chalcedony, cornelian, green jasper, and smoked topaz, which were worked up into pretty little ornaments.[1]

Soapstone, Jap. Rôseki (wax-stone), and In-seki (seal-stone), is found principally in Bizen, in simple greyish white and also coloured varieties. It is much worked up into seals (Ingiô or In) but for this purpose the Chinese Agalmatolite (To-Rôseki)[2] is preferred.

7. Metal Industry.[3]

Prefatory Remarks.—The Working up of Iron into Swords, Armour and Objects of Art.—Embossing of Cast Iron.—The use of Copper.—The most important Alloys of Copper.—Japanese Bronze.—Patina.—The use of Bronze in the Household, and the Buddhist Religion.—Magic Mirrors.—Gold and Silver in Japanese Industrial Art.—Bronze Analysis.

Numerous indications and historic statements which cannot be doubted, tell us that the Japanese people were acquainted with the most important metals in very early times, and have made great progress, especially with their preparation, since the 6th century of our era. The finding of pre-historic bronze weapons, like arrow-heads and swords, copper rattles and bells, and iron articles of various kinds, we must leave to the further study of the antiquarian. Japanese art industry in all its branches, including that of metal industry, was not really developed until Buddhism pushed hither from the continent, with its new ideas.

In the first half of the 8th century, at the time of Shômu-Tennô, the ability to work skilfully in metals generally, and especially in bronze, had already reached a high stage. This is seen in the idols, vases, censers, and other articles which the old celebrated temples at Nara, Kiôto and other places have preserved from that time. The influence of China and Corea, and the advancement of industry by Buddhism, are here also unmistakable.

This stimulus on the part of religion to metal industry decreased with the imperial power and the development of military despotism and feudalism. (See vol. i. p. 226). In the civil wars which the parties of the Taira and Minamoto carried on in the 12th century, as well as others which followed later, the forging of iron weapons and armour, became of greater importance than the casting of idols and vessels of bronze. Whoever could make good

[1] Lyman: "Geological Survey of Japan. Reports of Progress for 1878 and 1879." Pp. 35 and 58.

[2] Their external similarity to variegated soapstone, in colour and veining, is evidently the reason why the Japanese apply the name Rô-seki to serpentine, and also to coloured marble (p. 313).

[3] Kane = the metal; Kane-mono = the metal-ware: Kane-dzaiku = the metal-work.

swords stood at once higher in the general estimation than any other tradesman; his industry flourished when all others were laid low.

When the dynasty of the Tokugawa-Shoguns was firmly founded by Iyeyasu and his next successors, and the land was assured of peace, the other branches of metal industry, as well as of industrial art in general, became once more important. The disturbance which it suffered twenty years ago, through the setting aside of feudalism and the restoration of the Mikado government, has had no lasting effect except upon the forging of weapons. On the other hand, metal industry has made new openings for itself in many of its artistic branches, and shows in these remarkable progress, as will appear hereafter more especially in the instances mentioned.

There is scarcely any kind of metal ornamentation or decoration, with the exception of galvanizing, which the Japanese had not known and practised before the opening of the country. In their more eminent accomplishments they had already won the admiration of European connoisseurs. Precious metals, copper, bronze, and cast-iron, however different their properties may be, all yield to the skilful hand of the Japanese, and to his manifold little art-conceptions, which effectively supplement the simplicity of the tools. His decorations of iron and bronze belong notably to the most costly that can be accomplished in this direction. The wonderful skill with which apparently insurmountable difficulties in damascening, chasing and other work are overcome, surprises us no less than the great ability to work effective colour combinations, and the means of their representation.

Before I proceed now to the description of the chief accomplishments in the several divisions of Japanese metal industry, I will explain them briefly in the interest of such readers chiefly who may not understand the customary art expressions. The most common working utensils which are used by the Japanese in the various kinds of metal decoration are the following: 1st, the anvil, Kana-shiki or Kana-toko; 2nd, the tongs, namely: *a.* Yattoko, the pincers; *b.* Kana-hibashi, the fire tongs for holding hot metals; *c.* Kugi-nuki, the nail tongs; 3rd, the iron hammer, Kana-dzuchi (Sai-dzuchi is the wooden hammer which is used in the chiselling of wood, and other softer substances); 4th, the file or Yasuri; 5th, the chisel or Nomi, in many forms and sizes; 6th, the burin, bent graver or Tagane, a little piece of iron from a finger's to a hand's length, generally in the shape of a nail; the upper end a little enlarged like a head, the lower either pointed or sharpened like a chisel, and always edged with steel. The burin is used in engraving, chasing and inlaying, and is one of the simplest but most important of the tools of this industry. The punch is a kind of burin whose steel end has other forms and is often provided with figures. It is used in the chasing of metals; 7th, Ko-gatana, a small knife.

