remarks that sufficient attention has not hitherto been paid to the very detrimental effect on combustion itself, as well as on the work done, when the radiative power of the flame is in any way interfered with, so that it cannot be developed to its fullest extent. He hopes also to have made it clear that complete combustion is impossible whenever the live or active flame is allowed to come into contact with any solid surface, and that such solid surface will always suffer when so impinged upon—not, as has been hitherto believed, by the action of heat alone, but also by the mechanical and chemical action of such flame.

As flame is nothing but molecular motion of combining gases, this circumstance alone proves the necessity of not interfering with such motion, while the moving molecules, although indefinitely small, are so numerous, and move so rapidly, that they represent an amount of energy which, acting constantly, must in time destroy any surface or object exposed to it; besides which, the flame has most probably a chemical influence that tends to assist this process of destruction.

The author wishes to draw attention to the gas burner exhibited, which was fully described at a meeting of the Gas Institute, and is similar in principle to the regenerative gas burners brought out some years ago, which are now manufactured in various forms, and used extensively for lighting purposes. This particular burner is designed for warming rooms by means of radiant heat in the same way as the ordinary English fire. There is, however, this difference between the two—that with this burner heat is radiated in a more useful manner, being distributed uniformly throughout the room. Very active ventilation is insured by its use, it is not expensive to maintain—consuming about 50 cubic feet of gas a day, which is sufficient to warm a small sitting room—and is especially economical as regards labor, as no handling of coals, ashes, or soot is required, and smoke is entirely avoided.

In an ordinary fireplace, the heat which is not radiated out into the room, but is carried away with the products of combustion into the chimney, is lost; while it is utilized in this case to heat the air required for combustion, whereby the temperature, and, consequently, the heat-radiating power, of the flame is much increased. This process goes on in a progressive ratio, for as the temperature of the flame increases, so does that also of the air supplied to the burner, and thus it can be safely asserted that nearly all the heat produced by combustion is eventually radiated into the room.

The author has exhibited this burner at work, and has drawn so much attention to it, because it gives the best possible illustration of the conditions under which combustion can alone be perfect. It also shows to how great an extent radiant heat can be applied, and how important a part it plays in all operations of warming, heating, and transmitting heat. For these reasons the author recommends this burner to the consideration of the members as supplying information in the best and most easy manner regarding the requirements of large furnaces, with which it is so difficult to make experiments and obtain data.

In each case the flame is not permitted to come into direct contact with any surfaces whatever, while the heat still remaining in the non-luminous products of combustion is abstracted by direct contact in the regenerators, heating the air required for combustion, which air, being non-luminous, can only be heated by direct contact, as radiant heat has no effect in heating air, just as heated air cannot be made use of to supply radiant heat. The analogy being so perfect, it will be readily seen how well the requirements of combustion for the production of radiant heat can be studied by means of this little burner.

It is by means of radiant heat alone that nature warms us, and thus becomes the source of the development of all organic and inorganic matter. We should imitate nature, and employ radiant heat for artificial warmth, as well as in the arts and manufactures.

CHAIN CASTING.

THE PROCESS EMPLOYED IN CASTING BRASS CHAINS IN JEYPORE, RAJPUTANA.*

By MR. C. PURDON CLARKE, Keeper of the Indian Collection, South Kensington Museum.

In June last, at the request of your president, I had the honor of giving a general description of certain processes employed in making fine brass castings in Upper India, illustrating my paper by showing some finished pieces and moulds. One object, a double linked chain anklet, was then but imperfectly described, owing to the want of examples of the manufacture in its various stages. I therefore wrote for further details to Surgeon-Major Hendley, the physician to the Residency at Jeypore, and now propose reading a description sent by him: The peculiar anklet known as *santh*, made up of flat links formed at one casting, is produced in Southern Rajputana and Central India, and especially at Sawia Madhopore, a Jeypore town beneath the famous fort of Ranthambhor, which stands in the hills near the junction of the Banas and Chambal Rivers.

