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THE LIVING JERBOA IN THE ZOOLOGICAL GARDEN OF BERLIN.

Like other strangely formed quadrupeds, the jerboas are counted among the curiosities of the animal kingdom, and as such are described in natural history; but, nevertheless, there has never been a good exhibition of them, for the simple reason that live jerboas are seldom seen in Europe, as they usually die during the journey hither or soon after their arrival. After some hesitation I decided to purchase a pair that I happened to find mentioned in the price list of Mr. C. Reiche, of Alfeld, as one of the most interesting specimens obtained during his expedition to South Africa the year before; but I, also, found the sensitiveness and delicacy of the jerboa very trying, for the short journey from Alfeld to this city caused the death of the female and reduced her mate to such a condition that when it arrived there seemed little hope that it could ever be utilized for scientific research or artistic life studies.

[Illustration: *Jerboa in the zoological garden of Berlin*.—*Drawn from life by* G. MUTZEL.]

My anticipation and pleasure were changed to vexation and grief. The most careful nursing—the stiff, weak little legs were dipped into and rubbed with French brandy—and a warm pen with a dry sanded floor directly over a heater, did their work. As the new-comer got on his feet again my hope gained new life, and now our jerboa is my delight. It is, indeed, a curious animal. One who saw it only in the day time asleep would scarcely know what he had before him, for he would see little more than a mass of soft, bright sandy hair. The coming of the keeper with the dish of food and the unfastening of the door of the cage bring life to the ball of hair in the corner; a part of it is unrolled and the long, black-tipped tail with two lines of hair is laid out on the ground, and then on each side of it a leg is run out which is nearly as long as the tail and is provided with blunt, smooth, hoof-life nails; and, finally, the head and body are distinguishable and the animal stretches out comfortably on its back in the sand. The fine-skinned, hairless ears still hang limp, the eyes are half closed and the short fore legs are crossed under the chin.

But now the animal gets on its legs by an elastic swing, and its ears are raised and its eyes wide open, so that we can see that the latter are large and dark, with long eyelashes. Then the jerboa raises himself to his full height and playfully measures his cage by one bound from corner to corner. Soon after, the fresh food receives due attention, the animal either jumping toward it in rabbit fashion or crawling slowly on all fours. When it has reached its goal it again assumes the upright position, in which it is evidently most comfortable, and begins to eat it in his own peculiar way; that is, sitting on his hind

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legs he quickly seizes a piece of bread, turnip or other food in his fore paws and conveys it to his mouth, apparently indifferent to the nature of the food before him. He never takes anything directly in his mouth; even the grass on a piece of turf that I had given to him as an experiment was not eaten as it would have been eaten by other animals, but was first plucked with the fore paws. If we notice the position of the mouth, far back on the under side of the head, we will understand that the jerboa could not take his food in any other way. Besides this, nothing of special interest has been observed in this nocturnal creature, but he, of course, lives more regularly and quietly than if his mate had lived.

One who knows anything about the structure of animals' bodies need not be told that the jerboa is a rodent. One glance at the peculiar shape of his head would assure him of that. The form of the rest of its body, especially its long hind and short fore legs, give unmistakable proof that it is related to the jumping rodents; it belongs, in a wide sense, to the family of the jumping mouse, the scientific name (Dipodidea, two-footed) of which is very significant, as the very short fore legs are usually carried close under the chin and are scarcely noticeable when the animal is in its normal position, and are of little use when it moves about. The hind legs are very strong, and when going at full speed the jerboa takes jumps that measure from eight to ten yards, according to the unanimous testimony of various witnesses.

The jumping mouse of North America, which is somewhat larger than an ordinary mouse, is, according to Brehm, also as swift as an arrow or a low-flying bird. This exceptional velocity is not all that reminds us of a bird, for there is also a strong resemblance in the formation of certain parts of the bodies of the two creatures; but, after consideration, this should not seem strange, because in animal organisms similar means are employed to accomplish similar ends. It is only natural that there should be peculiarities in the construction of the limbs and skulls of the Dipodidea with their bird-like movements and bird-like sharp-sightedness, that are usually found only among birds. The consistency between the construction of their bodies and their mode of life is a beautiful example of fitness; only by extraordinary quickness of movement and sagacity could the little defenseless plant-eaters maintain the struggle for existence in the barren steppes and deserts. The formation of the bodies of the different members of the family varies according to their needs. The jerboa is the largest member of the family. Very little is known of his life when free; it being known only that the jerboas are widely spread over the whole of southern Africa, and are nocturnal burrowers of the steppes. During the rainy season they remain in a sort of winter sleep.—*Dr. L. Heck, in the Illustrirte Zeitung*.

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NEW OBSERVATIONS ON THE LANGUAGE OF ANIMALS.

By M. *De Lacaze* DUTHIERS, of the Institute of France.

I had occasion in a note published several years ago in the *Revue Scientifique* to mention a parroquet which I have since continued to observe, the manifestations of whose intelligence are both interesting and instructive. Many acts of birds are difficult of interpretation. To speak only of their songs, the meanings of most of the innumerable varieties of sounds which they produce, and of their diverse warblings, escape us completely. It is not possible to find the meaning of these things except by forming suppositions and hypotheses, or by catching the connections between cries and acts. But instances of the latter kind are extremely rare in comparison with the great majority of the manifestations made by animals.

Thus, to select examples which every one can observe, when a canary bird is warbling in its cage and becomes deafening, or when a lark rises straight up in the air and *incantat suum tirile tirile*—sings its *tirile tirile*—as Linnaeus picturesquely expresses it; when a tomtit, leaping from branch to branch of a willow or among the reeds, repeats its florid warblings; when a raven croaks; when a blackbird whistles—what significance can we attach to their songs and their cries? Certainty is impossible, and we can only form more or less plausible hypotheses concerning the interpretation of them.

The parrot furnishes us one more aid in this matter than other birds, and this helps us, to a certain extent, in overcoming the difficulty of interpretation. It has an articulate voice, and when we have taught it a few words, the meaning which it gives them may be better divined by us according to the tone and the rapidity or slowness of its utterance. This permits us to discover the feelings that move it, for we can better judge from an articulate sound than from one that is merely musical.

Much has been written on the language of animals. It is neither my desire nor my intention to repeat here all that may have been said on this subject. It would take too long and would be of no use. I have often witnessed facts that may be of interest to those who are occupied with the mental manifestations of animals. I will simply relate them; and of such as are already known, I will merely mention them anew, admitting in advance a priority for others which I do not demand for myself.

There can be no doubt that animals communicate their impressions by an inarticulate voice. Common sense and the most superficial observations are opposed to the negative of this proposition. But when a canary bird warbles till it stuns us, or a nightingale sings in the shadows on the fine nights of June, can we follow and discover the significance of those modulations—now sharply cadenced, now slowly drawn out, and ending with a trill long and accurate enough to challenge the most skillful musician?

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All the poets of every country have constantly sung of the songs of Philomela. But their fervent and enthusiastic verses cast little light on the value of the nightingale's song. It is said that the male sings for the entertainment of the sitting female, but there is no proof of the assertion. The note warning of the approach of danger is easier to recognize. The bird utters a short, hoarse cry, and repeats it with a succession of *trrre, trrre*, which is impossible to mistake. When we hear this cry we may be sure that an enemy is near. Music gives way to a cry of distress and warning, and the female leaves her nest if the sounds become piercing. What do we know of the gobbling of the turkey, which the whistling and the cries of children excite? They are doubtless responses to those challenges; but what do they mean?

The crowing of the cock, recurring regularly at fixed hours, has some signification, but we cannot comprehend it. If on a fine afternoon in autumn the cock crows, and repeats his strain between two and four o'clock, the countrymen in some places will say there will be a fog on the morrow, and they are generally not mistaken. Hens do not mistake his notes either; when a leader of the troop, coming upon a spot rich in food, utters his peculiar chuckle, they run from all around to share the find with him. It is evident that the cock has called them and they have understood him. These facts indicate that there is some definite sense in this inarticulate language; and examples of it, taken from other groups, might be multiplied.

The dog, intelligent animal as he is, manifests his affection on meeting his master, with peculiar cries which vary with the intensity of his joy. No one could confound these notes of pleasure with those which he utters when he is angrily driving away a beggar, or when he meets another dog of unpleasant appearance and puts himself in the position of attack.

An interesting study of the voice of the dog on guard may be made in the country at night. If another dog barks in the distance, the house dog answers in a peculiar manner. He gives a few growls, stops, seems to listen, begins again, very often getting answers; and, after two or three interruptions, he terminates his barking with abrupt yelps, loud at the beginning and long drawn out, and gradually dying away. This ending of his cries is habitually accompanied by his raising his head and throwing it back. I have often, when within the house, on hearing the watch dog bark in this way, opened the window to assure myself on the subject, and distinguished, as I could not do with the windows closed, the voice of another watch dog barking in the same way in the distance—the barkings of the two dogs alternating, one answering the other. There is in such cases an evident communication of impressions. One of the dogs, having had his attention aroused by some unusual noise, has transmitted his impression to the other, as sentinels posted at intervals call out theft warnings one to another. I have often repeated this observation during the long evenings of winter.

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Another example, little known in thickly populated countries, is drawn from a curious scene which I witnessed during a winter passed in Perigord Noir. We had remarked that for several nights the three watch dogs, a young and an old male and a bitch, howled often toward midnight, but in a peculiar way. One night in particular, during their tedious concert, just as we had got to sleep, they mingled with their cries howlings like those they would have uttered if they had been beaten, with a shading hard to define, but which we perceived plainly; and we remarked that, leaving their kennel in the avenue that led up to the lodge, they had come to close quarters with one another at the gate, with alternating howlings and plaintive cries. Inquiring in the morning for the cause of these singular cries, the peasants told me that a wolf had passed, and predicted that it would return. They said, too, that a neighbor’s hunting bitch had disappeared, and its bones had been found in the fields near a wood. We were awakened again about midnight by the cries of the dogs, and the scene was renewed. Informed as we now were of the nature of what was going on, we ran to one of the windows, whence we could see, in the clear light of the moon, all that passed. The three dogs were cowering against the gate, the oldest one howling by the side of the others, while the younger one and the bitch were exposed at intervals to the attacks of another animal, browner than they, and of about their size, without defending themselves, but moaning as if they were undergoing a vigorous correction.

Frightened, doubtless, by the opening of the blinds of the first story above him, the strange animal had gone away and was sitting in the middle of the road. We could only see that he had straight ears. While we were going down to get a gun the visitor came back to his charge on the dogs, which had begun howling after he left them, and resumed the cries significant of chastisement when they were attacked again. For some reason, perhaps because he heard the click of the gun, the foe drew back and sat down in a garden walk, concealed by a bunch of shrubbery. The three dogs, notwithstanding our reiterated urging, were no more disposed to pursue him than before. If the assailant had been a dog they would have rushed upon him, but they stayed cowering at the gate and howled distressfully. The bitch was most affected, and they all seemed paralyzed by fear. It is said in the country that bitches are especially liable to be attacked by wolves. It was so here. The most certain feature in the matter was the terror of the animals. They were capable of resisting the attack three times over. The young dog was a savage one, and passers-by were afraid of the bitch; but that night they were terrorized, and all incapable of defending themselves. Their cries were therefore due to the same cause as in the preceding night—the presence and attacks of the wolf. I could not have realized their meaning if I had not been a witness of the scene—that is, I could not have correlated the cries and the acts.

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A shot at the animal behind the bushes was followed by a hoarse cry. He was hit, and ran; but, in spite of our urgings, the dogs stayed at the gate and only stopped howling. Under any other conditions, upon the signal of the shot they would all have started in pursuit of the wounded animal.

A wolf came to the farm during the last winter (1890-91) and attacked the same bitch. He would have carried her off, for he had seized her by the throat, if we could judge from the stifled cries she uttered; but this time he found with her a new watch dog—a mountain bitch from the Pyrenees—of a breed that attacks the wolf and the bear. The wolf would have been caught if he had not run away. He did not return, for he had been attacked, and learned what he had to deal with.

The Pyrenean breed furnishes excellent watch dogs. I knew one of remarkable traits. At evening he would go round the house, giving two or three growls at each door. With his head raised he seemed to listen to his fine voice, then he would start again and go to another door. He seemed desirous to show those who were observing him that he was attending to his post as guardian. He then went away in silence along the walk, through a dark, rising hedgerow, leaping the slight hillock, yelping toward the wood. He listened, yelped again, and went in. There was never any failure in this performance, but every evening as night was coming on he began his round, which no one had taught him. It was all done in his function as a guard. It would be hard to determine what his yelps meant, but there were in them an inflection, a sonorousness, and a continuance quite different from those he uttered when pursuing a passer-by or when going to meet a person coming toward the house. Every one who has a watch dog is able to tell by the sound of his barking when a person is coming up, and usually what sort of a visitor it is.

The peasants’ dogs of the southwest of France dislike the country millers, because of the long whips which they are always carrying and snapping, and with which the dogs, running after them, are often struck. From as far off as the snapping of the whip can be heard, the dogs come to wait for the millers and pursue them; and it is easy to recognize when the millers are passing, by the behavior of the dogs. There is in this also a significance, at once aggressive and defensive, in the cries which one can, by giving a little attention, soon learn to distinguish.

Another example of the reality of the various meanings of the cries of the dog under different circumstances is afforded by the companies that collect around a female in heat.

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I have a very intelligent and experienced brach hound, the same which with the bitch had to face the attack of the wolf. He amuses me much at my country lunches. Hunting dogs which have been much with their masters at lunch do not like to have the drinking glass offered them. This dog was much afraid of the glass, and I had only to present it to him at lunch time to make him keep his distance. I used to keep my door open at lunch, for the amusement of observing how I could make him stop exactly at the threshold without stepping over it. If he had passed over it I could always send him back by casting toward him a few drops of water from the bottom of the glass after drinking. Sitting, as was his habit, on the sill of the door, with the tip of his muzzle never extending beyond the plane of the panels, he would follow my motions with the closest attention, reminding me, if I failed to give him a sign of attention, by a discreet, plaintive cry, that he was there. But if I touched my glass, he would spring up at once; if I filled it, he would put himself on guard, utter a kind of sigh, sneeze, lick his lips, yawn, and, shaking his ears briskly, make little stifled cries. Then he would grow impatient, and more and more watchful and nervous. When I lifted my glass to my lips he would draw back, working gradually nearer to the farther door, and at last disappear and hide. One who was looking at him without seeing me could tell by his wails and his attitude the level and position of my glass. When the glass was horizontal, I could see only about half of his head, with one eye regarding me fixedly, for that was usually the critical moment—the one, also, when the wails and restraints were most demonstrative of the anxious fear of my poor animal.

When we dine in the kitchen, which is on the ground floor, the dogs are usually all put out. There are four of them, three young and not experienced, and this old, sagacious brach hound. He insists on coming in, and, to gain his purpose, tries to have the door opened. Although no person may be coming up the walk, he dashes down it barking, all the others going along too and yelping with him; then he stops, remains a little behind after having got the others out of the way, and, turning his head from moment to moment, looks to see if the door has been opened, for we generally go to it to see who has come. In that case the feigned attack is successful, and the dog, who has evidently meant to give the alarm so as to have the door opened, comes in at once and claims a place at the table. He has accomplished his end, for the door is usually shut without paying attention to his having got in. I have frequently witnessed this stratagem, and when, during my kitchen dinner, I suddenly hear the dogs yelping after the brach hound has begun, I am pretty sure that nobody is in sight.

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I have forgotten where I found the next story of an old dog who was also very sagacious. Hunting dogs, when they grow old, become rheumatic, or are at least debilitated with pains. We know, too, that they crave heat, and get as near the fire as possible—a craving which increases as they grow older. One such dog, older than the others, and slower in getting into the lodge on returning from the hunt, was often crowded away from the fire by the other livelier dogs getting all the best places before him. Finding himself thus turned out in the cold, he would dash toward the door barking, when the others, supposing it was an alarm, would rush away too, while the old rheumatic went to the fire and selected a place to suit him.

It is not necessary to dwell upon the intelligence shown by such acts. But it is hardly contestable that the old animal, who knows how to play such tricks upon his less experienced companions, deceives them by his intonations, while he is well aware that no enemy is approaching the house; but he does it scientifically, by the inflections of his voice, as a man speaking to other men would do in announcing the arrival of an imaginary enemy.

Inarticulate cries are all pretty much the same to us; their inflections, duration, pitch, abruptness, and prolongation alone can inform us of their purpose. But experience and close attention have shown us the connection of these variations with the acts that accompany or precede them. Animals evidently understand these inflections at once. We cannot better compare the language of animals than with what takes place in a pleasant sport, a kind of pantomime of the voice or language which many youth doubtless understand, and which I venture to refer to here to aid in more easily conceiving of the communication of thought among animals by sounds which seem to us all alike. When I was engaged in hospitals, the evenings in the guard room were sometimes enlivened by the presence of a companion who excelled in humorous mimicry. He would represent a man in liquor who had stopped at a fountain that flowed with a gentle sound, somewhat like that of his own hiccough. A single oath, pronounced in different tones, was sufficient to enable us to comprehend all the impressions, all the states of mind through which this devotee of Bacchus passed. The oath, at first pronounced slowly and with an accent expressing relief, represented a feeling of satisfaction, with shadings of prolonged exclamation which it would be hard for one to imagine without suggestion. The continued flowing of the fountain made our drunken man impatient, and he wanted it to stop. This state of mind was translated by a new modulation of the same word. In a little while the gurgling of the fountain produced astonishment. Was it possible that he, with all the liquid he had imbibed, could vomit so much and for so long a time? This mental condition was expressed by a new modulation of the same oath. The first movement of surprise

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over, resignation follows, and our man decides to wait patiently for the end. A period of half lethargy was easily represented by the slowness and weakness of the man's voice while living up to this decision; but when he comes out of this sleepy condition and hears the fountain again, he is possessed with fear; he cannot understand the flood he is pouring out—he dares not move—he believes he is lost. Gradually the fumes of the liquor pass away, and, his mistake being recognized, the drunkard is taken with a laughing and a gayety which are indicated by the same oath repeated in tones corresponding with the satisfaction he is then enjoying. This making the series of impressions a man passes through comprehensible by a single word, varied in pronunciation and utterance, is very like the language of animals, which is always the same, and the significance of which is given by variety of intonations corresponding with sensational conditions.

The mewing of the cat is always the same; but what a number of mental conditions it expresses! I had a kitten whose gambols and liveliness entertained me greatly. I understood well, when it came up to me mewing, what the sound meant; sometimes the kitten wanted to come up and sleep in my lap; at other times it was asking me to play with it. When, at my meals, it jumped on my knees, turned round, looked at me, and spoke in a coaxing and flattering way, it was asking for something to eat. When its mother came up with a mouse in her jaws, her muffled and low-toned mew informed the little one from a distance, and caused it to spring and run up to the game that was brought to it. The cry is always the same, but varied in the strength of the inflections and in its protraction, so as to represent the various states of mind with which my young animal is moved—just as it was with the drunken man in the mimicry scene. These facts are probably well known to all observers of animals.

We have seen that this tonality of the watch dog's cries is competent to indicate that a person is coming to the house. We find similar cries of warning uttered by birds. When I was a professor in the faculty of Lille, I frequently visited the well known aged Professor of Physics, M. Delezenne. He had a working room at the end of a garden, in which a laughing mew wandered. From the time that any one came in till he went out, this bird made the vocal explosions to which it owes its name; and the good professor was certain, without ever being mistaken, that somebody was coming to his laboratory. He was notified. My Jaco in Paris has a warble that answers the ringing of the bell. If we have not heard the bell, we are notified by Jaco of its ringing, and, going to the door, find some one there. I have been told of a parrot belonging to the steward of a lyceum which had heard the words "Come in," when any one rang the bell. He never failed to cry, "Come in," when the bell moved, and the visitor was embarrassed at seeing nobody after having been invited to open the door.

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Instances in which the cries of birds had an incontestable and precise signification are numerous; let me refer to a few of the best known. The cackle of a hen, after having laid an egg and left her nest, is decidedly characteristic. Her clucking when she is impelled to sit on her eggs, or when she is calling her chicks, is no less demonstrative. There is not a farmer who does not recognize it and understand it. In these things we see the relation between the tone of the prating or cluck of the hen and her acts. But when a nightingale sings all night, or a goldfinch whistles, or a raven croaks, we cannot so easily interpret the significance of their inarticulate sounds. The finch calls its mate by uttering a few notes followed by a long trill. Matches of a barbarous character, based on this habit, I were held in the north of France while I was living at Lille, between 1855 and 1860. I do not know whether they have been suppressed or not, but the laws for the protection of animals ought to take cognizance of them. The gamesters put out the eyes of the male finches, and made them, thus blinded, compete as singers, for which purpose they brought their cages into proximity. When the birds heard and recognized one another’s voices, they made their appeal to the female; the one that renewed his amorous trills most frequently, protracted them longest and to the last, gained the prize. The bird that was declared victor received a medal amid the applause of a large and enthusiastic crowd; and considerable wagers were staked upon the result. I have heard that these poor blinded birds sometimes fell down exhausted with singing, and kept on calling the absent female till they died, not being willing to yield to a rival, who on his side was also keeping up his equally useless appeals.

These finch contests were suggested after the meaning of the song of the birds was learned. But when these birds, which are more usually isolated—whence they have been named *Fringilla coelebs*, or celibates—hop around our houses and also utter their amorous trills at another than the mating season, they are evidently not calling the female. Should we not then seek to determine by the tone whether their call, which is always the same, is amorous or not?

In countries where flocks of turkeys are raised one can learn very quickly from their gobblings when they have captured a hare. If they meet him standing still or lying down, they form in a circle around him, and, putting their heads down, repeat continually their peculiar cries. The hare remains quiet, and it is sometimes possible to take him up, terrorized as he is in the midst of the black circle of gobbling beaks and heads. The language of the turkeys is at that time incontestably significant. It is warlike, and similar to that of the males when they are fighting. In the present instance they have joined for war, and they make it on the frightened hare.

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My Jaco, like all parrots, which are excellent imitators, pronounces a few words and repeats them over and over again. Such birds amuse us because the words they know sometimes happen to be ludicrously fitting. A bird of this kind had been struck by the note sounded by the wind blowing into a room through a crack in the glass work whenever a certain door was opened; and he had become so perfect in his imitation that they sometimes, on hearing the noise, went to shut the door when it was not open.

Jaco formerly belonged to a very pious old lady who was accustomed to say her litanies with another person. He had caught the words “Pray for us,” in the invocations to the several saints, and said them so well as sometimes to deceive his learned mistress, and cause her to think she was saying her litanies with two colleagues. When Jaco was out of food, and any one passed by him, he would say, “My poor Cocotte!” or “My poor rat!” in an arch, mawkish, protracted tone that indicated very clearly what he wanted, and that his drinking cup was empty. There was no doubt in the house as to his meaning; and whenever one heard it he said: “He has nothing to eat.” He was exceedingly fond of fresh pits of apples and pears, and I was in the habit of collecting them and keeping them to give him. So whenever, as I came near him, I put my hand into my pocket he never failed to say: “Poor Cocco!” in a supplicating tone which it was impossible to mistake. A sugar plum is a choice morsel to him. He can tell what it is from a distance when I hold it out in my fingers; and when I give it to him he cannot restrain himself if it has been any considerable time since he has had the delicacy. Usually, after having made the first motion to get it, as if he were ravished and wanted to express his joy in advance, he would draw back before taking it, and say, in a comical tone, “Hold, my poor Cocotte!” His manner of thanking in advance is likewise amusing. The expression of his eyes and the pose of his head are all in accord with the tone of his exclamation. When he tastes the plum he utters a series of *ahs*, and produces a kind of warble by prolonging some of his notes and shortening up others. We find in these examples, without doubt, that the articulate voice makes us better able to judge the meaning of the impressions that are moving the animal than inarticulate cries, or merely musical sounds. When Jaco met a child for whom he had a great affection, he would promenade on his perch, or turn the wheel, spreading out his tail and ruffling the feathers of his head, while his eyes grew red with excitement if the child was too slow in bestowing the accustomed caress. Then he would stop, bend down his head, and, looking at his friend, say pleasantly, “Jaco,” in a tone and with a manner quite in contrast with the pronunciation of the same word when he was hungry.

