rains will then carry it to the slight depth necessary for the roots.

The operation of the spreading is of the highest importance with reference to the utilization by the plant of the nutritive matter introduced into the soil. The more plentiful and the more regular the dissemination, the greater will be the yield.

The slag, on account of its specific weight, is readily scattered, but in our region the northwest wind is often an obstacle to the application of the fertilizer at the right moment. The use of fertilizer distributors may therefore be advised, but it is better, I think, to mix the slag with fine earth, which may be scattered in a slight wind still too rough for sowing the slag. This mixture causes a more regular spreading; the workmen cannot scatter large parcels at once. The employment of the distributors is also useful when there are large quantities of slag to scatter, to prevent corrosion of the hand of the workman.

The slag should be mixed with other fertilizers, but it is necessary to state that there should not be ammonium sulphate in the mixture, for ammonia would be immediately disengaged. The proportions to be employed depend on the richness of the soil and on the plant to be cultivated. It may be said that if the soil is lacking in phosphoric acid, no inconvenience will result from applying the slag profusely.

THE TANREC.

The Berlin Menagerie, according to the *Illustrirte Zeitung*, numbers among its collections of rare animals two specimens of the Madagascar tanrec, an insectivorous animal which has inherited from its ancestors certain characteristics that are not to be found in any of the species of hedgehog. One of these hereditary characteristics is the bristling coat of the animal, which marks the transition stage from hair to spine. True bristles or spines in the tanrec are found only on the occiput, on the neck, and on the sides of the body, where they are longest. The cover-

While the earthquakes were felt throughout the entire southern lowland and all of the western fourth of the island, the most severe disturbances occurred in a triangular area in the southwest part not far from the sea and covering a district about 600 square miles in extent. Outside of this area and extending further inland strong shocks were felt over a region embracing about 1,500 square miles. Weaker effects were noted in a far larger area, outside these main regions of disturbance and including all the western part of the island; so that the total land area affected was about 21,000 square miles. As it is probable that an equally large area of the sea floor was disturbed it is supposed that the movements extended with greater or less intensity through the rocks covering an area of about 40,000 square miles or more than twice the area of New York State. The land surface affected was a little larger than this State. Reykjavik, the capital and chief town, was in the region of least disturbance, and practically no damage was done there.

If these earthquakes had occurred in any very populous land with high houses and large cities the destruction of life would have been very great. But in Iceland the danger is lessened by the peculiar type of buildings characteristic of the country. The village consists of small and low houses, the inner walls made of wood while the outer walls and roof are of warm grass thatch, a great protection against the winter cold. Stone houses are built in considerable numbers in the larger towns, but they are very dangerous for they are likely to become heaps of ruins immediately when assaulted by such terrific shocks as those of 1896. Wooden houses usually hold together until their occupants have time to get out of them. This is the reason why the loss of life is very small though a great number of buildings were destroyed or badly damaged.

Out of a total of 4,430 dwelling houses and 5,739 stables in the regions most severely shaken, 17 per cent were wholly destroyed and most of the remainder were severely damaged. The calamity was indeed a

completely draining small lakes and swamps which they happened to cross.

The earthquakes had a remarkable influence upon many mineral springs and geysers. New ones came to light and others were apparently blotted out of existence. On the night of September 5-6 a new geyser, amid the most deafening noise, suddenly made itself manifest by an outburst of water, steam and stones that were shot 600 feet into the air. Its force rapidly subsided and in a few days the ebullition was only twelve to sixteen feet above the surface. A year later the basin it had formed had a length of fifty-five feet and a breadth of thirty feet and was filled with clear hot water. The renowned Strokkur geyser, which came into action at the time of the great earthquake in 1783, suddenly suspended all activity in the earthquake period of 1896, and a year later its basin was full of tepid water. Still later, however, it regained its power and at last accounts had frequent periods of violent outbursts, throwing water to a great height. The hot spring at Biskupstungur, which merely boiled before the earthquake, now throws its water from twenty-five to thirty-five feet in the air. Many cold springs and wells underwent great changes, old ones disappearing and new ones being formed.

As is usual in Iceland the earthquakes began in the east and the movement was toward the west. The volcanoes Hecla, Kalta and Eyjafjallajökull were completely passive during and after the earthquake periods.

The southern lowland where these disturbances originated is an area of subsidence. Steep mountain slopes form the boundary between the highland and the low plain. Dr. Thoroddsen says the probability is that this boundary line extends deep into the earth as a line of breakage in the rocks. The earthquakes in the plain, probably caused by breakages and slippings among the deep-seated rocks under the plain, do not send their earth waves among the mountains of the interior, for the spreading of these waves to the highlands is interpreted by deep-lying crevasses and dislocations in the rocks. But the tremendous jar caused by these subterranean movements is felt far and wide, so that the effects of a severe earthquake extend over a large part of the island.—New York Sun.

