fices for three double journeys; the charging, during which the cells remain on board, takes a little more than an hour. The cars weigh 58 tons each, the batteries alone 17 tons. The track is fairly level, but there is a rise of 7 in 1,000 from Milan to Monza. With two intermediate stoppages, the journey is accomplished in 20 minutes. That would correspond to an average speed of about 28 miles; the speed can be raised to 37 miles. The line was opened in February, when two cars were put into service, both together making 11 double journeys daily. It is intended to add six cars, and to introduce the same kind of accumulator service cars on the line Milan-Pavia, which has a length of 22 miles. As Monza is on the road from Milan to the Lake of Como, we suppose that the ordinary engine service has not altogether been abandoned on that line. The introduction of electric traction has the support of the Italian government.—Engineering.

POWER AT THE PARIS EXPOSITION.

By JOHN T. BRAMHALL.

THE decision of the Paris Exposition management to establish an electric power plant upon the contracted space of the Exposition grounds is disappointing to those who believe that the seat of energy of this great exposition, which shall stand as the demonstration of the world's progress in the arts and sciences at the close of the nineteenth century, should itself be a worthy exponent of the engineering skill of the age.

What, then, should the Paris power plant of 1900 be like? Certainly not fashioned after those that preceded it, for that would confess inability to make further progress. It should mark a distinct advance upon the World's Fair at Chicago.

Looking back at the three American international exhibitions—New York, 1853, Philadelphia, 1876, and Chicago, 1893—as well as those of London, 1851, Paris, 1867, and Vienna, 1873, it is not difficult to associate the grand productions of inventive genius with the accelerated progress in the mechanical arts which followed in the next decade. But, to consider solely the subject of power generation, the Crystal Palace in New York was ill provided in that respect. America's industries in 1856 were still of the infant character, and the greater part of the machinery was imported from English workshops. The New York Tribune's reports of the exhibition, as edited for republication by Horace Greeley, devoted a hundred times the space to agricultural machinery (and indeed there was not much else) that they gave to the steam engine. Only one of these was mentioned as a primary motor, and this was dismissed with the following description:

"The beam engine, from Providence, by Corliss & Nightingale, exhibits a new application of governor. . . . The workmanship and the ingenuity displayed in this machine are above all praise. As to its practical utility, only experience can decide."

The Paris Exposition of 1867 was not remarkable for its machinery, but was noted by Geddes as the first world's fair to show processes of industry in action. The best example of transmission of power, according to the report of the American commissioners, was a "telodynamic" (wire rope) machine from Germany, capable of transmitting 120 horse power 400 feet, and a "hydro-aero dynamic wheel" (compressed air) from Belgium, which transmitted 9 horse power 600 feet, and was thought capable, under favorable conditions, of developing 15 horse power. The prime power engines, though more numerous, did not differ materially from those of the London exhibition of 1851, except that there seems to have been, according to the report of Special Commissioner Auchinclose, a marked adoption of the American model.

In regard to the Vienna Exposition of 1873, the situation is best explained in a paper by Prof. James Hart, making comparisons with the Centennial Exposition, then about to open. Prof. Hart said:

"In the department of machinery, if no other, the Centennial ought to eclipse all its predecessors. It is in the power of our manufacturers and inventors to make a display of machinery at Philadelphia that shall throw London, Paris, and Vienna completely in the shade. This utterance is not the outpouring of enthusiastic patriotism; it is based on a careful study of the Machinery Hall at Vienna. There were more 'inventive brains' in the little section occupied by America than in all the rest of the huge Machinery Hall. By the side of our ingenious contrivances, that did their work with such economy of space and force, and with such precision, the cumbersome structures from Germany, France, and even England, seemed twenty years behind the times. In this connection America may lay claim to a unique distinction. Mr. Corliss was the only person who received a diploma of honor without being an actual exhibitor. But in truth, the entire Machinery Hall, with its appurtenances, was his exhibition, for every stationary engine at work in the building or on the grounds was in principle a Corliss engine."

Grandly did the builders of the Centennial meet the hopes of its promoters and its friends. London, Paris, and Vienna were, indeed, surpassed by the long lines of busily working machinery which stretched away along the lines on either hand, all receiving their energy from a single master engine. The Corliss 1,000 horse power giant of 1876 was, in itself, the first world's fair power plant.