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It is not the word he speaks that is of interest; he might have been taught another, and it would have been the same; but it is the tone. In this case, too, the articulation gives an easier clew to the meaning the bird seeks to express, having a meaning according to the manner of pronouncing it, than any isolated, simply musical sound, like the song of the nightingale, canary bird, and warbler. This became evident to me, not from observing animals for a few moments without seeing them again, but from studying them continuously.

Jaco did not like solitude, and was talkative and fond of being caressed, like all of his kind. One day, when there was no one in the country house, all having gone out into the garden or the fields, I heard him saying over what few words he knew, in different inflections. I went quietly into the room where he was, without being seen; but he heard my steps, although I walked in very cautiously, hoping to surprise him. He ceased his chatter, listened, and, after a silence, pronounced “Jaco” in a low tone, drawing out the end of the word. He listened again, and repeated the word in the same tone; then, after another silence, repeated it with a rise of the voice. I continued observing him, and, as he heard no one, he raised his tone gradually, repeating the same word, and ended at last with a genuine cry of distress. The people ran in from without, supposing something had happened to him. He then repeated his name in a lower tone, which seemed to indicate his satisfaction at finding his isolation ended. I went in myself, and his prattle unmistakably betrayed his gladness at being no longer alone.

Is there not in this an act of real intelligence? While alone, the parrot entertained himself by talking; but when he heard a sound he hoped at first to see some one come; and when no one answered him, he raised his voice, as a person would do who calls, and, getting no reply, cried out louder and louder till he was heard and answered. The meaning of the differences of intonation is as evident in this case as in that of the drunken man. A parrot raised in the South had learned to swear in the local *patois*. Being fond of coffee, he was sometimes given a spoonful, which he would come awkwardly up to the table to drink with his master. One day the master, not thinking of his bird, had already added cognac to his coffee, and gave the parrot the accustomed spoonful. The parrot took a swallow of it, and, in his surprise at the novel taste, raised his head and repeated the oath in a tone that excited laughter in all who were present. The cause of his surprise being discovered, he was soothed, and then took his usual ration with evident signs of contentment. The mimicry of language in this case clearly represented the shade of the new impression he felt.

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Jaco is very timid. In the evening, when he is put to roost in a close and dark room, he is afraid of the shadow of his perch that is cast by the light we carry in our hand; he eyes it, and utters a low cry, which stops when the candle is blown out and he cannot see the shadow any longer. He stands in dread of blows in the bottom of his cage, because, having a wing broken, he cannot fly, and is afraid of falling. Feeling his weakness, his language has a different tone from the usual one. Large birds flying in the sky above him annoy him greatly, and we can all tell by his voice when such a bird is near or flying over. He inclines his head and chatters in a low tone as long as the bird is in sight, paying no attention to anything else. Turkeys and hens announce the approach of a bird of prey in a similar manner.

We find in the facts which we have related, as well as in many others which are cited respecting the ways and habits of parrots, proofs of a remarkable intelligence. These creatures are distinguished by the unlimited affection which they bestow upon some persons, as well as by their excessive dislikes, which nothing can explain. Jaco conceived an extraordinary dislike for a maid who, although she took good care of him, was in the habit of washing the bottom of his cage under a faucet. He afterward discarded another person, whom he had liked so much that she could do what she pleased with him, even to passing her hand over his back and taking him by the tail, holding him in her hands, or putting him in her apron—caresses of a kind that parrots do not usually permit. Nothing astonished him or offended him. He proved very inconstant toward her, and now, while better disposed toward the other girl, he is furious against this one. A third miss has come to capture his affection; and when he has been left asleep, or resting in his cage, he has always the same word, but different in the inflection wheedling, angry, or nearly indifferent, as either of the three persons comes near him. Jaco's pronunciation is scanned in many meters. Only one young student has had the privilege of retaining his affection unmarred.

Jaco had been left in the country for a whole week in the winter. Alone and isolated, he was taken care of by a person who was not constantly with him. The young student, accompanied by a tutor, came to pass a few days in the house. At the sight of the youth, Jaco, surprised, called out, "Momon! Momon!" "It was affecting," they wrote me, "to see so great signs of joy." I have also myself witnessed similar signs of joy at the coming of the student. Jaco's speech at such times is always in harmony with his feelings. In the pleasant season Jaco's cage is put outdoors; and at meal times, knowing very well what is going on within, he keeps up a steady course of suppliant appeals for attention. His appeals cease at once if I go out with fruit in my hand, and if I go toward him he utters a prattle of joy that sounds like musical laughter. These manifestations indicate that he is happy at seeing that he has been thought of.

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I close these anecdotes, as I began them, by repeating that animals communicate their impressions, and the feelings that move them, by various modulations of their inarticulate cries, which are incomprehensible to us unless we have succeeded by attentive observation in connecting them with the acts that follow or precede them. We have also seen that the articulation of a few words learned by parrots aids us greatly in learning the meaning of these different inflections.

The extension of these studies would furnish much of interest; but further observations should be made upon the same animals for a longtime continuously, relating especially to their peculiar instincts as manifested by their various cries. We might then, by comparing and relating acts and cries, reach the point of comprehending and perhaps fixing the meaning in many cases where we are now in ignorance. Every one has noticed a few facts, and has interpreted and related them, but much is still wanting for the co-ordination of them in the point of view of the signification of the language and communication of animals among themselves. It has not been made in a general sense. —*Translated for the Popular Science Monthly from the Revue Scientifique*.

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MODIFICATION OF OUR CLIMATE.

By *Joseph Wallace*.

Every now and then some weather sage predicts extremely cold winters, and another ventures to say that the sun is gradually losing heat and in time Arctic cold will prevail over the globe. Whatever may have been the changes during the vast cycles of time prior to the advent of man, or whatever may be the changes in the time to come, one thing is quite certain; that our climate has been much modified within the past two or three thousand years.

“There have been fifteen climatic changes since the beginning of the glacial age, each change lasting 10,500 years, and each change reversing the season in the two hemispheres, the pole which had enjoyed continuous summer being doomed to undergo perpetual winter for 10,500 years, and then passing to its former state for an equal term. The physical changes upon the earth’s surface during the past 80,000 years modified the changes of climate even in the Arctic regions, so that the intense cold of the former epochs was much modified during the latter epochs.” Reckoning these climatic changes in their order, we had entered the epoch of a more genial temperature about fifteen hundred years ago; and if no disturbing change takes place during the present epoch, we may reasonably expect a gradual modification of our winters for nine thousand years to come. The changes to intense cold from perpetual summer during the greater part of the glacial period are supposed to have been caused by the high temperature of the north pole as compared to that of the south pole, owing to the distribution of land around the two, the south having almost none. Dr. Croll thinks it was caused by the varying inclination of the earth's axis, which produced the relative position of the two poles toward the sun to be periodically reversed at distant periods. Dr. James Geikie agrees with Croll on the reverse of seasons every 10,500 years during certain periods of high ellipticity of the earth's orbit.

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But it may be asked, “How could the fauna and flora propagate themselves under such conditions?” The flora itself at the quaternary age was of extreme vigor. We know this from the little which is left us, but more especially from the presence of a large number of herbivorous animals—stags, horses, elephants, rhinoceros, *etc*.—which animated the plains and valleys of Europe and America at the same time. Evidently they could not have lived and propagated themselves without abundant vegetation for nourishment and development.

That which has deceived the adherents of the glacial theory, as understood in its absolute sense, is, they have generally placed a too high estimate on its extent and intensity. It needs but a little effort of the reasoning powers to come to the conclusion that the earth had cooled to the degree that all animal and vegetable life could exist upon it, and that a portion of the earth’s surface permanently covered with snow and ice was absolutely indispensable to the existence, perpetuity, and well-being of animal and vegetable life. Again, they have attributed to the glaciers the rocks, gravels, and other material which they have found spread here and there long distances from the mountains. The transportation of the so-called erratic rocks has appeared inexplicable in any other way, and the piles of rock and gravel have been considered so many *moraines*, that is, deposits of diverse material transported by the glaciers. They do not regard the probability of other agents taking the place of glaciers, and undervalue the moving power of water. Water in liquid state has often produced analogous effects, and it has often been the error of the glacialists to confound the one with the other. The erratic rocks and the moraines are undoubtedly the ordinary indications of the ancient gravels, but, taken isolatedly, they are not sufficient proof. In order to convince they should be accompanied with a third indication, which is the presence of striated rocks which we find in the neighborhood of our actual glaciers. When all these signs are together then there is hardly a possibility of error, but one alone is not sufficient, because it can be the effect of another cause.

No doubt the temperature was really lower at the quaternary age and at the epoch generally assigned to man’s advent in European countries, but the difference was not so great as some say. A lowering of four degrees is sufficient to explain the ancient extension of the glaciers. We can look on this figure as the maximum, for it is proved to-day that humanity played the main *role* in the glacial phenomena. The beds of rivers and the alluvia are there to tell that all the water was not in a solid state at that time, that the glaciers were much more extended than in our days, and that the courses of the rivers were infinitely more abundant. When this is understood we can reasonably reduce the extension of the ancient

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glaciers, the lowering of the temperature at the quaternary age, and account for the uninterrupted life of the fauna and flora. However, we must not fall into the opposite excess and assert, as some have done, that the glacial period is comparatively recent, the traces of which are too plain and fresh in some localities to assign to it an age prior to man, and that the temperature has rather lowered itself since this epoch. The ancient extension of the glaciers has been followed by a corresponding growth and extension of animal life, thus proving that the permanence of glaciers is a wise provision and absolutely essential to man and the high orders of animals and vegetation. The ancient extension does not prove alone that it was much colder than in historic times, for the animals themselves are proof of this. At that time the plains of Europe, and of France in particular, were animated by herds of reindeer, gluttons, camels, and marmots, which one does not find to-day except in the higher latitudes or more considerable heights. The mammoth and rhinoceros are no exception to this, for naturalists know they were organized to live in cold countries.

Space will not permit us to pursue this point further, or speculate on the probable climatic conditions of the ice age; but we can carry ourselves back a few thousand years and describe the climate of Europe and neighboring countries of Africa and Asia. Herodotus describes the climate of Scythia in terms which would indicate in our day the countries of Lapland and Greenland. He shows us the country completely frozen during eight months of the year; the Black Sea frozen up so that it bore the heaviest loads; the region of the Danube buried under snow for eight months, and watered in summer by the abundant rains which gave to the river its violent course. The historian adds that the ass cannot live in Scythia on account of the extreme cold which reigns there. The following century Aristotle makes the same remarks concerning Gaul. His contemporary, Theophrastes, tells us that the olive tree did not succeed in Greece more than five hundred furlongs from the sea. We can assure ourselves that both the ass and the olive thrive in these countries at the present day.

Three centuries later, Caesar speaks frequently and emphatically of the rigor of winters and early setting in of cold in France, the abundance of snow and rain, and the number of lakes and marshes which became every moment serious obstacles to the army. He says he is careful not to undertake any expedition except in summer. Cicero, Varro, Possidonius, and Strabo insist equally on the rigor of the climate of Gaul, which allows neither the culture of the vine nor the olive. Diodorus of Sicily confirms this information: “The cold of the winters in Gaul is such that almost all the rivers freeze up and form natural bridges, over which numerous armies pass quite safely with teams and baggages; in order to hinder the passengers to slip out upon the ice and to render the marching more secure, they spread straw thereon.”

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Virgil and Ovid insist on the severity of cold in the regions of the Danube. The first describes the inhabitants of these miserable countries withdrawing themselves into caves dressed with the skins of wild beasts. Ovid, who had passed several years of his life in that region, is more precise in his description. He says the wine has changed itself here (Black Sea) into a solid frozen mass; one gives it to drink by pieces. Fearing of being accused of poetic exaggeration he appeals to the testimony of two ancient governors of Moesia, who could establish the facts like himself. The author who would give such accounts of the Black Sea in our days would risk his reputation for veracity.

Italy, too, experienced its part of the cold in early days. Virgil tells us of the snows being, heaped up, rivers which carried ice along, the sad winter which split the stone and bound up the course of large streams, and all this in the warmest part of Italy, at the base of the walls of Taranto. Heratius affirms that the Soracte, a neighboring mountain of Rome, was whitened with thick snow, rivers frozen, and the country covered with snow. To-day the snow stays very little upon the Soracte and never in the country around Rome. During the four or five centuries which followed, writers speak of the severity of climate in Northern Italy, the lagoons on the Adriatic being frozen over. Algiers was much colder then than now. The Danube, Rhine, and other rivers in Europe, the Nile in Africa, the Amazon in South America, the Mississippi and Missouri in North America, had quite different volumes two thousand years ago than their present actual ones, and they especially rolled much greater masses of water.

There is everything to show a modification of climate in our own days. If this goes on in the future as in the past, there will be a marked difference in the temperature two or three hundred years from now. Even a degree in a thousand years would effect a great change in the course of time. The lowering of four degrees established the ancient extension of glaciers, though it did not interrupt animal or vegetable life. Fifty-four of the fifty-seven species of *Mollusca* have outlived the glacial age, and all our savage animals —even a certain number which have disappeared—date equally from the quaternary, and were contemporary with the great extension of the glaciers.—*Popular Science News*.

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THE ERUPTION OF KRAKATOA.

Before the year 1883 physical geographers, in speaking of the most disastrous volcanic eruption on record, referred first, in point of time, to the celebrated eruption of Vesuvius, in A.D. 79, when the cities of Herculaneum, Pompeii and several smaller towns on the slope of the mountain were destroyed by lava or buried under a mass of pumice stones and ashes; second to that of Hecla and Skaptar Jokull, contiguous mountains

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in Iceland, in 1783, when two enormous lava streams, one 15 miles wide and over 100 ft. deep and the other scarcely inferior, flowed, the first, 50 miles and the other 40, till they reached the sea, pouring a flood of white hot lava into the ocean, destroying everything in their paths and killing in the waters of the ocean the fish, the mainstay of the inhabitants, who were reduced by the disaster, directly or indirectly, to less than five-sixths of their former strength; and third to that of Galungung, in 1822, which devastated such an immense area in Java; but all the eruptions known besides were as mere child's play to the terrible one of Krakatoa in 1883.

If the reader will examine the map of the East Indies he will find represented in the straits of Sunda, which lie between Sumatra and Java, the little island of Krakatoa. In maps made before 1883 he will hunt in vain for the name, for like Bull Run before 1861, it was then unknown to fame, though navigators who passed through the straits knew it as a beautiful tropical isle, with an extinct volcanic cone in the center. In the beginning of 1883, however, the little well behaved island showed symptoms of wrath that boded no good to the larger islands in the vicinity. Noted for the fine fruits with which it abounded, it was a famous picnic ground for towns and cities even 100 miles away, and when the subterranean rumblings and mutterings of wrath became conspicuous the people of the capital of Java, Batavia, put a steamboat into requisition and visited the island in large numbers. For a time the island was constantly in a slight tremor, and the subterranean roar was like the continued but distant mutterings of thunder, but the crisis was reached August 23, at 10 o'clock A.M. It was a beautiful Sunday morning and the waters of the straits of Sunda were like that sea of glass, as clear as crystal, of which John in his apocalyptic vision speaks. The beauty that morning was enhanced by the extraordinary transparency of the tropical air, for distant mountain ranges seemed so near that it seemed possible to strike them with a stone cast from the hand. Only the mysterious rumblings and mutterings of the pent up forces beneath the island disturbed the breathless calm and silence that lay on nature—the calm before the terrible storm—the mightiest, the most awful on record! It burst forth! Sudden night snatched away day from the eyes of the terrified beholders on the mainland, but the vivid play of lightnings around the ascending column of dust penetrated even the deep obscurity to a distance of 80 miles. This awful darkness stretched within a circle whose diameter was 400 miles, while more or less darkness reigned within a circle with a diameter three times as great. Within this latter area dust fell like snow from the sky, breaking off limbs of trees by its weight miles distant, while in Batavia, 100 miles away from the scene of the disaster, it fell to the depth of several inches. The explosions

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were so loud as to be distinctly heard in Hindostan, 1,800 miles away, and at Batavia the sound was like the constant roar of cannon in a field of battle. Finally the whole island was blown to pieces, and now came the most awful contest of nature—a battle of death between Neptune and Vulcan; the sea poured down into the chasm millions of tons, only to be at first converted into vapor by the millions of tons of seething white hot lava beneath. Over the shores 30 miles away, waves over 100 ft. high rolled with such a fury that everything, even to a part of the bedrock, was swept away. Blocks of stone, of 50 tons weight were carried two miles inland. On the Sumatra side of the straits a large vessel was carried three miles inland. The wave, of course growing less in intensity, traveled across the whole Indian Ocean, 5,000 miles, to the Cape of Good Hope and around it into the Atlantic. The waves in the atmosphere traveled around the globe three times at the rate of 700 miles per hour. The dust from the volcano was carried up into the atmosphere fully twenty miles and the finest of it was distributed through the whole body of air. The reader doubtless remembers the beautiful reddish or purple glow at sunrise and sunset for fully six months after August, 1883—that glow was caused by volcanic dust in the atmosphere interfering with the passage of the sun’s rays of the upper part of the solar spectrum, more manifest at sun rising and setting than at other times during the day, because at these periods the sun’s rays have to travel obliquely through the atmosphere, and consequently penetrating a very deep layer, were deprived of all their colors except the red.

The loss of life was appalling. The last sight on earth to 35,000 people was that of the awful eruption. Engulfed in the ocean or covered with heaps of ashes, a few hours after the eruption commenced the awful work was done, and that vast multitude had vanished from off the face of the earth. The fact that in the neighborhood of the mountain there was a sparse population accounts for there not being even a far greater loss of life.

Notwithstanding the awfulness of volcanic and earthquake phenomena, there is some silver lining to the dark clouds. They prove that the earth is yet a *living* planet. Centuries must pass away before it will become like the moon—a dead planet—without water, air or life. Our satellite is a prophecy indeed of what the earth must eventually become when all its life forces, its internal energies, are dissipated into space.—-*Granville F. Foster, Min. Sci. Press*.

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PENTAPTERYGIUM SERPENS.

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This is one of five species of Himalayan plants which, until recently, were included in the genus vaccinium. The new name for them is ugly enough to make one wish that they were vacciniums still. Pentapterygium serpens is the most beautiful of the lot, and, so far as I know, this and P. rugosum are the only species in cultivation in England. The former was collected in the Himalayas about ten years ago by Captain Elwes, who forwarded it to Kew, where it grows and flowers freely under the same treatment as suits Cape heaths. Sir Joseph Hooker says it is abundant on the Sikkim mountains at from 3,000 to 8,000 feet elevation, and that it usually grows on the stout limbs of lofty trees. In this it resembles many of the rhododendrons of that region, and it has been suggested that they are epiphytic from force of circumstances, not from choice. On the ground they would have no chance against the other vegetation, which would strangle or starve them out. Remove them from this struggle for existence, and they at once show their preference for rich soil and plenty of it. All the pentapterygiums have the lower part of the stem often swelling out into a prostrate trunk, as thick as a man's leg sometimes, and sending out stout branching roots which cling tightly round the limbs of the tree upon which it grows. These swollen stems are quite succulent, and they serve as reservoirs of moisture and nourishment. In the wet season they push out new shoots, from which grow rapidly wands three or four feet long, clothed with box-like leaves, and afterward with numerous pendulous flowers. These are elegant in shape and richly colored. They are urn-shaped, with five ribs running the whole length of the corolla, and their color is bright crimson with deeper colored V-shaped veins, as shown in the illustration of the flowers of almost natural size. They remain fresh upon the plant for several weeks. The beautiful appearance of a well grown specimen when in flower may be seen from the accompanying sketch of the specimen at Kew, which was at its best in July, and remained in bloom until the middle of September.

[Illustration: PENTAPTERYGIUM SERPENS (FLOWERS NEARLY NATURAL SIZE)]

P. rugosum is also grown as a greenhouse plant at Kew, where it has been in cultivation about twenty years. It has larger leaves and a more bushy habit than P. serpens, while the flowers are produced in fascicles on the old wood. They are as large as those here figured, but differ in color, being whitish, with brown-red V-shaped marks. Both species may be propagated from cuttings. The plants thrive in sandy peat, and they like plenty of moisture at all times.—*W. Watson, in The Gardeners' Magazine*.

[Illustration: PENTAPTERYGIUM SERPENS (FLOWERS DEEP CRIMSON)]

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THE PERFORATION OF FLOWERS.

The subject of the relations and adaptations which exist between flowers and insects does not appear to excite as much popular attention as many other branches of natural science which are no more interesting. Sprengel, Darwin, and Hermann Muller have been the chief authors in giving us our present knowledge and interest in the study; Sir John Lubbock has helped to popularize it, and Prof. W. Trelease and others have carried on the work in this country.

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The perforation as well as the fertilization of flowers has received attention, but there is a wide field for further study for those who have leisure to pursue it, as it requires much time and patience, as well as closeness and accuracy of observation.

The accompanying figures, from drawings by Mr. C.E. Faxon, show a few characteristic perforations and mutilations, and also represent two of the principal kinds of insects which make them.

Any one interested in the subject will find an excellent brief review of the work already done, a fair bibliography, and a list of perforated flowers in Professor L.H. Pammel's paper on the "Perforation of Flowers," in the *Transactions of the St. Louis Academy of Science*, vol. v., pp. 246-277.

The general beauty of flowers is usually not greatly marred by the perforations except in a few cases, as when the spurs of columbines and corollas of trumpet creepers are much torn, which frequently happens.

The great object of the perforations by insects is the obtaining of the concealed nectar in an easy way. Very naturally, flowers which depend on insect agency for fertilization rarely produce seed when punctured if they are not also entered in the normal way. Perforating is only practiced by a small number of species of insects, and many but not all of the perforators do so because their tongues are too short to reach the nectar by entering the flower. Some obtain nectar from the same kind of flower both in the normal way and by perforating.

The chief perforators of flowers, in this part of the continent at least, appear to be some kinds of humble bees (Bombus) and carpenter bees (Xylocopa). These insects have developed an unerring instinct as to the proper point to perforate the corollas from the outside, in order to readily get at the nectar. The holes made by the humble bees and by the carpenter bees are usually quite different and easily distinguished.

The humble bees have short, stout, blunt jaws, ill adapted for cutting, and the perforations made by them are apparently always irregular in shape, and have jagged edges. It has been stated that the humble bees often bore through the tubes of their corollas with their maxillae, but in all cases observed by me the mandibles were first brought into use in effecting an opening. The noise caused by the tearing is often audible for a distance of several feet.

The true jaws of the carpenter bees are not any more prominent or better adapted for making clean-cut perforations than those of the humble bees; but behind the jaws there is a pair of long, sharp-pointed, knife-like, jointed organs (maxillae) which seem to be exclusively used on all ordinary occasions in making perforations. The inner edges of these maxillae are nearly straight, and when brought together they form a sharp-pointed, wedge-shaped, plow-like instrument which makes a clean, narrow, longitudinal slit when it is inserted in the flower and shoved forward. The slits made by it are often not readily seen, because the elasticity of the tissues of some flowers causes them to partially close again. When not in use the instrument can be folded back, so that it is not conspicuous. The ordinary observer usually sees no difference between the humble bees and the carpenter bees, but they may be readily distinguished by a little close observation.

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[Illustration: THE PERFORATION OF FLOWERS.

1. Xylocopa and heads of male and female. 2. Bombus and head. 3. Dicentra spectabilis, showing punctures. 4. Ribes aureum. 5. Ligustrum Ibota. 6. AEsculus glabra. 7. Lonicera involucrata. 8. Caragana arborescens. 9. Andromeda Japonica. 10. Buddleia Japonica. 11. Mertensia Virginica. 12. Rhododendron arborescens. 13. Corydalis bulbosa.]

No doubt, in some of the recorded cases of perforations, carpenter bees have been mistaken for humble bees. The heads of all our Northern humble bees are rather narrow, retreating from the antennae toward the sides, and with a more or less dense tuft of hair between the antennae. The abdomen, as well as the thorax, is always quite densely covered with hair, which may be black or yellowish or in bands of either color. With possibly one or two exceptions, the only species I have seen doing the puncturing is Bombus affinis, Cresson.

