they lay concealed, and their entrance had been protected with iron doors.

One of these, No. 25 on the plan, has at last been identified as the long looked-for hypogeum of the king. The main entrance-passage, cut into the mountain to a depth of fifty metres, opens into a chamber supported by four pillars. To the right of this passage, another corridor, forty-five metres long, branches out, opening into an unfinished chamber thought to be that of the queen. Somewhat further, on the same side, are three chambers, two of which are decorated with paintings; and among these occurs the name of the young princess Aten-Macht, the second daughter of Amenhotep IV. The decorations on the walls of the king's chamber represent him surrounded by his family, in adoration before the sun. The condition of the tomb when found showed it to have been disturbed in ancient times, a fact for which the circumstances of this reign furnish abundant explanation.

Until 1887 all that was known of Amenhotep IV. was that he peacefully succeeded his great father, Amenhotep III., whose queen was a foreigner; but that having selected for his only god the life and light-giving sun-disk "Aten," and having attempted to establish his worship to the exclusion of that of other gods, and particularly of that of Amon, he antagonized the arrogant priesthood, whose growing power was already then a force that the Pharaohs must count with. In consequence of this, he found it expedient to leave Thebes and to remove his court and the seat of government to middle Egypt, where, at some seventy-five kilometres south of Minieh, he founded the new city, "Khu-n-aten," i.e., Splendor of the Disk, the site of which is now known as Tel-el-Amarna.

Consistent in his unconpromising hatred of Amon and his priests, he changed his own name in which that of the now discarded god of his fathers entered as an element, and was henceforth called "Khu-n-aten."

He seems to have been a devoted husband and father, and the worship he introduced — and which, after all, was but a return to ancient sun-worship, and therefore more of a reform than an innovation — seems to have been a lofty one, if one may judge from the aspirations kindled by it in the souls of its worshippers, as expressed in the beautiful hymns that have come down to us.

Khu-n-aten left only daughters. At his death his sons-in-law, who succeeded him, had not the strength to continue the struggle; they gradually abandoned his faith to return to the old popular worship, and the eighteenth dynasty closed with a period of disturbance, indicated by the shortness of the reigns.

Was Khu-n-ated only a religious reformer, a mere fanatical monotheist, who, as has so often been stated, was urged by a devout foreign mother to break with the traditions of his father's race, and whose blind intolerance tried to enforce his own views upon his people? or was he a shrewd, far-sighted prince, who, perceiving the danger to the royal power lurking behind the increasing pretentions of the Theban priesthood, sought to put a check upon their encroachments and to insure the independence of the crown by removing the court and by surrounding himself with foreigners, thus defying this formidable caste?

The latter view receives support from the fact that it is against Amon alone that the king's animosity was practically directed, and that, whilst the worship of the disk was the official religion of the capital, the names of the other divinities of Egypt remained undisturbed upon the monuments of his reign, and Amon's name alone was everywhere erased.

In 1887 the discovery of the archives of Khu-n-aten, consisting of some three hundred cuneiform tablets, containing important correspondence between Egypt and its Asiatic allies and tributaries, as well as official reports from royal lieutenants in foreign lands, threw a most unexpected light upon the condition of the ancient civilized world in the fifteenth century B.C. Among the many interesting glimpses thus obtained is a mention of Canaan in pre-Exodus times, found in a letter from the tributary king of Jerusalem, which reveals the existence of that city at that remote period.

The fact that the correspondence between Asia and Egypt was conducted in the Neo-Babylonian characters was alone sufficiently extraordinary to draw the attention of the learned world to Tel-el-Amarna and to the remarkable figure of the man who, in his day, filled not only that spot, but no doubt the whole civilized world, with his strong personality. There are many peculiarities connected with the monuments of his reign and with the art they betray that have never yet been quite satisfactorily explained; and despite all that has been written, and the ingenious theories that have been advanced on the subject, there still remains enough that is hypothetical to make any monumental discovery connected with this period of the greatest interest to scholars.

S. Y. STEVENSON.

A SIMPLE APPARATUS FOR THE PRODUCTION OF LISSAJOU'S CURVES.

THE requisites are a piece of thin glass tube or rod, a gas flame, and a slight knowledge of elementary glass working. The apparatus consists of a short piece of rod or tube which serves as a base or handle, to which is fused a glass thread ten or fifteen centimetres long and from one-half to one millimetre thick, carrying at its extremity a second and much thinner thread of about the same length, whose free end is fused into a small clear bead. Both threads are in the same line with the handle, and the whole forms a compound rod.

In constructing this rod, two glass threads of the kind already indicated are selected rather longer than required. They are fused together, and the connection straightened by a gentle pull while still soft. The double rod is then held near its centre, and the finer thread shortened until in vibration it appears, by persistance of the visual impression, as a sheet or cone. The thicker thread is next adjusted in the same way until the vibration of this double rod, when held by its thicker end, is sufficiently rapid. This thicker end is now attached to a larger piece of glass (the handle), and a very small bead formed at the other end. The exact position and weight of the bead required to form any given set of curves must be found by trial.

Now, holding the bead in a strong light, stand nearly facing the light, but so as to see the bead with a dark background, and tap the handle lightly with the finger-tips. If the adjustment is perfect, the bead will appear transformed into a shining curve, oscillating or rolling and twisting upon itself with inimitable grace like a living thing, and dying away with the decreasing amplitude of the vibrations.