Here twenty-five men obtain a livelihood in making these ornaments. Their ancestors brought the art from Bundi a hundred years ago. The anklet is termed *sant* or *santh*, from Hindoo words signifying joining or sticking. Three different varieties of the *santh* are made at Sawia Madhopore: (1) *Sut wan santh*, in which the pattern is of plain or thread-like links. (2) *Chakti dar santh*, having small patches or projections upon its edge. (3) *Kil kunda-ki santh*, in which the ornaments are fastened by a screw. The following is a description of the process of manufacturing a plain *santh*, variety 1.

Several specimens were made in the writer's presence. A composition is prepared of seven parts of wax, forty parts of resin or *ral*, eleven parts of oil of sesamum. These ingredients are well mixed and melted together in an earthen pot. The mixture is then poured through a fine cloth into another vessel, which is nearly full of cold water. It falls to the bottom in a thick mass, which is then pulled and repulled in the fashion of making barley sugar, and again dropped into cold water.

A portion of it is next taken and rolled out with a flat wooden tool on a board, in such a way as to form, from one end of the cylinder, a long thin string of the

thickness of the future links of the *santh*. A stick, having the same diameter as the proposed links, is taken, and the thin wax cord is coiled round it from near one end to the other. A straight cut is next made along one edge of the spiral, by which a number of rings, open at one side, are formed. A knife edge is made hot in a charcoal fire, and by applying the ends of the rings to it they can be easily united. One ring is first formed, and then the second linked into it. The two edges of the third ring are passed over the first two and joined.

The fourth ring, in like manner, passes through the two preceding it, and thus the process is continued, until perhaps sixty or seventy rings are used—a sufficient number to make an ordinary anklet. When a curved chain of the requisite length has been thus formed, it is flattened out on a board, and the ends united. The workman takes the anklet in his hands, and rapidly moves it through his fingers, and presses the links together in such a way as to make the ornament firm, flat, and regular. He uses warm or cold water, as may be necessary, to insure that the wax maintains a suitable pliancy.

A solution of red clay is prepared in the following manner: Red clay three parts, dried cowdung one part, with sufficient water. The first two ingredients are powdered, and made into a paste with water. The wax *santh* is dipped in the composition, so that the fine clay adheres to every part of the links. As soon as the coat becomes dry the operation is repeated, in all four or five times. A thicker paste, composed of red clay (not strained) sixteen parts, fresh cowdung two parts, water one part, is spread over the *santh*, so as to form a mould.

Three coatings are required. When the mould is dry, the upper edge is scratched with an iron tool, so as to expose the wax links within. The links are oiled, and a flat thin piece of wax is attached to them all

open furnace, or pit in the ground, filled up with dried cowdung cakes.

The moulds are placed in this and made red hot. After a time the wax escapes in black fumes, and the metal melts. When the metal is quite melted, blue fumes appear. The moulds are kept upright, the inverted *mus* being at the bottom. They are removed in this position, and cracks from which fumes escape are carefully plastered over with clay, and the whole dipped for an instant in cold water. The mould is now inverted, and the melted metal poured into the cavity from which the wax has been burnt out. All that remains is to take out the ornament when the mould is cool, to break off the leading rods and ribbons, and to file away any inequalities or adhesions which may prevent free movement of the links. A *santh* made of *dharkree* is of a yellow color. If of equal parts of the above and of old anklets, it will be white.

The latter variety only is made at Sawia Madhopore. When the *santh* is finished, it may be plated with a composition of pewter, or *rang*, forty parts, hydrochlorate of ammonium, or *nausadar*, one part. The pewter is made of three parts of zinc and two of lead. A small portion of the composition is applied to each *santh* by heat, and the anklet is then cleaned and brushed with cold water. One man can make twenty-five pairs of *sanths* in fifteen days, at a cost of five rupees for fuel and labor and five rupees for metal. He does nothing else, and sells the ornaments himself at from eight to ten annas a pair.