The carpenter bees (Xylocopa Virginica) of this region have the head very broad and square in front, and with no noticeable hair between the antennae. The heads of the male and female differ strikingly. In the male the eyes are lighter colored and are hardly half as far apart as in the female, and the lower part of the face is yellowish white. The female has eyes smaller, darker, and very far apart, and the whole face is perfectly black. The abdomen is broad, of a shining blue-black color, very sparsely covered with black hairs, except on the first large segment nearest the thorax. On this segment they are more dense and of the same tawny color as those on the thorax. But it is particularly from the character of the head that the amateur observer of the perforators may soon learn to distinguish between a Xylocopa and a Bombus as they work among the flowers. It is also interesting to know that the Xylocopas are not so inclined to sting as the humble bees, and the males, of course, being without stinging organs, may be handled with impunity.

Among other insects, honey bees have been said to perforate flowers, but authentic instances are rare of their doing much damage, or even making holes. I have only recorded a single instance, and in this a honey bee was seen to perforate the fragile spurs of Impatiens. When searching for nectar they quite commonly use the perforations of other insects. Wasps and other allied insects also perforate for nectar. My only observations being a Vespa puncturing Cassandra calyculata, an Andrena (?) perforating the spurs of Aguilegia, and Adynerus foraminatus biting holes close to the base on the upper side of rhododendron flowers. The holes made by some of the wasp-like insects are often more or less circular and with clean-cut edges. The ravages committed by larvae, beetles and other insects in devouring flowers, or parts of them, do not properly come under the head of perforations.

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The question as to the cause of the handsome corollas of the trumpet creeper (Tecoma radicans) being so often split and torn has been accounted for in various ways in published notes on the subject. Humming birds and ants have been blamed, the humming birds being such constant visitors of these flowers that it really seemed as though they must be the authors of the mischief. I have often watched them when they appeared as though they were pecking at the blossoms, but careful examinations, both before and after their visits, always failed to show any trace of injury. Finally, on July 26, 1890, I was rewarded by seeing a number of Baltimore orioles vigorously pecking at and tearing open a lot of fresh blossoms, and this observation was afterward repeated. That the oriole should do this was not surprising, considering its known habits in relation to some other flowers. J.G. JACK.

[Mr. Jack adds a list of sixteen plants whose flowers he has seen punctured by the carpenter bee and seventeen others whose flowers were punctured by the humble bee. He names more than thirty other flowers which he has found perforated without having seen or identified the authors of the mischief.—ED.]—*Garden and Forest*.

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ELECTRICITY IN HORTICULTURE.

The influence of electricity upon vegetation has been the subject of numerous investigations. Some have been made to ascertain the effects of the electric current through the soil; others to ascertain the effect of the electric light upon growth through the air. Among the latter are those of Prof. L.H. Bailey of the Cornell University Agricultural Experiment Station. In Bulletin No. 30 of the Horticultural Department is given an account of experiments with the electric light upon the growth of certain vegetables, like endive, spinach, and radish; and upon certain flowers like the heliotrope, petunia, verbena primula, *etc*. The results are interesting and somewhat variable. The forcing house where the experiments were carried on was 20 x 60 ft., and was divided into two portions by a partition. In one of these the plants received light from the sun by day and were in darkness at night. In the other they received the sunlight and in addition had the benefit of an arc light the whole or a part of the night. The experiment lasted from January until April during two years, six weeks of the time the first year with a naked light and the balance of the time with the light protected by an ordinary white globe. It is not the purpose here to enter into any great details, but to give the general conclusions.

The effect of the naked light running all night was to hasten maturity, the nearer the plants being to the light the greater being the acceleration. The lettuce, spinach, *etc*., “ran to seed” in the “light” house long before similar plants in the dark. An examination of the spinach leaves with the microscope showed the same amount of starch in each, but in the electric light plants the grains were larger, had more distinct markings and gave a deeper color with iodine.

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With lettuce it was found that the nearer the plants were to the light the worse the effect; and conversely those furthest away were the best developed. Cress and endive gave the same results. In the case of the latter, some of the plants were shaded from the light by an iron post, and these grew better and were larger than those exposed to its direct rays. The average weight of eight plants in full light was 49.6 grains, as opposed to an average of six plants in the shade of 93.8 grains. Radishes were strongly attracted to the light and moved toward it during the night. During the day they straightened up, but moved again toward the light at night. The plants nearest the lamp made a poor growth and were nearly dead at the end of six weeks. Averaging the weight of plant, of top and of tuber, it was found that those grown in the dark were heavier in every instance than those grown in the light; and the percentage of marketable tubers from the light-grown plants was twenty-seven, as opposed to seventy-eight in the dark. Chemical analyses showed the plants in the light to be more mature than those in the dark, although they were much smaller. Dwarf peas showed the same facts, those in full light being smaller than those in the dark. The former bloomed a week earlier than the latter, but the production of seed was less, being only about four-sevenths as great.

Further experiments were made by excluding the sun during the day and exposing the plants to the diffused electric light only. In all cases, with radishes, lettuce, peas, corn, and potatoes, the plants died in about four weeks. Only a little starch and no chlorophyl was found in the plants deprived of sunlight and only receiving the electric light. Thus the experiments with a naked light showed conclusively that “within range of an ordinary forcing house the naked arc light running continuously through the night is injurious to some plants.” In no case did it prove profitable.

Experiments with the light inclosed in a white globe and running all night were different in their results. The effect was much less marked. Lettuce was decidedly better in the light house; radishes were thrifty but did not produce as much as in the dark house. A third series of experiments with the naked light running a part of the night only were also made. Radishes, peas, lettuce, and many flowers were experimented upon. The lettuce was greatly benefited by the light. “Three weeks after transplanting (Feb. 5),” we are told, “both varieties in the lighthouse were fully 50 per cent. in advance of those in the dark house in size, and the color and other characters of the plants were fully as good. The plants had received at this time 701/2 hours of electric light. Just a month later the first heads were sold from the light house, but it was six weeks later when the first heads were sold from the dark house. In other words, the electric light plants were two weeks ahead of the others. This gain had been purchased by 1613/4 hours of electric light, worth at current prices of street lighting about $7.”

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This experiment was repeated with the same results. In the second experiment the plants receiving eighty-four hours of electric light, costing $3.50, were ready for market ten days before the plants in the dark house. The influence of the light upon color of flowers was variable. With tulips the colors of the lighted plants were deeper and richer than the others, but they faded after four or five days. Verbenas were injured in every case, being of shorter growth and losing their flowers sooner than those in the dark house. “Scarlet, dark red, blue and pink flowers within three feet of the light soon turned to a grayish white.” Chinese primulas seven feet from the light were unaffected, but those four feet away were changed. Lilac colors were bleached to pure white when the light struck them fairly. An elaborate series of tables of the effect of the light is given in the paper. The author believes it possible that the electric light may be used some day to pecuniary advantage in floricultural establishments.

These experiments naturally open up many questions. Those which will be of most importance to the practical man will be such as relate to the benefits to be derived from the use of the electric light. That electricity has a great effect upon vegetation can no longer be denied. What remains now is to ascertain how to use the force with the most economy and to the best advantage. If by its use early vegetables will be made earlier, bright flowers be made brighter, it will be a question of only a short time before it will come into general use. To the student of plant physiology there are also many questions of interest, but into these it is not the intention to enter. Prof. Bailey’s general conclusions are, in part, as follows: “There are a few points which are clear: the electric light promotes assimilation, it often hastens growth and maturity, it is capable of producing natural flavors and colors in fruits, it often intensifies colors of flowers and sometimes increases the production of flowers. The experiments show that periods of darkness are not necessary to the growth and development of plants. There is every reason, therefore, to suppose that the electric light can be profitably used in the growing of plants. It is only necessary to overcome the difficulties, the chief of which are the injurious influences upon plants near the light, the too rapid hastening to maturity in some species, and in short the whole series of practical adjustments of conditions to individual circumstances. Thus far, to be sure, we have learned more of the injurious effects than of the beneficial ones, but this only means that we are acquiring definite facts concerning the whole influence of electric light upon vegetation; and in some cases, notably in our lettuce tests, the light has already been found to be a useful adjunct to forcing establishments.... It is highly probable that there are certain times in the life of the plant when the electric light will prove to be particularly helpful. Many experiments show that injury follows its use at that critical time when the planetlet is losing its support from the seed and is beginning to shift for itself, and other experiments show that good results follow from its later use.... On the whole, I am inclined toward Siemens’ view that there is a future for electro-horticulture.”

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JOSEPH P. JAMES.
Washington, Jan. 20, 1892.

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ELECTRICITY IN AGRICULTURE. By CLARENCE D. WARNER.

It is well known that currents of electricity exist in the atmosphere. Clouds are charged and discharged. There is a constant change of electricity from earth to air and from air to earth, the latter being the great reservoir for all electricity. Hills, mountain peaks, trees, high chimneys, spires, in fact all points elevated above the earth's surface assist greatly in charging and discharging the atmosphere. Again, if two iron rods are driven into the earth and connected by a copper wire with an electrometer in the circuit, the instrument is almost immediately affected, showing that currents of electricity are running through the ground. Now, what is the function of these atmospheric and ground electric currents? Many scientists are agreed that certain forms of precipitation are due to electrical action; but my observations have led me to believe conclusively that electricity is a potent factor in the economy of nature, and has more to do with the growth and development of plants than has hitherto been known. Davy succeeded in the decomposition of the alkalies, potash and soda, by means of electric currents. In our laboratories, water and ternary compounds are rapidly decomposed by the battery, and we may reasonably suppose that that which is effected in our laboratories by artificial means takes place in the great laboratory of nature on a grander and more extended scale.

Plant food is carried throughout the plant by means of the flow of sap; these currents circulate through all the rootlets and center, as it were, in the stalk, carrying their tiny burdens of various elements and depositing them in their proper places. That this phenomenon of circulation is due to electricity cannot be doubted. Most plants grow more rapidly during the night than in the day. May not the following be a reason for this?

We have already mentioned how electric currents pass from air to earth and *vice versa*; at night the plant is generally covered with dew and the plant itself becomes a good conductor, and, consequently, currents of electricity pass to each through this medium, and during the passage convert soil elements into plant food and stimulate the upward currents to gather up the dissolved elements and carry them to their proper places.

From the time electricity became a science, much research has been made to determine its effect, if any, upon plant growth. The earlier investigations gave in many cases contradictory results. Whether this was due to a lack of knowledge of the science on the part of the one performing the experiments, or some defect in the technical applications, we are not prepared to say; but this we do know, that such men as

Jolabert, Nollet, Mainbray and other eminent physicists affirmed that electricity favored the germination of seeds and

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accelerated the growth of plants; while, on the other hand, Ingenhouse, Sylvestre and other savants denied the existence of this electric influence. The heated controversies and animated discussions attending the opposing theories stimulated more careful and thorough investigations, which establish beyond a doubt that electricity has a beneficial effect on vegetation. Sir Humphry Davy, Humboldt, Wollaston and Becquerel occupied themselves with the theoretical side of the question; but it was not till after 1845 that practical electroculture was undertaken. Williamson suggested the use of gigantic electrostatic machines, but the attempts were fruitless. The methods most generally adopted in experiments consisted of two metallic plates—one of copper and one of zinc—placed in the soil and connected by a wire. Sheppard employed the method in England in 1846 and Forster used the same in Scotland. In the year 1847 Hubeck in Germany surrounded a field with a network of wires. Sheppard's experiments showed that electricity increased the return from root crops, while grass perished near the electrodes, and plants developed without the use of electricity were inferior to those grown under its influence. Hubeck came to the conclusion that seeds germinated more rapidly and buckwheat gave larger returns; in all other cases the electric current produced no result. Professor Fife in England and Otto von Ende in Germany carried on experiments at the same time, but with negative results, and these scientists advised the complete abandonment of applying electricity to agriculture. After some years had elapsed Fichtner began a series of experiments in the same direction. He employed a battery, the two wires of which were placed in the soil parallel to each other. Between the wires were planted peas, grass and barley, and in every case the crop showed an increase of from thirteen to twenty-seven per cent. when compared with ordinary methods of cultivation.

Fischer, of Waldheim, believing atmospheric electricity to aid much in the growth and development of plants, made the following tests:

He placed metallic supports to the number of about sixty around each hectare (2.47 acres) of loam; these supports were provided at their summits with electrical accumulators in the form of crowns surmounted with teeth. These collectors were united by metallic connection. The result of this culture applied to cereals was to increase the crop by half.

The following experiment was also tried: Metallic plates sixty-five centimeters by forty centimeters were placed in the soil. These plates were alternately of zinc and copper and placed about thirty meters apart, connected two and two, by a wire. The result was to increase from twofold to fourfold the production of certain garden plants. Mr. Fischer says that it is evidently proved that electricity aids in the more complete breaking up of the soil constituents. Finally he says that plants thus treated mature more quickly, are almost always perfectly healthy, and are not affected with fungoid growth.

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Later, N. Specnew, inspired by the results arrived at by his predecessors, was led to investigate the influence of electricity on plants in every stage of their development; the results of his experiments were most satisfactory and of practical interest. He began by submitting different seeds to the action of an electric current, and found that their development was rendered more rapid and complete. He experimented with the seeds of haricot beans, sunflowers, winter and spring rye. Two lots, of twelve groups of one hundred and twenty seeds each, were plunged into water until they swelled, and while wet the seeds were introduced into long glass cylinders, open at both ends. Copper disks were pressed against the seeds, the disks were connected with the poles of an induction coil, the current was kept on for one or two minutes and immediately afterward the seeds were sown. The temperature was kept from 45 deg. to 50 deg. Fahrenheit, and the experiments repeated four times. The following table shows the results:

	Peas.	Beans.	Barley.	Sunflowers.
	Days.	Days.	Days.	Days.
Electrified seeds developed in	2.5	3	2	8.5
Non-electrified seeds developed in	4	6	5	15

It was also observed that the plants coming from electrified seeds were better developed, their leaves were much larger and their color brighter than in those plants growing from non-electrified seeds. The current did not affect the yield.

At the Botanical Gardens at Kew, the following experiment was tried:

Large plates of zinc and copper (0.445 meter and 0.712 meter) were placed in the soil and connected by wires, so arranged that the current passed through the ground; the arrangement was really a battery of (zinc | earth | copper). This method was applied to pot herbs and flowering plants and also to the growing of garden produce; in the latter case the result was a large crop and the vegetables grown were of enormous size.

Extensive experiments in electroculture were also made at Pskov, Russia. Plots of earth were sown to rye, corn, oats, barley, peas, clover and flax; around these respective plots were placed insulating rods, on the top of which were crown-shaped collectors—the latter connected by means of wires. Atmospheric electricity was thus collected above the seeds, and the latter matured in a highly electrified atmosphere; the plots were submitted to identical conditions and the experiments were carried on for five years. The results showed a considerable increase in the yield of seed and straw, the ripening was more rapid and the barley ripened nearly two weeks earlier with electroculture. Potatoes grown by the latter method were seldom diseased, only to 5 per cent., against 10 to 40 per cent. by ordinary culture.

Grandeau, at the School of Forestry at Nancy, found by experiment that the electrical tension always existing between the upper air and soil stimulated growth. He found plants protected from the influence were less vigorous than those subject to it.

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Macagno, also believing that the passage of electricity from air through the vine to earth would stimulate growth, selected a certain number of vines, all of the same variety and all in the same condition of health and development. Sixteen vines were submitted to experiment and sixteen were left to natural influences. In the ends of the vines under treatment, pointed platinum wires were inserted, to which were attached copper wires, leading to the tops of tall poles near the vines; at the base of these same vines other platinum wires were inserted and connected by copper wires with the soil. At the close of the experiment, which began April 15, and lasted till September 16, the wood, leaves and fruit of both sets of vines were submitted to careful analysis with the following results:

Without conductor. With conductor.

Moisture per cent.	78.21	79.84
Sugar.	16.86	18.41
Tartaric acid.	0.880	0.791
Bitartrate of potash.	0.180	0.186

Thus we see that the percentage of moisture and sugar is greater and the undesirable acid lower in those vines subject to electrical influences than in those left to natural conditions. There are also experiments which prove the beneficial effects of electricity on vines attacked by phylloxera.

The following experiments were made at this station: Several plots were prepared in the greenhouse, all of which had the same kind of soil and were subjected to like influences and conditions. Frames in the form of a parallelogram, about three feet by two feet, were put together; across the narrow way were run copper wires in series of from four to nine strands, each series separated by a space about four inches wide, and the strands by a space of one-half inch. These frames were buried in the soil of the plot at a little depth, so that the roots of the garden plants set would come in contact with the wires, the supposition being that the currents of electricity passing along the wires would decompose into its constituents the plant food in the vicinity of the roots and more readily prepare it for the plants. Two electric gardens were thus prepared and each furnished with two common battery cells, so arranged as to allow continuous currents to pass through each series of wires. Near each electric garden was a plot prepared in the same manner, save the electrical apparatus. We will call the two gardens A and B.

The place chosen for the experiments was in a part of the greenhouse which is given up largely to the raising of lettuce, and the gardens were located where much trouble from mildew had been experienced. The reason for this choice of location was to notice, if any, the effect of electricity upon mildew, this disease being, as it is well known, a source of much trouble to those who desire to grow early lettuce. The soil was carefully prepared, the material taken from a pile of loam commonly used in the plant house.

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Garden A was located where mildew had been the most detrimental; the experiments began the first of January and closed the first of April. For the garden, fifteen lettuce plants of the head variety were selected, all of the same size and of the same degree of vitality, as nearly as could be determined; the plants were set directly over the wires, so that the roots were in contact with the latter; the plants were well watered and cared for as in ordinary culture, and the fluid in the battery cells was renewed from time to time, that the current of electricity might not become too feeble. At the close of the experiments the following results were noted:

Five plants died from mildew, the others were well developed and the heads large. The largest heads were over the greatest number of wires and nearest the electrodes. It was further noticed that the healthiest and largest plants, as soon as the current became feeble or ceased altogether, began to be affected with mildew. On examining the roots of the plants it was found that they had grown about the wires as if there they found the greatest amount of nourishment; the roots were healthy and in no way appeared to have been injured by the current, but, rather, much benefited by the electrical influences.

Beside garden A was prepared another plot of the same dimensions, having the same kind of soil and treated in like manner as the first, but the electrical apparatus and wires were wanting. At the close of the experiments only three plants had partially developed, and two of these were nearly destroyed by mildew—one only was free from the disease. The results, therefore, show that the healthiest and largest plants grew in the electric plot.

In the second experiment, which we called B, twenty plants of the same variety of lettuce and of equal size were taken. The treatment given was the same as the plants in plot A received. Five plants only remained unaffected with mildew; seven died from the disease when they were half grown; the rest were quite well developed, but at the last part of the experiment began to be affected. Several heads were large, the largest being over the greatest number of wires and nearest the electrodes. Examination of the roots disclosed the same phenomena as in A.

Near plot B were also set twenty other plants, subjected to like conditions as the first, but without electricity; all but one died from mildew before they were half grown, the solitary plant that survived being only partly developed at the close of the experiment, and even this was badly affected with the disease.

Everything considered, the results were in favor of electricity. Those plants subjected to the greatest electrical influence were hardier, healthier, larger, had a better color, and were much less affected by mildew than the others. Experiments were made with various grasses, but no marked results were obtained.

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The question would naturally arise whether there may not be a limit reached where electricity would completely overcome the attack of mildew and stimulate the plant to a healthy and vigorous condition throughout its entire growth. From the fact that the hardiest, healthiest, and largest heads of lettuce grew over the greatest number of currents and nearest the electrodes, it would seem that electricity is one of the agents employed by nature to aid in supplying the plant with nourishment and to stimulate its growth. To what extent plants may be submitted to electrical influence, or what strength of current is best suited to them and what currents prove detrimental to their development, have not been determined as yet, but it is desirable to continue this research until some definite information shall be gained on these points. Probably different varieties of plants differ greatly in their capacity for enduring the action of electric currents without injury—experiment alone must determine this.

It has been proved that the slow discharge of static electricity facilitates the assimilation of nitrogen by plants. Faraday showed that plants grown in metallic cages, around which circulated electric currents, contained 50 per cent. less organic matter than plants grown in the open air. It would seem from the researches of the latter physicist that those plants requiring a large percentage of nitrogen for their development would be remarkably benefited if grown under electric influence.—*Massachusetts Agricultural College, Bulletin No 16.*

[A very interesting article on the Influence of Electricity upon Plants, illustrated, is given in SUPPLEMENT 806. It presents the results of the studies of Prof. Lemstrom, of Helsingfors.]

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THE TREATMENT OF RATTLESNAKE BITE BY PERMANGANATE OF POTASSIUM, BASED ON NINE SUCCESSFUL CASES.

By AMOS W. BARBER, M.D.,[1] Cheyenne.

[Footnote 1: Governor of Wyoming.]

Poisoned wounds, inflicted by the fangs of the rattlesnake, are happily more rare each year, since, as the country is becoming more populated, the crotalus is rapidly being exterminated. Yet, considering the recklessness which characterizes the cow boy in his treatment of this reptile, it is astonishing that this class of injury is not more common. Thus it is the invariable custom among the cattlemen to dismount and destroy these snakes whenever they are seen. This is readily accomplished, since a slight blow will break the back. This blow is, however, generally delivered by means of the quirt, a whip not over two and a half feet long, and hence a weapon which brings the one who wields it in unpleasant proximity to the fangs of the reptile. A still more dangerous practice, and one which I have frequently seen, is a method of playing with the rattlesnake for the delectation of the cow boy at the expense of a “tenderfoot.”

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It is well known that unless a snake is coiled, or held by the tail or body, or placed at length in a hole or crevice so narrow that by rendering its length sinuous a certain amount of support is given, it cannot strike. On this theory a mounted cow boy first puts a rattler to flight, then pushes his pony in pursuit, stoops from the saddle, seizes it by the tail, gives a quick upward jerk, and, swinging it so rapidly around his head that it is impossible for it to strike, sets off in pursuit of whoever has exhibited most terror at the sight of the reptile. When within fair distance he hurls the snake at the unfortunate victim, in the full assurance that even should it strike him it cannot bury its fangs in his flesh, since it is impossible for it to coil till it reaches the ground. This is a jest of which I have frequently been the victim, nor have I yet learned to appreciate it with unalloyed mirth.

The belief that rattlesnakes always give warning before striking is not well founded. If come upon suddenly, they often strike first, and if disturbed when in a space so narrow that the coil cannot be formed, they may give no warning of their presence beyond the penetration of the fangs into the hand or foot of an intruder. One such case I saw.

It seems to be well established that a snake will not voluntarily crawl over a hair rope, and in certain parts of the country it is common for campers-out to surround their beds with such a rope, since the reptiles seek warmth, and are frequently found under or in the blankets of those sleeping on the ground.

After an exceptionally large experience with wounds inflicted by the fangs of the rattlesnake, and an experience which, I am glad to say, has been most successful in its outcome, I think it my duty to add, from a practical standpoint, my testimony as to the efficacy of permanganate of potassium in the treatment of this class of cases. This drug was first introduced by Lacerda, of Brazil, and, if more generally used, would, I believe, render comparatively innocuous a class of injury which now usually terminates in death.

I make this statement as to the fatality of crotalus poison advisedly. I know the belief is very common that the poison of a rattlesnake is readily combated by full doses of whisky. This is fallacious. I have taken the pains to investigate a number of instances of cure resulting from the employment of free stimulation. In each case the fangs did not penetrate deeply into the tissues, but either scratched over the surface or tore through, making a wound of entrance and exit, so that the poison, or at least the major part of it, was not injected into the tissues of the person struck. The effect is very much the same as when an inexperienced practitioner picks up a fold of skin for the purpose of making a hypodermic injection, and plunges his needle entirely through, forcing the medicament wide of his patient.

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Nearly all, if not all, of the cases treated by stimulation alone have, according to my experience, perished if they have received a full dose of virus from a vigorous snake. One of these cases lived for upward of a month. He then perished of what might be considered a chronic pyaemia, the symptoms being those of blood poisoning, accompanied by multiple abscesses. Another case, not occurring in my own practice, died at the end of four days apparently of cardiac failure. Active delirium persisted all through this case. Two other cases treated by stimulants also died with symptoms of more or less acute blood poisoning.

The feeling is almost universal among the people of Wyoming that a fair strike from a rattlesnake is certain death, and that the free use of stimulants simply postpones the end. I do not for a moment deny that a strong, lusty man may be struck fairly by a rattlesnake and if the wound is at once opened and cauterized, and the heart judiciously supported, he may yet recover; still the fact remains that the great majority of these cases perish at a longer or shorter interval following the infliction of the wound. Hence any treatment that will save even the majority of such cases is a distinct gain, and one which has saved every one of nine cases to which it has been applied needs no further commendation.

