

which the exciting current of any of the dynamos can be most effectively regulated; it is in constant use for the considerable variations of voltage necessary during the progress of some of the furnace operations. We now come to the actual furnace equipment and the different types of apparatus which are best adapted for laboratory work. Foremost among these must be placed the Moissan furnace.* A dimensioned drawing of this type for a power of about 40 kilowatts is given in Fig. 6. Taking into consideration the many discoveries made by Moissan in the course of his investigations, it is surprising that as yet only a very small percentage have found commercial application. The reason of this may, perhaps, be ascribed to the fact that this form of furnace, though proving itself eminently suitable for the pioneering work for which it was intended, scarcely gives any data on which a technical process could be founded. It is, in fact, a striking example of how the apparatus most suited for purely scientific work is seldom capable of direct commercial application. It was not until the work was taken up by the practical engineer that the scientific discovery developed into a commercial industry. We shall see below that most frequently the financial success of a process has been in direct proportion to the mechanical improvements introduced, the chemical modifications being generally of secondary importance. It is therefore necessary to be able to provide a type of furnace corresponding in principle to the most usual technical forms, and thus carry out the experiments, if not on the same scale, at least in the same manner as would be done in the factory. Fig. 7 is a plan of an apparatus similar to that used by Haber,† which we have found extremely useful for representing many different forms of furnace. Connected as shown in Fig. 9A, it has proved itself most satisfactory for the manufacture of aluminium by the electrolysis of cryolite containing Al_2O_3 ; replacing the carbon block C shown in this figure by a small furnace built of loose bricks, a good example of a carbide "pot" furnace giving a most satisfactory yield of calcium carbide can be obtained. Frequently in the electrolysis of fused salts it is an absolute necessity to make the crucible lining of the material itself. This result is obtained (as shown by Muthmann, Hofer, and Weiss),‡ by the use of a water-cooled crucible. The arrangement is shown in Fig. 9B. While the vertical holder enables us to represent a large number of different types of furnace those of the Acheson Carborundum type can be very simply built up by the use of ordinary materials. Fig. 10 shows a carborundum furnace as used with 40 horse power.

The next figure (Fig. 11) is a drawing of a furnace suitable for making calcium carbide or for other furnace operations. The design is inexpensive, and the apparatus most serviceable.

Such experimental equipment will be of importance not only from an educational point of view, but it is by no means impossible that certain of the difficulties in technical processes may be overcome by its use. It is important, however, not to neglect the purely scientific work, which, though it may possibly not find any direct application in the immediate future, has, however, frequently proved to be the starting-point of notable advances. In this direction the work in progress consists in the determination of the effect of gaseous pressures on high temperature chemical phenomena; it is proposed to study carefully some of the gaseous and other reactions which may be expected to differ considerably from those occurring under ordinary conditions. The apparatus shown in Fig. 12 is destined for work up to 200 atmospheres, and for currents up to 1,000 amperes, and has been provided out of funds received from the Government Grant Committee of the Royal Society.

(To be continued.)

VENOMOUS SERPENTS.—V.

By RANDOLPH I. GEARE.

SNAKE VENOM.

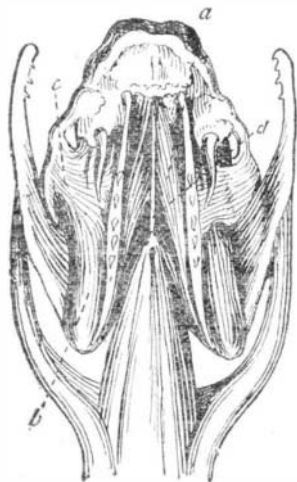
A VENOMOUS snake is one which is provided with a specific poison and an apparatus especially adapted for introducing this poison into a wound. The mere fact that a snake-bite produces symptoms similar to those of poisoning is not sufficient to characterize the snake as "venomous." In general, the poisonous snakes of this or any country may be described as being possessed of a movable or constantly erect poison-fang at the anterior end of the upper jaw bones.

