

rattlesnake and two other species or classes. Rattlesnake serum is prepared in Philadelphia. At the Pasteur Institute of Lille, which supplies all the French colonies, Calmette produces a polyvalent serum from mixed venoms of *Colubridae* and *Viperidae*. The former are obtained in abundance from French Indo-China, but there is often a shortage in viper venom. Hence Calmette's serum is especially anti-neurotoxic, while its anti-hemorrhagic power varies greatly, according to the quantity of viper venom which the inoculated horses have received.

The serum is prepared by the following method: A horse is first injected with a mixture of venom and hypochlorite of lime. The injection is repeated every three or four days, the proportion of hypochlorite being gradually diminished to zero, and the operation being interrupted if the animal loses flesh. After this treatment has been continued about 16 months, the horse can withstand the hypodermic injection of 2 grammes (30 grains troy) of dry cobra venom, which is about 80 times the normally mortal dose, and is in condition to furnish an efficacious serum. The animal is then bled, 8 liters of blood being drawn 12 days after the last injection of

venom, 6 liters after an interval of 5 days, and 6 liters after a second equal interval. These 20 liters of blood yield a little more than 10 liters of serum, which is decanted into bottles, which are sealed and sterilized. The serum retains its activity for several years, but more certain preservation for a much longer period can be assured by desiccating the serum and sealing it in glass capsules, each containing one gramme (15.4 grains troy) of the dried serum, which when required for use, is dissolved in 10 cubic centimeters (one third fluid ounce) of water that has been boiled and cooled.

If the patient is treated promptly, before toxic symptoms have appeared, a hypodermic injection of 10 to 20 cubic centimeters (one third to two thirds fluid ounce) of serum usually suffices to prevent poisoning in an adult. While awaiting the injection it is advantageous to ligature the limb, immediately above the bite, and to cauterize the wound with a red hot iron or a solution of potassium permanganate or hypochlorite of lime. If the bite has been inflicted by a large or very venomous serpent, 30 cubic centimeters (1 fluid ounce) of serum should be injected at once. The quantity of serum required varies directly with the time lost and the gravity of the symp-

toms, and inversely with the size of the patient. More is needed for a child than for an adult.

If the case is far advanced and the patient is in a critical state, there should be no hesitation about injecting 30 cubic centimeters into the veins, and repeating the dose if necessary. If the respiratory centers have already been affected, it is advisable to practise artificial respiration, in order to prolong the stage during which the organism can resist the venom until the serum can produce its effect. No matter how desperate the case may appear, there should never be any hesitancy about employing the serum, which has effected cures absolutely unhopd for.

Wherever the serum treatment is employed, the mortality among treated cases has become almost zero. In Sao Paulo, Brazil, of 275 cases treated with appropriate serums only one resulted fatally, and in this case the patient was at the point of death when the serum was applied. In India and some other countries, unfortunately, the natives rebel against the new treatment, and many deaths are still caused by venomous serpents. —Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from *La Nature*.

The Industrial Synthesis of Sodium Cyanide*

Probable That the Supply Will Exceed the Demand Through a New Development

By Charles Gravier

Of the three industrial forms of combined nitrogen—cyanides, ammonia and nitric acid—the cyanides occupy the lowest place in industrial statistics. While Chile annually produces 2,500,000 tons of sodium nitrate, and 1,000,000 tons of ammonium sulphate are furnished by gas works and coke ovens, the annual production of cyanides does not exceed 25,000 tons. The employment of cyanides has greatly increased since the introduction of the MacArthur and Forrest process in the metallurgy of gold, in 1888. Before that date, the annual production of potassium cyanide, the only cyanide then utilized, did not exceed 100 tons.