He requires about one and a half maunds of charcoal to make twenty-five pairs of *sanths*. The above description is accompanied by a set of Indian ink drawings showing the founders at work and several examples of the anklets and moulds in various stages. In the first illustration is shown the melting and preparation of the wax, in the second rolling it into thin rods. In the

THE EAST INDIAN METHOD OF CASTING BRASS CHAINS.

along the edge by means of a hot wire. All the inequalities are removed by careful scratching, and the whole covered with the clay paste, which is allowed to dry as before. A quarter of an inch of the top of the *santh* is left uncovered by the clay, and to the portion of the wax thus exposed is attached a thicker ribbon of the same material an inch long, a quarter of an inch broad, and the sixth of an inch thick. The top band, the ribbon, and the links are thus continuous, though the latter are quite separate from each other. Two *sanths* are cast together, and for this purpose are so placed that the leading rods on each anklet are next each other. The two end ribbons are close together at the top.

Three distinct coatings of the thick paste of red clay are now applied over the pair of *sanths*, so as to form one ring-like mould, which ends in a boss or projection over the end ribbons. To prevent cracking of the moulds and loss of metal, a coating of thick black earth, mixed with chaff in the proportion of thirty-two parts of the former to one of the latter, is applied over the whole mould, and the top over the projection containing the ribbons is formed into a cup. The mould is now ready for casting. The metal usually employed is a composition termed *dharkree*, *phut*, or *bharat* by the workmen; *kansi* or bell metal by the public. It is composed of sixteen parts of brass and six of zinc. Another mixture is made of sixteen parts of the above mass with four additional parts of zinc. A third consists of old and broken anklets. The melting is done in a small conical cup termed *mus*, which is made of black potter's earth.

A sufficiency of metal is taken and placed in pieces in the *mus* with a small quantity of borax. (For a *santh* of one seer, one and a quarter seers must be used to admit of wastage.) The *mus* thus filled is inverted over the top of the cup-shaped head of the mould in which the wax ends of the ribbons have been exposed, and the edges of the two are united by the black earth and chaff composition. A small opening is also made in the mould near the top, by means of a style, to allow of the escape of the wax. The kiln is simply an

third this rod is twisted round the stick, to form even sized links; the fourth shows making up the links into chain; the fifth applying the moulding earth to the wax model; the sixth firing the moulds, and the seventh the moulds after firing, with sections showing their internal structure.

I have only to add that there is a seeming omission in the description of the firing, also in the corresponding drawings. It seems probable that, like other furnaces I saw in various parts of India, some form of bellows communicating with the hearth should be used to intensify the fire, the ordinary heat of burning cowdung not being sufficient to melt the mass of metal.

Dr. Hendley, the writer of the above notes, is the founder of the Science and Art Museum at Jeypore, Rajputana. This institution is connected with the local school of art, where technical teaching is carried to the extent of actual manufacture. Many curious processes are, therefore, from time to time brought to notice, which would otherwise sooner or later join the long list of the lost arts of antiquity. The two samples have been examined by Mr. Edgar Jackson, who has kindly furnished me with the following analysis: The brass contains: tin 3.53, lead 3.49, copper 46.33, zinc 45.98, iron 0.76. The pewter is composed of tin 38.16, lead 61.74, and a trace of copper.

ON THE CASTING OF CHAINS IN SOLID STEEL.

By M. FERD. GAUTIER, Paris.

FOR a number of years past, there has been an increased tendency to substitute steel, in one or other of its forms, for wrought iron. Hitherto, however, the chain manufacture has resisted the encroachments of steel to a larger extent than most other departments of the trade. This has been due to the necessity that has hitherto existed for welding the links, since it appeared to be difficult to apply steel to this purpose. Some years ago experiments were made by MM. David

* Read before the Iron and Steel Institute.

and Demoiseau, of Paris, with a view to casting chains in steel, and so to get rid of the process of welding in that industry.