NEW RESEARCHES ON THE ALLOYS OF GOLD, SILVER, AND OTHER MATTER FOUND IN THE EGYPTIAN TOMBS.*

By M. BERTHELOT.

IN pursuing my researches on the metals of antiquity, I have been led to make a special examination of the samples of pure or alloyed gold proceeding from Egyptian tombs, and particularly of fine leaves used in the gilding of mummies and other objects. I have endeavored to see if it were possible to establish some probable relations between the chemical composition of these leaves and the date and the processes of their manufacture, in the cases where this date is established by the archaeologists, so as to be able in other cases to ascend from the composition revealed by chemical analysis, either to the unknown date of manufacture or to the mineralogical origin of the samples. To arrive at conclusions of value, the determinations must be repeated sufficiently.

I have already published some results of this kind in my studies on the Dahchour excavations and on the samples furnished by our confrère, M. Maspero, director of Egyptian Antiquities. He has had the kindness to send me various new samples, and I will give the results of my examination.

A. I. *Small fragments of gold, from the tomb of King Horus of Dahchour, XIIIth dynasty.*—This sample weighs 0.0032 gramme. It is a beaten metallic leaf (about a thousandth of a millimeter thick). The tint of the two surfaces is notably different, one of them being of a pure golden yellow, the other reddish and quite dark in places. This last tint is distributed unequally. It does not appear attributable to the metal itself, but to an extremely thin coating of organic material, proceeding without doubt from contact with the mummy. The weight is not appreciable on so small a sample. The material burns when the gold is subjected to a red heat, and the metal retakes its normal color.

The analysis has furnished in 100 parts—Gold, 92.7; silver, 4.6; other matters, 2.4 per cent.

B. *Two little packets of metallic leaves designated as gold, silver, or electrum, coming from a tomb of the XIIIth or XIIth dynasty (XIIIth probably), discovered at Bercheh and belonging to a certain Tahoutinakhout.*—I have divided these leaves according to their appearance into four groups for analysis.

II. *Silver from packet No. 1.*—Lamella, 0.002 mm. thick, on the average. Variable thickness, from 0.001 mm. to 0.0015 mm. and 0.0025 mm. Gold, 74.52; silver, 14.94; patina and other matter, 10.54.

III. *Yellow gold of packet No. 1.*—Gold, 80.1; silver, 20.3 = 100.4 per cent.

IV. *Red gold of packet No. 1.*—Lamella of about 0.001 thickness in the thinnest parts. Gold, 73.7; silver, 20.9 = 99.6 per cent.

V. *Yellow gold of packet No. 2.*—Lamella about 0.001 mm. in thickness. Gold, 77.3; silver, 22.2 = 99.5 per cent.

VI. *Deeper red gold of packet No. 2.*—The gold is tarnished on one side by an organic matter, like that of sample I., which gives it the appearance of being plated. This matter is destroyed when the gold leaf is heated to the red. Thickness about 0.001 mm. in the thinnest parts. Gold, 73.2; silver, 21.1 = 99.3 per cent.

It will be remarked that the gold leaves have a thickness of about one to two thousandths of a millimeter, but without regularity. The samples III., IV., V., VI., have nearly the same composition, consisting of an artificial alloy or of a native mineral, which contains four parts of gold and one part of silver. The difference in tint, which made the distinct existence of gold and of electrum thought of, is attributable to a thin coating produced by the contact or by the emanations of the mummy.

Sample II. is composed of silver mixed with one-fifth of gold, an alloy, or rather a native ore.

Like the Dahchour treasure, none of these samples

* Paper presented to the Académie des Sciences.

THE MADAGASCAR TANREC.

ing on the back of the animal consists of a bristle-like formation, while the abdomen and legs are covered by hair. The tanrec lives in the dense underbrush and ferns of its native island. As a skillful borer the tanrec forms passages and galleries in the earth, which may sometimes cover a considerable area. One of the peculiarities of the animal is its summer hibernation. The tanrec thus sleeps during the time in which it is difficult to obtain nourishment. So delicate is the flesh of the creature that it is rather keenly hunted by the natives of Madagascar.

ICELAND'S EARTHQUAKES.

No part of the world excepting Japan and a few other Asiatic islands is visited so frequently by earthquakes as Iceland. This great volcanic rock is shaken by about seventy-five severe earthquakes in a century. The most violent effects are often found in the uninhabited parts of the country which comprise most of the island. Of course, in these cases, there is not much destruction of life or property; this is the reason why comparatively little is heard of the earthquakes of Iceland.