The various forms of decoration which the Japanese employ with

metals are called casting, embossing, beating, turning, chasing, engraving, inlaying, damascening, encrusting, plating, enamelling, and colouring.

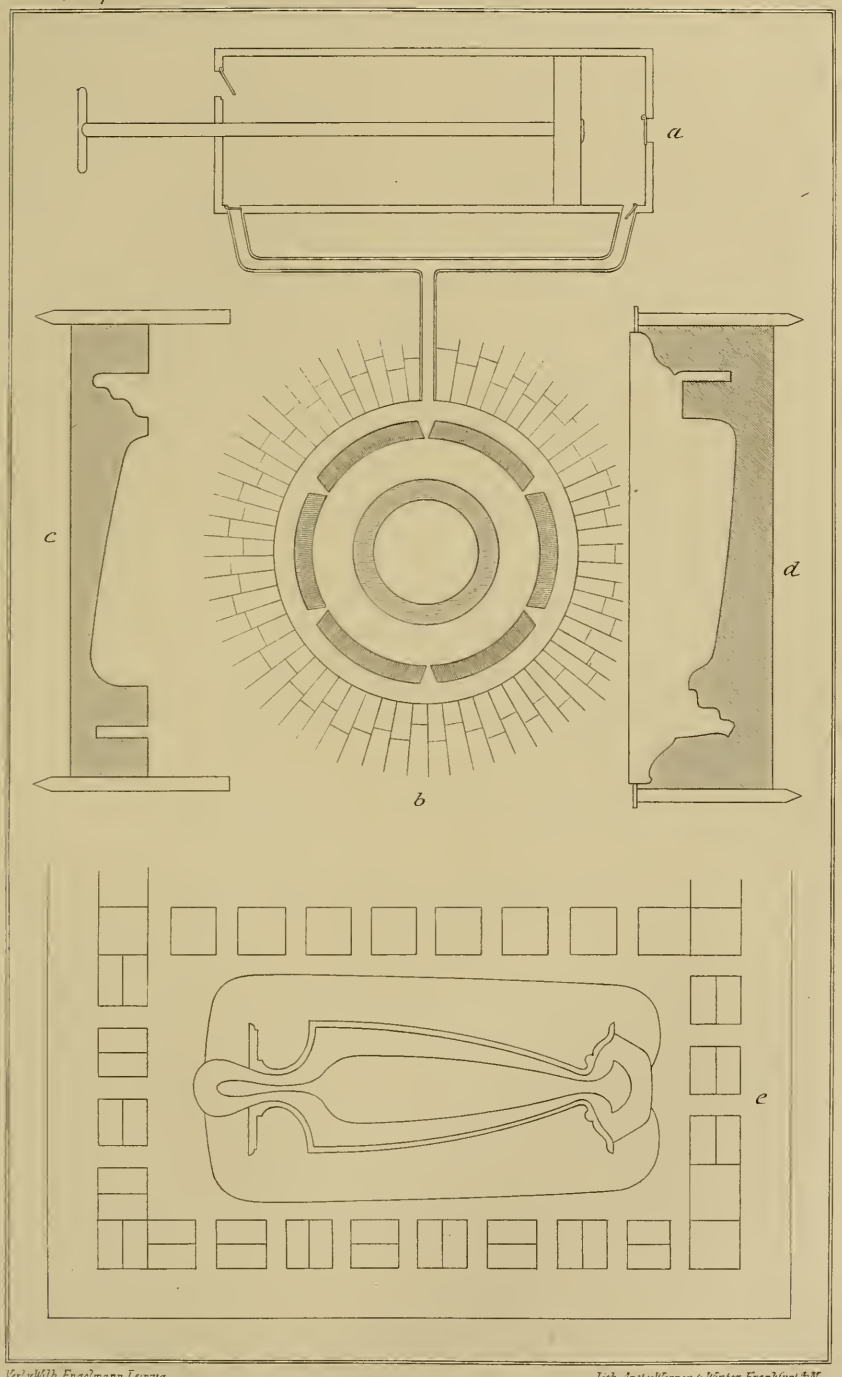
Casting, Jap. Iru. (I-mono, the casting). Plate XV. shows in *b* the lower cross-section of the common, small, smelting furnace ; in *a* that of the box bellows. The air of the latter is forced in six places into the fire-box in which charcoal is brought to a glowing heat. These places surround the smelting furnace, which is made of fire clay. Figure *e* shows the cross-section of the clay mould of vase with its interior, which has been beforehand turned on the patterns *c* and *d*. Such moulds are, of course, duly prepared before each casting. The results in iron, and especially in bronze casting are astonishing when one considers these simple arrangements. At the Vienna Exhibition was seen for instance, a group of flying birds, which appeared separate from each other, and still were formed at one casting.