The first case of rattlesnake wound to which I was called occurred in 1885. A cow boy was bitten on the foot, the fang penetrating through the boot. He was brought forty miles to Fort Fetterman, where I was then stationed. I saw him about twenty-four hours after he was struck. There was an enormous swelling, extending up to the knee. The whole limb was bronzed in appearance. There was no special discoloration about the wound; in fact, the swelling disguised this to such an extent that it was impossible to determine exactly where the fangs had entered. The pulse was scarcely perceptible at the wrist; the heart was beating with excessive rapidity. The patient was suffering great pain. His mind was clear, but he was oppressed with a dreadful anxiety. Up to the time I saw him he had received absolutely no treatment, excepting the application of a cactus poultice to the leg, since there was no whisky at the ranch where he was wounded. I at once made free incisions, five or six in number, from one to two inches in depth, and about three inches in length. These cuts gave him very little pain, nor was there much bleeding, though there was an enormous amount of serous oozing. Into these wounds was poured a fifteen per cent. solution of permanganate of potassium, and fully half an hour was devoted to kneading this drug into the tissues. In addition I made many hypodermic injections into all portions of the swollen tissue, but particularly about the wound. Since there was no very distinct line of demarkation between the swollen and healthy tissue, I did not, as in other cases, endeavor to prevent the extension of the cellular involvement by a complete circle of hypodermic injections. I employed, in all, about forty grains of the permanganate. In addition to the local treatment I pushed stimulation, employing carbonate of ammonium and whisky. By means of diuretics and laxatives the kidneys and bowels were encouraged to eliminate as much of the poison as possible.

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The patient went on to uninterrupted recovery. The wound healed with very little sloughing. The patient returned to his work in about a month. The cure of this case was regarded by the cow boys as most exceptional, since, in their experience, similar cases, even though very freely stimulated, had not recovered.

Some time later I was called to see a girl, aged 14, who was struck by a rattlesnake, fifty-six miles from Fort Fetterman. There was some trouble about procuring relays, and I was compelled to ride the same horse all the way out. This took a little short of five hours. This, together with the time consumed in sending me word, caused an interval of about twenty hours between the infliction of the injury and the time I saw the patient. I found the fangs had entered on either side of the distal joint of the middle metacarpal bone. The arm was enormously swollen, almost to the axilla, and exhibited a bronzed discoloration; this was especially marked about the wound and along the course of the lymphatics. The swollen area was *boggy* to the touch, and exhibited a distinct line of demarkation between the healthy and diseased tissues, excepting along the course of the brachial vessels, where the indurated discolored area extended as a broad band into the axilliary lymphatics, which were distinctly swollen. The patient was delirious, was harrassed by terror, complained bitterly of pain, and had an exceedingly feeble, rapid heart action. There was marked dyspnoea, and all the signs of impending dissolution. I at once made free multiple incisions into all parts of the inflamed tissue, carrying two of my cuts through the wounds made by the fangs of the snake. In the arm these incisions were several inches long and from one to two inches deep. As in the former case, the bleeding was slight, but there was a free exudation of serum. Into these wounds a fifteen per cent. permanganate of potassium solution was poured, and as much as possible was kneaded into the tissues. In addition multiple hypodermic injections were made, these being carried particularly into the bitten region, and circularly around the arm just at the border of the line of demarkation, thus endeavoring to limit by a complete circle of the antiseptic solution the further extension of the inflammatory process. In the region of the brachial vessels I hesitated to make my injections as thoroughly as in the rest of the circumference of the arm, fearing lest the permanganate of potassium might injure important vessels or nerves.

This treatment caused very little pain, but immediately after the constitutional symptoms became distinctly aggravated. I stimulated freely, and at once made preparations to take the patient to the Fort Fetterman hospital. She was transported over the fifty-six miles, I riding the same horse back again, and arriving at Fort Fetterman the same evening.

The after treatment of this case was comparatively simple. She was stimulated freely as long as cardiac weakness was manifested. As in the former case, diuretics and laxatives were employed. The arm was wrapped in cloth soaked in a weak permanganate solution, was placed in a splint, and was loosely bandaged. There was some sloughing, but this was treated on general surgical principles. The patient recovered the entire use of her arm, and was turned out cured in about six weeks.

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The third case I saw about fourteen hours after he was struck. The patient was a healthy blacksmith, about 30 years of age. The wound was at about the middle of the forearm, the fangs entering toward the ulnar side. When I saw the patient he exhibited comparatively trifling symptoms. His heart action was rapid, and he was suffering from the typical despondency and terror, but I could not note the profound systemic depression characteristic of the great majority of cases. Surrounding the wound and extending up the forearm for several inches there was a boggy swelling, exhibiting a sharp line of demarkation. It was bronzed in color, and was apparently spreading. I at once applied the intermittent ligature just above the elbow, and injected the permanganate of potassium solution freely all through the involved tissues, particularly in the region of the bite and about the periphery of the swelling, surrounding the latter by a complete ring of injections.

The general treatment of this patient was continued on the same general line as described in the former cases, stimulants being employed moderately. He recovered without any bad symptoms. There was no sloughing; the swelling disappeared without any necrosis of tissue. He is still pursuing his trade in Cheyenne, and suffers from absolutely no disability.

I saw but one case shortly after the wound was inflicted. This patient was a healthy young man, who was struck about the middle of the dorsal surface of the hand, the fangs entering on each side of a metacarpal bone, and the poison lodging apparently in the palm of the hand. The patient, when seen, exhibited the characteristic terror and depression, weak, rapid heart action, and agonizing local pain. I made two small incisions in the region of the wound upon the dorsum of the hand, and injected permanganate of potassium freely. This patient ultimately recovered, but only after sloughing and prolonged suppuration. I believe that had I incised freely and at once from the palmar surface, I would have been spared this unpleasant complication.

I have had in all nine cases, and without a single death. The others are in their general features and in the treatment employed quite similar to those given.

The symptoms resulting from snake bite poison are strikingly like those dependent upon the violent septic poison seen in pre-antiseptic times. There is often the same prodromal chill, the high elevation of temperature, the profound effect on the circulation, and the rapid cellular involvement. The tissue disturbance following snake poisoning differs from ordinary cellulitis, however, in the following particulars: The color is *bronze*, not red; the involved area is *boggy*, not brawny; and the extension of the process is *exceedingly rapid*.

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The treatment applicable to one condition seems to be equally successful when applied to the other. In cellulitis, free incisions, antiseptic lotions, and active stimulation are the three means upon which the surgeon mainly depends, and in combating the local and general symptoms excited by snake bite poisoning, the same treatment has given me the successful results detailed above. Whether or not permanganate of potassium is more active than other antiseptics in snake bite poisoning I am not prepared to state, but the high authority of S. Weir Mitchell, together with my own experience, does not incline me to substitute any other drug at present.

I would formulate the treatment for poison of the rattlesnake as follows:

1. Free incisions to the bottom of the wound and immediate cauterization; or, if this is not practicable, sucking of the wound.

2. The immediate application of an intermittent tourniquet, that is, one which is relaxed for a moment at a time, so that the poison may gain admission into the circulation in small doses.

3. The free administration of alcohol or carbonate of ammonium.

This might be termed the *urgency treatment* of snake bite poisoning. The *curative treatment* requires—

4. Free incisions into all portions of the inflamed tissues, and the thorough kneading into these incisions of a fifteen per cent. solution of permanganate of potassium.

5. Multiple injections of the same solution into all the inflamed regions, but particularly into the region of the wound.

6. The complete surrounding of all the involved tissues, by permanganate of potassium injections placed from half an inch to an inch apart, the needle being driven into the healthy tissue just beyond the line of demarkation, and its point being carried to the deepest part of the border of the indurated area.

7. The permanganate of potassium solution should be used freely in fifteen per cent. solution. I have used one and a half drachms of the pure drug diluted, and would not hesitate to use four times that quantity were it necessary, since it seems to exert no deleterious effect, either locally or generally.

8. The involved area should be dressed by means of lint saturated with fifteen per cent. permanganate of potassium solution. Stimulants should be given according to the indications—i.e., the condition of the pulse. Laxatives, diuretics, and diaphoretics should be administered to aid in the elimination of the poison. The diet should be as nutritious as the stomach can digest.—*The Therapeutic Gazette*.

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CHINESE COMPETITIVE EXAMINATIONS.

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Wuchang, on the Yangtsze opposite Hankow, is the capital of the two provinces Hupeh and Hunan. Here, every third year, the examination for competitors from both provinces is held, and a correspondent of the *North China Herald*, of Shanghai, describes the scene at the examination at the beginning of September last. The streets, he says, are thronged with long-robed, large-spectacled gentlemen, who inform the world at large by every fold of drapery, every swagger of gait, every curve of nail, that they are the aristocracy of the most ancient empire of the world. Wuchang had from 12,000 to 15,000 bachelors of arts within its walls, who came from the far borders of the province for the examination for the provincial degree. About one-half per cent. will be successful; thousands of them know they have not the shadow of a chance, but literary etiquette binds them to appear. In the wake of these Confucian scholars come a rout of traders, painters, scroll sellers, teapot venders, candle merchants, spectacle mongers, *etc*.; servants and friends swell the number, so that the examination makes a difference of some 40,000 or 50,000 to the resident population. In the great examination hall, which is composed of a series of pens shut off from each other in little rows of 20 or 30, and the view of which is suggestive of a huge cattle market, there is accommodation for over 10,000 candidates. The observance of rules of academic propriety is very strict. A candidate may be excluded, not only for incompetence, but for writing his name in the wrong place, for tearing or blotting his examination paper, *etc*. After the examination of each batch a list of those allowed to compete for honors is published, and the essay forms for each district are prepared with proper names and particulars. The ancestors of the candidate for three generations must be recorded, they must be free from taint of *yamen* service, prostitution, the barber's trade and the theater, or the candidate would not have obtained his first degree. With the forms 300 cash (about 1s.) are presented to each candidate for food during the ordeal. The lists being thus prepared, on the sixth day of the eighth moon (Tuesday, the 8th of September, in 1891), the city takes a holiday to witness the ceremony of "entering the curtain," *i.e*., opening the examination hall. For days coolies have been pumping water into great tanks, droves of pigs have been driven into the inclosure, doctors, tailors, cooks, coffins, printers, *etc*., have been massed within the hall for possible needs. The imperial commissioners are escorted by the examination officials to the place. A dozen district magistrates have been appointed to superintend within the walls, and as many more outside, two prefects have office inside, and the governor of the province has also to be locked up during the eight days of examination. The whole company is first entertained to breakfast at the *yamen*, and then the procession forms;

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the ordinary umbrellas, lictors, gongs, feathers, and ragamuffins are there in force; the examiners and the highest officers are carried in open chairs draped in scarlet and covered with tiger skins. The dead silence that falls on the crowd betokens the approach of the governor, who brings up the rear. Then the bustle of the actual examination begins. The hall is a miniature city. Practically martial law is proclaimed. In the central tower is a sword, and misdemeanor within the limits is punished with instant death. The mandarins take up their quarters in their respective lodges, the whole army of writers whose duty it is to copy out the essays of the candidates, to prevent collusion, take their places. Altogether there must be over 20,000 people shut in. Cases have been known in which a hopeful candidate was crushed to death in the crowd at the gate. Each candidate is first identified, and he is assigned a certain number which corresponds to a cell a few feet square, containing one board for a seat and one for a desk. Meanwhile the printers in the building are hard at work printing the essay texts. Each row of cells has two attendants for cooking, *etc*., assigned to it, the candidates take their seats, the rows are locked from the outside, the themes are handed out, the contest has begun. The examination is divided into three bouts of about 36 hours, two nights and a day, each, with intervals of a day. The first is the production of three essays on the four assigned books; the second of five essays on the five classics; the third of five essays on miscellaneous subjects. The strain, as may be imagined, is very great, and several victims die in the hall. The literary ambition which leads old men of 60 and 70 to enter not unfrequently destroys them. Should any fatal case occur, the coffin may on no account be carried out through the gates; it must be lifted over or sometimes through a breach in the wall. Death must not pollute the great entrance. At the end of the third trial, the first batch of those who have completed their essays is honored with the firing of guns, the bows of the officials, and the ministry of a band of music. Three weeks of anxious waiting will ensue before a huge crowd will assemble to see the list published. Then the successful candidates are the pride of their country side, and well do the survivors of such an ordeal deserve their credit. The case of those who are in the last selection and are left degreeless, for the stern reason that some must be crowded out, is the hardest of all.

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HIGH SPEED ENGINE AND DYNAMO.

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We illustrate a high speed engine and dynamo constructed by Easton & Anderson, London. This plant was used at the Royal Agricultural Society's show at Doncaster in testing the machinery in the dairy, and constituted a distinct innovation, as well as an improvement, on the appliances previously employed for the purpose. The separator, or whatever might be the machine under trial, was driven by an electric motor fed by a current from the dynamo we illustrate. A record was made of the volts and amperes used, and from this the power expended was deduced, the motor having been previously carefully calibrated by means of a brake. So delicate was the test that the observers could detect the presence of a warm bearing in the separator from the change in the readings of the ammeter.

[Illustration: IMPROVED HIGH SPEED ENGINE AND DYNAMO.]

The engine is carefully balanced to enable it to run at the very high speed of 500 revolutions per minute. The cranks are opposite each other, and the moving parts connected with the two pistons are of the same weight. The result is complete absence of vibration, and exceedingly quiet running. Very liberal lubricating arrangements are fitted to provide for long runs, while uniformity of speed is provided for by a Pickering governor. The high pressure cylinder is 4 in. in diameter, and the low pressure cylinder is 7 in. in diameter. The stroke in each case is 4 in.

[Illustration: Fig. 2.]

The dynamo is designed to feed sixty lamps of 16 candle power each, the current being 60 amperes at 50 volts. The armature is of the drum type. The peculiar feature of it is that grooves are planed in the laminated core from end to end, and in these grooves the conductors, which are of ribbon section, are laid. Slips of insulating material are laid between the coils and the dovetailed mouths of the grooves are closed with bone or vulcanized fiber, or other dielectric. At each end of the core there are fitted non-magnetic covers. At the commutator end the cover is like a truncated cone, and incloses the connections completely. One end of the cone is supported on the end plate of the armature and the other end on a ring on the commutator. A bell-shaped cover incloses the conductors at the other end of the armature. The result is that the conductors are completely incased, protected from all mechanical injury, and positively driven. They can neither be displaced nor abraded. The conductors on the magnet coils are likewise carefully protected from harm by metal coverings. These dynamos are made in sixteen sizes, of which seven sizes are designed to feed more than 100 lamps, the largest serving for 600 lamps.

[Illustration: Fig. 3.]

Messrs. Easton & Anderson are showing machinery of this type at the Crystal Palace Electrical Exhibition now open in London.—*Engineering*.

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CHLORINE GAS AND SODA BY THE ELECTROLYTIC PROCESS.

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The decomposition of a solution of common salt, and its conversion into chlorine gas and caustic soda solution by means of an electric current, has long been a study with electro-chemists. Experimentally it has often been effected, but so far as we are aware, the success of this method of production has never until now been demonstrated on a sound commercial basis. The solution of this important industrial problem is due to Mr. James Greenwood, who has been engaged in the development of electro-chemical processes for many years. The outcome of this is that Mr. Greenwood has now perfected an electrolytic process for the direct production of caustic soda and chlorine, as well as other chemical products, the operation of which we recently inspected at Phoenix Wharf, Battersea, London. One of the special features in connection with Mr. Greenwood’s new departure is the novel and ingenious method by which the electrolyzed products are separated, and their recombination rendered impossible. This object is attained by the use of a specially constructed diaphragm which is composed of a series of V-shaped glass troughs, fitted in a frame within each other with a small space between them, which is lightly packed with asbestos fiber. Another important feature of the apparatus is a compound anode which consists of carbon plates, with a metal core to increase the conductivity. The anode is treated in a special manner so as to render it non-porous and impervious to attack by the nascent chlorine evolved on its surface. No anode appears ever to have been invented that is at all suitable for working on a large scale, and the successful introduction of this compound anode, therefore, constitutes a marked advance in the apparatus used in electrolytic methods of production.

The apparatus by which the new process is being successfully demonstrated on a working scale has been put up by the Caustic Soda and Chlorine Syndicate, London, and has been in operation for several months past. The installation consists of five large electrolytic vessels, each of which is fitted up with five anodes and six cathodes arranged alternately. The anodes and cathodes are separated by the special diaphragms, and each vessel is thus divided into ten anode or chlorine sections and ten cathode or caustic soda sections. The anodes and cathodes in each vessel are connected up in parallel similar to an ordinary storage battery, but the five electrolytic vessels are connected up in series. The current is produced by an Elwell-Parker dynamo, and the electromotive force required to overcome the resistance of each vessel is about 4.4 volts, with a current density of 10 amperes per square foot of electrode surface. The anode sections, numbering fifty altogether, are connected by means of tubes, the inlet being at the bottom and the outlet at the top of each section. The whole of the cathode sections are connected in the same manner. In commencing operations, the electrolytic vessels are

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charged with a solution of common salt, through which a current of electricity is then passed, thus decomposing or splitting up the salt into its elements, chlorine and sodium. In the separation of the sodium, however, a secondary action takes place, which converts it into caustic soda. An automatic circulation of the solutions is maintained by placing the charging tanks at a slight elevation, and the vessels themselves on platforms arranged in steps. The solutions are pumped back from the lowest vessel to their respective charging tanks, the salt solution to be further decomposed and the caustic soda solution to be further concentrated. The chlorine gas evolved in the fifty anode sections is conveyed by means of main and branch tubes into several absorbers, in which milk of lime, kept in a state of agitation, takes up the chlorine, thus making it into bleaching or chlorate liquor as may be required. If the chlorine is required to be made into bleaching powder, then it is conveyed into leaden chambers and treated with lime in the usual manner. The caustic soda formed in the fifty cathode sections is more or less concentrated according to the particular purpose for which it may be required. If, however, the caustic soda is required in solid form, and practically free from salt, then the caustic alkaline liquor is transferred from the electrolytic vessels to evaporating pans, where it is concentrated to the required strength by evaporation and at the same time the salt remaining in the solution is eliminated by precipitation.

Such is the method of manufacturing caustic soda and chlorine by this process, which will doubtless have a most important bearing upon many trades and manufactures, more particularly upon the paper, soap, and bleaching industries. But the invention does not stop where we have left it, for it is stated that the process can be applied to the production of sodium amalgam and chlorine for extracting gold and other metals from their ores. It can also be utilized in the production of caustic and chlorate of potash and other chemicals, which can be manufactured in a state of the greatest purity. A very important consideration is that of cost, for upon this depends commercial success. It is therefore satisfactory to learn that the cost of production has been determined by the most careful electrical and analytical tests, which demonstrate an economy of over 50 per cent. as compared with present methods. Highly favorable reports on the process have been made by Dr. G. Gore, F.R.S., the eminent authority on electro-chemical processes, by Mr. W.H. Preece, F.R.S., and by Messrs. Cross & Bevan, consulting chemists. Dr. Gore states that the chemical and electrical principles upon which this process is based are thoroughly sound, and that the process is of a scientifically practical character. Should, however, the economy of production even fall somewhat below the anticipations of those who have examined into the process very carefully, it can hardly fail to prove as successful commercially as it has scientifically.

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COMPLETION OF THE MERSEY TUNNEL RAILWAY.

On the 11th of January (says the *Liverpool Daily Post*) will be opened for traffic the new station of the Mersey Tunnel Railway at the bottom of Bold Street. With the completion of the station at Bold Street the scheme may be said to have been brought successfully to a conclusion. It was not until 1879, after the expenditure of 125,000_l._ upon trial borings, that the promoters ventured to appeal to the public for support, and that a company, of which the Right Hon. H. Cecil Raikes, M.P., was chairman, was formed for carrying the project of the Mersey Railway into effect. The experience of the engineers in the construction of the tunnel is not a little curious. It was proved by the borings that the position in which the tunnel was proposed to be bored was not only the most important from the point of view of public convenience, and therefore of commercial advantage, but was from the point of view of engineering difficulty decidedly the most preferable. In this position the cuttings passed through the sandstone rock, although on the Liverpool side the shafts were sunk through a considerable depth through “made” ground, the whole of Mann Island and the Goree being composed of earth and gravel tipped on the old bank of the river. Indeed the miners passed through the cellars of old houses and unearthed old water pipes; excavated through a depth of tipped rubbish on which these houses had evidently been built; and then came upon the former strand of the river, beneath which was the blue silt usually found; then a stratum of bowlder clay; and finally the red sandstone rock. Once begun, the works were pushed forward night and day, Sundays excepted, until January, 1884, when the last few feet of rock were cleared away by the boring machine, and the mayors of Liverpool and Birkenhead met in fraternal greeting beneath the river. The operations gave employment to 3,000 men working three shifts of eight hours each, but were greatly accelerated by the use of Colonel Beaumont’s boring machine, on which disks of chilled iron are set in a strong iron bar made to revolve by means of compressed air. This machine scooped out a tunnel 7 feet in diameter; and by successive improvements Colonel Beaumont attained a speed of 150 feet per week, leaving the old method of blasting far behind. As the machine moved forward the rock behind was broken out to the size of the main tunnel and bricked in in short lengths. One remarkable circumstance in connection with the work is that the boring from the Birkenhead side and the boring from Liverpool were found, when they were completed and joined, to be out of line by only 1 inch.

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This excellent result was attained by careful calculations and experiments with perpendicular wires kept in position by weights, which, to avoid oscillation, were suspended in buckets of water. From shaft to shaft the tunnel is 1,770 yards in length and 26 feet in diameter; but for a length of 400 feet at the James Street and Hamilton Square stations the arch is enlarged to 501/2 feet. The tunnel is lined with from six to eight rings of solid brickwork embedded in cement, the two inner rings being blue Staffordshire or Burnley bricks. For the purpose of ventilation a smaller tunnel, 7 feet in diameter, was bored parallel with the main tunnel, with which it is connected in eight places by cross cuts, provided with suitable doors. Both at Liverpool and at Birkenhead there are two guibal fans, one 40 feet and the other 30 feet in diameter. The smaller, which throw each 180,000 cubic feet of air per minute, ventilate the continuations of the tunnel under Liverpool and Birkenhead respectively, and the larger tunnel under the river. The fans remove together 600,000 cubic feet of air per minute, and by this combined operation the entire air in the tunnel is changed once in every seven minutes. By the use of regulating shutters the air passes in a continuous current and the fans are noiseless. The telegraph and telephone wires pass through the tunnel, thus avoiding the long detour by Runcorn. Probably, as a feat of engineering, the construction of the new station at Bold Street is not inferior to any part of the scheme advanced. Under very singular and perplexing difficulties it could only be proceeded with in its first stages from midnight until six o'clock the following morning, it being of course essential that the traffic at the Central Station should not be interfered with. During these hours, night after night, trenches were cut at intervals of 10 feet across the roadway connecting the arrival platforms at the station, and into these were placed strong balks of timber, across which planks were laid as a temporary roadway. Beneath these planks, which were taken up and put down as required, the rock was excavated to a depth of 9 feet, and the balks supported upon stout props. Then from the driftway or rough boring beneath well holes were bored to the upper excavation, and through them the strong upright iron pillars designed to support the roof of the new tunnel station were passed, bedded and securely fixed in position. No sooner were they *in situ* than the most troublesome part of the task was entered upon, for the balks had then to be removed in order to allow to be placed in position the girders running the length of the new station, and resting on the tops of the upright pillars. From these longitudinal girders cross girders of great strength were placed, and between these were built brick arches, packed above with concrete. This formed the roof of the new station. One portion of it passed under the rails in the station above, and had to be

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constructed without stoppage of the traffic. The rails had consequently to be supported on a temporary steel bridge of ingenious design, constructed by Mr. C.A. Rowlendson, the resident engineer and manager of the company, under whose personal supervision, as representing Sir Douglas Fox, the work has been carried out. With this device the men were enabled to go on in safety although locomotives were passing immediately above their heads. After the completion of the roof the station below was excavated by what is technically called “plug and feather” work—that is to say, by drilling holes into which powerful wedges are driven to split the rock.

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A STEAM STREET RAILWAY MOTOR.