The real character of the venom has been a subject of some study and much speculation. In early days when organic chemistry was hardly developed as a science, there was much guess-work in this matter, which resulted principally in the concoction of numerous antidotes, most of which were then supposed to be infallible. To Prince Lucien Bonaparte belongs the honor of having made, in 1843, the first chemical analysis of viper poison, with the result that he declared it to be albuminoid or proteid in its nature, somewhat like the white of an egg. Early in the "sixties" Dr. S. Weir Mitchell, of Philadelphia, analyzed the poison of the rattlesnake, and corroborated the conclusions of Bonaparte as to the albuminoid nature of snake venom. Later, in 1881, Dr. Armand Gautier asserted positively that he had extracted from the venom of a cobra a small quantity of matter belonging to the organic alkalies, although he did not regard this as constituting the most dangerous part of the venom, which, he stated, was of a nitrogenous nature. The alkalies seemed chiefly to stupefy, but were not found to be necessarily fatal. The toxic constituent of the venom has been now proven beyond all doubt to be an albuminoid, as declared by Bonaparte. Later, in 1883, Dr. Mitchell announced that this albuminoid body (which in the venom of the rattlesnake he named "crotaline," and in that of the viper Bonaparte had named "echidine" or "viperine") is complex. An important point in this discovery is that the venom of both the rattlesnake and the cobra consists of several proteids, two of which preponderate, although present

in each in a varying degree. These, according to Mitchell, are "globulin" and a peptone; although Wolfenden, an English physiologist, asserted that a peptone could not be present, referring this constituent to the albumoses, and in his analysis of the viper poison naming it *albumose* or *syntonin*, which is practically the same as Mitchell's peptone.

Another important point is that these two constituents are present in different proportions in the various poisons, the globulin occurring mostly in the Crotalids, but only in a very small degree in the cobra. And, as Dr. Stejneger points out in his "Poisonous Snakes of North America," this difference in the composition of the venoms corresponds to a marked degree with the difference in the symptoms accompanying poisoning by the Crotalids and the Vipers on the one hand, and by the Cobras and Elapids on the other hand.

Still later studies of the chemical nature of venom were made, as already mentioned, by Dr. C. J. Martin and Mr. J. McGarvie Smith, of Sydney, Australia. In this case the poison investigated was that of the Australian black snake, *Pseustes porphyriacus*. Their con-



MUSCLES OF POISON APPARATUS OF RATTLE-SNAKE, PALATAL VIEW.

a, Spheno-ptyergoid muscle; b, external pterygoid muscle; c, fascial sheath of this muscle attached to the capsule of the gland; d, median ridge of base of skull. After Stejneger's "Poisonous Snakes of North America."

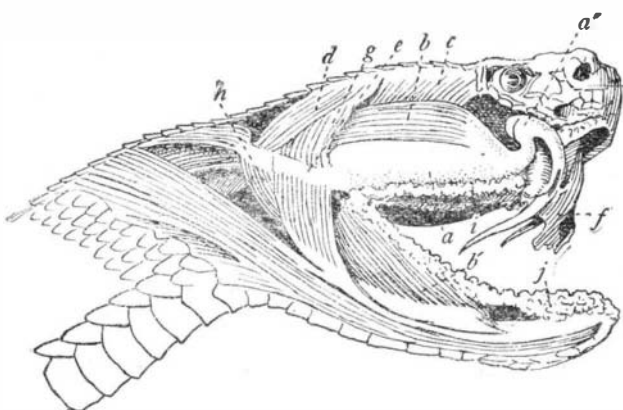
clusions agreed in the main with those of Mitchell, Reichert and others.

The results of snake poisoning depend upon whether the predominating poison is elapine or viperine in its character. In the former the effect acts directly on the nervous system, while in the latter the result is principally local. Since elapine poison is always mixed more or less with viperine poison, there are also systemic effects when the poisoning is of the viperine kind, which of course is most dangerous in case of the intravenous injection.

In closing this part of the subject, it seems proper to state that the facts presented, as in the other divisions of this article, are gathered from the published writings of recognized authorities on this subject, and space of course puts a limit to the extent to which they can be discussed.

THE POISON-FANGS.