Embossing, Jap. Uchi-dashi or Uchi-age. The decoration of bronze in relief is accomplished either in the casting of the subject, or by turning and chiselling, or finally by embossing, French Repoussé-work. The last consists in forcing the metal from the inside outward, generally with the aid of the punch. Embossed work can, of course, be executed only in sheet metal. In Japan it is made principally in Hiroshima and the three capital cities, but is far less important than other modes of decoration.

Beating, Jap. Tataku or Utsu is the name given to the hammering of cold metal into sheet form on the anvil. The skilfulness is shown in the finished products (for example, a silver or copper vessel), chiefly in the even distribution and conformity of the marks of the hammer or Tsutchi-me (hammer eyes). The well-known silversmith, Tiffany of New York, furnishes beautiful beaten work of this kind which excels even the finest of Kiôto.

Turned work or the Rokuro-saiku is generally done on the turning lathe in cast bronze. It has become more and more the custom in modern times to produce the decorations in relief, not in the casting, but by sculpture (Horu). The article, a vase for instance, is cast smooth but with very thick walls. The bronze sculptor, or Hori-mono-shi, draws the ornamentations which are to protrude above the ground, and next cuts away to the required depth the superfluous metal around the outlines by means of chiselling and turning. He then applies himself to the projecting parts, and forms them just as the sculptor or the wood-carver forms his rough block. What he loses by this in time he spares himself in the preparation and simplifying of the casting.

Chasing, Jap. Horu and Hori-age, is the name given to the afterwork with the chisel, burin, and file applied to the relief obtained by casting, embossing or sculpturing. By chasing, the seams of the casting and other accidental unevennesses are removed. Folds, furrows and angles are developed, or better brought out



Verl. v. Wilh. Engelmann, Leipzig *Lith. Anst. v. Werner & Winter, Frankfurt a/M.*

APPARATUS FOR CASTING METAL.

a Box-bellows, b. Cross-section of a smelting-furnace,
c. d. Model, e. Mould.

and in general, the imperfections of the first, coarse work are overcome.

Engraving, to carve in, to incise, is called in Japan also Horu, but likewise Kiri-tsuke, and is nearly related to chasing. It is done with the knife (O-gatane) and the bent graver (Tagane), and usually serves for the decoration of flat surfaces, not of raised work. Hori-mono is the name given to every kind of graven or chased work, and the article thus decorated is called Hori-mono-zaiku.

Damascening, Japanese Zogan (German Tauschirung, French Damasquinure), is the name given to the inlaying of wires and fine strips of gold and silver in the furrows of baser metals. Iron, steel, bronze and copper especially are damascened. The ornamentation stretched out beforehand must be engraved according to the pattern with the burin, or hollowed with the chisel. The furrows which are produced with the former, have in the cross section the form of a swallow's tail, or are made "under cut" as the bent graver is held in receiving the blows of the hammer, first vertically, then inclined, once to the right and once to the left.