A bar of soft steel, cut in the form of a plate, was made to assume the shape of two elongated rings, tied together by a flat piece, and this became the origin of the link. It was found that, in curving such bars in the form of a U, it was possible to tie them together through the two elongated rings, and so make a continuous connection. The experiment, however, was only partially successful. The weight of the chain was not much reduced, as compared with wrought iron, by the alteration of form. The links were moved more stiffly, and they were not so easily curved in different directions, especially on a small radius. Another serious difficulty was that of catching a link in such a way as to stop the falling of a chain cable or other chains used in the merchant marine.

Another process of manufacturing chains, and which possesses the advantage of allowing the usual form of the links to be retained, is as follows: A steel bar rolled into the form of a section resembling a cross—being similar to two cross links in horizontal projection—is drilled and cut with suitable tools into the form of an ordinary weldless chain. This process, however, involved a great deal of work and much loss of metal in reducing the bars to the form of links, so that it could not be regarded as economical. In other respects it might have become established as a good process. The true solution of the problem would appear to be that of producing a moulded or cast chain. This seems to be possible with certain descriptions of metal, when the shrinkage is moderate, but otherwise numerous cracks would be likely to occur in the links. At the last meeting of the Institute, an endless curb chain of Indian manufacture, cast in bronze or brass at a single operation, was shown by the President; and at the Inventions Exhibition last year a chain was exhibited, of large size, cast in Delta metal, and of very small shrinkage indeed. This chain was intended for a large Brazilian cruiser, the Riachuelo, which was constructed in this country.

The casting of chains in solid steel, however, appears, theoretically at any rate, to be a somewhat difficult process, having regard to the conditions which it is necessary to fulfill, viz.: (1) In order to arrive at an economical product which could compete successfully with ordinary wrought iron, weight for weight, it is necessary to have a quick method of moulding the chains. (2) It is necessary to employ steel of such a character as to afford the most perfect security—steel that is quite solid, and absolutely without blow holes. (3) It is necessary to avoid all cracks or similar defects likely to result from the shrinkage of the metal. Absolute security must also be provided in this direction, otherwise the chains would obviously be quite unfitted for use in so important an employment as the merchant marine.

The problem presented for solution was therefore a difficult one, but MM. Joubert and Leger, of Lyons, have succeeded in overcoming all the difficulties involved by the use of a process which combines chilled casting and instantaneous removal from the moulds. I. A chilled casting, or, in other words, casting the metal in an iron mould, is obviously, when practicable, both the readiest and the most economical process, the work being reduced to a cleaning of the moulds and scrubbing them with graphite. This labor can be performed by boys or by women, and special or experienced workmen are not necessary. Chilled casting is the best method of retaining unaltered the structure of steel which was originally without blow holes. It is easy, for example, to get a solid soft steel, if silicon and manganese are added in suitable proportions; but it is not always possible to maintain it in that condition if it is cast into complicated shapes by the use of sand moulds. This difficulty is due to the action of the metal on the moulds, in which gases are occluded that are unable to escape before solidification takes place. The adoption, therefore, of a chilled casting, which secures the minimum amount of action between the metal and the mould, must be preferred.

II. Instantaneous removal from the moulds is another point of importance, which it is absolutely necessary to attend to in producing chains with a metal having so high a shrinkage as steel. This is the only method whereby the links can become free to contract, and by which cracks can be got rid of. In carrying out this process, a link, having been previously cast, is kept in a vertical position through an iron casting block, which is in two pieces, one of them lying upon the other in a horizontal position. At the end of this block there is a casting hole, used as a head to feed the casting. This part of the mould may be made in sand, in order to keep the steel liquid for a longer period than it would be if cast in iron, should such a course be rendered necessary by the special character of the steel employed. The instantaneous removal from the moulds is done through three blocks or taps, which are connected with a shaft that may have an oscillating movement, depending upon a hand beam. Two of these blocks are so arranged as to act on the two ends of the upper part of the mould, which they can thereby raise, whereas the third block, being connected with the lower part of the mould, can let it down. Thus, by the simple movement of a hand lever, the mould may be opened, and the casting is thereby directly liberated, so as to cool and shrink.