Until the last great series of shocks occurred the earthquakes of Iceland were never studied by a man competent to collect accurate data and to describe them adequately. These earthquakes occurred five years ago in the western, or inhabited, part of the country and a great deal of damage resulted though the loss of life was very small. They continued through August and September, 1896. Later that fall Dr. Theodore Thoroddsen, who has made himself famous as the scientific explorer of Iceland, collected by correspondence much information from persons who lived in the disturbed area. In the summer of 1897 he traveled all through the region affected in order to study all phases of the catastrophe and to collect evidence from many eye-witnesses. He wrote an exhaustive report which was published in the Icelandic language in 1899, making a book of 200 pages. A condensed account of these earthquakes has just been published by Dr. Thoroddsen in German, and the few facts here given are taken from this long report.

terrible one to the poor farmers, herders and fishermen, who comprise nearly all the population of Iceland; but fortunately their heavy material losses were their severest affliction. While many received slight wounds, few were badly injured and only four were killed outright. Nearly all the cattle and sheep were in the meadows, and so only nine cows and twenty sheep were killed. If the earthquake had occurred in winter when the animals were in the stables thousands of them would have perished.

The strongest and most destructive shocks were five in number beginning on August 26, the second on August 27, the third on September 5, the fourth on September 6 and the fifth on September 11. There were also a large number of shocks of less intensity and the movements continued with lessening strength till the end of September, 1897, or more than a year after they began. During the most violent periods the surface of the earth was in continual motion like the waves of the sea, so that neither men nor animals could stand on their feet but were thrown to and fro. These earth waves were plainly visible moving over the alluvial lowlands, but there was no trace of them among the mountains behind them.

Great landslides, however, occurred among the mountains. Skardsfjall, an isolated eminence rising about 700 feet above the plain, had the appearance of shaking itself like a poodle that has just come out of the water; many cracks appeared on its surface, and the thick blanket of earth that had covered its slopes slipped to the foot of the mountain where it lay in great heaps. Near Krokur, a great mass of earth several acres in extent and from six to nine feet in thickness was loosened from the underlying rock and slipped and rolled downward, though the slope was only one to two degrees. In another place a basalt rock, eight feet high and forty feet in circumference, was thrown some distance from its original position. Before each shock noises long drawn out and most alarming were heard in the interior of the earth.

A great many wide crevasses were found. Some of them, six to nine miles in length, filled with water and looked like long, thread like lakes, some of them also had an important influence upon the surface water,

is of pure gold; the ratio of gold to silver is five to one; the gold leaves of the VIth and of the XIIth dynasties contain only 3.2 to 4.5 hundredths of silver, a ratio similar to those of sample L., proceeding from the Horus tomb. This confirms the preceding remarks on the composition of Egyptian gold.

C. *Other objects.*—I will give the results observed on some other objects coming from the same tomb.

VII. *Solid material, reputed perfume.*—This is a fragile resin, of a brownish yellow, compact, with conchoidal fracture. Heated, it behaves like colophony, having a similar odor.

VIII. *Two round whitish bowls,* having the appearance of a petrified material, afterward agglomerated by desiccation. The tomb contained about thirty of them. Diameter, 22 mm.

These bowls were regarded by the persons who found them as perfume. I have ascertained that they do not contain organic matter. They are in reality made up of fragments of pulverized glass, not porphyzied, rich in silica, and associated with a little calcium carbonate, which must have served as cement. The density of the matter is about 2.60. It is difficult to comprehend the motives which have led to the placing of such articles in a tomb.

IX. M. Maspero has added to his parcel a little red metallic lamella, about 60 mm. long, 6 to 7 mm. wide, according to the points, and 0.66 mm. thick and cov-

It is almost pure copper, like the most ancient statuettes of Gondeah and of the palace of the King Our-Nina.

THE STEAM TURBINE.

THE problem of thermodynamic energy conversion, so far as the reciprocating steam engine is concerned, is to-day not much nearer its solution than it was more than a century ago. Ideal in its complex construction and revolutionary in its applications and achievements, the steam engine, originating with Newcomen and perfected by Watt, is, however, very far from perfect as a heat engine, and there is little prospect that future improvements will bring this type of heat motor much closer to the ideal. This assumption is to some degree borne out by the fact that the improvements ever since the days of James Watt have only been mechanical, and even though these improvements naturally have increased its efficiency, the steam engine of to-day in its ingenious and complex perfection, thermodynamically presents little improvement over that of Watt.

The conversion of heat energy by means of the steam engine is accomplished by allowing steam to expand behind the piston, not utilizing its kinetic energy, but subjecting it to a resistance correspond-

been brought out in a state of great perfection and practical application.