In the Coral Snakes, or Elapids, some of the species are so gentle that they use their fangs as an offensive weapon only in cases of extreme irritation. Indeed Prince Max von Wied, speaking of the Brazilian Coral Snakes (*Elaps corallinus* and *Elaps marcovii*) states that he used to carry specimens about his person, and that they never even attempted to bite. Even the *Elaps fulvus*, or Harlequin Snake, of our country is defended by no less an authority than Prof. Holbrook, who, in his work relating to North American herpetology, states that the individuals he had seen were of a very mild character, and could not be induced to bite under any provocation whatever. Indeed, although possessed of poisonous fangs, he affirms that they are universally regarded as innocent snakes, and are constantly handled with impunity, never to his knowledge having injured



POISON APPARATUS OF RATTLESNAKE; VENOM GLAND AND MUSCLES.

Lateral view. a, Venom gland; a', venom duct; b, anterior temporal muscle; b', mandibular portion of same; c, posterior temporal muscle; d, digastric muscle; e, posterior ligament of gland; f, sheath of fang; g, middle temporal muscle; h, external pterygoid muscle; i, maxillary salivary gland; j, mandibular salivary gland. Reproduced from Stejneger's "Poisonous Snakes of North America."

anyone. In another place, however, Holbrook calls their fangs "instruments of destruction," and describes them as hollow and fastened, one on each side of the upper jaw, to the anterior end of the maxillary bone. In this position they may certainly become a very dangerous weapon, and Dr. Stejneger demonstrates that "the little beauty is fully capable of using it when required."

With reference to the fangs of the Coral Snakes, the same authority remarks: "The *Elaps* is provided with

permanently erect, perforated fangs; that is, there is found at the front end of each upper jawbone one solitary curved tooth, which has a channel running through its center and a groove on its anterior surface, and which is not followed by any other teeth on the upper jawbone, while the other snakes with which it can be confounded, have no such perforated fang, but, instead, a series of smaller solid teeth on the entire length of the bone in question!"

The rattlesnake has long, curved fangs in the anterior portion in the upper jaw. They are similar to those in the Elapids, but much larger, and differ from these others by being folded up toward the palate, "somewhat," as Dr. Stejneger says, "like the blades of a jack-knife when not in use." This does not mean that the fangs themselves are movable; for, on the contrary, they are solidly fixed in their sockets; but, whereas in the Elapids the maxillary bones, into which the fangs are fastened, are elongated and horizontal (just as in the harmless snakes), in the Crotalids they are extremely shortened, and higher than they are long.

In the Elapids the fangs are inserted nearly at right angles, whereas in the Crotalids, as already remarked, they more nearly represent the blades of a knife, the jawbone representing the handle, and it is the jawbone which is movable vertically, and not the fang alone. The above cut shows well the poison apparatus of the rattlesnake, as well as the venom gland and the muscles, while the next cut—a palatal view—shows more satisfactorily the muscles which elevate and depress the fangs.

"The whole poison apparatus," writes Dr. Stejneger in another place, "has very appropriately been compared to a hypodermic bulb syringe; the needle, with its obliquely cut point and slit-like outlet, representing the fangs, the bulb corresponding to the poison glands, and the muscles of the hand which presses the bulb, performing the same task as the anterior temporal muscle of the snake."

TREATMENT FOR SNAKE-BITES.

Numerous indeed are the methods of treatment which have been suggested for snake poisoning and in many cases the discoverer doubtless believed his own remedy to be the all-and-only powerful one. It must be remembered, however, that the majority of them were given to the world before analysis had shown what snake venom consisted of. They must therefore have been largely guess work. But when Bonaparte, Mitchell, Fayver, Lauder Brunton, Wall, Vincent Richards, Calmette, and others had concluded their experiments, then and only then could remedies formulated on a scientific basis be furnished.

From Dr. Mitchell we learn that by mixing any venom with a strong enough solution of potassa or soda, its power to kill is destroyed. And so also by the use of a solution of iodine, perchloride of iron, or bromohydric acid, but in lesser degree. He regards permanganate of potash, however, as the best solution, and remarks that if this agent be injected as soon as possible through a hollow needle, wherever it touches venom, it destroys it. "If at once we can cut off the circulation by a ligature," he writes, "and thus delay absorption, and then use permanganate freely, we certainly lessen the chances of death."