The same result could, of course, be obtained by the use of hydraulic power acting on three cylinders, so arranged as to operate together in opposite directions. The finishing of the chain is quite a simple process. Several casting blocks are placed on a revolving turntable, or it may be on a truck rolling on wheels. It is possible to cast several pieces of chain together, each cast adding a link. After the opening of the moulds, a workman cuts the head off the link, and afterward files the cut, if that should be necessary. The links are subsequently placed in a vertical position, and the casting is continued as before.

The chain having been completed in this way, it is annealed and hardened in oil, if necessary, after which it is ready to be tested. It appears superfluous to describe the advantages of a process so simple and so quickly performed as that just referred to. The process is one that opens up a new field for the successful employment of the highest qualities of steel—such steel as can be trusted to remain solid and without blow holes when cast in chilled moulds. Crucible steel generally would be suited to this purpose, and probably also the *mitis* metal, the high, manganese steel, and chrome steel.

If, by this process, better chains can be manufactured with a diminished weight of metal, it would manifestly be an important departure, and especially for naval purposes. A specimen piece of chain, 20 mm. diameter of link, which had stood a pull of 38 tons per square inch, was shown by the author.

Mr. Spencer, of Newcastle, said that patents had been taken out in England, for identically the same plan, in 1882. As a manufacturer of steel, he was asked, some two years ago, to undertake the carrying out of experiments thereon, and since that time they had made a considerable amount of steel chain of varying sizes, everything being, from a steel maker's point of view, perfectly successful. At the beginning they found that the smaller chain was comparatively easy to cast, the great difficulty usually being from the contraction; but when it came to the longer links, there they found very considerable difficulties indeed, because the steel, and especially mould steel, of which they cast it all, when run into the chilled mould, contracted immediately, very much more rapidly than they anticipated at the time, and the consequence was that there was a draw in the link.

But, by the improvements in the apparatus for the quick disengagement of the various pieces, they at last succeeded in making very considerable sized links on this plan, and he might say, now, that they would undertake to make a cable. He certainly had not encouraged their friend, Mr. Benman, the inventor (who was originally, he might say, a working chain-smith, and a very intelligent man), on account of the great cost, for when iron outfits for ships were being sold at about £11 per ton, they could not afford to make crucible steel chain at that price. One or two of the tests lately made would give the meeting some idea as to what was being done:

"A link was attached to two ordinary welded links of the best $2\frac{1}{2}$ in. cable iron, without studs, and five sizes larger than the patent link, and sustained a strain of 78 tons 16 cwt. It was afterward tested to 96 tons, when one of the ordinary links parted at the weld, leaving the patent link in position slightly fractured, having sustained, without parting, an overproof strain of about 22 per cent. The elongation upon the patent link was $\frac{3}{4}$ in., and on the ordinary also $\frac{3}{4}$ in. Another link was also attached to two ordinary welded links of the best cable iron $2\frac{1}{2}$ in. and four sizes larger than the patent link, studded and tested to the appropriate breaking strain, 82 tons 15 cwt. for studded cables, which it sustained, and was afterward tested as follows: 102, 104, 108, 112, 116, 120, and 124 tons, at which proof the welded link parted, leaving the patent link in position much fractured at a defective part. The elongation upon the patent link was $1\frac{1}{2}$ in., and on the ordinary link $1\frac{1}{4}$ in., thus showing the patent sustained, without parting, about 50 per cent. above the required proof for studded chain cables for $1\frac{1}{2}$ in.