[Illustration: North Chicago Street Railroad Engine]

While in Paris, President Yerkes, of the North Chicago Street Railway Company, purchased a noiseless steam motor, the results in experimenting with which will be watched with great interest. The accompanying engraving, for which we are indebted to the *Street Railway Review*, gives a very accurate idea of the general external appearance. The car is all steel throughout, except windows, doors and ceiling. It is 12 ft. long, 8 ft. wide, and 9 ft. high, and weighs about seven tons. The engines, which have 25 horse power and are of the double cylinder pattern, are below the floor and connected directly to the wheels. The wheels are four in number and 31 in. in diameter. The internal appearance and general arrangement of machinery, *etc*., is about that of the ordinary steam dummy. It will run in either direction, and the exhaust steam is run through a series of mufflers which suppress the sound, condense the steam and return the water to the boiler, which occupies the center of the car. The motor was built in Ghent, Belgium, and cost about $5,000, custom house duties amounting to about $2,000 more.—*The Railway Review*.

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TWENTY-FOUR KNOT STEAMERS.

Probably the most important form of steam machinery is the marine engine, not only because of the conditions under which it works, but because of the great power it is called upon to exert. Naturally its most interesting application is to Atlantic steaming. The success of the four great liners, Teutonic, Majestic, City of Paris and City of New York, has stimulated demand, and the Cunard Company has resolved to add to its fleet, and place two ships on the Atlantic which will outstrip the racers we have named.

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The visitor to the late Naval Exhibition interested in shipping will have remarked at each of the several exhibits of the great firms a model of a projected steamer, intended to reduce the present record of the six days' voyage across the Atlantic—the *ne plus ultra* at this time of steam navigation. To secure this present result a continuous steaming for the six days at 20 knot speed is requisite, not to mention an extra day or two at each end of the voyage. The City of Paris and the City of New York, Furst Bismarck, Teutonic and Majestic are capable of this, with the Umbria and Etruria close behind at 18 to 19 knots. Only ten years ago the average passage, reckoned in the same way as from land to land—or Queenstown to Sandy Hook—was seven days with a speed of 17 knots, the performance of such vessels as the Arizona and Alaska. Twenty years ago the length of the voyage was estimated as seven and a half to eight days at a speed of 16 knots, the performance of such vessels as the Germanic and Britannic of the White Star fleet of 5,000 tons and 5,000 horse power. Thirty years ago the paddle steamer was not yet driven off the ocean, and we find the Scotia crossing in between eight and nine days, at a speed of 13 or 14 knots. In 1858 ten and a half to twelve and a half days was allowed for the passage between Liverpool and New York. So as we recede we finally arrive at the pioneer vessels, the Sirius and Great Western, crossing in fourteen to eighteen days at a speed of 6 to 8 knots. For these historical details an interesting paper may be consulted, "De Toenemende Grootte der Zee-Stoombooten," 1888, by Professor A. Huet, of the Delft Polytechnic School.

Each of the last two or three decades has thus succeeded, always, however, with increasing difficulty, in knocking off a day from the duration of the voyage. But although the present six-day 20 knot boats are of extreme size and power, and date only from the last two or three years, still the world of travelers declares itself unsatisfied. Already we hear that another day must be struck off, and that five-day steamers have become a necessity of modern requirements, keeping up a continuous ocean speed of 231/2 knots to 24 knots. Shipbuilders and engineers are ashamed to mention the word *impossible*; and designers are already at work, as we saw in the Naval Exhibition, but only so far in the model stage; as the absence of any of the well known distinguishing blazons of the foremost lines was sufficient to show that no order had been placed for the construction of a real vessel. It will take a very short time to examine the task of the naval architect required to secure these onerous and magnificent conditions, five days' continuous ocean steaming at a speed of 24 knots.

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The most practical, theory-despising among them must for the nonce become a theorist, and argue from the known to the unknown; and, first, the practical man will turn—-secretly perhaps, but wisely—to the invaluable experiments and laws laid down so clearly by the late Mr. Froude. Although primarily designed to assist the Admiralty in arguing from the resistance of a model to that of the full size vessel, the practical man need not thereby despise Froude's laws, as he is able to choose his mode: to any scale he likes, and he can take his experiments ready made by practice on a large scale, as Newton took the phenomena of astronomy for the illustration of the mechanical laws. Suppose then he takes the City of Paris as his model, 560 ft. by 63 ft., in round numbers 10,000 tons displacement, and 20,000 horse power, for a speed of 20 knots, with a coal capacity of 2,000 tons, sufficient, with contingencies, for a voyage of six to eight days. Or we may take a later 20 knot vessel, the Furst Bismarck, 500 ft. by 50ft., 8,000 tons, and 16,000 horse power, speed 20 knots, and coal capacity 2,700 tons, to allow for the entire length of voyage to Germany.

In Froude's method of comparison the laws of mechanical similitude are preserved if we make the displacements of the model and of its copy in the ratio of the sixth power of the speeds designed, or the length as the square of the speed. Our new 24 knot vessel, taking the City of Paris as a model, would therefore have 10,000 (24 / 20)^{6} = 29,860, say 30,000 tons displacement, and would be 800 ft. x 90 ft. in dimensions. The horse power would have to be as the *seventh* power of the speed, and our vessel would therefore have 20,000 (24 / 20)^{7}, or say 72,000 horse power. Further applications of Froude's laws of similitude will show that the steam pressure and piston speed would have to be raised 20 per cent., while the revolutions were discounted 20 per cent., supposing the engines and propellers to be increased in size to scale. To provide the requisite enormous boiler power, all geometrical scale would disappear; but it would carry us too far at present to follow up this interesting comparison.

Our naval architect is not likely at present to proceed further with this monstrous design, exceeding even the Great Eastern in size, if only because no dock is in existence capable of receiving such a ship. He has however learned something of value, namely, that this vessel, if the proper similitude is carried out, is capable of keeping up a speed of 24 knots for five days with ample coal supply, provided the boilers are not found to occupy all the available space. For it is an immediate consequence of Froude's laws that in similar vessels run at corresponding speeds over the same voyage, the coal capacity is proportionately the same, or that a ton of coal will carry the same number of tons of displacement over the same distance. Thus our enlarged City of Paris would require to carry about 4,000 tons of coal, burning 800 tons a day.

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With the Britannic and Germanic as models of 5,000 tons and 5,000 horse power at 16 knot speed, the 24 knot vessel would require to be of 57,000 tons and 85,000 horse power, to carry sufficient coal for the voyage of 3,000 miles. These enormous vessels being out of the question, the designer must reduce the size. But now the City of Paris will no longer serve as a model, he must look elsewhere for a vessel of high speed, and smaller scale, and naturally he picks out a torpedo boat at the other end of the scale. A speed of 24 knots—and it is claimed even of 25, 26, and 27 knots—has been attained on the mile by a torpedo boat. But such a performance is useless for our mode of comparison, as sufficient fuel at this high speed for ten or twelve hours only at most can be carried—a voyage of, say, 500 miles; while our steamer is required to carry coal for 3,000 miles. The Russian torpedo boat Wiborg, for instance, is designed to carry coal for 1,200 miles at 10 knot speed; but at 20 knots this fuel would last only twenty-seven hours, carrying the vessel 540 miles. It will now be found that with this limited coal capacity the speed of the ordinary torpedo boat must be reduced considerably below 10 knots for it to be able to cross the Atlantic, 3,000 miles under steam. So that, even at a possible speed of 10 knots for the voyage, the full sized 24 knot five-day vessel, of which the best torpedo boat is the model, must have (2.4)^{6}, say 200 times the tonnage, and (2.4)^{7}, or 460 times the horse power. The enlarged Wiborg would thus not differ much from the enlarged City of Paris. A better model to select would be one of the recent dispatch boats, commerce destroyers, or torpedo catchers, recently designed by Mr. W.H. White, for our navy—the Intrepid or Endymion, for instance. The Intrepid is 300 ft. by 44 ft., 3,600 tons, and 9,000 horse power for 20 knot speed, with 800 hours' coal capacity for 8,000 miles at 10 knot speed; which will reduce to 3,000 miles at 16 knots, and 2,000 miles at 20 knots.

The Endymion is 360 ft. by 60 ft., with coal capacity for 2,800 miles at 18 knot speed, or for about 144 hours or six days. The enlarged Endymion for the same voyage of 2,800 miles in five days, or at 211/2 knot speed, would be 44 per cent larger and broader, that is 520 ft. by 86 ft., and of threefold tonnage, and three and a half times, or about 30,000 horse power—about the dimensions of the Furst Bismarck, but much more powerfully engined. This agrees fairly with the estimate in the SCIENTIFIC AMERICAN of 19th Sept, 1891., where it is stated that twenty-two boilers, at a working pressure of 180 lb. on the square inch, would be required, allowing 11/2 lb. of coal per horse power hour.

The Intrepid, enlarged to a 24 knot boat, for the same length of voyage of 3,000 miles, would be 650 ft. by 100 ft., 40,000 tons, and about 45,000 horse power. So now we are nearing the Messrs. Thomson design in the Naval Exhibition of the five-day steamer, 231/2 knot speed, 630 ft. by 73 ft., and 30,000 to 40,000 horse power.

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No one doubts the ability of our shipbuilding yards to turn out these monsters; and on the measured mile, and for a good long distance, we shall certainly see the contract speeds attained and some excelled. But the whole difficulty turns on the question of the coal capacity, and whether it is sufficient to last for even five days or for 3,000 miles. Every effort then must be made to shorten the length of the voyage from port to port; and we may yet see Galway and Halifax, only 2,200 miles apart, once more mentioned as the starting points of the voyage as of old, in the earliest days of steam navigation. In those days the question of fuel supply was a difficulty, even at the then slow speeds, in consequence of the wasteful character of the engines, burning from 7 lb. of coal and upward per horse power hour. Dr. Lardner's calculations, based upon the average performance of those days, justified him in saying that steam navigation could not pay —as was really the case until the introduction of the compound engine.

It is recorded in Admiral Preble's "Origin and Development of Steam Navigation," Philadelphia, 1883, page 160, that the Sirius, 700 tons and 320 horse power, on her return voyage had to burn up all that old be spared on board, and took seventeen days to reach Falmouth. An interesting old book to consult now is Atherton's "Tables of Steamship Capacity," 1854, based as they are upon the performance of the marine engine of the day. Atherton calculates that a 10,000 ton vessel could at 20 knots carry only 204 tons of cargo 1,676 miles, while a 5,000 ton vessel at 18 knots on a voyage of 3,000 miles could carry no cargo at all. Also that the cost per ton of cargo at 16 knots would be twenty times the cost at eight knots, implying a coal consumption reaching to 12 lb. per horse power hour. It is quite possible that some invention is still latent which will enable us to go considerably below the present average consumption of 2 lb. to 11/2 lb. per horse power hour; but at present our rate of progress appears asymptotic to a definite limit.

To conclude, the whole difficulty is one of fuel supply, and it is useless to employ a fast torpedo boat as our model, except at the speed at which the torpedo boat can carry her own fuel to cross the Atlantic. If the voyage must be reduced in time, let it be reduced from six days to four, by running between Galway and Halifax, a problem not too extravagant in its demands for modern engineering capabilities. A statement has recently gained a certain amount of circulation to the effect that the Inman Company was about to use petroleum as fuel, in order to obtain more steam. We have the best possible authority for saying there is not the least syllable of truth in this rumor. It has also been stated that since solid piston valves have been fitted to the Teutonic in lieu of the original spring ring valves, she has steamed faster. This rumor is only partially true. Her record, outward passage, of 5 days 16 hours 31 minutes, was made on her previous voyage. She has, however, since made her three fastest trips homeward.—-*The Engineer*.

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THE MILITARY ENGINEER AND HIS WORK.[1]

By Col. W.R. KING.

[Footnote 1: A lecture delivered before the students of Sibley College, Cornell University, December 4, 1891.—*The Crank*.]

It is not an easy matter to present a dry subject in such an attractive form as to excite a thrilling interest in it, and military science is no exception to this rule. An ingenious military instructor at one of our universities has succeeded in pointing out certain analogies between grand tactics and the festive game of football, which appears to have greatly improved the football, if we may judge from the recent victories of the blue over the red and the black and orange, but it is not so clear that the effect of the union has been very beneficial to military science; and even if such had been the case, I fear there are no similar analogies that would be useful in enlivening the subject of military engineering.

From the earliest times of which we have record man has been disposed to strive with his fellow man, either to maintain his own rights or to possess himself of some rights or material advantage enjoyed by others. When one or only a few men encroach on the rights of others in an organized community, they may be restrained by the legal machinery of the state, such as courts, police, and prisons, but when a whole community or state rises against another, the civil law becomes powerless and a state of war ensues. It is not proposed here to discuss the ethics of this question, nor the desirability of providing a suitable court of nations for settling all international difficulties without war. The great advantage of such a system of avoiding war is admitted by all intelligent people. We notice here a singular inconsistency in the principles upon which this strife is carried on, *viz*.: If it be a single combat, either a friendly contest or a deadly one, the parties are expected to contest on equal terms as nearly as may be arranged; but if large numbers are engaged, or in other words, when the contest becomes war, the rule is reversed and each party is expected to take every possible advantage of his adversary, even to the extent of stratagem or deception. In fact, it has passed into a proverb that “all things are fair in love and war.”

Now one of the first things resorted to, in order to gain an advantage over the enemy, was to bring in material appliances, such as walls, ditches, catapults, scaling ladders, battering rams, and subsequently the more modern appliances, such as guns, forts, and torpedoes, all of which are known as engines of war, and the men who built and operated these engines were very naturally called engineers. It is this kind of an artificer that Shakespeare refers to when he playfully suggests that “’tis the sport to have the engineer hoist with his own petard.”

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The early military engineer has left ample records and monuments of his genius. The walls of ancient cities, castles that still crown many hills in both hemispheres, the great Chinese wall, the historical bridge of Julius Caesar, which with charming simplicity he tells us was built because it did not comport with his dignity to cross the stream in boats, the bridge of boats across the Hellespont, by Xerxes, are all examples of early military engineering. The Bible tells us “King Uzziah built towers at the gates of Jerusalem, and at the turning of the wall, and fortified them.” We may note in passing that the buttresses, battlements, and bartizans with which our modern architects ornament or disfigure churches, peaceful dwellings, and public buildings, are copied from the early works of the military engineer.

Coming down to the military engineers of our own country, we find that one of the first acts of the Continental Congress, after appointing Washington as commander-in-chief, was to authorize him to employ a number of engineers. It was not, however, until 1777 that a number of engineer officers from the French army arrived in this country, and were appointed in the Continental army. General DuPortail was made Chief Engineer, and Colonel Kosciusko, the great Polish patriot, was among his assistants. Other officers of the Continental army were employed on engineering duty; and under their supervision such works as the forts and the great chain barrier at West Point were built, and the siege operations around Boston and Yorktown were carried on.

After the close of the war, in 1794, a Corps of “Artillerists and Engineers” was organized. This corps was stationed at West Point, and became the nucleus of the United States Military Academy. In 1802, by operation of the law reorganizing the army, this corps was divided, as the names would indicate, into an Artillery Corps and Corps of Engineers. The Corps of Engineers consisted of one major, two captains, four lieutenants, and ten cadets. The Artillery Corps was again divided into the Ordnance Corps and several regiments of artillery, now five in number, while the duties of the Corps of Engineers were divided between the Engineer Corps and a Corps of Topographical Engineers, organized at a later date; but on the breaking out of the late rebellion it was deemed best to unite the two corps, and they have so remained until the present time. The Corps of Engineers now consists of 118 officers of various grades, from second lieutenant to brigadier general, of which last grade there is only one officer, the chief of the corps, and it requires something more than an average official lifetime for the aforesaid lieutenant to attain that rank. Hardly one in ten of them ever reach it. Daniel Webster’s remark to the young lawyer, that “there is always room at the top,” will not apply to the Corps of Engineers. The officers are all graduates of the Military Academy, which institution continued as a part of the Corps of Engineers until 1866. The vacancies in the corps are filled by the assignment to it of from two to six graduates each year, and there is attached to the corps a battalion of four companies of enlisted men, formerly called Sappers and Miners, but now known as the Battalion of Engineers.

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We now come naturally to the duties of our military engineer, and here I may remark that these duties are so varied and so numerous that a detailed recital of them would suggest Goldsmith's "Deserted Village:"

> ... "And still the wonder grew
> That one small head could carry all he *ought to know*"

[Never lose sight of fact for the sake of rhyme.]

In general terms, his duties consist of:

1. Military surveys and explorations.

2. Boundary surveys.

3. Geodetic and hydrographic survey of the great lakes.

4. Building fortifications—both permanent works and temporary or field works.

5. Constructing military roads.

6. Pontoniering or building military bridges, both with the regular bridge trains and with improved materials.

7. The planning and directing of siege operations, either offensive or defensive; sapping, mining, *etc*.

8. Providing, testing and planting torpedoes for harbor defense when operating from shore stations.

9. Staff duty with general officers.

10. Improving rivers and harbors.

11. The building and repairing of lighthouses.

12. Various special duties as commissioner of District of Columbia, superintendent military academy, commandant engineer school, instructors at both of these schools, attaches to several foreign legations, for the collection of military information, *etc*.

It would, of course, exceed the proper limits of a single lecture to go into the details of these many duties, but we may take only a passing glance at most of them, and give more special attention to a few that may involve some points of interest. Perhaps the most interesting branch of the subject would be that of permanent fortifications, or what amounts to almost the same thing in this country, sea coast defenses. And here our trouble begins, for, while civil engineers have constant experience to guide them, their roads, bridges, and other structures being in constant use, the military engineer has only now and then, at long intervals, a war or a siege of sufficient extent to furnish data upon which he can safely plan or build his structures. Imagine a civil engineer designing a bridge, road, or a dam to meet some possible future demand, without having seen such a structure used for twenty years or more, and you can form some estimate of the delightful uncertainties that surround the military engineer when called upon to design a modern fort. The proving ground shows him that radical improvements are necessary, but actual service conditions are almost entirely wanting, and such as we have contradict many of the proving ground theories. Thus we have the records of shot going through 25 inches of iron or 25 feet of concrete on the proving

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ground; but such actual service tests as the bombardment of Fort Sumter, Fort Fisher, and the forts at Alexandria contradict this entirely, and indicate that, except for the moral effect, our old forts, with modern guns in them and some additional strengthening at their weaker points, would answer all purposes so far as bombardment from fleets is concerned. This is not saying that the forts are good enough in their present condition, but simply that they can readily be made far superior in strength, both offensive and defensive, to any fleet that could possibly be provided at anything like the same expense, or in fact at any expense that would be justified by the condition of our treasury, either past, present, or probable future. It might be added that a still more serious difficulty in the way of the military engineer, so far as practice and its consequent experiences are concerned, is that for many years past, until quite recently, there have been no funds either for experiments or actual work on fortifications, so that very little has been done on them during the last twenty years.

Without going into the question of the necessity for sea coast defenses, we may assume that an enemy is likely to come into one of our harbors and that it is desirable to keep him out. What provisions must be made to accomplish this, *i.e.*, to secure the safety of the harbors and the millions of dollars' worth of destructible property concentrated at the great trade centers that are usually located upon those harbors? We must first take a look at the enemy and see what he is like before we can decide what will be needed to repel his attack. For this purpose we need not draw on the imagination, but we may simply examine some of the more recent armadas sent to bombard seaports. For example, the fleet sent by Great Britain to bombard the Egyptian city of Alexandria, in 1882. This fleet consisted of eight heavy ironclad ships of from 5,000 to 11,000 tons displacement and five or six smaller vessels; and the armament of this squadron numbered more than one hundred guns of all calibers, from the sixteen inch rifle down to the seven inch rifle, besides several smaller guns. But this fleet represented only a small fraction of England's naval power. During some recent evolutions she turned out thirty-six heavy ironclads and forty smaller vessels and torpedo boats. The crews of these vessels numbered nearly 19,000 officers and men, or about three times the entire number in our navy. Such a fleet, or, more likely, a much larger one, might appear at the entrance say of New York harbor within ten days after a declaration of war, and demand whatever the nation to which it belonged might choose, with the alternative of bombardment.

The problem of protecting our people and property from such attacks is not a new one, and, in fact, most of the conditions of this problem remain the same as they were fifty years ago, the differences being in degree rather than in kind. The most natural thought would be to meet such a fleet by another fleet, but the folly of such a course will become apparent from a moment's consideration. The difficulties would be:

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1st. Our fleet must be decidedly stronger than that of the enemy, or we simply fight a duel with an equal chance of success or failure.

2d. In such a duel the enemy would risk nothing but the loss of his fleet, and even a portion of that would be likely to escape, but we would not only risk a similar loss, but we would also lose the city or subject it to the payment of a heavy contribution to the enemy.

3d. Unless we have a fleet for every harbor, it would be impossible to depend upon this kind of defense, as the enemy would select whichever harbor he found least prepared to receive him. It would be of vital importance that we defend every harbor of importance, as a neglect to do so would be like locking some of our doors and leaving the others open to the burglars.

4th. It might be thought that we could send our fleet to intercept the enemy or blockade him in his own ports, but this has been found impracticable. Large fleets can readily escape from blockaded harbors, or elude each other on the high seas, and any such scheme implies that we are much stronger on the ocean than the enemy, which is very far from the case. To build a navy that would overmatch that of Great Britain alone would not only cost untold millions, but it would require many years for its accomplishment; and even if this were done, there would be nothing unusual in an alliance of two or more powerful nations, which would leave us again in the minority. *Fleets, then, cannot be relied on for permanent defense*.

Again, it may be said that we have millions of the bravest soldiers in the world who could be assembled and placed under arms at a few days' notice. This kind of defense would also prove a delusion, for a hundred acres of soldiers armed with rifles and field artillery would be powerless to drive away even the smallest ironclad or stop a single projectile from one. In fact, neither of these plans, nor both together, would be much more effective than the windmills and proclamations which Irving humorously describes as the means adopted by the early Dutch governors of New York to defend that city against the Swedes and Yankees.

Having considered some of the means of defense that will *not* answer the purpose, we may inquire what means *will be* effective. And here it should be noted that our defenses should be so effective as not only to be reasonably safe, but to be so recognized by all nations, and thus discourage, if not actually prevent, an attack upon our coast.

In the first place, we must have heavy guns in such numbers and of such sizes as to overmatch those of any fleet likely to attack us. These guns must be securely mounted, so as to be worked with facility and accuracy, and they must be protected from the enemy's projectiles at least as securely as his guns are from ours. Merely placing ourselves on equal terms with the enemy, as in case of a duel or an ancient knight's tournament, will not answer, first,

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because such a state of things would invite rather than discourage attack, and secondly, because the enemy would have vastly more to gain by success and vastly less to lose by failure than we would. This can be accomplished much easier than is generally supposed, either by earthen parapets of sufficient thickness or by iron turrets or casements. It is evident that the weight of metal used in these structures may be vastly greater than could be carried on shipboard. Great weight of metal is no objection on land, but, aside from its cost, is a positive advantage. This is evident when we consider the enormous quantity of energy stored in the larger projectiles moving at high velocities. For example, we often hear of the sixteen inch rifle whose projectile weighs about one ton, and this enormous mass projected at a velocity of 2,000 feet per second would have a kinetic energy of 60,000 foot tons, or it would strike a blow equal to that of ten locomotives of 50 tons each running at 60 miles an hour and striking a solid wall. Any structure designed to resist such ponderous blows must, therefore, have enormous weight, or it will be overturned or driven bodily from its foundations. If the armor itself is not thick enough to give the required weight as well as resistance to penetration, the additional stability must be supplied by re-enforcing it with heavy masses of metal or masonry. It is evident, therefore, that *quality* of metal is less important than *quantity*, and that so long as it is sufficiently tough to resist fracture, a soft, cheap metal, like wrought iron or low steel, is better adapted for permanent works than any of the fancy kinds of armor that have been tested for naval purposes. As an illustration of this, we may compare compound or steel-faced armor with wrought iron as follows: The best of the former offers only about one-third greater resistance to penetration than the latter, or 12 inches of compound armor may equal 16 inches of wrought iron, but the cost per ton is nearly double; so that by using wrought iron we may have double the thickness, or 24 inches, which would give more than double the resistance to penetration, in addition to giving double the stability against overturning or being driven bodily out of place. But our guns may be reasonably well protected by earthen parapets without any expensive armor by so mounting them that when fired they will recoil downward or to one side, so as to come below the parapet for loading. This method of mounting is called the disappearing principle, and has been suggested by many engineers, some of whose designs date back more than one hundred years. We may also mount our guns in deep pits, where they will be covered from the enemy’s guns, and fire them at high elevation, so that the shell will fall from a great height and penetrate the decks of the enemy’s ships. This is known as mortar firing, but the modern ordnance used for this purpose is more of a howitzer than a mortar, being simply short rifled pieces arranged for breech loading. All our batteries should, of course, be as far from the city or other object to be protected as possible, to prevent the enemy from firing over and beyond the batteries into the city.