The steam turbine in principle is not new, being the first heat motor recorded in the history of steam engineering, as far back as 120 B. C., when Hero of Alexandria, then the center of the civilized world, describes an apparatus for utilizing heat energy. This apparatus, a reaction turbine, consisted of a spherical vessel mounted upon trunnions through which steam was admitted, to finally issue from openings tangential to the sphere. Many centuries later, in 1629, the Italian, Giovanni Branca, brought out the impact turbine, employing a jet of steam to impinge upon the vanes or blades of a wheel. This latter, familiar to us in the hydraulic motors of the Pelton type, exhibits in general principle the characteristic features embodied in the present-day De Laval steam turbine.

Thus we see as early as 1629 the introduction of the reaction and impact turbine, although of imperfect form and not capable of practical application, and all attempts at perfection along these lines have, until a comparatively short time ago, proven unsuccessful; this was probably owing, however, to the interest aroused in the success of Newcomen in 1705, and later by Watt and his followers, in perfecting the reciprocating engine.

The steam turbine is, in the form produced by De

FIG. 1.—THE DE LAVAL TURBINE WHEEL AND NOZZLES.

FIG. 2.—DE LAVAL STEAM TURBINE, 300 H. P.

FIG. 3.—DE LAVAL STEAM TURBINE DYNAMO 300 H. P.

FIG. 4.—15 H. P. STEAM TURBINE PUMP.

ered in places with verdigris. I have found in 100 parts of it: Copper, 87.7; tin, trace; oxidized patina, about 12.3. I do not know to what object it previously belonged.

X. In examining the gold leaves, alloyed with one-fourth of silver, included in B, I found three little rings, perfectly alike and regular, which have occupied my attention. One of them weighed 13.9 mgr. It constituted a regular torus. Its outer diameter was equal to 3.05 mm.; the diameter of the torus was 0.75 mm., and consequently the diameter of the interior circumference, 1.55 mm.

This ring was made of devitrified glass, without tin or any other metal in its interior, but covered with a thin greenish patina, containing a trace of copper.

The existence of such objects raised new questions. In fact, these little rings must have hung on some object of art or of attire, such as a necklace of glass beads, because they have not been connected by soldering, but strung on a linen or metal thread. Their manufacture must have presented some difficulty, because of the thinness of the rings (0.75 mm.) compared with their diameter (3.05 mm.).

I will add to the preceding analysis that of a sample of Chaldean metal sent by M. Henzey. It is from the statuette of King Rim-Sin, of date about 2200 before our era. The filings detached contain: Copper, 92.9; sand, 0.2; oxidized potash, 8.9 (without other metal).

ing with its pressure. The ideal efficiency of this process, and in fact the solution of the problem of thermodynamic conversion, is expressed by the Carnot cycle.

This means that for the highest efficiency obtainable the steam should be expanded from maximum to minimum pressure and temperature, and furthermore this expansion should be adiabatic, which, as is well known in practical operation with the steam engine, is not and never can be accomplished. The reason for this, now so well known, need not here be mentioned.

When the science of steam engineering was thoroughly understood and the defects of and the improbability of further than mechanically improving the steam engine were realized, engineers and inventors, with more or less success, set about devising means for mechanical utilization of heat energy by methods promising a closer approach to the ideal than is possible with the reciprocating steam engine.

The activity along this line of research has been most marked in the past century, and among the devices having any pretense to rivalry with the reciprocating engine has been the rotary steam engine. This type of engine, successful in obviating the defects due to reciprocating motion, has, however, in other respects proven far inferior to the type it has sought to replace; it is especially wasteful of steam, and cannot, therefore, be seriously considered.

The steam turbine, as proposed by De Laval, has

Laval, characterized by the great simplicity of its construction and the directness of its energy conversion, producing adiabatic and complete expansion, ideal conditions which can never be attained with the steam engine. That the steam turbine, which now more than rivals the steam engine, should have been known at such an early date and yet should have been so long delayed in its perfection in a practical form, may seem astonishing. This is, however, not remarkable, for even if the high efficiency of the steam turbine had been known to Hero, Branca, and others of early times, a practical steam turbine could not well have been produced for want of materials and tools of such refinement and quality as we to-day know are as essential to the construction of a successful steam turbine as are the principles involved. The steam engine, less exacting in this respect, has been the natural forerunner, producing the favorable conditions that have enabled us to weld another link to the chain of evolution in heat engines.

In 1883 De Laval made the first successful steam turbine, using it in direct connection with the shaft of the well-known cream separator manufactured in this country by the De Laval Separator Company. This, his first steam turbine, a reaction wheel, was, however, soon replaced by one of the Branca type, and of the results attained Prof. Thurston says: "The result was an astonishing efficiency in many cases of good design; and the Branca form, particularly, ex-