The first effect of the venom seems to be to lessen suddenly the pressure under which the blood is kept while in the vessels, and at that stage any alcoholic stimulant would be useful, although it can hardly be doubted that many a man has been killed by too powerful a stimulant at such a time, and Dr. Mitchell affirms that men dead drunk with whisky and then bitten, have died of the bite.

Dr. A. Calmette, of Paris, found by experiments some years ago that the hypochlorites of sodium and lime would neutralize the venom by chemical action. Chloride of gold was found to be of equal value, but ordinary chloride of lime gave perhaps the best results of all. He expressed himself as certain that, in the absence of any other treatment, this last-mentioned substance would prove an adequate remedy for rattlesnake bites, and this is probably the worst form of snake poisoning that we in North America are likely to encounter.

A discussion of the remedies for snake-bites would be incomplete without a reference to Dr. Calmette's anti-toxin treatment. In this the serum is obtained much in the same manner as the anti-diphtheritic serum, i. e., by inoculating horses with cobra poison. It can be procured from the Pasteur Institute at Lille, France, and is said to have both preventive and therapeutic effects.

Dr. Stejneger, who has made an exhaustive study of the subject, says: "In very acute cases, in which the venom has been injected directly into the circulation, no matter by what kind of a snake, the chances for recovery are very slight indeed. The only chance in such cases seems to be to stimulate the nervous centers as speedily as possible, the best-known means to this end being injection of large doses of strychnine, if necessary, intravenously, until tetanic effects are obtained and the patient roused from the coma which has probably seized him. This result obtained, other systematic or local remedies, as the case may require, can then be applied."

Dr. Stejneger is of the opinion that, as a rule, amputation or cauterization should be resorted to only in very extreme cases, where the victim is absolutely isolated and far removed from any opportunity to seek proper treatment. "After all," he adds, "the main thing really to be done is to assist Nature in her effort to get rid of the poison, by keeping the sufferer alive until by natural processes it has passed out of his system."

The extent of this article could of course be prolonged indefinitely by presenting *in extenso* the results of the numerous experiments that have been made, but space forbids, and the reader who desires to acquaint himself more fully as to remedies for snake bites can readily do so, as the literature is quite voluminous.

I can perhaps not do better in conclusion than to quote the remarks of Dr. Mitchell in reply to queries as to what he would do if he were bitten by a poisonous snake while far away from help. He says: "If the wound be at the tip of a finger, I should like to get rid of the part by some such prompt auto-surgical

* Moissan, Le Four Electrique, Paris, 1897.

† Haber, Zeitschr. für Elektrochemie, vol. 8, pp. 1, 26, 607 (1902).

‡ Leibig's Annalen, vol. 320, pp. 231-269 (1902).

§ This is the last installment of a series of articles begun in the SCIENTIFIC AMERICAN, February 14, 1903.

means as a knife or a possible hot iron affords. Failing these, or while seeking help, it is wise to quarantine the poison by two ligatures drawn tight enough to stop all circulation. The heart weakness is made worse by emotion, and at this time a man may need stimulus to enable him to walk home. As soon as possible, some one should thoroughly infiltrate the seat of the bite with permanganate or other of the agents above mentioned. By working and kneading the tissues the venom and the antidote may be made to come into contact, and the former be so far destroyed. At this time it becomes needful to relax the ligatures to escape gangrene. This relaxation of course lets some venom into the blood-round, but in a few moments it is possible again to tighten the ligatures, and again to inject the local antidote. If the dose of venom be large and the distance from help great, except the knife or cautery little is to be done that is of value. But it is well to bear in mind that in this country a bite in the extremities rarely causes death. I have known of nine dogs having been bitten by as many snakes, and of these dogs but two died. In India there would have been probably nine dead dogs."

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Import of Tropical Fruit.—The greater part of central Europe gets its supplies of tropical fruit by way of Hamburg. In the south the chief competitor is Trieste, the leading market on the Mediterranean. In the west the Spanish fruit is brought to the Paris market by rail. To supply the country along the Rhine there is considerable rivalry between Hamburg on the one hand and Rotterdam, Amsterdam, and Antwerp on the other. The fruit trade with Norway, Sweden, and Denmark is shared by Hamburg with the English dealers, but the German city controls the Russian markets by way of the Baltic. Altogether, Hamburg imported during 1901 about 47,000 tons of oranges and 10,000 tons of lemons, not to mention other kinds of fruit. During the same period only 879 tons of oranges and 120 tons of lemons were landed at Bremen.