These curves are represented approximately by the equations: —

$$x = a \cos m\theta$$
$$y = b \sin (n\theta + \alpha),$$

where a and b are the amplitudes, α is the phase-difference, and the ratio $m : n$ is a function of the time. When the

ratio $m : n$ can be expressed by small integers the curve is completely shown by this apparatus. When this ratio cannot be expressed by small, but can by moderate, whole numbers, the curve cannot well be seen, but may be readily photographed. The most beautiful effects are seen when the ratio $m : n$ has almost some such values as 1:1, 1:2, 2:3, or 3:1. The values of a, b, and α vary with every tap of the finger, and thus a single apparatus will show a great variety of curves of one class.

I have not tried projecting these curves with a lantern, but I see no difficulty in the way of such a proceeding.

Clark University. T. PROCTOR HALL.

VALUABLE EXPERIMENTS IN VEIN-FORMATION.

IN No. 3, Vol. XII., of the *School of Mines Quarterly* there appeared a short paper "On the Genesis of Ore-Deposits," by W. H. von Streeruwitz, the chief of the Western Division of the State Geological Survey of Texas.

In these days of hasty conclusions and the overcrowding of scientific literature with opinions and half-developed theories, it is refreshing to run across an occasional example of undue modesty in presenting the results of elaborate experimentation. My excuse for thus tardily calling attention to a marked case of this character, entirely without the knowledge of the author, is the conviction that the gentleman himself will not lay claim to full credit for the work which he has planned and executed in a thoroughly scientific manner. Especially does this action seem fitting as preliminary to an extension of the same investigations by the present writer in the metallurgic laboratory of the Arizona School of Mines. In fact, it is only just to confess that the inspiration of these last experiments, for which preparations are now being made, came originally and wholly from the most interesting results of Professor von Streeruwitz's patient and intelligent observations in his laboratory at Houston, Texas.

In the paper quoted Professor von Streeruwitz does not make very clear how much of the value of his well-fortified conclusions rests upon the skill with which he has himself conceived and executed a most convincing series of experiments. But those who have seen some of the tubes with miniature veins of gold, silver, copper, lead, etc., and others with beautifully formed agates, need only the concise reasoning of the article referred to, in order to understand the originality, perseverance, and devotion to truth with which the investigation has been carried out through several years of diligent experimentation.

In the language of our author, the experiments would, so far, appear to establish the following points, viz.: —

1. It is principally the iron which, in silico-ferruginous fissure veins, brought the other metals from greater to (by mining) accessible depths.

2. Most siliceous ore-leads, carrying also large quantities of iron and having silico-ferruginous outcrops, seem to be deposited from hot aqueous solutions of the metals and silicates.

3. Metals and metal combinations contained in the rock surrounding the fissures and crevices were probably leached out by the hot liquids contained in the fissures and precipitated on and combined with the siliceous iron growing up in the fissures.

4. The fissures could be charged with ore-veins in a comparatively short time, since, no doubt, high temperature and galvanic currents existed in the fissures at the time of formation of the ore-gangues.

5. In contact-gangues the precipitation and deposition of ores was materially facilitated by galvanic currents caused by the contact of different rocks, and it is owing to the prevalence of galvanic currents that in most cases richer deposits at the intersection of two or more leads were formed.

6. The so-called iron outblows ("gossan," "eiserner hut," "Pacos," "Colorados," etc.) are frequently not the product of igneous eruption, but a deposition product from aqueous solutions; and alterations in the rocks contiguous to such outblows are not necessarily the result of eruptive agencies, but of a leaching process.

7. The formation of banded agates does not always take place, as is generally believed, in the cavities of a rock, but can also occur free in solutions; and the thickness of the bands progresses from the centre outwards, although a reverse process by osmosis may be possible under certain conditions.

The bases for these conclusions are somewhat more explicit than might, perhaps, be inferred from a reading of Professor von Streeruwitz's paper alone, but, as he is most careful to insist, the experiments possess their greatest scientific importance in the element of suggestiveness for future inquiry. It is remarkable that so little has heretofore been done in such directions; and, like the admirable flexure tests of the United States Geological Survey in orographic work, they point out little-trodden fields in geology which offer rich rewards to capable investigators who will approach the problems in inductive experimental mood, following the guidance of results as they are gradually manifested.

No one will be better pleased than Professor Streeruwitz to know that others are earnestly engaged in this study. The incidental discoveries, whatever they may be, are liable to prove as interesting and valuable as any which may be directly sought. Indeed, it is impossible at this juncture to predict to what legitimate length the investigation may lead.

The main thing to be desired is the inauguration of a large number of experiments with as widely varied conditions as possible of material, situation, environment, and activity. While co-operation is not really essential, it can do no harm and may result most beneficially. May not some of our zealous young geologists be induced to undertake this work, which should be continued with constant observation for a term of years?

Instruction will gladly be given to any who may require it, and from those who cannot otherwise aid the cause thoughtful suggestions will be most welcome.

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ROYAL METEOROLOGICAL SOCIETY.

AT the meeting of this society on Wednesday evening, March 16, Dr. C. Theodore Williams, the president, delivered an address on the "Value of Meteorological Instruments in the Selection of Health Resorts." He drew attention to thermometers, maximum and minimum, as the foundation-stone on which medical climatology rests, and instanced effects of extreme cold or heat on the human organism. The direct rays of the sun are of the greatest importance, and in health resorts should be utilized to the full; in fact, only climates where, during the winter months, even a delicate person can lie or sit for several hours a day basking in the sunshine are to be recommended for most complaints, and the various forms of sunshine recorders are used to aid the medical adviser in choice of such health stations.

After referring to the value of rain-gauges, hygrometers, and barometers, Dr. Williams stated that many health resorts owe their reputation almost solely to their shelter from cold winds; for