"The next link tested was dealt with in the same way as the last one, as regards preparing for testing, and tested to the appropriate breaking strain, 82 tons 15 cwt., which it sustained, and was afterward tested as follows: 86, 92, 96, and 100 tons 16 cwt., when it was found, on examination, that one of the ordinary links had six fractures in it, and the patent link had none, thus showing the patent link to have sustained without parting (but showing a small fracture) an overproof strain of about 22 per cent. above the appropriate breaking strain. The elongation on this patent link was $\frac{3}{4}$ in., and on the ordinary link $1\frac{1}{2}$ in. In another test the link was dealt with in the same way as No. 1, as regards preparing for testing, viz., two unstudded $2\frac{1}{2}$ in. links attached, being five sizes larger than the patent link, and tested as follows: 96, 100, 105, 110, 115, 120, 125, 130, and 135 tons. At this proof the links were examined, and small fractures were found in the ordinary and also in the patent links. The links were so thoroughly rigid and locked together, owing to the enormous strain they had sustained (about 71 per cent. over the required proof), that it was impossible to ascertain any further injury to the specimen than that described above."

In every case the patent link had pulled asunder the other two, with considerable advantage, as a rule, in favor of the steel. There was no reason whatever why the steel, instead of being about 28-ton steel, should not go up to 30-ton steel, and even 35 or 40 tons. The chief point was to insure its soundness. He was quite satisfied that there were serious difficulties to be got over before a 50 or 60 fathom cable could be manufactured of crucible steel. He thought the line in which steel would be used in the manufacture of cables and other articles where very high strains were required, would be in the use of steel of a high grade of carbon—built up.

Mr. John Rogerson said that at the exhibition of 1867 a steel chain was shown that had been made at the Stanter Works, Wolsingham, of about twenty or twenty-five links, at the suggestion of Mr. Crawshaw, of Messrs. Hawks, Crawshaw & Sons. This was the result of a series of experiments that had been going on from several years during Mr. Attwood's time, possibly from the year 1865 or 1866. The chain was tested at their own works, and the cost was the only difficulty that Mr. Crawshaw saw in its introduction for general purposes of cable chain. He was not at all certain that some were not supplied to the War Office for experiment, but he had no particulars, not having been aware that this paper was to be read, but had no doubt that he could, at some future meeting, supply a piece of the chain that was made and shown in 1867; they had the chain at present, and he would endeavor to show it at the Newcastle meeting.

Mr. Fox said that the firm he represented had been engaged in this work for some considerable time, and although they had encountered very serious difficulties on account of contraction, he thought he might safely say that they had overcome them. A $\frac{5}{8}$ studded link chain had been tested to destruction; the test for that size of chain was $7\frac{1}{2}$ tons, and it broke at 11 tons. They had also a $1\frac{1}{2}$ chain, studded links. This was tested at Kirkcaldy's.

BLEACHING WITH CHLORINE GAS.

HERR GEORGE HERTEL has communicated to the *Faererei Muster-Zeitung* some interesting results of experiments in bleaching cotton by means of chlorine gas, or rather hypochlorous acid gas. Several empty carboys were filled with scoured cotton; the mouth of each vessel was hermetically closed, and made to communicate with another empty carboy by means of a

small pipe which could be closed up by a little stop-cock. The carboys filled with cotton were placed on a frame with their necks downward, while the empty bottles were placed below in an upright position. In the empty bottles was introduced chloride of lime, and afterward sulphuric acid, and then immediately covered, and the stop-cock opened communicating with the carboy above, in order to allow the gas to react on the cotton, when the bleaching was immediately effected. The author stated that no air should be allowed to enter the carboy containing the cotton at the same time with the gas, otherwise the bleaching reaction was diminished. With this dry bleaching process by gas, the proportions were as follows: 2 per cent. bleaching powder, $\frac{1}{2}$ per cent. sulphuric acid to the weight of the cotton; while by the ordinary process (according to the author) 8 to 10 per cent. of chloride of lime is required. With the above proportions no injury was caused to the fiber, and a perfect bleach was obtained, which only required a washing and soaping to be complete; while it was found that by employing the gas obtained from 10 per cent. of bleaching powder the fiber was completely rotten. The author recommends the construction of an apparatus in which the gas could be pressed in by means of a pump, and thus made to react on the cotton. We rather think, however, that the best method would be to employ the well-known vacuum bleaching keirs, in which the vacuum would be first effected as is now done, but, instead of reacting with the bleaching liquor, to act with the bleaching gas liberated in carboys, or in larger stone or lead lined vessels. We do not apprehend any mechanical difficulty in the carrying out of the proposed bleaching process, since the apparatus already exists; but we apprehend one very great difficulty, and that is that, when treating large quantities of cotton, it would be very difficult, if not impossible, to have the gas penetrate all through the mass. It will also be remembered that chlorine was at first applied in the form of gas in the bleaching process, but that experience showed it to be best applied in the form now generally in vogue.