But 1893, the occasion of the Columbian quadri-centennial, saw another great step taken in the dominion of mind over matter, in the great central power plant, which, from the Brobdignagian battery of boilers adjoining the Palace of Mechanic Arts and the silent cyclopean Corliss of 3,000 horse power, transmitted power and light through the agency of ponderous dynamos to every part of the capacious grounds of the Exposition. Nor was this all. Not only were there no visible wires and no shafting and belting beyond the central plant itself, but there was no visible fuel supply. The power seemed to be produced by magic. There was smoke, indeed, from the great stacks, but no coal. The fuel was pumped from the oil fields of Ohio, 200 miles distant, and automatically fed to the furnaces in Jackson Park.

And now, what of Paris in 1900? Oil or gas being unavailable as a steam producer, must she go back to the antiquated system of shoveling coal beneath the great boilers that are to supply steam for her power

plant on the Seine? Must great piles of coal obstruct the Champs de Mars, and boats take cargoes of ashes at the Pont de Jena? Must huge chimneys belch forth smoke to sully the white walls of the Trocadero and smut the fine fabrics in her Palais de l'Industrie? It is to be hoped that the Queen City of the world will never consent to such a confession of weakness. What then remains?

The Schaffhausen-Frankfort experiment demonstrated the possibilities of long distance transmission of power, which was confirmed by the Niagara-New York experiment. While neither was practically satisfactory from an economic point of view, they were as scientifically successful as was the telephone at Philadelphia in 1876. It now remains for France to outdo the achievements of Germany and America in the practical transmission of power, and to proclaim to the world that France celebrates the closing of the century with a feat of engineering worthy of the event and of herself.

The problem, though new, is not a difficult one for engineers. In the coal mines of Du Nord and Pas-de-Calais, within 100 miles of Paris, are great stores of energy which modern science may transmit to Paris or to the Mediterranean, if necessary, by electricity. By establishing the power plant at the mines instead of at the Exposition itself, many economies are effected, which more than offset any increase in cost of the plant and the losses in transmission. Not only the cost of delivering coal would be saved (it is 1.8 cents a ton per mile on French railways), but the "run of the mine" being used, the first cost of fuel would be far less. At the Exposition grounds valuable space would be gained for exhibits; the handling of coal and ashes would be avoided in crowded streets and grounds; the smoke nuisance would not worry exhibitors, and the fire risk would be materially lessened. These are important features to be taken into consideration when the matter of economy is discussed.

The feasibility of conducting high potentials such a distance, or even greater, with a practical efficiency, need be no longer questioned. The Niagara electrical engineers place the economic limit nearer 500 miles than 100. As to cost of plant, the conductors would furnish the heaviest item, but the copper or aluminum should not be charged on the account as a permanent investment, since the value of the metal does not deteriorate by use. Indeed, it is not unlikely that the successful operation of the plant would encourage sufficient patronage from city consumers after the close of the Exposition to warrant its continuance and extension, and thus stand as a model to London, Chicago and other great cities in the matter of the abolition of the smoke nuisance.

Nearly three years ago the suggestion was made by the writer to the directors of the Paris Exposition of 1900 of a plan for the generation and transmission of power as thus outlined, and the proposal, coming from this country, and originating, in a sense, with the Chicago Exposition, its adoption would add to the record of London (1851), Paris (1867), and Vienna (1873) another laurel wreath for America.—Western Electrician.

ELECTRICAL PROTECTION OF SAFES AND VAULTS.*

By CLYDE J. COLEMAN.

THE title of this paper assumes that all people are not honest and implies the necessity for guarding against surreptitious entrance. No one questions the right of the provident to protection against theft.

I will first aim to justify the need for a thoroughly effective safeguard by a slight research in criminology. There is one instance on record where a steel-lined bank vault was entered from the top by first ascertaining the thickness of the steel with a very small drill, leaving a hole too small to be discernible from the inside, and then using a large drill provided with a gage, so as to drill all but through the lining, and with this a series of holes was drilled embracing a section of sufficient size to admit a person when the section was removed. This method admitted of work being done each night over quite a period of time, as the drill, held from going clear through, did not show any marks from the vault interior, and still cut the metal so effectively that all that was necessary was to pound it down with a heavy sledge in order to gain access to the vault. In another instance, where entrance was gained to a vault from the top, after the vault had been plundered a wedge was so placed that the lock and bolt work on the door could not be operated from the outside; in the morning the cashier, failing to open the vault, telegraphed for an expert, who worked for three or four days drilling before he succeeded in opening and discovered what had been done and that the vault had been robbed. This delay allowed the burglars sufficient time to successfully escape.