In this way both the outer edges of the furrow, which grows larger towards the inside, are beaten back, welt fashion. They are then filed off smooth, and the prepared piece of precious metal (wire or plate) is laid in the furrow and driven in with a hammer. The Japanese distinguish three kinds of work according to the manner in which this is done, as they do in gold lacquer work, as follows :

a. Taka-zogan, *i.e.* raised damascene work in which the gold and silver, like the *à jour* precious stone in its setting, for the most part projects over the furrow.

b. Hira-zogan, flat damascening in which the inlaid precious metal does not project over the surface of that metal decorated with it.

c. Nuno-me-zogan, *i.e.* damascening in meshes. That variety of Hira-zogan which is used chiefly as a universal surface decoration, such as plate XVII. shows on both sides of the vine border, as well as the clouds in fig. 17, receives this designation. The cobweb on the bronze vase, plate XVIII., and the handle ornament on fig. 15, are specimens of simple Hira-zogan, while raised damascening is what we see in the girls' figures, and other forms in plate XVII., as well as in several of the following illustrations.

The expression damascening is now used generally as a synonym for inlaying. In its secondary significance, the etched mirror-like decorations of silky lustre on steel and iron are understood.[1]

[1] In Europe, the beginning of the art of inlaying is traced back by antiquarians generally to the Celts. I do not share this opinion, and think the artistic sense and ability of this people was too little developed, and that the discovered works attributed to them do not originate with them, but with the Romans. These latter certainly understood and practised the inlaying of iron weapons and armour when they came into contact with the Celts. Proofs

Incrusting, or incrustation, is the name given in art industry to the decoration inlaid in the surface or crust of an article. Thus, intarsia work, enamelling and damascening are all varieties of incrustation.

Plating, Jap. Kin-kise and Gin-kise. The covering of a common metal with gold or silver in sheet form, where the precious metal is made fast to the foundation by hammering, pressing or rolling, is called by this name. The inside of the copper-box (fig. 16) was silvered by plating.

The last chapter of this section will give all necessary details concerning the metal decorations of the Japanese by means of enamel (Shippô), *i.e.* opaque coloured glassy flux, while the equally important subject of patina-work or of colouring (Iro-tsuke) will be explained in the section concerning bronze work.

Iron, Tetsu or Kurogane.

The consumption of iron of all kinds has grown so enormously since the opening of Japan, that the home production has not been able to keep pace with it, and the average yearly importation, since 1868, mounts up to nearly two millions of yen. But even in earlier times, during the long rule of the Tokugawa, the iron produced in the country itself did not suffice for the demand, so that China and Holland were obliged to contribute to its supply.

The Japanese smithing has been developed chiefly in making weapons and armour, also in casting and decorating cast-iron water kettles, whereas its accomplishments (apart from the hardening of steel) in the manufacture of all those little tools and utensils used in daily life and handicraft, cannot be very highly valued.

Among the nations of Eastern Asia the Japanese were known as skilful workers of iron, which their celebrated Katana-kaji, or armourers, transformed into famous weapons of excellent steel. They produced swords by which one could cut through iron nails without nicking the blades in the slightest. These swords were as celebrated in Eastern Asia during the Middle Ages as those of Indian steel, σίδερος Ἰνδικος (Arrian), and the polished weapons made out of this material in the Persian Empire of former times.[1] Magnetic iron, in the form of ferruginous sand, was the raw material in both cases. Its reduction is carried on even now in Japan, in small smelting furnaces with charcoal, occupying three

of this exist in many collections of Roman antiquities. I remember, for instance, one—a Roman sword, inlaid with silver, at the Museum at Mayence, that was found in the Rhine.

[1] On the plateau of the Deccan, especially in Hyderabad near Dundurti and eastward from Nimal, magnetic iron was obtained, from which the Indian steel was made which furnished the celebrated Indian and Persian cut and thrust weapons, as well as the Damascus blades.

days in the process, as for example, at Anegawa in Idzumo. Steel and iron are obtained in this way at the same time.[1]

The sword, the most beautiful, most valuable, and the most dreaded weapon of Japan during the feudal times, was, according to the expression of the Iyeyasu, "the living soul of the Samurai." To wear the sword was his greatest privilege. He was trusted with it even when a boy, and carried it with him on his way to school (see vol. i. p. 327). The oldest Japanese sword, Tsurugi, or Ken, was carried crosswise over the back, and brandished with both hands. It was a straight, heavy weapon, with sharp edges on both sides, nearly a meter long, and from six to seven centimeters broad. As these were later made half the length and somewhat shortened, another weapon, the Katana or common sword of the Japanese, was devised, with an edge which is slightly curved toward the end. The Samurai carried this either alone or with a second smaller, dagger-like sword, on the left side of his girdle. These smaller weapons were known by the names Wakizashi, and were in later times shortened to 29 centimeters (nine and a half inches) and used in the Harakiri, or disembowelling.