Four hundred and fifty tons were produced in 1888, 750 tons in 1890, 3,500 tons in 1895, and for several years there was a steady annual increment of about 1,000 tons, consisting partly of sodium cyanide, which had been introduced meanwhile. Almost the entire output of alkaline cyanides is used in the refining of gold, only a very small proportion being consumed in electroplating with gold and silver. But, though the cyanides occupy a comparatively small place in the great industry of nitrogen compounds, nitrogen in the form of cyanogen commands a higher market price than nitrogen in the form of ammonia or nitric acid, which are worth not more than 1.5 francs per kilogramme (13.2 cents per pound) of nitrogen, while the cyanides cost at least 6 francs per kilogramme (52.8 cents per pound) of nitrogen. In these conditions, it would be profitable to convert nitric acid or ammonia into cyanides. The transformation can be effected by various reactions, none of which has been utilized for converting sodium nitrate into sodium cyanide, though cyanides are actually made from ammonia. The inverse transformation is still easier to accomplish, as cyanides evolve ammonia when they are heated in a current of water vapor. Hydrogen cyanide, in presence of water, tends to decompose into ammonia and formic acid, while its salts, in similar conditions, yield ammonia and formates. At red heat, however, the formates split up into carbonates, carbon monoxide

and hydrogen, so that the final result is given by the equation:



Many chemists are now endeavoring to effect the industrial synthesis of ammonia by way of the cyanides. To me this method appears illogical, because hydrocyanic acid, a compound formed from its elements by an endothermic reaction in which 30.5 calories of heat per gramme-molecule are absorbed, will always be more costly than ammonia, which is formed by an exothermic reaction, evolving 12 calories per gramme-molecule.

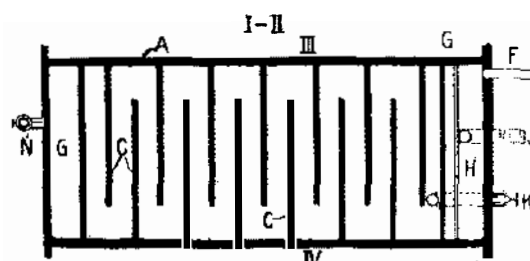


Fig. 2.—Horizontal section of retort for producing sodium amide.

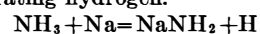
The cheapness with which metallic sodium can be produced by electrolysis of fused soda, has made possible the development of a process by which a large part of the cyanide required by gold refiners is now produced from sodium, ammonia and carbon.

The English firm of Castner, whose name is intimately associated with the history of sodium, first devised these methods of obtaining the metal and its cyanide, but the industrial production of cyanide was made practicable by improvements introduced by the Deutsche Gold- und Silberscheide Anstalt, of Frankfurt.

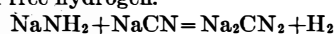
The chemical formula of sodium cyanide, NaCN, in which Na=23 and N=14, shows that nearly 2 kilogrammes of sodium are required in order to convert 1 kilogramme of nitrogen from the ammonia form to the cyanide form, and thus to raise its market value from 1.5 francs to 6 francs. The Castner electrolytic process, using a cheap source of electricity, furnishes the 2 kilogrammes of sodium for 2 francs, leaving a margin of 2.5 francs to cover other expenses and profits.

THE ORIGINAL CASTNER PROCESS FOR THE SYNTHESIS OF CYANIDES.

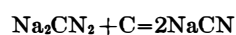
1. *Theory of the Process.*—It is well known that metallic sodium, at a temperature of about 400 deg. Cent. (752 deg. Fahr.) absorbs ammonia gas, forming an amide and liberating hydrogen.



One molecule of this amide and one molecule of sodium cyanide, fused together, combine at 550 to 600 deg. Cent. (1,022 to 1,112 deg. Fahr.), yielding 1 molecule of sodium cyanide and free hydrogen.

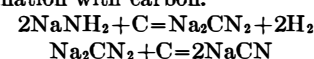


Finally, this molecule of cyanamide, mixed intimately with carbon, combines with it at 750 to 800 deg. Cent. (1,382 to 1,472 deg. Fahr.), forming 2 molecules of sodium cyanide.



Thus the molecule of cyanide used in the process is recovered and a second molecule is gained.

By a modified process, in which the employment of cyanide as a reagent is avoided, the sodium amide is converted first into sodium cyanamide, and then, at 800 deg. Cent. (1,472 deg. Fahr.), into sodium cyanide, by direct combination with carbon.