The use of nitro-glycerine and other high explosives has been so successful as to show the folly of trying to make something so strong that it cannot be broken. The latest danger to the banker is the electric current. While it involves a certain amount of engineering on the part of the burglar, the conditions existing, especially in large cities, are such that it is a comparatively easy matter to provide sufficient power to effect an entrance to any vault, as it will accomplish what explosives cannot, owing to the environments in the larger cities making such a method extremely risky, while the electric arc can be used quietly, quickly, and employed so as to show no light. Where current from incandescent or power circuits cannot be obtained, storage batteries are by no means out of the question, as they can, for a case of this kind, be discharged far above their rated capacity, besides being made especially light for the occasion, as they need be used but once, and all the usual considerations of local action and long life do not have to be considered. The use of the electric arc does not require the amount of intelligence so often displayed in constructing an ingenious set of burglar's tools, and as to weight these tools often weigh over 500 pounds. An interesting thing is that no insulating material interposed between vault plates seems to make any difference with the arc, as it has been found by experiment that asbestos, concrete, etc., burn as rapidly as any metal,

which is due no doubt to their fusing and becoming electrolytic conductors.

The present Secretary of the United States Treasury, after investigating the subject of burning and the use of storage batteries, said he considered it entirely feasible for a burglar to rent a room adjacent to a bank and carry in as many batteries as he liked at his leisure, and offered the argument that if discovered they would not be evidence of criminal intent, as would burglar's tools. The future possibilities of new dangers are almost unlimited. It would be interesting to know what might be done with liquid air by pouring a couple of gallons on top of a safe and cooling the steel to a point where it could be easily broken with a sudden blow from a heavy hammer. Liquid oxygen might be used to burn a hole through a wall of steel by lighting a piece of sulphur and using it as a match to start the combustion of the steel and then turning in a stream of oxygen.

Now, coming directly to the subject of this paper, it might be well to divide electric protective systems broadly into open and closed circuit systems. The open circuit system, as its title implies, depends for its operation upon contacts or equivalent devices, closing a circuit to operate some alarm mechanism, when an unwarranted entrance is attempted. This system is little used, except in residences, and then it has proved really more of a nuisance than an advantage.

The closed circuit system comprehends the use of a current of given strength, continuously traversing the line wire connecting the vaults or premises with the alarm station, together with contacts, circuits, linings, resistance coils, etc., and connected with a relay at the alarm station, which is so adjusted that this normal amount of current keeps the instrument balanced. Should the current be increased or decreased, which would be the case were any part of the circuit broken or short-circuited, the balance on the relay would be disturbed in such a way as to give an alarm by closing a local circuit connected with and controlling the alarm mechanism. But it has been found that a system of this kind is capable of being circumvented. By interpolating a low resistance milliamperemeter in the circuit and employing two sets of variable resistances, so that by gradually cutting in resistance on the alarm circuit and cutting out resistance across the alarm circuit, and by observing the milliamperemeter, so as to maintain at all times the current constant on the alarm station end of the circuit, it is possible to finally shift the current from the protected structure to the artificial resistance, so that the circuits at the vault or guarded premises are rendered inoperative.

To overcome this difficulty and thoroughly protect the line wires (which are the most vulnerable part of an alarm system) a number of schemes have been proposed, such as having frequent predetermined signals, changes of resistance, voltage, etc., sent to the alarm station by a watchman or some automatic device. Then, again, this must be so arranged as not to allow of its cycle of operations being ascertained by any outside means; it should also be capable of automatic operation at both ends; otherwise, it will involve so much constant manual attention at the alarm station as to be impractical. One very effective and simple method is to construct the line wire of a number of very fine and thinly insulated wires and braid the whole into a cable. By connecting each wire to the system the cable will present a veritable labyrinth of circuits so closely interwoven that it is physically impossible to do anything with it. Another method proposed is the use of wireless telegraphy, thereby dispensing with any wires to tamper with.