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But, with all these precautions, the enemy might put on all steam and run by us either at night or in a dense fog, and we must have some means of holding him under the fire of our guns until his ships can be disabled or driven away. This object is sought to be accomplished by the use of torpedoes anchored in the channels and under the fire of our guns, so that they cannot be removed by the enemy. These torpedoes are generally exploded by electricity from batteries located in casements on shore, these casements being connected with the torpedoes by submarine cables. It is easy to see how the torpedo may be so arranged that when struck by a ship the electric current will be closed, and, if the battery on shore is connected at the same instant, an explosion will take place; on the other hand, if the battery on shore is disconnected a friendly ship may pass in safety over the torpedoes. Many ingenious contrivances have also been devised by which the torpedo may be made to signal back to the shore station either that it has been struck or that it is in good order for service, in case the enemy should undertake to run over it. One simple plan for this is to have a small telephone in the torpedo with some loose buckshot on the diaphragm, which is placed in a horizontal position, and will be slightly tilted as the torpedo is moved about by the waves. By connecting the shore end of the cable with a telephone receiver, the rolling of the shot may be distinctly heard if the torpedo is floating properly, but if sunk at its moorings, or if the cable is broken, no sound will be heard.

The use of torpedoes involves the use of both electricity and high explosives, and a careful study based upon actual experiments has been carried on for many years, by the engineers and naval officers in all civilized countries. Some of these experiments have supplied interesting and useful data, for the use of the agents in question, for various industrial purposes.

Another form of torpedo is that known as the locomotive torpedo, of which there are several kinds; some are propelled by liquid carbonic acid, which is carried in a strong tank and acts through a compact engine in driving the propeller. One of these is steered by electricity from the shore, and is known as the Lay-Haight torpedo, and can run twenty-five miles per hour. The Whitehead torpedo is also propelled by liquid carbonic acid, but is not steered from shore. Its depth is regulated by an automatic device actuated by the pressure of the water. The Howell torpedo is driven by a heavy fly wheel which is set in rapid rotation just before the torpedo is launched. It has but a short range and is intended for launching from ships. Another torpedo is propelled and steered from shore by rapidly pulling out of it two fine steel wires which, in unwinding, drive the twin screw propellers. This is the Brennan torpedo. The Sims-Edison torpedo is both propelled and steered by electricity from the shore, transmitted to a motor and steering relay in the torpedo by an insulated cable. This cable has two cores and is paid out by the torpedo as it travels through the water just as a spider pays out its web. The cable is about half an inch in diameter and two miles long, and the torpedo can be driven at about eighteen miles per hour with a current of thirty amperes and 1,800 volts pressure.

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Still another auxiliary weapon of defense is the dynamite gun, or rather, a pneumatic gun, that throws long projectiles carrying from 250 to 450 pounds of dynamite, to a distance of about two miles. The shells are arranged to explode soon after striking the water, by an ingenious battery that ignites the fuse as soon as the salt water enters it. The gun, which is known as the Zalinski gun, is some sixty feet long and fifteen inches in caliber, the compressed air being suddenly admitted to it from the reservoirs at any desired pressure by a special form of valve that regulates the range. These guns are to be mounted in deep pits and fired at somewhat higher elevations than ordinary guns, but it has great accuracy within reasonable limits of range.

FIELD FORTIFICATIONS.

In field fortification an enormous quantity of work was done during our last war. Washington, Richmond, Nashville, Petersburg, Norfolk, New Berne, Plymouth, Vicksburg, and many other cities were elaborately fortified by field works which involved the handling of vast quantities of earth, and, where the opposing lines were near together, ditches, abbatis, ground torpedoes, and wire entanglements were freely used. In some cases the same ground was fortified in succession by both armies, so that the total amount of work expended, in this way, would have built several hundred miles of railway. Around Richmond and Petersburg alone the development of field works was far greater than Wellington’s celebrated lines at Torres Vedras. In all future wars, when large armies are opposed to each other, it is probable that field works will play even a more important part than in the past. The great advantage of such works, since the introduction of the deadly breech loading rifles and machine guns, was shown at Plevna, where the Russians were almost annihilated in attempting to capture the Turkish intrenchments.

SIEGES.

It is not proposed to go into historical or other details of this branch of the subject, but to give in a condensed form some account of siege operations. According to the text books, the first thing to be done, if possible, in case of a regular siege, is to “invest” the fortress. This is done by surrounding it as quickly as possible with a continuous line of troops, who speedily intrench themselves and mount guns bearing outward on all lines of approach to the fortress, to prevent the enemy from sending in supplies or re-enforcements. As this line must be at considerable distance from the fort, it is usually quite long, and so is its name, for it is called the line of “Circumvallation.” Inside of this line is then established a similar line facing toward the fort, to prevent sorties by the garrison. This line is called the line of “Countervallation,” and should be as close to the fort as the range of its guns and the nature of the ground will permit. From this line the

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troops rush forward at night and open the trenches, beginning with what is called the first parallel, which should be so laid out as to envelop those parts of the fort which are to be made the special objects of attack. From this first parallel a number of zigzag trenches are started toward the fort and at proper intervals other parallels, batteries, and magazines are built; this method of approach being continued until the besieged fort is reached, or until such batteries can be brought to bear upon it as to breech the walls and allow the attacking troops to make an assault.

During these operations of course many precautions must be observed, both by the attacking and defending force, to annoy each other and to prevent surprise, and the work is mostly carried on under cover of the earth thrown from the trenches. These operations were supposed to occupy, under normal conditions, about forty-one days, or rather nights, as most of the work is done after dark, at the end of which time the fort should be reduced to such a condition that its commander, having exhausted all means of defense, would be justified in considering terms of surrender.

The *Theoretical Journal* of the siege prescribes just what is to be done each day by both attack and defense up to the final catastrophe, and this somewhat discouraging outlook for the defenders was forcibly illustrated by the late Captain Derby, better known by the reading public as “John Phoenix,” who, when a cadet, was called upon by Professor Mahan to explain how he would defend a fort, mounting a certain number of guns and garrisoned by a certain number of men, if besieged by an army of another assumed strength in men and guns, replied:

“I would immediately evacuate the fort and then besiege it and capture it again in forty-one days.”

Of course the fallacy of this reasoning was in the fact that the besieging army is generally supposed to be four or five times as large as the garrison of the fort; the primary object of forts being to enable a small force to hold a position, at least for a time, against a much larger force of the enemy.

Sieges have changed with the development of engines of war, from the rude and muscular efforts of personal prowess like that described in Ivanhoe, where the Black Knight cuts his way through the barriers with his battle axe, to such sieges as those at Vicksburg, Petersburg, and Plevna, where the individual counted for very little, and the results depended upon the combined efforts of large numbers of men and systematic siege operations. It should also be noticed that modern sieges are not necessarily hampered by the rules laid down in text books, but vary from them according to circumstances.

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For example, many sieges have been carried to successful issues without completely investing or surrounding the fortress. This was the case at Petersburg, where General Lee was entirely free to move out, or receive supplies and re-enforcements up to the very last stages of the siege. In other cases, as at Fort Pulaski, Sumter, and Macon, the breeching batteries were established at very much greater distances than ever before attempted, and the preliminary siege operations were very much abbreviated and some of them omitted altogether. This is not an argument against having well defined rules and principles, but it shows that the engineer must be prepared to cut loose from old rules and customs whenever the changed state of circumstances requires different treatment.

MILITARY BRIDGES.

In the movement of armies, especially on long marches in the enemy’s country, one of the greatest difficulties to be overcome is the crossing of streams, and this is usually done by means of portable bridges. These may be built of light trestles with adjustable legs to suit the different depths, or of wooden or canvas boats supporting a light roadway wide enough for a single line of ordinary wagons or artillery carriages. The materials for these bridges, which are known as Ponton Bridges, are loaded upon wagons and accompany the army on its marches, and when required for use the bridge is rapidly put together, piece by piece, in accordance with fixed rules, which constitute, in fact, a regular drill. The wooden boats are quite heavy and are used for heavy traffic, but for light work, as, for example, to accompany the rapid movements of the cavalry, boats made of heavy canvas, stretched upon light wooden frames, that are put together on the spot, are used.

During Gen. Sherman’s memorable Georgia campaign and march to the sea, over three miles of Ponton bridges were built in crossing the numerous streams met with, and nearly two miles of trestle bridges. In Gen. Grant’s Wilderness campaign the engineers built not less than thirty-eight bridges between the Rappahannock and the James Rivers, these bridges aggregating over 6,600 feet in length. Under favorable circumstances such bridges can be built at the rate of 200 to 300 feet per hour, and they can be taken up at a still more rapid rate. When there is no bridge train at hand the engineer is obliged to use such improvised materials as he can get; buildings are torn down to get plank and trees are cut to make the frame. Sometimes single stringers will answer, but if a greater length of bridge is required it may be supported on piles or trestles, or in deep water on rafts of logs or casks. But the heavy traffic of armies, operating at some distance from their bases, must be transported by rail, and the building of railway bridges or rebuilding those destroyed by the enemy is an important duty of the engineer. On the Potomac Creek, in Virginia, a trestle bridge 80 feet high and 400 feet long was built in nine working days, from timber out of the neighborhood. Another bridge across the Etowah River, in Georgia, was built in Gen. Sherman’s campaign, and a similar bridge was also built over the Chattahoochee.

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SURVEYS AND EXPLORATIONS.

For more than half a century before the building of the great Pacific railways, engineer officers were engaged in making surveys and explorations in the great unknown country west of the Mississippi River, and the final map of that country was literally covered with a network of trails made by them. Several of these officers lost their lives in such expeditions, while others lived to become more famous as commanders during the great rebellion. Generals Kearney, J.E. Johnston, Pope, Warren, Fremont and Parke, and Colonels Long, Bache, Emory, Whipple, Woodruff and Simpson, Captains Warner, Stansbury, Gunnison and many other officers, generally in their younger days, contributed their quota to the geographical knowledge of the country, and made possible the wonderful network of railways guarded by military posts that has followed their footsteps. Their reports fill twelve large quarto volumes.

BOUNDARY AND LAKE SURVEYS.

The astronomical location of the boundaries of the several States and Territories, as well as of the United States, is a duty frequently required of the engineer officer, and such a survey between this country and Mexico is now in progress. The entire line of the 49th parallel of latitude from the Lake of the Woods to the Pacific Ocean, which forms our northern boundary, was located a few years ago by a joint commission of English and United States engineers, and monuments were established at short intervals over its entire length.

A careful geodetic and hydrographic survey of the Great Northern Lakes, including every harbor upon them and the rivers connecting them, was carried on for many years and was finally completed some ten years ago. Maps and charts of these surveys are published from time to time for use of pilots navigating these waters.

Not only are the duties of the military engineer similar in many respects to those of the civil engineer, but there are many instances in which the duties of one branch of the profession have been performed by members of the other branch, quite as efficiently as though they had been performed by engineers specially educated for the purpose. During the late civil war there were many illustrations of this, all showing that an ingenious engineer can readily adapt himself to circumstances entirely different from those to which he has been accustomed. A very good example of this occurred in the Red River expedition of General Banks and Admiral Porter. In that memorable but disastrous campaign an army accompanied by a fleet of transports and light draught gunboats, sometimes called “tin clads” because some parts of them were covered with boiler plate to stop the bullets of the enemy, ascended the Red River in Louisiana; but the advance having been checked and a retreat commenced, it was found that the river had fallen

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to such a low state that the fleet was caught above the rapids near Alexandria, and it would in all probability have been a complete loss had it not been for the timely application of engineering skill by Lieut. Col. Joseph Bailey, a civil engineer from Wisconsin, who built a temporary dam across the river below the rapids and floated out the entire fleet. This dam was over 750 feet long and in connection with some auxiliary dams raised the water level some 61/2 feet. It was built under many difficulties, but by the skill and ability of the engineer and the co-operation of the troops it was completed in ten days. Another case was at the siege of Petersburg, Va., where Lieut. Col. Pleasants, a Pennsylvania coal miner, ran a gallery from our lines, under the rebel battery, some 500 feet distant, and blew it entirely out of existence. The mine contained four tons of powder and produced a crater 200 feet by 50 feet and 25 feet deep, and was completed in one month. The sequel to this was to be an attack on the enemy's line through the gap made by the explosion, and such an attack properly followed up would doubtless have had a marked effect in shortening the duration of the war, but this attack was so badly managed that it utterly failed and caused a severe loss to our own army. The mine itself, however, was a great success and produced a decided moral effect on both sides which lasted until the end of the war.

It may be out of place to digress a moment to illustrate the moral effect of such a convulsion. Several weeks after this great mine explosion, the 18th Army Corps, to which I then belonged, was holding a line of works recently captured from the rebels, about six miles from Richmond, when one night the colonel commanding Fort Harrison, a large field work forming a part of this line, came down to headquarters and reported that some old Pennsylvania coal miners in his command had heard mining going on under the fort. As the nearest part of the enemy's line was some 400 yards from the fort, I was quite certain that they could not have run a gallery that distance in the time that had elapsed since we occupied the work, but there was of course the possibility that the mine had been partly built beforehand so as to be ready in just such a case as had arisen, *viz*., the capture of the fort by our troops. I therefore went with the colonel up to the fort to listen for the mining operations, and got the men who claimed to have heard the subterranean noises, down in the bottom of the ditch of the fort, which was ten feet deep, and at the angles formed a fairly good listening gallery, but nothing unusual could be heard. I therefore made arrangements to sink a line of pits in the bottom of the ditch, something like ordinary wells; the bottoms of these pits to be finally connected by a horizontal gallery which would envelop the fort and enable us to hear the enemy and blow him up, before he could get under the fort. Although the commanding officer

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of that fort was as brave an officer as the war developed, he would not keep his men in the fort after dark, but withdrew them quietly to the flanks of the work, where they not only would be safe from an explosion, but would be ready to fall upon the enemy in case he should blow up the fort and rush in to capture the line, as our troops had attempted to do at Petersburg. No explosion took place, however, and after our countermining work was completed, the garrison became reassured and remained in the fort at night as well as in day time. A few months later, when the enemy was driven from his lines, I went through his works to see whether any mining had been attempted, and found that a gallery leading toward Fort Harrison had been carried quite a distance, but was still incomplete, and it is barely possible that the old miners were right, after all, in thinking that they could hear the sound of the pick, although the distance was almost too great to make this theory very probable.

Still another illustration of the way in which civil engineers can make themselves extremely useful in military operations was the wonderful system of military railways, or railways operated for military purposes, that formed complete lines of transportation for the armies and their enormous quantities of supplies and munitions, more especially those in the West and Southwest. Construction trains were organized in the most complete style, and when a piece of track or a number of bridges were destroyed by the enemy, they would be rebuilt so rapidly that our trains would hardly seem to be delayed by it. The trains carried spare rails, ties, and bridges of various lengths ready to put up, and they also carried the necessary rolling stock and tools for destroying the roads and bridges of the enemy. So expert had this construction corps become that the enemy was ready to believe almost any statement in regard to it. General Sherman tells of an instance where it was proposed to blow up a tunnel, to check his “March to the Sea,” when one of the men objected, saying it was of no use, for Sherman had a duplicate tunnel in his train.

Although this is not a sermon, it may not be out of place to point out a few qualifications common to all engineers, for they all deal more or less with the same materials and forces and employ similar methods of investigation and construction. Wood, iron, steel, copper and stone and their compounds are the materials of the civil, mining, mechanical and electrical, as well as of the military engineers. They all deal with the forces of gravitation, cohesion, inertia and chemical affinity. They all require skill, intelligence, industry, confidence, accuracy, thoroughness, ingenuity and, beyond all, sound judgment. Wanting in any one of these qualifications, an engineer is more or less disqualified for important work. It is said that a distinguished engineer was always afraid to cross his own bridges, although built in the most thorough and approved manner. He was deficient in confidence. Another engineer distinguished for his mathematical attainments built a bridge which promptly collapsed at the first opportunity. On overhauling his computations he ejaculated somewhat forcibly, “That confounded minus sign! It should have been plus." He was deficient in sound judgment, or what is sometimes called "horse sense."

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Another and more common defect in young engineers is a want of thoroughness. It is generally best to go to the bottom of a question at first and keep at it until it is thoroughly and fully completed. Confucius says, “If thou hast aught to do, first consider, second act, third let the soul resume her tranquillity.” Those who begin a great many things and never fully complete them lose a great deal of valuable time, but do very little valuable work. The way to avoid this difficulty is to be cautious about beginning things, but when once started don’t leave it until you are satisfied to leave it for good. There is an Arabian saying, “Never undertake *all* you can do, for he who undertakes *all* he can do will frequently undertake *more* than he can do.”

Another common error is extravagance. On the plea that “the best is always the cheapest,” and to be sure of a large factor of safety, or as the late Mr. Holley called it a “factor of ignorance,” without much trouble to themselves, some engineers use more or better materials than the work requires, and thus greatly increase the cost without any corresponding advantage. Almost any engineer can do almost anything in the way of engineering if not limited by the cost, but the man who knows just what materials to use and how to use them so that they will answer the purpose as to strength and durability can save his own salary to his employer many times over by simply omitting unnecessary expense.

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HOW MECHANICAL RUBBER GOODS ARE MADE.

While the manufacture of rubber goods is in no sense a secret industry, the majority of buyers and users of such goods have never stepped inside of a rubber mill, and many have very crude ideas as to how the goods are made up. In ordinary garden hose, for instance, the process is as follows: The inner tubing is made of a strip of rubber fifty feet in length, which is laid on a long zinc-covered table and its edges drawn together over a hose pole. The cover, which is of what is called “friction,” that is cloth with rubber forced through its meshes, comes to the hose maker in strips, cut on the bias, which are wound around the outside of the tube and adhere tightly to it. The hose pole is then put in something like a fifty foot lathe, and while the pole revolves slowly, it is tightly wrapped with strips of cloth, in order that it may not get out of shape while undergoing the process of vulcanizing. When a number of these hose poles have been covered in this way they are laid in a pan set on trucks and are then run into a long boiler, shut in, and live steam is turned on. When the goods are cured steam is blown off, the vulcanizer opened and the cloths are removed. The hose is then slipped off the pole by forcing air from a compressor between the rubber and the hose pole. This, of course, is what is known as hose that has a seam in it.

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For seamless hose the tube is made in a tubing machine and slipped upon the hose pole by reversing the process that is used in removing hose by air compression. In other words, a knot is tied in one end of the fifty foot tube and the other end is placed against the hose pole and being carefully inflated with air it is slipped on without the least trouble. For various kinds of hose the processes vary, and there are machines for winding with wire and intricate processes for the heavy grades of suction hose, *etc*. For steam hose, brewers', and acid hose, special resisting compounds are used, that as a rule are the secrets of the various manufacturers. Cotton hose is woven through machines expressly designed for that purpose, and afterward has a half-cured rubber tube drawn through it. One end is then securely stopped up and the other end forced on a cone through which steam is introduced to the inside of the hose, forcing the rubber against the cotton cover, finishing the cure and fixing it firmly in its place.

CORRUGATED MATTING.

After the mixing of the compound and the calendering, that is the spreading it in sheets, the great roll of rubber and cloth that is to be made into corrugated matting is sent to the pressman. Here it is hung in a rack and fifteen or twenty feet of it drawn between the plates of the huge hydraulic steam press. The bottom plate of this press is grooved its whole length, so that when the upper platen is let down the plain sheet of rubber is forced into the grooves and the corrugations are formed. While in that position steam is let into the upper and lower platens and the matting is cured. After it has been in there the proper time, cold water is let into the press, it is cooled off, and the upper platen being raised, it is ready to come out. A simple device for loosening the matting from the grooves into which it has been forced is a long steel rod, with a handle on one hand like an auger handle, which, being introduced under the edge and twisted, allows the air to enter with it and releases it from the mould.

PACKING.

Sheet packing is often times made in a press, like corrugated matting. The varieties, however, known as gum core have to go through a different process. Usually a core is squirted through a tube machine and the outside covering of jute or cotton, or whatever the fabric may be, is put on by a braider or is wrapped about it somewhat after the manner of the old fashioned cloth-wrapped tubing. The fabric is either treated with some heat-resisting mixture or something that is a lubricant, plumbago and oil being the compound. Other packings are made from the ends of belts cut out in a circular form and treated with a lubricant. There are scores of styles that make special claims for excellences that are made in a variety of ways, but as a rule the general system as outlined above is followed.

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JAR RINGS.

The old fashioned way of making jar rings was first to take a large mandrel and wrap it around with a sheet of compounded rubber until the thickness of the ring was secured. It was then held in place by a further wrapping of cloth, vulcanized, put in a lathe and cut up into rings by hand. That manner of procedure, however, was too slow, and it is to-day done almost wholly by machinery. For example, the rubber is squirted out of a mammoth tubing machine in the shape of a huge tube, then slipped on a mandrel and vulcanized. It is then put in an automatic lathe and revolving swiftly is brought against a sharp knife blade which cuts ring after ring until the whole is consumed, without any handling or watching.—*India Rubber World*.

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HOW ENAMELED LETTERS ARE MADE.

The following is a description of a brief visit by a representative of the *Journal of Decorative Art* to the new factory of the Patent Letter and Enamel Company, Ltd., situate in the East End of London.

The company have recently secured a large freehold plot in the center of the East End of London, and have built for themselves a most commodious and spacious factory, some hundreds of feet in length, all on one floor, and commanded from one end by the manager’s office, from whence can be seen at a glance the entire premises.

The works are divided into two large compartments, and are lighted from the roof, ample provision being made for ventilation, and attention being given to those sanitary conditions which are, or should be, imperative on all well managed establishments.

We first explore the stockroom. Here are stored the numerous dies, of all sizes and shapes, which the company possess, varying in size from half an inch to twelve or sixteen inches. Here, too, is kept the large store of thin sheet copper out of which the letters are stamped. Our readers are familiar with the form or principle upon which these letters are made. It is simply a convex surface, the reverse side being concave, and being fixed on to the glass or other material with a white lead preparation. When these letters were first made, the practice was to cut or stamp them out in flat copper, and then to round or mould them by a second operation. Recent improvements in the machinery, however, have dispensed with this dual process, and the stamping and moulding is done in the one swift, sharp operation.

The process of making an enameled letter has four stages—stamping, enameling, firing, and filing. There are other and subsequent processes for elaborating, but those named are of the essence of the transaction.

STAMPING.

The stamping is done by means of presses, and is a very rapid and complete operation.

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The operator takes a piece of the sheet copper, places it on the press, the lever descends, there is a sharp crunching, bursting sound, and in a time shorter than it has taken to describe, the letter is made, sharp and perfect in every way.

ENAMELING.

The letters are now taken charge of by a girl, who lays them out on a wire tray, the hollow side up, and paints them over with a thin mordant. While they are in this position, and before the mordant dries, they are taken on the gridiron-like tray to a kind of large box, which is full of the powdered enamel, and, holding the tray in her left hand, the girl takes a fine sieve full of the powder and dusts it over the letter, all superfluous powder falling through the open wirework and into the bin again, so that there is absolutely no waste.

[Illustration: DUSTING THE LETTERS BEFORE FIRING.]

FIRING.

The letters are now taken and placed carefully on thin iron disks or plates on the bench, where they remain until they are fired. It will be remembered that we said at the outset that the factory was divided into two large compartments, and it is into the second of these that we now go.

Here are ranged the series of furnaces which convert the copper and superincumbent enamel into one common body—fuse the one into the other. An unwary step soon warns us that we are too near the furnace, unless we want to run the risk of a premature cremation, and in the interests of the readers of this journal we step back to a respectful and proper distance, and watch the operations from afar.

There seems to be something innately picturesque about all furnaces and those who work about them. Whether it is the Rembrandt effects produced by the strong light and shade, or whether it is that the necessary use of the long iron instruments, such as all furnace workers employ, compels a certain dignity and grace of poise and action, we know not; but certain it is that the grace is there in a marked degree, and as we watched the men take their long-handled iron tongs and place in or lift out the plates of hot metal, we could not fail to be impressed with the charm of the physical action they displayed.