Castner's first idea was to produce sodium cyanide directly from its elements. As the combination is exothermic, evolving 50 calories per gramme-molecule, there can be no doubt of its possibility. I verified this theoretical deduction before I knew of Castner's researches. I obtained sodium cyanide by passing a current of pure nitrogen over a mixture of charcoal and sodium, but the yield of cyanide was small. Castner had previously, in 1894, made similar experiments. He poured fused sodium slowly on charcoal, heated in a vertical cylinder, to which a current of nitrogen was admitted by a lateral orifice. Sodium cyanide accumulated at the bottom of the cylinder. The quantity produced was greater than was obtained by passing nitrogen over a mixture of charcoal and sodium carbonate, but Castner soon recognized the advantage of substituting ammonia for nitrogen.

The original Castner process for the synthesis of sodium cyanide was conducted in two successive stages, sodium amide being produced in one apparatus at 300 to 400 deg. Cent. (572 to 752 deg. Fahr.) and converted into sodium cyanide in a second apparatus at 700 to 800 deg. Cent. (1,292 to 1,472 deg. Fahr.).

2. *Preparation of Sodium Amide.*—The reaction between ammonia and sodium takes place in a horizontal rectangular retort with a sloping bottom (A, Fig. 1). The upper part of the retort is divided into compartments by vertical partitions C which dip slightly into the liquid sodium M. These partitions, which do not extend entirely across the retort and are attached alternately to its two sides, compel the current of ammonia to pass

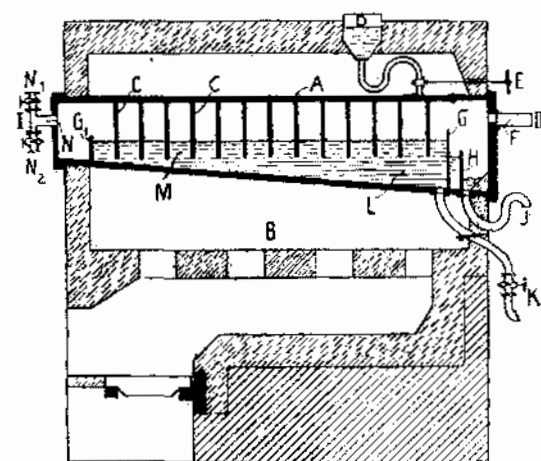


Fig. 1.—Castner apparatus for producing sodium amide.

A, horizontal retort; B, hearth; C, partitions; M, fused sodium; D, sodium inlet; N, ammonia inlet; F, hydrogen outlet; J, siphon; EKN, cocks.

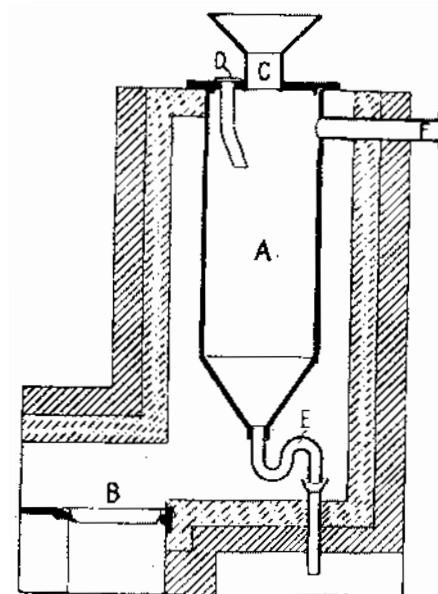


Fig. 3.—Castner apparatus for converting sodium amide into sodium cyanide.

A, retort; B, hearth; C, funnel for introduction of charcoal; D, inlet for fused sodium amide; E, siphon for drawing off sodium cyanide.

through the compartments successively and prolong its contact with the sodium.

The retort is heated to 300 to 400 deg. C. (572 to 752 deg. F.) and a little very dry ammonia is passed through it to expel the air. Fused sodium is then poured into the funnel *D* until it begins to overflow at *G* and escape through the siphon *J*. Ammonia, entering at *N*, is absorbed by the liquid sodium, the pure surface of which is continually renewed, as the sodium amide formed, also liquid, but heavier than the sodium, falls to the bottom of the retort, whence it flows, through a small orifice near the base of the wall *G*, into the chamber *H*, and escapes through the siphon *J*. The ammonia is entirely consumed; the hydrogen evolved escapes at *F*. Sodium has recently acquired considerable importance from its employment in the synthesis of indigo.