Instead of the usual alarm station, involving manual attention and consequently susceptible of collusion, a system much more practical for banks is one in which a large alarm mechanism is placed in a heavily constructed steel box, which, in turn, is electrically protected, so it cannot be tampered with, and is located in some conspicuous place on the bank premises. A system of this character must possess the advantage of being automatic in its operation and entirely under the control of the banker from the vault end.

ELECTRICAL BARRIERS.

One of the most exacting conditions relative to this branch of electrical engineering is to obtain a satisfactory protective means for the vault or guarded premises. Probably the simplest and most efficient window protection consists simply in cementing narrow tinfoil strips on the inner surface of the glass, as any breakage or fracture of the glass will suffice to open the circuit.

For guarding entrances or the walls of rooms, glass tubes filled with mercury and connected in circuit or tubes filled with water or compressed air, or conversely maintaining a vacuum in a partition or inclosure, have all been used, so that any disturbance from a normal condition will result in an alarm being given.

A very difficult barrier to circumvent is one in which steel wires are tensioned by a spring and adapted to a contact, so that any increase or diminution in its tension will allow a contact arm to touch a contact point located on either side of it, which is connected to the opposite side of the system, constituting practically a mechanical relay. A Frenchman proposes, by a burglar stepping on a mat, to automatically light a flashlight and open a shutter in a camera concealed in the ceiling and focused on the vault entrance, to obtain a photograph of the invaders. A rather ingenious and quite effective scheme contemplates balancing the safe on a scale platform, which is so connected to the alarm system that any weight added to or taken from it will cause an alarm. The Bank of France lowers its vaults each night in a pit filled with water, which connects with float devices, so in case it should be drained an alarm would be given.

One inventor does not propose to make any noise at all, and does not believe in letting a single burglar get away; to this end he constructs around the entrance of the vault a divided steel caging, each section of which is held open, against the pressure of a very strong spring, so arranged that any attempt to enter the vault will result in capture. Microphones have been located inside the vault and connected with a system and so adjusted that the noise attendant upon forcible entry or such as persons moving about in the interior of the vault would cause sufficient disturbance

* Read before the Chicago Electrical Association, May 5, 1899.

of the controlling current to actuate the alarm. It has also been proposed to connect the system with a transmitter at the alarm station, or at the banker's residence, so he may listen for any unusual noise should the alarm indicate a disturbance in the circuit.

The construction found to best fulfill all requirements in modern practice is an electrical lining covering the entire inner surface of the vault, which is constructed of a number of tinfoil strips cemented on insulating paper and composed of several layers of such sheets, and placed between steel plates to afford mechanical protection against injury, also to render it absolutely impossible by any means to remove such mechanical armor without destroying or disturbing so delicate a condition as the linings, while at the same time there are no moving parts to get out of order or give trouble, and if substantially installed, is permanent for any length of time.

In conclusion I will say that a modern protective system should be sensitive to the conditions it is intended to guard against, while not involving such delicacy as to give trouble, and should, so far as possible, be automatic in its operations and incapable of defeat by an expert conversant with all conditions, even to the minutest details.

The time belongs to the past when custodians of funds may place safe dependence upon mechanical safeguards, solely to resist physical force. They must provide such safeguards with something that will give notice of any attempt to attack, and in electricity is to be found the secret slave and silent sentinel that is the omnipotent and omnipresent guardian.

TAXATION IN CHINA—RATES IMPOSED AND METHOD OF COLLECTION.

ONE obstacle to the industrial and commercial progress of China is the irregular system of taxation which prevails. Aside from the import and export duties collected by the imperial maritime customs under the administration of Sir Robert Hart and his European and American assistants, there are other duties levied on nearly all goods, native or foreign, and levied repeatedly on the same goods, whether carried inland from the seaports or from the interior to the coast, or even from one town or city to another. These are the *likin* and *octroi* dues, which at present are exciting so much discussion. Every eight or ten miles along the principal waterways or caravan routes a *likin* station is found, where a tax is levied upon some article or articles carried through by boat, pack animal, or wheelbarrow. At some points every article is taxed. This is the usual rule at the gates of cities. In some cases the tax is as little as 2 per cent. *ad valorem*; in others, such as silk, satin, and native opium, much more, amounting at times to 6, 8, or even 10 per cent. Between Shanghai and Soochow, a distance of eighty-four miles, there are eight *likin* stations. At the first and last stations all goods are dutiable; at the rest all goods must be examined, and there is scarcely a single article that does not in that distance pay at least three taxes. It is easily seen that under such a system foreign goods cannot be carried very far from the coast before their prices become prohibitive for ordinary people.