The disk containing the enameled letters is taken at the end of a long iron handle and carefully placed in a dome-shaped muffle. These muffles are all heated from the outside; that is, the fire is all round the chamber, but not in it, the fumes of the sulphur being destructive of the enamel if they are allowed to come into contact with it. So intense is the heat, however, that a muffle lasts only about nine days, and at the end of that time has to be renewed.

[Illustration: FIRING THE LETTERS]

After the enamel is fused on to the copper, the disk is taken out and placed on a side slab, where it is allowed to cool.

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This process is repeated on the front side of the letter, when all that remains to complete it is

THE FILING.

[Illustration: FILING THE LETTERS AFTER ENAMELING.]

This is done by girls, who, with very fine files, rub off the edges and any protuberances which may be there. Every letter is subject to this operation, and all are turned out smooth and well finished.

Sometimes the letters are colored or further defined by the addition of a line, but the essentials are as we have already described.

[Illustration: MIXING THE ENAMEL]

BRUSHING OUT.

There are, however, one or two other operations of interest which we may notice. The company do not confine their exertions to the making of letters, various collateral developments having taken place which fill an important part in this scheme of work.

Of these, small tablets, containing advertisements or notices, such as we see in railway carriages, “Push after raising window,” or “Close this door after you,” or some legend pertaining to Brown’s Soap or Robinson’s Washing Powder. These are done by different processes, the transfer process, as used in the potteries, being employed, but the one most largely used is that of “brushing out,” which is done by plates.

Let us suppose that the tablet shows white letters on a dark ground, the *modus operandi* is as follows:

The tablet has been enameled, as already described, and is white. The operator now takes a dark enamel and spreads it evenly over the entire surface of the tablet. He, or she, now takes a stencil plate, of tinfoil, out of which the ground is cut, leaving the letter in the center.

This is carefully placed over the tablet and held tight with the left hand, while with the right hand he holds a fine brush, which he uses with a quick, sharp movement over the surface. This action readily removes the unfired color from the hard, glassy surface underneath, and leaves a white letter. This is fired, and is then complete.

Sometimes two and, it may be, three plates are necessary to complete the brushing out, as ties must be left, as in the case of ordinary stencils, and these have to be brushed out with additional plates. Two or three colors may be introduced by this process, but each separate color means separate firing. If the letters are dark on a light ground, the process is exactly the same, the stencil only being modified. In addition to the letters and tablets thus described, the company also undertake the production of large enameled signs, and to cope with the rapid expansion of this department of their work they are erecting special furnaces, to enable them to deal with any demand likely to be made upon them. The call for things permanent and washable in the way of advertising is on the increase, and the enameled plates made by the company is one of the most successful ways of meeting the demand.

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[Illustration: “THE SMITH A MIGHTY MAN IS HE.”]

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BURNING BRICK WITH CRUDE OIL FUEL.

At the present time there is not the least reason why either wood, coal, or any other solid fuel should be used for the burning of brick. This style of burning brick belongs to a past age. The art of brickmaking has made tremendous progress during the past quarter of a century. It is no longer the art of the ignorant; brains, capital, experience, science, wide and general knowledge, must in these days be the property of the successful brick manufacturer. There are some such progressive brick manufacturers in Chicago, who use neither coal nor wood in the drying or burning of their clay products. Crude oil is the fuel which they employ, and with this fuel they obtain cheaper and better brick than do manufacturers who employ solid fuel. Some of these manufacturers have expressed themselves as preferring to quit the brick business rather than return to the use of wood or coal as fuel in brick burning.

This shows plainly that progress in our art, when it does come, comes to remain. It is true that crude oil for brick-burning purposes is not everywhere obtainable. But there is a fuel which is even better than crude oil, namely, fuel gas, and which can be produced and employed on any brick yard at a saving of seventy-five per cent. over coal or other solid fuel.

The Rose process for making fuel gas gives a water gas enriched by petroleum. Roughly, about half the cost of this gas as made at Bellefonte, Pa., was for oil. The gas cost 6.68c. per 1,000 cu. ft., with oil at 21/4c. a gallon. At double this price the gas would cost but 10c., and show that in practice, foot for foot, it equals natural gas.

Fuel gas means a larger investment of capital than does any of the other modes of brick burning, and is, therefore, not within the reach of the entire trade. The cost of appliances for burning brick with crude oil is not very large, and as all grate bars, iron frames, and doors can be dispensed with in the use of crude oil fuel, the cost of an oil-burning equipment is but little in excess of an equipment of grates, *etc*., for coal-burning kilns.

At works using small amounts of fuel, especially if cost of fuel bears but a small proportion to total cost of the manufactured product, oil will be in the future very largely used. It is clean, as compared with coal, can be easily handled, and when carefully used in small quantities, is safe. There are several methods of burning oil that are well adapted to the use of brick manufacturers and other fuel consumers.

The Pennsylvania Railroad made some very thorough experiments on the use of petroleum in their locomotives, and while the results obtained are reported to have been satisfactory, it was the opinion of those having the experiments in charge that the demand for the Pennsylvania Railroad alone, were it to change its locomotives from coal to oil, would consume all the surplus and send up the price of oil to a figure that would compel a return to coal.

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It is true that production has enormously increased in the last three years, and the promise for the near future is that a high rate will be maintained. It is further true that the production of Russia has increased enormously, and will probably be larger this year than ever before. This Russian oil must go to markets and supply demands that have been met by American oil, and this will still further increase the amount of oil available for fuel purposes.

There is no doubt, therefore, that petroleum has a future for fuel uses. Many brick manufacturers are ready to use it, notwithstanding the possibility of an advance in its cost.

While there are some objections to the use of petroleum as a fuel, growing chiefly out of the risk attending its storage and conveyance to the point of consumption, it is undoubtedly true that the chief objection is the fear that with the increased demand that would follow any extended use for this purpose would come an increase in price that would make its continued use too expensive.

Just four years ago, when the fuel oil industry was first projected, it was cried down because, as its enemies claimed, there was not enough oil fuel to be obtained in America to supply the New York City factories alone, to say nothing of other territory, and because of the high prices for oil that were sure to follow its substitution for coal fuel. Since then the industry has experienced a magnificent success, the sales exceeding 20,000,000 barrels a year, while the price is lower than ever.

A curious impression seems to have gained ground to the effect that the Standard Oil Company does not want to sell oil for fuel. It may be stated authoritatively that the company is not only able but willing to sell and deliver oil for fuel purposes in any quantity that may be desired. It is now delivering oil for fuel purposes in fourteen States of the Union. For its sales in Chicago and the West and Northwest, the delivery is by tank cars from the terminus of the pipe line at South Chicago, to which point it is pumped from Lima, O. The Chicago price is 1-2/3c. per gallon, or 70c. per barrel of 42 gallons, f.o.b. cars at Chicago.

A great many of the brick manufacturers here and throughout the Northwest are beginning to use crude petroleum as a substitute for soft coal. It is smokeless, for the fine spray of oil which comes from the injector consists of such minute drops of the liquid and is so thoroughly mixed with oxygen that when it burns the combustion is complete, and only steam and carbonic acid gas go out of the top of the kiln. Not a speck of soot comes from the kiln or the smokestack or soils the whitewashed purity of the boiler room. Oil fuel is absolutely clean. It is labor saving, too. No fireman has to keep shoveling coal, there are no ashes to be dragged out from under the furnace grates, and there are no clinkers to clog up the bars. One man, by turning a valve, may regulate the heat of a kiln containing one million brick.

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Not only is it cleaner than coal and calls for less labor, but it is actually cheaper as a fuel. A barrel and a half of crude oil is equal for furnace fuel to a ton of the best Illinois bituminous coal, and at 70c. a barrel any one can easily calculate the advantages petroleum has over its smoky rival. Theoretically, two barrels of oil equal in heating power one ton of best Pittsburg coal.

An examination into the relative cost of the Pittsburg and Chicago coal to the oil consumed shows that the price of oil at Pittsburg is 59c. per barrel of 42 gallons, and slack coal can be purchased at from 70c. to 80c. per ton, and the best quality of lump coal at from $1.10 to $1.25 per ton, while the same quality of fuel can be bought in Chicago at about 70c. a barrel, as against coal at from $2 to $3.50 per ton. It would, therefore, look as though there could be no question whatever as to the economy and advantages to be derived from the use of oil as a fuel in this vicinity.

The weight of oil required is less than half that of average coal to produce the same amount of steam.

A great advantage in using oil as fuel in brick burning is that the fires are always under the absolute and direct control of the man in charge of the burning, who can regulate the volume of flame to the nicest degree and throw the heat to any part of the arches that he may desire.

From present indications, oil will be the fuel adopted generally for generating power and for brick burning in Chicago, as it saves the boilers, avoids grate bars, saves dirt and cinders, and reduces running expenses, *etc*.

Much skepticism was at first exhibited in Chicago only a few years ago when one of the leading brick manufacturers attempted to burn a kiln of brick with coal for fuel. Nearly all the brickmakers then in business put on wise looks and predicted the failure of the experiment with coal. But coal proved to be a better and cheaper fuel than wood, and in five or six years wood was used only for the kindling of the coal fires.

Then came the attempt to burn brick with crude oil, and the experiment having proved a success, coal has been banished from the leading brick yards in Chicago and vicinity.

The Purington-Kimball Brick Co., Adams J. Weckler, Weber & La Bond, the May-Purington Brick Co., the Union Brick Co., and the Pullman Brick Co., all having headquarters in Chicago, as well as the Peerless Brick Co. and the Pioneer Fireproof Construction Co., both of Ottawa, Ill., are using crude oil fuel for brick burning.

Lima crude oil is used, and it is atomized by means of steam in small furnaces extending about two feet from the face of the brick kilns, and in which furnaces combustion occurs, and the conversion of the oil and steam into a gaseous fuel is secured. There is little doubt that the fuel employed in the future by the successful brick manufacturer must be in the gaseous form. Owing to the enormous cost of handling

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coal, wood, and other crude fuel, and of removing the ash resulting from such fuel, it has been demonstrated in practice by the use of crude oil that the expense connected with the burning of brick can be reduced fully 60 per cent. This large saving is made by converting crude petroleum into gas and utilizing this fuel, either directly in the arches of the kiln or by converting the crude oil into gas in a gas producer, and drawing this fuel gas from the producer and burning the same as required in kilns of suitable construction.

Crude oil fuel must in the future play an important part in all branches of manufacture requiring high, constant heats, and in which the cost of wood, coal, and other solid fuels, together with the labor cost of handling them, forms a considerable part of the cost of production. Where coal is required to be hauled in carts from the wharves, or from a line of railway to the brick yard, located a mile, more or less, from the places where the coal is received, the cost of handling, haulage, and waste is an important item. Added to these costs, the deterioration of soft coal under atmospheric influences and the waste from imperfect combustion and from the particles which fall from the grate bars into the ash pits, all eat a large hole in the brickmakers' profit.

Mr. D.V. Purington, of Chicago, Ill., in speaking on this subject, says:

"I will say that my fuel bill for oil is cheaper than it would cost me for coal. There is a very wide difference in the cost of unloading, hauling away ashes and cinders, and getting my coal around to the kiln, or boilers, or drier, or wherever I use it, and I get very much better results by being able to put the heat from oil fuel just where I want it."

In order to secure the best results with any fuel it is not only necessary that a cheap fuel should be used, but that it should be always obtainable, and that all of it should be burned and turned to commercial account in the operations of brick manufacture.

Owing to the losses which we have previously mentioned, and resulting from the use of coal, this fuel is destined to be superseded by some form of fuel which will avoid such losses, and which will dispense with all of the inconveniences now encountered in the handling of coal and of the ashes resulting from combustion. Wood is rapidly becoming too scarce and high near the great centers of man's habitation to be regarded in the present discussion.

Fully two hundred million of brick a year are being burned in the city of Chicago with crude oil fuel, and a clamp kiln containing one million brick can be burned with crude oil in Chicago at a labor cost of less than $100, and at a total cost for labor and oil of about 40c. per thousand brick.

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There are not, however, many places in the world where brick can be burned with oil at such a low cost as in the city of Chicago; the reason being that oil is not everywhere obtainable so cheaply as in this city, and because few clays in the world are so easily burned into brick as are the clays of Chicago. In Milwaukee, Wis., and in other places within a distance of 100 miles from Chicago, the time required to burn building brick with crude oil fuel averages from sixteen to twenty-one days, whereas the time of burning the Chicago clays averages only about five days, and splendid “burns” have been secured there with crude oil in three and one-half days. It is evident, therefore, that the advantages of using crude oil fuel for the burning of brick will vary in different parts of the United States.

Where circumstances and the nature of the clay permit of its use, crude oil is, next to fuel gas, the brickmakers’ ideal fuel.—*The Brickmaker*.

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INVESTIGATION OF A MOUND NEAR JEFFERSON CITY, MO.

By A.S. LOGAN.

Recently, a party consisting of engineers and employes of the Missouri River Improvement Commission began an exploration of one of the mounds, a work of a prehistoric race, situated on the bluff, which overlooks the Missouri River from an elevation of one hundred and fifty feet, located about six miles below Jefferson City.

This mound is one of about twenty embraced in a circle one quarter of a mile in diameter.

The above party selected the mound in question apparently at haphazard; all the mounds presenting nearly a uniform outline, differing only in size and mostly circular in form, and from twenty to twenty-four feet at the base, rising to a height of eight feet and under. A trench was cut on a level with the natural soil, penetrating the mound about eight feet. A stone wall was encountered which was built very substantially, making access in that direction difficult, in consequence of which the earth was removed from the top for the purpose of entering from that direction. The earth was removed for a depth of four feet, when the top of the wall was exposed. Further excavation brought to light human bones, some of them fairly well preserved, especially the bones of the legs. On the removal of these and a layer of clay, another layer of bones was exposed, but presenting a different appearance than the first, having evidently been burned or charred, a considerable quantity of charcoal being mixed with the bones. In this tier were found portions of several skulls, lying close together, as if they had been interred without regard to order. They were, in all probability, detached from the body when buried.

The portions of the skulls found were those of the back of the head, no frontal bones being discovered. Some jaw bones with the teeth attached were among the remains, but only that portion of the jaw containing the molar teeth.

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A few pieces of flint weapons were found in the upper layers, and nothing else of any significance.

At this juncture the diggers abandoned the search, and some days later the writer, desirous of seeing all that was to be seen, resumed the work and removed the earth and remains until the bottom of the vault was reached; several layers being thus removed. All of these had evidently been burned, as charcoal and ashes were mixed with the bones of each succeeding layer. The layers were about an inch in thickness, with from two to four inches of earth between, and small flat stones, about the size of a man's hand, spread on each different layer, as if to mark its division from the next above.

Between the bottom layers, mixed with charcoal, ashes and small portions of burned bones were found what gives value to the search, numbering about fifty tools and a smoking pipe.

The material of the tools is the same as the rock forming the vault, locally known as "cotton rock." I would consider it a species of sandstone.

Overlying the edge of "cotton rock" in the bluff is flint in great quantities, and in every conceivable shape, that these people could have resorted to had they been so disposed, and why they used the softer material I will leave to some archaeologist to determine. The tools themselves are made after no pattern, but selected for their cutting qualities, as they all have a more or less keen edge which could be used for cutting purposes, and were no doubt highly prized, as they were found all in a pile in one corner of the vault and on top of which was found a stone pipe. The pipe is made bowl and stem together, and it is curious that people of such crude ideas of tools and weapons should manufacture such a perfect specimen of a pipe. It is composed of a very heavy stone, the nature of which would be difficult to determine, as it is considerably burned.

A description of the vault will be found interesting to many. The wall of the vault rests upon the natural surface of the ground, about three feet high and eight and a half feet square, the inside corners being slightly rounded; it is built in layers about four inches in thickness and varying in length upward to three feet, neither cement nor mortar being used in the joints; the corners formed a sort of recess as they were drawn inward to the top, in which many of the stones were found. The stone for constructing the vault was brought from a distance of about a quarter of a mile, as there is none in sight nearer.

I assume from all these circumstances that these people lived in this neighborhood anterior to the age of flint tools, as the more recent interments indicate that they were then entering upon the flint industry, and it may be that the "cotton rock" had become obsolete.

These people buried their dead on the highest ground, covering and protecting them with these great mounds, when it would seem much easier to bury as at the present day; but instead, they, with great labor, carried the rock from a great distance, and it is reasonable to suppose, also, that the earth was brought from a distance with which they are surrounded, and piled high above, as there is no trace of an immediate or local excavation.

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In my view from the mounds and their surroundings I would unhesitatingly say the water, the foot hills of the glacier and the swamps left in its wake were but a short distance to the north of them, and during the summer months the melting ice would send a volume of water down this valley that the Missouri River of to-day is but a miniature of, and therefore the highest hills were the only land that could be used by that ancient race.

In this connection I would make the following suggestions that may lead to more important disclosures: My object is the hope of a more thorough investigation at some future time. Nearer to the top of the mound was found, certainly, the remains of a people of more recent date than those found in the vault, as their bones were larger, which would indicate a more stalwart tribe, and also their mode of burial was different, as there was no indication of fire being used, as was the case with the lower burials. I would pronounce the upper interments those of Indians of the present day; the tools found with these were weapons of the chase. On the other hand, those found in the vault were of a peaceful character, and their surroundings would readily comport, in my opinion, to the glacial period. The entire absence of flint in the bottom of the mound would show one of two things, either they were unacquainted with the use of flint or at that time there was no flint to be had. It is there now in great abundance, in such forms for cutting purposes that would render the “cotton rock” almost useless. The flint is found in a hill close to the river bank, about half a mile from the mound, and the upper portion of the ledge has the appearance, to me, of glacial action and probably forms a moraine, as it has, evidently, been pushed over the underlying ledge, and been ground and splintered in a manner that could not have been without great crushing force. It would be reasonable enough to suppose that the action of the river may have uncovered this flint by washing away the softer material since the occupation of the older race.

In relation to the Indian interment in the examined mound, I could not say distinctly whether the Indian burials had been such as to make them aware of former burials or not, but I think from the thickness of the clay between the two that they were ignorant of former burials. The mounds of the modern Indian, so far as my investigations are concerned, would indicate a more rudely formed structure which would appear to be an imitation of the older mounds, as they are not finished with like care nor have they the ulterior structures.—*The Scientist*.

* * * * *

ACTION OF CAUSTIC SODA ON WOOD.

By M.H. TAUSS.

The researches of the author upon the action which water exerts upon wood at a high temperature have shown how much of the incrusting material can be removed without the aid of any reagent.

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In connection with the manufacture of cellulose, it is also interesting to prosecute at the same time experiments with solutions of the caustic alkalies, in order to study the mode of action upon both wood and pure cellulose. The manufacture of cellulose has for many years been an industry, and yet little or nothing from a chemical point of view is known of the action of caustic soda upon vegetable fibers.

Braconnot, in 1820, obtained alumina by treating wood with an alkali, but the first application of wood to the manufacture of paper was due to Chauchard. By boiling vegetable fibers with caustic lyes, Collier and Piette obtained cellulose. Again, in 1862, Barne and Blondel proposed to make cellulose in a similar way, but employed nitric acid in the place of soda.

The first cellulose made exclusively from wood and caustic soda was produced at the Manayunk Wood Pulp Works, in 1854, in the neighborhood of Philadelphia, by Burgess & Watt. The operation consisted in treating the wood for six hours at a pressure of from six to eight atmospheres, with a solution of caustic soda of 12 deg. B.

Ungerer noticed that it was sufficient to limit the pressure from three to six atmospheres, according to the quality of the wood, and advised the use of solutions containing four to five per cent. of caustic soda. He employed a series of cylinders, arranged vertically, in which the wood was subjected to a methodical system of lixiviation. The same lye passed through many cylinders, so that when it made its exit at the end it was thoroughly exhausted, and the wood thus kept coming in contact with fresh alkaline solutions.

According to the account of Kiclaner, the disintegration of wood may be effected in the following four ways:

1. By heating direct in boilers at a pressure of 10 atmospheres. (See Dresel and Rosehain.)

2. In vertical boilers heated direct or by steam, and kept at a pressure of from 10 to 14 atmospheres. (Sinclair, Nicol, and Behrend.)

3. In revolving boilers, maintained at a pressure of 12 atmospheres by direct steam.

4. By means of a series of small vessels communicating with each other, and through which a lye circulates at a pressure of six atmospheres. (Ungerer.)

This latter process is preferable to the others.

Researches have also been made by the author in order to ascertain the loss which wood and cellulose suffer at different temperatures or in contact with varying quantities of alkali (NaHO).

The following is a *resume* of the experiments, giving the loss in per cent. resulting from a “cooking” of three hours duration:

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I. Ordinary pressure:

10 grms. cellulose, with 580 c.c. of caustic soda solution, sp. gr. 1.09	21.99
10 grms. of soft wood, treated as above	49.19
10 " hard " " "	53.68

II. Pressure of five atmospheres:

10 grms. cellulose, with 500 c.c. caustic soda solution of sp. gr. 1.099	58.02
10 grms. of soft wood, treated as above	75.85
10 " hard " " "	69.80

III. Pressure of ten atmospheres:

10 grms. of cellulose	58.99
10 " soft wood	81.80
10 " hard "	70.39

IV. Ordinary pressure:

10 grms. of cellulose, with 500 c.c. caustic soda solution of sp. gr. 1.162	21.88
10 grms. of soft wood	35.45
10 " hard "	46.43

V. Pressure of five atmospheres:

10 grms. of cellulose, with 500 c.c. caustic soda solution of sp. gr. 1.162	77.33
10 grms. of soft wood	97.13
10 " hard "	91.48

VI. Ordinary pressure:

10 grms. of cellulose, with 500 c.c. caustic soda solution of sp. gr. 1.043	12.07
10 grms. of soft wood	28.37
10 " hard "	30.25

VII. Pressure of five atmospheres:

10 grms. of cellulose, with 500 c.c. of caustic soda solution of sp. gr. 1.043	15.36
10 grms. of soft wood	50.96
10 " hard "	55.66

VIII. Pressure of ten atmospheres:

10 grms. of cellulose, with 200 c.c. caustic soda solution of sp. gr. 1.043	20.28
10 grms. of soft wood	70.31
10 " hard "	65.59

From this it is evident that by increasing the temperature and pressure the solvent action of the alkali is increased, but the strength of the lye exercises an influence which is even more marked. Thus, at a pressure of five atmospheres, the loss of cellulose was 0.75 with a caustic lye containing 14 per cent. of NaHO, while it was only 0.05 with a lye of 8 per cent. NaHO.

To further elucidate the action of the alkali under the conditions given above, the author has estimated the amount of precipitate which alcohol gives with the soda solutions, after boiling with the wood:

	1.	2.	3.
Specific gravity of NaHO solutions	1.043	1.09	1.162
Soft wood, ordinary pressure	1.043	traces	4.8
" pressure of five atmospheres	1.043	2.0	26.8
" " ten "	1.043	1.7	—
Hard wood, ordinary pressure	11.10	27.40	30.80
" pressure of five atmospheres	1.10	25.70	15.8
" " ten "	traces	5.20	15.8

The estimation of the precipitate, produced in the soda solutions employed in the experiments cited above, gives:

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Soft wood, ordinary pressure	1.31	traces	2.0
" pressure of five atmospheres	15.94	16.0	24.80
" " ten "	17.00	25.4	—
Hard wood, ordinary pressure	5.40	6	5.60
" pressure of five atmospheres	9.40	15.40	33.60
" " ten "	14.00	18.40	33.60

As a general rule manufacturers employ a greater pressure than that which was found necessary by the author. As a result, it appears from these experiments that the wood not only loses incrusting matter, but that part of the cellulose enters into solution. As a matter of fact, the yield obtained in practical working from 100 parts of wood does not exceed 30 to 35 per cent.—*Le Bull. Fab. Pap.; Chemical Trade Journal.*

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NEW BORON COMPOUNDS.