As Bremen can offer the same advantages for handling the fruit business as Hamburg can, a movement was set on foot here about a year ago with a view of making an effort to get a large share of this trade. The Bremen senate made an appropriation for the purpose of constructing a storage house in the free port, which is provided with excellent heating and ventilating apparatus. In addition, the senate abolished the usual official fee on all auctions of fruit, and materially reduced the water-way or river tax on all vessels engaged in this traffic.

The fruits imported are mainly oranges, lemons, apples, grapes, bananas, and pineapples; vegetables, such as potatoes, onions, and tomatoes, are also brought in. The imports come from Sicily and Spain, with which countries Bremen has excellent and regular steamer connections.

The first shipments of southern fruits began to arrive last November, and many tons have been imported during the last months. They are sold at auction, and thus far the sales have been very successful, all the fruit having been rapidly disposed of at satisfactory prices. The fruit packer in Italy and Spain buys oranges while the crop is still on the trees, has them picked, sorted in the storehouses according to size and quality, packed, and consigned to a broker in some fruit market. Upon arrival at their destination, the goods are taken to the storage house, where the consignee divides the entire shipment into lots of 20 and 30 cases, one of which is opened for inspection and sampling. As soon as convenient, the fruit is sold at auction to the highest bidder and the proceeds are credited to the shipper, after deducting expenses for freight and selling. In most cases the buyers are permitted to leave the lots purchased in storage for a limited time, free of charge, in order to resell or repack for further transportation.

Though this promising fruit market is not so readily accessible to fruit growers on the western continent as it is to their competitors in Europe, American dealers would do well to carefully examine the new arrangements at Bremen and the opportunities they offer. About 4,000 barrels of American apples were sold at the four auctions recently held here, which, of course, is but a small beginning. However, I see no reason why, in the course of time, American fruit of all kinds should not be unloaded at this new storage house at Bremen and disposed of at profitable prices. The Germans are not great fruit eaters, when compared with other nations. While in England the annual consumption of southern fruit amounts to 15 pounds per head, it averages not quite 3 pounds per head in Germany; but this simply shows that there is great room for improvement, and it is not unreasonable to hope for a steady increase of the demand for fruit in this market.—Henry W. Diederich, Consul at Bremen.

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TABLE OF CONTENTS.

	PAGE
I. AERONAUTICS.—The Langley Aerodrome.—Letter from L. Hargrave.....	22737
II. BOTANY.—How some Important Results in Plant Breeding Are Accomplished.—By WILLET M. HAYS.—6 illustrations.....	22740
III. CHEMISTRY.—Crystallized Peroxide of Hydrogen.—By WILLIAM STABEL.....	22739
The Radio-activity of Uranium.—By FREDERICK SODDY.....	22739
IV. COMMERCE.—The New Department of Commerce.....	22738
Trade Suggestions from United States Consuls.....	22746
V. ELECTRICITY.—Contemporary Electrical Science.....	22745
High Temperature Electro-chemistry: Notes on Experimental and Technical Electric Furnaces.—By R. S. HUTTON.—4 illustrations.....	22746
VI. HYDRAULIC ENGINEERING.—Improved Filtering and Sterilizing System.—3 illustrations.....	22736
VII. MEDICINE.—The Scientific Aspect of Modern Medicine.—By FREDERIC S. LEE.....	22741
VIII. MISCELLANEOUS.—The Apparent Change of Position of the Ball's Eye on a Target During the Day.—By DR. FRIEDRICH W. F. RIEHL.—8 illustrations.....	22738
Trying to Stop the Work of the Tereido.....	22737
IX. NATURAL SCIENCE.—Venomous Serpents.—V.—By RAN-DOLOPH I. GEARE.—2 illustrations.....	22747
X. NAVAL WARFARE.—The Naval War Game Between the United States and Germany.—XI.—By FRED T. JANE.—4 illustrations.....	22744
XI. TECHNOLOGY.—Crushed Steel and Steel Emery.—By M. M. KANN.....	22735
The French Beet Sugar Industry.—7 illustrations.....	22734

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