By article 28 of the Tientsin treaty of 1858 it was proposed to substitute for these *likin* dues a fixed tax of 2½ per cent. *ad valorem*, payable at the ports where imports were landed or at the first barrier passed by exports in their outward journey, a certificate being granted to exempt the goods of any further charges. This provision has found but limited employment. Transit passes, except on certain main lines of traffic, did not protect the merchant against the exactions which long custom had sanctioned. Local and provincial authorities depended upon these collections for their support, and no provision seems to have been made to compensate them for their losses by appropriations from the imperial treasury. The question has come to the front again in connection with the proposed revision of treaties. Since the war with Japan, China is burdened with a public debt amounting now to about \$200,000,000 gold. To meet the annual interest and other expenses connected with this debt the sum of \$12,000,000 per annum will be needed. For such a large empire as China these sums seem insignificant, but at present China's revenue, aside from *likin* dues, amounts to about 56,000,000 taels (\$44,000,000), viz.:

	Taels.
Customs.....	21,000,000
Land tax.....	25,000,000
Salt gabelle.....	10,000,000
Total.....	56,000,000

The customs revenue is pledged to the debt; but when the interest on the debt and the expenses of maintaining the customs service are deducted there remains from this source not more than 3,000,000 taels for the imperial government. This leaves some 38,000,000 taels (\$30,400,000) for the whole imperial administration, and it is quite evident that such a sum is altogether insufficient. It has been suggested that the customs duties should be increased, and the request does not seem unreasonable; but there is a strong feeling among foreign merchants, our own among them, that this increase should not be agreed to unless some definite arrangement be made for the abolition of *likin*. At the same time it has been proposed to levy an extra tax on the products of all steam cotton mills and silk filatures, and this has called out a protest from the various chambers of commerce in China. A special committee of the Shanghai chamber has recently formulated its views on the subject. It is set forth that these mills are built under the provisions of the Shimonoseki treaty, which guaranteed them freedom from taxation; that the protocol of October 19, permitting the Chinese government to tax the product of these mills, was, in effect, an abrogation of one of the principal articles of the Shimonoseki treaty, and unfair to those who had acted in good faith upon the assurances therein given.

The Japanese government, it is believed, found that untaxed mills in China would ruin existing industries of a similar character in Japan, and were quite willing to withdraw from the position taken at Shimonoseki, and gave their nationals due notice beforehand, so that the proposed Japanese mills at Shanghai were abandoned. The Shanghai chamber pleads that an indus-

try of such manifest benefit to China as cotton manufacturing should be fostered by freedom from taxation. If this be impossible, the tax levied should not exceed the duty on imported yarn less the transit tax on the cotton used in the yarns to be manufactured at these mills, viz., import duty on three piculs yarn, 2·10 taels (\$1·68); less transit duty on three piculs forty catties cotton, 0·60 taels (48 cents), or 5 mace per picul. The point emphasized is that as imported yarns pay duty only as yarns and not as cotton, so the native yarns should not be compelled to pay duty both as cotton and as yarns. It is also asked that on payment of this duty the goods shall have the same privileges as imported yarns, and on payment of a further half duty be freed from all further exactions when sent inland. Similarly, raw cotton bought in the interior for the mills is to be treated as if an export and freed by one payment from all further *likin*; and it is suggested that this payment should go to the provincial authorities.

All cotton, whether native or foreign, imported to these mills, it is urged, should be admitted free of duty, or if the duty be paid, it should afterward be deducted on payment of full excise.

It is pointed out that in India and America, China's competitors in cotton raising, cotton is not taxed; and that in India and Japan, China's nearest competitors in cotton manufacturing, the product of cotton mills is not taxed. The inference is that to levy heavy taxes on the raw cotton and the manufactured product would make the industry unprofitable.