3. *Conversion of Sodium Amide into Sodium Cyanide.*—This transformation is accomplished in a cylindrical retort with a conical bottom (*A*, Fig. 3). The retort is filled with wood charcoal through the funnel *C*, and is heated to about 800 deg. C. (1,472 deg. F.). A stream of fused sodium is then admitted at *D*. The liberated hydrogen escapes at *F* and the liquid sodium cyanide flows through the siphon *E* into molds, in which it solidifies.

THE CASTNER-ROESSLER PROCESS.

Roessler, of the Deutsche Gold- und Silberscheide Anstalt of Frankfurt, recognized the possibility of greatly increasing the efficiency of the second of the above-described operations, which comprises two successive reactions. At the temperature required for the formation of sodium cyanide, the sodium amide begins to decompose, disengaging nitrogen and proportionally diminishing the yield of cyanide. On the other hand, the sodium cyanide produced is accompanied by sodium cyanamide, the proportion of which increases the more the temperature is lowered. If the temperature is too high, therefore, a large part of the sodium amide is destroyed, while if it is too low, sodium cyanamide is produced instead of sodium cyanide.

After many researches Roessler succeeded in converting ammonia almost completely into cyanide by dividing the entire operation into three parts, producing successively sodium amide, sodium cyanamide and sodium cyanide. The first and second phases are conducted at a comparatively low temperature, 300 to 400 deg. C. (572 to 752 deg. F.), at which the amide is stable; the third at a high temperature, 800 deg. C. (1,472 deg. F.), which does not affect the cyanamide. As we have already seen, the amide can be converted into cyanamide either by fusing it with an equivalent quantity of cyanide or by heating it with charcoal to 350 to 400 deg. C. (662 to 752 deg. F.). In practice the fused amide is heated with finely-divided charcoal to 380 deg. C. (716 deg. F.). A violent evolution of hydrogen takes place and the mass gradually loses its fluidity, for the temperature of fusion of sodium cyanamide is 550 deg. C. (1,022 deg. F.). In order to complete the transformation, therefore, it is necessary to raise the temperature gradually to 550 to 600 deg. C. (1,022 to 1,112 deg. F.). In these conditions the theoretical yield of cyanamide is obtained.

The charcoal must be very finely divided in order to supply every molecule of amide with the carbon required for its transformation. It has been proposed to substitute liquid or gaseous hydrocarbons for charcoal. Acetylene is especially suitable for this purpose, but its employment would sensibly increase the cost of the product.

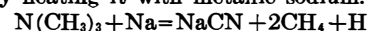
The Frankfurt company and its licensees now conduct the three phases of cyanide synthesis successively in the same apparatus, consisting of a series of large iron crucibles. Each crucible is charged with 70 kilogrammes (144 pounds) of finely-divided wood charcoal and heated to 500 deg. C. (932 deg. F.). Dry ammonia gas is forced slowly through the apparatus to expel the air, then 100 kilogrammes (220 pounds) of sodium are added, the velocity of the ammonia current is increased and the temperature is gradually raised to 600 deg. C. (1,112 deg. F.), in order to complete the transformation of

the amide into cyanamide. Finally, the temperature is raised to 800 deg. C. (1,472 deg. F.) to convert the cyanamide into cyanide, which is drawn off into molds and, after solidification, is ready for the market, without further treatment. The theoretical quantity of cyanide is produced, the loss being only that which is inherent to any industrial operation, but the temperature must be rigorously controlled. The product contains from 90 to 98 per cent of pure sodium cyanide, equivalent to 120 to 130 per cent of potassium cyanide, which is the standard adopted for estimating the value of cyanides.