An important paper is contributed by M. Moissan to the current number of the *Comptes Rendus*, describing two interesting new compounds containing boron, phosphorus, and iodine. A few months ago M. Moissan succeeded in preparing the iodide of boron, a beautiful substance of the composition BI_{3}, crystallizing from solution in carbon bisulphide in pearly tables, which melt at 43 deg. to a liquid which boils undecomposed at 210 deg.. When this substance is brought in contact with fused phosphorus an intense action occurs, the whole mass inflames with evolution of violet vapor of iodine. Red phosphorus also reacts with incandescence when heated in the vapor of boron iodide. The reaction may, however, be moderated by employing solutions of phosphorus and boron iodide in dry carbon bisulphide. The two solutions are mixed in a tube closed at one end, a little phosphorus being in excess, and the tube is then sealed. No external application of heat is necessary. At first the liquid is quite clear, but in a few minutes a brown solid substance commences to separate, and in three hours the reaction is complete. The substance is freed from carbon bisulphide in a current of carbon dioxide, the last traces being removed by means of the Sprengel pump. The compound thus obtained is a deep red amorphous powder, readily capable of volatilization. It melts between 190 deg. and 200 deg.. When heated *in vacuo* it commences to volatilize about 170 deg., and the vapor condenses in the cooler portion of the tube in beautiful red crystals. Analyses of these crystals agree perfectly with the formula BPI_{2}. Boron phospho-di-iodide is a very hygroscopic substance, moisture rapidly decomposing it. In contact with a large excess of water, yellow phosphorus is deposited, and hydriodic, boric, and phosphorus acids formed in the solution. A small quantity of phosphureted hydrogen also escapes. If a small quantity of water is used, a larger deposit of yellow phosphorus is formed, together with a considerable quantity of phosphonium iodide. Strong nitric

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acid oxidizes boron phospho-di-iodide with incandescence. Dilute nitric acid oxidizes it to phosphoric and boric acids. It burns spontaneously in chlorine, forming boron chloride, chloride of iodine, and pentachloride of phosphorus. When slightly warmed in oxygen it inflames, the combustion being rendered very beautiful by the fumes of boric and phosphoric anhydrides and the violet vapors of iodine. Heated in contact with sulphureted hydrogen, it forms sulphides of boron and phosphorus and hydriodic acid, without liberation of iodine. Metallic magnesium when slightly warmed reacts with it with incandescence. When thrown into vapor of mercury, boron phospho-di-iodide instantly takes fire.

The second phospho-iodide of boron obtained by M. Moissan is represented by the formula BPI. It is formed when sodium or magnesium in a fine state of division is allowed to act upon a solution of the di-iodide just described in carbon bisulphide; or when boron phospho-di-iodide is heated to 160 deg. in a current of hydrogen. It is obtained in the form of a bright red powder, somewhat hygroscopic. It volatilizes *in vacuo* without fusion at a temperature about 210 deg., and the vapor condenses in the cooler portion of the tube in beautiful orange colored crystals. When heated to low redness it decomposes into free iodine and phosphide of boron, BP. Nitric acid reacts energetically with it, but without incandescence, and a certain amount of iodine is liberated. Sulphuric acid decomposes it upon warming, without formation of sulphurous and boric acids and free iodine. By the continued action of dry hydrogen upon the heated compound the iodine and a portion of the phosphorus are removed, and a new phosphide of boron, of the composition $B_{5}P_{3}$, is obtained.—*Nature*.

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BORON SALTS.

A paper upon the sulphides of boron is communicated by M. Paul Sabatier to the September number of the *Bulletin de la Societe Chimique. Nature* gives the following: Hitherto only one compound of boron with sulphur has been known to us, the trisulphide, $B_{2}S_{3}$, and concerning even that our information has been of the most incomplete description. Berzelius obtained this substance in an impure form by heating boron in sulphur vapor, but the first practical mode of its preparation in a state of tolerable purity was that employed by Wohler and Deville. These chemists prepared it by allowing dry sulphureted hydrogen gas to stream over amorphous boron heated to redness. Subsequently a method of obtaining boron sulphide was proposed by Fremy, according to which a mixture of boron trioxide, soot, and oil is heated in a stream of the vapor of carbon bisulphide. M. Sabatier finds that the best results are obtained by employing the method of Wohler and Deville. The reaction between boron and sulphureted hydrogen only commences at red heat, near the temperature of the softening of glass. When, however, the tube containing the boron becomes raised to the temperature, boron sulphide condenses in the portion of the tube adjacent to the heated portion; at first it is deposited in a state of fusion, and the globules on cooling present an opaline aspect. Further along the tube it is slowly deposited in a porcelain like form, while further still the sublimate of sulphide takes the form of brilliant acicular crystals. The crystals consist of pure $B_{2}S_{3}$; the vitreous modification, however, is usually contaminated with a little free sulphur. Very fine crystals of the trisulphide may be obtained by heating a quantity of the porcelain-like form to 300 deg. at the bottom of a closed tube whose upper portion is cooled by water. The crystals are violently decomposed by water, yielding a clear solution of boric acid, sulphureted hydrogen being evolved. On examining the porcelain boat in which the boron had been placed, a non-volatile black substance is found, which appears to consist of a lower sulphide of the composition $B_{4}S$. The same substance is obtained when the trisulphide is heated in a current of hydrogen; a portion volatilizes, and is deposited again further along the tube, while the residue fuses, and becomes reduced to the unalterable subsulphide $B_{4}S$, sulphureted hydrogen passing away in the stream of gas.

Two selenides of boron, $B_{2}Se_{3}$ and $B_{4}Se$, corresponding to the above described sulphides, have also been prepared by M. Sabatier, by heating amorphous boron in a stream of hydrogen selenide, $H_{2}Se$. The triselenide is less volatile than the trisulphide, and is pale green in color. It is energetically decomposed by water, with formation of boric acid and liberation of hydrogen selenide. The liquid rapidly deposits free selenium, owing to the oxidation of the hydrogen selenide retained in solution. Light appears to decompose the triselenide into free selenium and the subselenide $B_{4}Se$.

Silicon selenide, $SiSe_{3}$, has likewise been obtained by M. Sabatier by heating crystalline silicon to redness in a current of hydrogen selenide. It presents the appearance of a fused hard metallic mass incapable of volatilization. Water reacts most vigorously with it, producing silicic acid, and liberating hydrogen selenide. Potash decomposes it with formation of a clear solution, the silica being liberated in a form in which it is readily dissolved by alkalies. Silicon selenide emits a very irritating odor, due to the hydrogen selenide which is formed by its reaction with the moisture of the atmosphere. When heated to redness in the air it becomes converted into silicon dioxide and free selenium.

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NATURAL SULPHIDE OF GOLD.

By T.W.T. ATHERTON.

The existence of gold in the form of a natural sulphide in conjunction with pyrites has often been advanced theoretically as a possible occurrence, but up to the present time this occurrence has, I believe, never been established as an actual fact.

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During my investigations on the ore of the Deep Creek Mines, I have found in them what I believe to be gold existing as a natural sulphide. The description of this ore will, no doubt, be of interest to your readers.

The lode is a large irregular one of pure arsenical pyrites, existing in a felsite dike near the sea coast. Surrounding it on all sides are micaceous schists, and in the neighborhood is a large hill of granite about 800 ft. high. In the lode and the rock immediately adjoining it are large quantities of pyrophylite, and in some places of the mine are deposits of this pure white, translucent mineral, but in the ore itself it is a yellow and pale olive green color, and is never absent from the pyrites.

From the first I was much struck with the exceedingly fine state of division in which the gold existed in the ore. After roasting and very carefully grinding down in an agate mortar, I have never been able to get any pieces of gold exceeding the one-thousandth of an inch in diameter, and the greater quantity is very much finer than this. Careful dissolving of the pyrites and gangue, so as to leave the gold intact, failed to find it in any larger diameter. As this was a very unusual experience in investigations on many other kinds of pyrites, I was led further into the matter. Ultimately, after a number of experiments, there was nothing left but to test for gold as a sulphide.

Taking 200 grammes of pyrites from a sample assaying 17 ounces fine gold per ton, grinding it finely, and; heating for some hours with a solution of sodium sulphide (Na_2S_2), on decomposing the filtrate and treating it for gold I got a result at the rate of 12 ounces gold per ton. This was repeated several times with the same result.

This sample came from the lode at the 140 ft. level, while samples from the higher levels where the ore is more oxidized, although carrying the gold in the same degree of fineness, do not give as high a percentage of auric sulphide.

It would appear that all the gold in the pyrites (and I have never found any apart from it) has originally taken its place there as a sulphide.

The sulphide is an analysis of a general sample of the ore:

Silica	13.940 p.c.
Alumina	6.592 "
Lime	0.9025 "
Sulphur	16.584 "
Arsenic	33.267 "
Iron	27.720 "
Cobalt	0.964 "

	Per Ton.
Nickel	Traces.
Gold	5 ozs. 3 dwts. 8 grs.
Silver	0 " 16 " 0 "

	99.969

Nambucca Head’s Gold Mining Company, Deep Creek, N.S. Wales, Oct. 9, 1891.—-*Chemical News*.

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SOME MEANS OF PURIFYING WATER.

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There are several methods extant for the purpose of purifying and softening water, and in the following brief account some of the chief features of these methods are summarized. The Slack and Brownlow apparatus we will deal with first. This purifier is one which is intended to remove the matter in suspension in the water to be treated by subsidence and not by filtration. The apparatus consists of a vertical iron tank or cylinder, inside which are a series of plates arranged in a spiral direction around a fixed center, and sloping at an angle of 45 deg. on both sides outward. The water to be dealt with flows through a large inlet tube fixed to the bottom of the cylinder, rises to the top by passing spirally round the whole circumference, and depositing on the plates or shelves all solids and impurities at the outer edges of the plates. Mud cocks are placed to remove the solids deposited during the flow of the water upward to the outlet pipe, placed close to the top of the cylinder. One of these tanks, a square one, is at work purifying the Medlock water at Manchester, and on drawing samples of water from nearly every plate, that from the lower mud cock showed considerable deposit, which decreased in bulk until the top mud cock was reached, when the water was quite free from deposit. It is stated that one man would be sufficient to attend to 20 of these purifiers.

To filter or purify 2,000,000 gallons per 24 hours would require 40 tanks, 10 ft. by 7 ft. diameter, each doing 2,000 gallons per hour, and would cost, with their fittings, L6,400, including all patent rights, but exclusive of lime mixing tanks, agitators, lime water and softening tanks, engine and boiler, and suitable buildings, the cost of which would not be far short of L5,000, or a total of L11,400 to soften 2,000,000 gallons per 24 hours. The labor and other working expenses in connection with this plant would not be less than that necessary to work the Porter-Clark process, which is given as O.55d. per 1,000 gallons.

The Brock and Minton filter press system is another method. This patent press is made of steel, perforated with 1/2 inch holes. On the inside of the shell there is first laid a layer of fine wire netting, then a layer of cloth, and lastly another layer of wire netting of a larger mesh than the other. The matter treated is pumped into the body of the cylinder, the liquid passing through the filtering material to the outside, the solids being retained inside, and are got rid of by partially revolving the upper half to relieve it from the knuckle joint, and, after being raised, the lower half is turned over by machinery, and the solid matter is simply allowed to fall out into wagons or trucks run underneath for that purpose. Such, in brief, is the manner of using this filter press for chemical works' purposes. The cost of each filter press, including royalties, is from L250 to L300, the size being 8 ft. by 4 ft. diameter. Having a filtering area of 100 square

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feet, it would require 32 of these applied to softening water to effectually deal with 2,000,000 gallons per 24 hours; this, at the lowest estimate for filters alone, would be L8,000, and, using the same figures, L5,000 for lime mixing tanks, *etc*., as referred to in the “Slack and Brownlow” purifier, would bring the total cost up to L13,000, and the working expense would not be less than that required to work the Porter-Clark process, and would probably be very much greater. This filter press is not in use anywhere for dealing with large quantities of water in connection with a town water supply.

A process which has been working for a long time at Southampton is the Atkins system, which also includes the use of filter presses. The pumping station and softening works are situated at Otterbourne, eight miles from Southampton, and were built together as one scheme. The mixing room has two slaking lime tanks, with agitators driven by steam power. The mixture is then run as cream of lime into a tank 20 ft. square and is then pumped into the lower ends of two lime water producing cylinders. The agitation is here obtained by pressure from a small cistern placed above them with a 12 ft. head, the pipe from which is attached to the lower ends of the cylinders. This has been found by experiment to be the most satisfactory means of obtaining the proper degree of agitation necessary; the clear lime water is then drawn off at the top of the cylinders, and flows by gravity into a mixer, where it comes in contact with the hard water. Both flow together into a distributing trough, from which it overflows into a small softening reservoir, having a capacity of one hour’s supply, a weir being placed along the lower end, over which the water flows to 13 filter presses. The clear water from the filters is then conveyed to a small well, from which the permanent engines raise it to the first of a series of high level covered service reservoirs.

In the filter press there are 20 hollow disks representing a filtering area of 250 square feet, or a total of 3,250 square feet. The water to be filtered passes into the body of the filter and then through a filtering medium of cloth laid on a thin perforated zinc plate, into the inner side of the disks, from whence it is conveyed through the hollow shaft, to which the disks are attached, to the high level pumps.

The filter cloths are cleaned three times every 24 hours, without removal, by jets of softened water from the main, having a pressure of 60 pounds to the square inch. During cleaning operations the disks are made to revolve slowly; this only occupies a space of five minutes for each cleaning. The cloths last from six to eight months without being renewed. They also occasionally use for further cleaning the cloths a jet of steam injected upon the center of the disks in order to remove by partial boiling the insoluble particles engrained in the cloths. This has been found to make the cloths last longer. This cloth is obtained from Porritt Bros. and Austen, Stubbing Vale, Ramsbottom, and costs 131/2d. per lineal yard of a width to suit the disks.

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The quantity softened is 21/4 million gallons per 24 hours, but the present plant can deal with 21/2 million gallons, and the buildings are erected for 31/2 million gallons, additional filters and lime producing tanks being only required to deal with the increased quantity. The costs of the softening works was L10,394, of which L7,844 was for the softening machinery and plant and L2,550 for the reservoir, buildings, *etc*.

The working expenses, including lime, labor, cloths, general repairs, and steam, is stated to be 0.225d. per 1,000 gallons, the labor required being only two men, one on the day and the other on the night shift, with an occasional man to assist.

The hardness of the Southampton water on Clark's scale is 18 deg. of total hardness, and this is reduced down to 6 deg. or 8 deg. by this process.—*Chem. Tr. Jour.*

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A NEW LABORATORY PROCESS FOR PREPARING HYDROBROMIC ACID.

By G.S. NEWTH.

This method is a synthetical one, and consists in passing a stream of hydrogen and bromine vapor over a spiral of platinum wire heated to bright redness by means of an electric current. A glass tube, about 7 inches long and 5/8 of an inch bore, is fitted at each end with a cork carrying a short straight piece of small tube; through each cork is also fixed a stout wire, and these two wires are joined by means of a short spiral of platinum wire, the spiral being about 1 inch long. One end of this apparatus is connected to a small wash bottle containing bromine, through which a stream of hydrogen can be bubbled. The other end is attached to a tube dipping into a vessel of water for the absorption of the gas, or, if a large quantity of the solution is required, to a series of Woulf's bottles containing water. Hydrogen is first slowly passed through the tube until the air is displaced, when the platinum spiral is heated to bright redness by the passage of a suitable electric current. Complete combination takes place in contact with the hot wire, and the color imparted to the ingoing gases by the bromine vapor is entirely removed, and the contents of the tube beyond the platinum are perfectly colorless. The vessel containing the bromine may be heated to a temperature of about 60 deg. C. in a water bath, at which temperature the hydrogen will be mixed with nearly the requisite amount of bromine to combine with the whole of it. So long as even a slight excess of hydrogen is passing, which is readily seen by the escape of bubbles through the water in the absorbing vessels, the issuing hydrobromic acid will remain perfectly colorless, and therefore free from bromine; so that it is not necessary to adopt any of the usual methods for scrubbing the gas through vessels containing phosphorus. When the operation is proceeding very rapidly a lambent flame occasionally appears in the tube just before the platinum wire,

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but this flame is never propagated back through the narrow tube into the bromine bottle. The precaution may be taken, however, of plugging this narrow tube with a little glass wool, which renders any inconvenience from this cause quite impossible. By this method a large quantity of bromine may be rapidly converted into hydrobromic acid without any loss of bromine, and the operation when once started can be allowed to proceed without any further attention.—*Chemical News.*

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SAPOTIN: A NEW GLUCOSIDE.

By GUSTAVE MICHAUD.

Achras Sapota, L., is a large tree scattered through the forests of Central America and the West Indies; its fruit is often seen upon the Creole dinner table. This fruit is a berry, the size of an orange, the taste of which suggests the flavor of melon, as well as that of hydrocyanic acid. The fruit contains one or two seeds like large chestnuts, which, if broken, let fall a white almond. This last contains the glucoside which I call *sapotin*.

I obtained sapotin for the first time by heating dry raspings of the almond with 90 per cent. alcohol. While cooling, the filtered liquid deposited a good deal of the compound. Since that time I have advantageously modified the process and increased the amount of product. I prepare sapotin in the following way: The almonds are rasped, dried at 100 deg. C. and washed with benzene, which takes away an enormous quantity of fatty matter. The benzene which remains in the almond is driven put first by compression, afterward by heating. Then the raspings are exhausted with boiling 90 per cent. alcohol. The solution is filtered as rapidly as possible, in order to avoid its cooling and depositing the sapotin in the filter. As soon as the temperature of the filtered liquid begins to fall, a voluminous precipitate is seen to form, which is the sapotin.

In order to purify it, the precipitate is collected in a filter and expressed between sheets of filter paper. When dry it is washed with ether, which takes away the last particles of fatty and resinous matter. The purification is completed by two crystallizations from 90 per cent. alcohol. At last the substance is dried at 100 deg..

The sapotin separates from its alcohol solution in the form of microscopic crystals. When dry, it is a white, inodorous powder. Its taste is extremely acrid and burning. If the powder penetrate into the nostrils or the eyes, it produces a persistent burning sensation which brings about sneezing and flow of tears. It melts at 240 deg. C., growing brown at the same time.

It has a laevo-rotatory power of [a]_{j} = -32.11, which was determined with an alcoholic solution, the aqueous solution not being sufficiently transparent.

It is very soluble in water, easily soluble in boiling alcohol, much less in cold alcohol, and insoluble in ether, chloroform and benzene. Its alcoholic solution is precipitated by ether.

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Tannin has no action on it, but basic acetate of lead produces a gelatinous precipitate in its aqueous solution. Strange enough, this precipitate is entirely soluble in a small excess of basic acetate of lead. If thrown into concentrated sulphuric acid, sapotin colors it with a garnet red tint. It does not reduce Fehling's solution. Its analysis gave the following results:

	Calculated for $C_{29}H_{52}O_{20}$.	Found. I.	II.
C	48.33	48.69	48.31
H	7.23	7.33	7.45

When heated with water and a little sulphuric acid, sapotin is decomposed and yields glucose and an insoluble matter which I call *sapotiretin*. One hundred parts of sapotin produce 51.58 parts of glucose and 49.67 of sapotiretin. The equation which represents this reaction is:

$$C_{29}H_{52}O_{20} + 2H_{2}O = 2C_{6}H_{12}O_{6} + C_{17}H_{32}O_{10}$$

and requires 50 per cent. of glucose and 55 per cent. of sapotiretin.

Sapotiretin is an amorphous compound, insoluble in water, very soluble in alcohol, less soluble in chloroform, insoluble in ether. Below is the result of its analysis:

	Calculated for $C_{17}H_{32}O_{10}$.	Found. I.	II.
C	51.52	51.51	51.20
H	8.08	8.19	8.34

—*Amer. Chem. Jour.*

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DETECTION OF PEANUT OIL IN OLIVE OIL.

Holde, after a careful trial of the various processes for detecting the above adulteration, gives the preference to Renard's, which he describes as follows:

Ten grms. of the suspected oil, after being saponified, and the fatty acids separated by hydrochloric acid, are dissolved in 90 per cent. alcohol, and precipitated by sugar of lead. The oleate of lead is separated by ether, and the residuum, consisting of palmitic and arachic acids, is decomposed by hydrochloric acid. The fatty acids are dissolved, with the aid of heat, in 50 c.c. of 90 per cent. alcohol. The arachic acid which separates after cooling is filtered out and washed, first with 90 per cent. and afterward with 70 per cent. alcohol. It is then dissolved in hot alcohol, and the solution evaporated in a weighed saucer. The weight of the residuum, after taking into account the acid dissolved in the alcohol, equals the whole amount of arachic acid contained in the oil; the melting point of this residuum should be 70 deg. to 71 deg. C. With this process the author has always been successful; but when the olive oil contains not more than 5 to 10 per cent. of peanut oil, it is necessary to make the test with 40 grms. of the former, otherwise the melting point of the arachic acid cannot be estimated. Furthermore, the acids which are separated from the lead salt by hydrochloric acid must be recrystallized repeatedly with 90 per cent. alcohol, until the melting point ceases to rise, in case the latter is not found to exceed 70 deg. C. at the first estimation. When peanut oil is present, the melting point will always be above 70 deg..—*Chem. Zeit.*

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HYDROXYLAMINE.

Free hydroxylamine, NH_2OH, has been isolated by M. Lobry de Bruyn, and a preliminary account of its mode of preparation and properties is published by him in the current number of the *Recueil des travaux chimiques des Pays-Bas* (1891, 10, 101). The manner in which the free base was obtained was briefly as follows. About a hundred grammes of hydroxylamine hydrochloride, $NH_2OH.HCl$, were dissolved in six hundred cubic centimeters of warm methyl alcohol. To this solution a quantity of sodium dissolved in methyl alcohol was added, in such proportion that the hydrochloride of hydroxylamine was present in slight excess over and above that required to convert it to sodium chloride. After deposition of the separated sodium chloride the solution was decanted and filtered.

The greater portion of the methyl alcohol was next removed by distillation under the reduced pressure of 160-200 mm. The remainder was then treated with anhydrous ether, in order to completely precipitate the last traces of dissolved sodium chloride. The liquid eventually separated into two layers, an upper ethereal layer containing about 5 per cent. of hydroxylamine, and a lower layer containing over 50 per cent. of hydroxylamine, the remainder of the methyl alcohol, and a little dissolved salt. By subjecting this lower layer to fractional distillation under 60 mm. pressure, it was separated into three fractions, of which the first contained 27 per cent. of hydroxylamine, the second 60 per cent., and the third crystallized in the ice-cooled receiver in long needles. This third fraction consisted of free solid NH_2OH. Hydroxylamine as thus isolated in the free state is a very hygroscopic substance, which rapidly liquefies when exposed to air, owing to the absorption of water.

The crystals melt at 33 deg., and the fused substance appears to possess the capability of readily dissolving metallic salts. Sodium chloride is very largely soluble in the liquid; powdered niter melts at once in contact with it, and the two liquids then mix. Free hydroxylamine is without odor. It is heavier than water. When rapidly heated upon platinum foil it suddenly decomposes in a most violent manner, with production of a large sheet of bright yellow flame. It is only very slightly soluble in liquid carbon compounds, such as chloroform, benzene, ether, acetic ether, and carbon bisulphide. The vapor attacks corks, so that the solid requires to be preserved in glass-stoppered bottles. The free base appears also to act upon cellulose, for, upon placing a few drops of the melted substance upon filter paper, a considerable amount of heat is evolved. The pure crystals are very stable, the base in the free state appearing to possess much greater stability than when dissolved in water. The instability of the solution appears, however, to be influenced to a considerable extent by the alkalinity of the glass of the containing vessel, for concentrated solutions free from dissolved alkali are found to be perfectly stable. Bromine and iodine react in a remarkable manner with free hydroxylamine.

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Crystals of iodine dissolve instantly in contact with it, with evolution of a gas and considerable rise of temperature. Bromine reacts with violence, a gas again being explosively evolved and hydrobromic acid formed. The nature of the gas evolved is now undergoing investigation. A letter from M. Lobry de Bruyn appears in the number of the *Chemiker Zeitung* for October 31, warning those who may attempt to prepare free hydroxylamine by the above method that it is a dangerously explosive substance when warmed to a temperature of 80 deg.-100 deg.. Upon warming a flask containing the free solid base upon a water bath a most violent explosion occurs. A spontaneous decomposition appears to set in about 80 deg., and even in open vessels the explosion is very violent. Care must also be taken during the fractional distillation of the concentrated solution in methyl alcohol to cool the apparatus before changing the receiver, as if air is admitted while the retort is heated the experiment ends with an explosion.—*Nature*.

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