether under the late Nubian dynasty the Negro disappears from the work, and the Egyptian takes the subordinate place when the latter became subject to the Negro dynasty. The drill represented in the closing pages of the paper is capable of performing more and better work in boring stone than any other known hand-implement, either of ancient or modern date. This drill familiarises us somewhat with the high degree of skill possessed by the Egyptian workman of a remote antiquity. The author, in reproducing the Egyptian drill, has no doubts as to the identity of its shaft, its disc, the straps used to revolve it, or of the principle upon which it worked. He also believes that it was braced in some way. The bracing and method of tightening down the braces, invariably accompanying the drill, and even the possibility of the shafts having been tautened by strings or straps, are matters not satisfactorily interpreted. It will be a matter of interest to have more examples of this implement, which acquaints us with the man of Ancient Egypt in possession of a very complicated machine at a period in the life of the nation centuries prior to any date heretofore suggested. The scarcity of works and photographs on Egypt accessible to the author, prevents the hope that he may further interpret with available material the braces and means of tightening down this drill; but it is suggested that, in Europe and the East, there may be found sufficient data to answer this enigma.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Prof. W. J. Sollas, F.R.S., has been appointed a delegate to attend the International Geological Congress to be held at St. Petersburg in August or September next.

The following examiners for the Honour School of Natural Science have been appointed:—Physics: Mr. S. A. F. White. Chemistry: Mr. V. H. Veley, F.R.S. Physiology: Prof. F. Gotch, F.R.S. Morphology: Mr. G. C. Bourne, Mr. Adam Sedgwick, F.R.S. Botany: Mr. P. Groom, Mr. R. W. Phillips. Geology: Prof. W. J. Sollas, F.R.S., Dr. J. W. Gregory.

There are thirty-eight entries this year in Natural Science; eighteen of these are in physiology, twelve in chemistry, three in animal morphology and physics respectively, and two in geology.

The degree of Honorary M.A. has been conferred upon the Mayor of Oxford, Alderman Buckell, J.P. This is the first time that the University has conferred a degree on the Mayor of the city.

Miss Kingsley gave a public lecture at Manchester College on Friday last, on "The Connection of Fetish with West African Customary Law: a Study in Primitive Religion."

CAMBRIDGE.—The Rev. Prof. Wiltshire has presented to the Woodwardian Museum his valuable geological library, consisting of about 600 volumes and 900 pamphlets.

Prof. Macalister announces a course in Osteology, and Mr. J. E. Marr a course in Practical Geology, in the ensuing Long Vacation.

The Council of the Senate propose the re-establishment of the Professorship of Chinese, held by the late Sir Thomas F. Wade. It is understood that a distinguished Chinese scholar is willing to accept the office without stipend, and to undertake the charge of the magnificent collection of Chinese books given to the University by the late Professor. The collection is said to be unmatched in Europe, and probably in China.

The examination in Agricultural Science for the University's diploma will be held from July 5 to July 12.

The degree of LL.D. is to be conferred on Colonel Maharaj Dhiraj Sir Pratap Singh, K.C.S.I., as representing India, on June 17, when the Colonial Premiers are to receive honorary degrees.

A grant of 300*l.* from the Worts Fund has been made to Dr. A. C. Haddon, towards the expenses of an anthropological expedition to the Torres Straits. It is understood that Dr. Haddon will be accompanied by two or three other Cambridge men skilled in various branches of anthropological research, and by an expert in the Melanesian languages.

A grant of 100*l.* has also been made to Mr. H. H. W. Pearson for botanical research in Ceylon.

Dr. Humphry, Dr. Foxwell, Dr. Sidney Martin, and Dr. Mitchell Bruce have been appointed Examiners in Medicine; Dr. Phillips and Dr. Cullingworth, Examiners in Midwifery; and Mr. Pitts, Mr. Bennett, Mr. Watson-Cheyne, and Mr. Golding-Bird, Examiners in Surgery for the ensuing year.

THE London Technical Education Board has appointed Dr. J. O. W. Barratt to the scholarship in sanitary science. Dr. Barratt will commence his research work under the pathological superintendent at Claybury Asylum during the present summer.