The governor of Chekiang recently proposed to levy a tax on seed cotton of 0·40 cent per bale = 2·65 taels on a bale of yarn. The proposal of certain members of the Tsung-li Yamén was that a tax of 10 per cent. should be levied on the product of the mills. This would raise the tax on local yarns to 8·05 taels as against 2·10 taels on imported yarns, much to the advantage, therefore, of the foreign article. As Shanghai yarns at present are not taxed at all, the schedule proposed by the chamber would no doubt add a considerable amount to the revenue of the government, while its moderate character would greatly stimulate the industry, and thus in the end the treasury would gain more than by a heavier tax.—From a Report by the United States Consul-General in China; Commercial Relations, 1896.

ROMAN GIFTS FOR HEALTH A THOUSAND YEARS AGO.

FOR centuries before the science of medicine was practiced as an art, the custom of making offerings to the gods, both as tokens of gratitude for restoration to health, as well as an inducement or bribe to the deity to grant some special favor, such as the curing of a disease or affected limb, was found among the ancients. The temples of the gods in early Greece, and in Italy also, were at that time the centers of the healing art, and each was presided over by some wise philosopher believed by the people, himself, to be immortal, existing on earth as a divine instrument to carry out an omnipotent will. At these temples gathered also the students, who sat at the feet of the wise men and imbibed their teaching and precepts.

Many of the temples were fine and imposing structures with richly decorated interiors, while others were more simple in style and usually built at the source of some hot spring or mineral water, the use of which formed the chief treatment of those who came to be healed. The water was employed both for drinking and bathing, its use being regulated and prescribed by the priests and attendants.

It was customary for each patient, however poor, to bring some gift as a votive offering, called by the Romans *donaria*, a practice which exists among the Italian peasantry in some districts at the present time. These offerings took a variety of forms, according to the position and wealth of the patient. The wealthy presented land, buildings, jewelry, or vessels of gold and silver. Others would add embellishments to the temple in the form of paintings, sculptures, or other decoration. The less prosperous votaries brought cattle, fruit, tools of trade, or even left their cast-off clothes as propitiatory gifts.

While some made their offerings to the deities in general, others confined their gifts to some particular divinity, and thus the temple of Artemis Brauronia was filled with women's clothing.

In the neighborhood of other temples have been found weapons, surgical instruments, tablets painted with representations of miraculous healings and enormous numbers of models of various parts of the human frame, composed of metal, stone, clay, and terra cotta. The latter are especially interesting, as they illustrate many of the diseases from which humanity suffered at that time.

These offerings were made by the patient throwing the article into the healing well or bath, or, where possible, hanging it on the walls of the temple, or round the statues of the various gods. In the temple of Æsculapius, in Greece, the names of the diseases from which the patients suffered, and their cures, were registered on tablets of marble.

The valuable offerings—many magnificent cups and vases of gold with votive inscriptions have been discovered—were well taken care of by the priests, who, it is said, melted them down after a time according to the regulations of the particular temple. The *donaria* of less value, when they had become too numerous, were placed in large boxes or simply buried in deep furrows in the earth, from which they are still occasionally brought to light. A peculiarity of these offerings was that their character was usually determined by the complaint from which the giver suffered. Thus, we find that certain surgical instruments were offered as a thanksgiving for a successful operation. It is recorded that Erostratus offered a forceps of lead to Apollo, in the Temple of Delphus, to show his disapproval of this method of extraction in place of the fingers.

In most of the museums in Italy, especially in the National Museum at Rome, and in several interesting private collections, many specimens of these curious native offerings may be found. Drs. Allaire and Sambon and Mr. E. Toulonze have made many interesting discoveries among *donaria* which throw a considerable light on many of the diseases prevalent at that early period, and on this subject Dr. Sambon has given a

very complete description, to which we are indebted for many particulars. He states, among the many surgical instruments and appliances found in all parts of the Roman Empire, more than a hundred different ones are known which are certainly not inferior to those of the present day.

The old Roman instruments were composed entirely of metal, mostly bronze and iron, some being beautifully shaped and richly inlaid with silver.

Pottery in immense quantities has been found in the neighborhood of these temples, but it is usually of a fragmentary kind, but among it there are cups and vessels of every form and description, and from these a certain idea may be gathered of the epoch at which the shrine was frequented. Many of the cups are pierced with a hole, by means of which they are hung up as a votive offering after being used. Among other articles invalids' medicine cups and infants' feeding bottles have been found. The latter are both curious and interesting, and most ingeniously constructed. They were made on the plan of what is now known as the pocket ink bottle, and no flies or dust could reach their contents. The milk was introduced by inverting the bottle and pouring it through an open tube ascending within from the middle of the base almost to the apex, which also prevented its escape, except through the mouthpiece. This was in the form of a small spout emerging from one side, while opposite to it was a small handle for holding the bottle.