This improved Castner process is employed in Germany by the Deutsche Gold- und Silberscheide Anstalt of Frankfurt and the Elektrochemische Fabrik Natrium of Rheinfelden, in America by the Niagara Electrochemical Company, and in France by the Société d'Electrochimie.

Germany annually exports about 7,000 tons of cyanides and produces nearly one third of the 25,000 tons which the world annually consumes. England produces almost as much, and large quantities are made in France and the United States.

The Castner-Roessler process, although the newest, is by far the most important process of the cyanide industry, as its quantitative efficiency and the simplicity of its apparatus enable it to produce cyanide at a price that defies competition. The future of the process appears less certain, owing to the development of a new industry, which is obtaining from distillery and sugar refinery wastes a great variety of substances, including trimethylamine, which is subsequently converted into cyanide by heating it with metallic sodium.



An experimental factory established at Nesles, France, already produces 2,000 tons, and is capable of producing 3,000 tons of cyanides annually. When this industry shall have been perfected and numerous factories established in distilling and sugar refining centers, it appears probable that the supply of cyanide will exceed the demand, and its price will be very low.

The Arms of the Venus of Milo

The End of a Mystery

IN "Le Roman d'une statue," M. Jean Aicard, of the French Academy, has given a final and authoritative answer to the enigmas of that wonderful antique which the world at large, following the French spelling, knows as "the Venus of Milo." For now almost a century—92 years, to be exact—scholars and dilettanti have been forming theories as to the exact pose of the missing arms and hands. Some would have it that this particular Venus had carried a lance. One theory, very plausibly based upon certain lines in the "Hecuba" of Euripides, made the subject of this masterpiece not Venus, but Polynena, calmly advancing to the altar on which she is to be sacrificed, with: "Lay no hand upon me, for I am a daughter of kings." Henceforth there need be no more guessing as to those arms, what they meant, or what became of them. M. Aicard tells what they looked like before they were severed from the trunk, how they were severed, and even why the whole story has been left to obscurity and to guessing until now. And, as *Le Temps* remarks in giving its résumé of M. Aicard's monograph, when we know what this classic lady went through in 1820, the wonder is not that she lost her arms, but that she kept a head on her beautiful shoulders.

The trouble began when Iorgos Bottonis, in the early spring of 1820, undertook, with his son Antonios and a nephew, to clear a piece of ground on the Bottonis farm at Castro, in the island of Melos. While they were all three busy, the spade of one of them suddenly sank into a cavity beneath the surface. They at once investigated, and found a sort of vault. Breaking through the masonry of this vault, they found a statue of heroic size, representing a female, nude as to the upper half, but draped from the girdle to the feet, the drapery "held up below the hips by the right hand, while the left arm was raised, partly flexed, the hand holding a sphere not larger than an apple." To the right and left of the statue were two small figures, one the head of a woman, the other the head of an old man with a long beard.

Bottonis knew that every fragment of antique sculpture had a money value. He took measures to hide this precious find. It was the easier of transportation because it was not one block of marble, but three; one block for the upper part, another for the lower part, and a third for the right arm, which was attached to the shoulder by an iron peg. Still, the work was difficult to perform quietly, without letting the neighbors know. In the event, Bottonis, his son and his nephew succeeded in removing the upper half of the statue to their little hut, leaving the lower half, with its pedestal, in the vault.

It was only a few weeks later, on the 20th of April, that the good genius of the Louvre sent the French man-of-war "Chevette" into the harbor of Castro, having first arranged that two of her officers, Lieutenant Matterer and Ensign Dumont d'Urville, should be in-

spired with archaeological enthusiasm. These two officers were on the alert for antique finds, and, naturally, they got into communication with Bottonis, who showed them the lower portion of the statue where it still stood, in the vault, and then the upper portion in his hut. Next day the "Chevette" sailed for Constantinople. This, we must remember, all happened before the Kingdom of Greece had come into existence, and when Melos was still Turkish territory. Arrived at Constantinople, they made haste to inform the French ambassador, the Marquis de Rivière, of their discovery. Bottonis had given them, it seems, an option on the statue, promising not to sell it without their consent, and this option was duly made over to their ambassador.