HISTORY OF THE ANILIN MANUFACTURING PROCESS.

M. BECHAMP, the inventor of the modern process for the manufacture of anilin, has made public some interesting facts concerning the way he came by his discovery. Zinin was the first chemist to show that anilin could be obtained by the reduction of nitro-benzene. He employed sulphhydrate of ammonia as the reducing agent, a substance which yields only a very small product, and the reduction does not take place very easily by this means. Toward 1854 M. Bechamp was making investigation on gun cotton, which he at first believed to be a nitro product capable of reduction, like nitro-benzene, but, not succeeding in effecting the reduction, he concluded that pyroxylin was a nitrate of cellulose, a combination analogous to an ether in which cellulose acted as an alcohol. In treating gun cotton with protochloride of iron and a small amount of hydrochloric acid, he regenerated the cellulose; with the acetate of the protoxide of iron he also obtained the same result, the nitrogen of the nitric acid being in this case eliminated as ammonia. It was in conducting these investigations that the idea struck him of trying his method of reduction by means of the acetate of protochloride of iron on nitro-benzene, in which he was thoroughly successful, and which he simplified afterward by effecting the reduction by means of iron filings and acetic acid instead of the ready formed acetate. M. Bechamp's investigations were published in the *Annales de Chimie et de Physique* in 1854, in which the cost price of anilin is put down at 20 francs per kilo. In the discussion which followed in the sitting of the Societe Industrielle du Nord de la France, M. Faucher observed that he shared M. Bechamp's opinion as to gun cotton being a pentanitate, while many chemists, especially in Germany, consider the same as a trinitrate of cellulose.

THE MAKING OF RUBBER STAMPS.

THE wording of the desired rubber stamp having been correctly set up in ordinary type, the same is locked up and placed upon a level support. Around it is put an iron frame, which will determine the shape and size of the matrix.

By means of a soft brush, the type as well as all surrounding parts that are to be covered by the plaster of Paris are well oiled.

For the purpose of making the cast, finely ground fresh plaster of Paris is needed; if of long standing, the same will lose its desirable properties. This plaster of Paris, of which a sufficient quantity should at one time be mixed to the consistency of pap, using clear water, is poured over the frame containing the type in a thin layer, so as to barely cover it. With a stout brush the mixture is driven into all spaces and interstices, until all details are thoroughly covered. After this the remaining pap of plaster of Paris is added until the frame is full to overflowing. The surface is smoothed down, after the plaster has settled somewhat, and in a short while the matrix in the frame may be removed from the type.

After this it becomes necessary to bake the matrix in an oven for a period of from four to six hours. When thoroughly baked, the matrix should be well brushed with a thin solution of shellac to impart a smooth surface, and, at the same time, greater strength.

The matrix at this stage represents a yellowish-white block, in which the lettering appears indented, but in proper place. The indentation corresponds to the height of the letter upon the piece of type or the marks upon a cut, while the remaining parts should be perfectly smooth and free from holes. This matrix, obtained by a coating from the type or cut, will serve as the mould for the final rubber stamp.

Pieces of caoutchouc are cut to the required size and laid upon the matrix. If pressure is now exerted, the soft mass will adjust itself to fill all the spaces and reproduce the mould invertedly. Indentations become raised matter, and the whole will show as did primarily the type.

But as the caoutchouc has a tendency to return to its previous shape, it becomes necessary to apply the process called vulcanizing. The object is to impart hardness to the rubber, and to prevent its losing the form into which it has been pressed.

To accomplish this, the caoutchouc must be heated