Several of the bottles found were fashioned in the shape of the human breast, and others take the form of various animals. They are usually discovered in the tombs of children, together with a tiny rattle, having doubtless been placed there by the mothers at the time of burial, a custom which has prevailed from time immemorial in some parts of Italy.

Another class of *donaria* are those representing the limbs and organs of the human body, or models of the diseased parts of the patient. These are often beautifully modeled in clay, and were presented as offerings to the healing gods by the sufferer. The most common variety are heads of every size and epoch. Some represent youth, others bearded men, while a large number are those of females. Occasionally the whole head is represented, but sometimes only one side of it is shown, the reverse being a flat surface. From the style of hairdressing represented, a good idea may be formed as to the period and locality to which they belong, the ages, according to the authorities, varying from the fifth century B. C. to the second A. D.

Models of eyes and ears are also very common, while the internal organs, such as the heart with its auricles, the kidneys, the larynx, the pelvis, and many others are frequently found. Arms, legs, hands, feet, and sometimes single fingers have also been discovered. The hands are generally represented in the attitude of worship, while the feet are usually clad in sandals, the sole being shaped in the clay and the straps painted.

These terra cotta models were made in large quantities by the wayside potters, and sold for a trifling sum to the votaries on the road to temples. The most perfect images of bronze usually consisted of figures of gods, patients offering gifts, etc. They vary in size from two or three to twenty inches, and were sometimes fixed by means of lead to small bases of marble, which bore votive inscriptions. In Dr. Sambon's collection is a model of the scalp with neatly plaited hair, and was probably a votive offering to Minerva Medica for recovery from loss of hair. Among other bronze models those of leeches have also been found.

Votive tablets of wood painted with representations of the gods or the donors were often hung on the walls or suspended from the trees in the neighborhood of the shrine and called *oscilla*. This curious custom of offering models in wax, wood, and silver still survives in Italy, and in many of the country churches and the small shrines in the street it is a common practice to present these gifts on recovery from sickness.

Sir William Hamilton, in a description of the Feast of S. S. Cosmo and Damian in Isernia, near Naples, he wrote in 1780, states:

"In Isernia, at the annual fair, which is held on September 27, images of wax, representing different parts of the body, are publicly offered for sale. The devout distributors of these votive offerings carry a basketful of them in one hand, and hold a plate in the other to receive the money, crying aloud, 'S. S. Cosmo Damiano.' If you ask the price of one, the answer is, 'The more you give, the more's the merit.' In the vestibule are two tables, at each of which one of the canons of the church presides, crying out, 'Here masses and litanies are received,' and the other, 'Here the votive offerings are received.' On each table is a large basin for the reception of the different offerings, which are chiefly presented by the female sex."

At the great altar in the church another of its canons attends to give the holy unction with the oil of St. Cosmo. Those who have an infirmity present themselves at the great altar and uncover the member affected, which the priest anoints.

The ancient temples must have presented a strange spectacle indeed, crowded as they were with these *donaria*, which hung from the walls, ceilings, and round the figures of the gods, representing the helplessness of suffering humanity and divine mercy.—Br. and Col. Dr.

The purification of acetylene is effected in Dr. Ullmann's process by means of an acidified solution of chromic acid. Dr. Wachs, of Carlsruhe, has been experimenting with the process. Two glass towers, 40 cm. in height, were packed with broken pumice saturated with a solution of crystallized chromic acid in twice its weight of 50 per cent. acetic acid and the solution also stood 2 cm. above the inlets to the towers. Acetylene containing 0·5066 gr. of phosphorus per cubic meter was passed through these towers, and then through a smaller tower packed with lime and sawdust, which retained any acetic acid sprayed over from the large towers. The gas thus purified was found to be free from phosphorus, and to have only a faint garlic-like odor, when the rate of passage was 29 liters per hour; but at the rate of 119 liters per hour, which was considerably greater than the prescribed rate for the towers used, a small amount of phosphorus was detected in the issuing gas. The illuminating power of the gas was observed before and after purification, and was found to be virtually the same.—The Engineer.