If these French suitors of the goddess had not relied so implicitly on Bottonis's promise to them, the "Venus of Milo" might have taken her place in the sight of men with her proper complement of arms and an unchipped shoulder. But M. de Marcellus, commissioned by the Marquis de Rivière to go and acquire the statue for his Government, was in no particular hurry. He did not reach Castro, on the schooner "Estafette," until the 23d of May—just in time to see a brig, flying the Ottoman flag, waiting in the roadstead, and a knot of Turkish sailors marching toward the strand. The Turkish sailors were carrying between them something white and heavy on a wooden litter; through a telescope, M. de Marcellus, on the deck of the "Estafette," got his first view of the Venus of Milo; and, for the moment, he feared it would be his last. But Commandant Robert, appraised of the state of affairs, acted promptly, and a cutter loaded with French blue-jackets was soon pulling for the shore. The sequel was a very lively scrimmage between French and Turkish sailors—not between the naval forces of France and the Ottoman Empire, or the incident would have been publicly acknowledged, and we should have known all its details long ago—only an unofficial scrimmage on the beach at Castro. The results of this unofficial action were: first, the Turks dropped Venus and made for their brig; secondly, the litter was smashed beyond any further use; thirdly, the French sailors, surmizing that the Turks would presently return with reinforcements, made all haste to haul the upper half of the statue (which was all that had been on the litter) with ropes over the rocks and loose stones down to where their cutter was beached. It turned out, on inquiry, that the pedestal and lower half had already been taken aboard the Turkish brig, but M. de Marcellus entered into negotiations, and the Turkish captain was induced to surrender his half of the prize. After all, why should a good Moslem fight, and perhaps forego substantial *bakshish*, for the sake of a fragmentary heathen abomination?

The French sailors were careful to pick up all the pieces that were knocked off in the course of their hauling or of the rough-and-tumble unofficial action which preceded it. That is, they picked up all they could find and

brought them aboard the "Estafette" carefully wrapped up in canvas. These scattered members included the chip from the shoulder and much of the two arms; and so most of the Venus of Milo was conveyed to Paris via Marseilles. When this new wonder appeared in the antique gallery of the Louvre, people naturally asked questions about the missing arms and the great chip on her shoulder, perhaps the fractures showed fresh and white by contrast with the other creamy, time-stained surfaces; perhaps the authorities were canny enough to use a little wash of coffee. But at all costs the French Government had to discourage inquisitiveness in this direction; it would never have done—it would have raised a diplomatic scandal—to tell the international world about that unofficial scrimmage on the beach at Castro.

Now so far as this, M. Aicard has told us, though in a circumstantial and more logical way, little more than what many artists and archaeologists have long vaguely understood, in spite of all theories to the contrary, that the two arms were broken in a fight when the French sailors were taking Venus away from her home of twenty centuries (the common story said that the fight was with the natives), and that one hand had held an apple. But the real importance of "Le Roman d'une statue" is in its authoritative character, derived, first from the hitherto unpublished memoranda of Lieutenant Matterer and Ensign Dumont d'Urville and, next, from the testimony of the late M. Jules Ferry. For reasons probably connected with the recent turn of affairs in the Balkan Peninsula, as well as with the lapse of time, M. Aicard believes that no harm can now come of laying the whole story before the world and depositing the manuscripts of Matterer and Dumont d'Urville in the archives of the Institute of France, for reference. As for the corroborative statement of Jules Ferry, it relates how, when he occupied the post of French ambassador at Athens, in 1872, he personally visited Castro and there found Antonios, the son, and the nephew of Iorgos Bottonis. These two remembered and were willing to substantiate the story of the discovery and the particulars about the appearance of the statue as it was when they found it. There can be no longer any doubt as to the original position of those much talked-of arms, or as to the much debated apple. The only subject now left open to conjecture is the fate of the two heads—the woman's and the bearded old man's.

A Remarkable Achievement in Slow Flying.—After the close of the Paris exposition the Paul Schmidt biplane was tested at Chartres before an Italian military commission. The minimum speed realized was actually 24½ miles an hour, and the ease of landing at that speed was remarkable. It was the world's record for slow flying.