The forging and polishing of swords was a wearisome work, demanding much skill and practice. Hütterott especially gives particular details concerning the various methods of combining the hard steel with the soft, elastic iron. The tempering (Yakiba, from Yaki, to burn, and Ha, edge) of the edge is carefully done in the charcoal furnace, the softer backs (Mune) and the sides being surrounded up to a certain point with fire clay, so that only the edge remains outside. The cooling takes place in cold water. It is in this way that the steeled edge may be distinguished clearly from the back, by its colour and lustre. The backs of knives, axes and other weapons are united to the steel edge either by welding on one side, or by fitting the edge into a fluted groove of the back blade, and welding on both sides.

Toward the end of the 15th century the occupation of the artist was united to that of the smith. Then they commenced to pay great attention to the mounting of the blade. In this work Tsuka, the hilt, Tsuba, the guard on the hilt, and Saya, the sheath, are brought especially into consideration.

The wooden hilt of a Japanese sword is about 15 centimeters long, in the cross section a long oval, covered with grained shark-skin or other decorations, and furnished further with the Me-nuki, two little metal ornaments, each one of which is fastened nearly in the middle of one side. At one end of the handle toward the blade is an oval copper or bronze plate, the Habaki or throat; on the other end is the Kashira, the head, or Tsuka-gashira, a metal cap. Lengthwise in the handle are two slots through which a strong silk cord, almost a centimeter broad, is threaded. This is wound around the whole handle in such a way that its two halves connect

[1] See Lyman: "Geological Survey of Japan, 1878 and 1879," p. 63.

closely on the two sharply arched sides, but cross each other over the broad sides so that rhomboid meshes are formed, through which the decorations of the handle, including the Me-nuke, appear.

The sword-shell, or guard, Tsuba, is as old as the sword. It is an oval metal plate from one to two millimeters thick and about six centimeters in diameter, with an opening in the middle to admit the blade of the sword. A second opening at the side serves for the fitting in of a straight knife, the Ko-dzuka, whose blade has been made to lie in an outside furrow of the sheath, with a groove for the point. There is often a third perforation in the opposite side of the guard, through which the Kô-gai, or "hair-pin" was put.

Saya, the sword sheath, was usually made out of the wood of the Hô-no-ki (*Magnolia hypoleuca*) protected and decorated by coats of lacquer varnish. The greatest luxury in the metal decoration of sword guards, hilts, and ends of the Ko-dzuka, was developed in the 15th century, the time of the Ashikaga Shôguns. This branch of art-industry "has given to Japan its thousands of skilled workmen and its scores of famous masters." [1]

As has been said on p. 426 the iron industry, in so far as the equipment of warriors was concerned, received its great impulse during the struggles of the Taira and Minamoto (see vol. i. p. 228). Skilful sword-cutlers gained for themselves high social position, and won immortal glory and fame with their swords. Kiôto, Ôsaka and Kamakura were their chief seats; in later centuries also Okayama in Bizen, Sakai in Idzumi, Seki in Mino, and Tôkio.

Masamune, who lived in Kamakura, about the year 1290, was especially highly esteemed.[2] His name became an appellative in the sense of most perfect workmanship, and was later bestowed on the celebrated sculptor Jôchô, at Nara in Yamato, a distinction enjoyed by his descendants for six generations. [3]

Many smiths acquired great skill also in making the Gusoku or armour, especially the Kabuto (helmets), Kusari-katabira (chain coats or mail) and the Oke-gawa or breast armour, which superseded them later. Among these Yoroi-shi or armour-smiths, the family Miyôchin has especially distinguished itself for many

[1] See W. Anderson, in Murray's "Hand-book of Japan," 2nd ed., p. 115.

[2] Whoever wishes to learn more of the history of Japanese swords is referred to the following treatises.

1. "The Sword of Japan," by Thomas McClatchie, in Transactions of the As. Soc. of Japan. Vol. ii. 1874, p. 63 ff.

2. "Die Japanischen Schwerter," von G. Müller-Beeck, *Zeitschrift für Ethnologie*, 15. Bd. 1882, p. 30 ff.

3. "Das Japanische Schwert," von G. Hütterott. "Mittheil. der deutsch. Gesellschaft Ostasiens," 33 Heft, 1885.

[3] See W. Anderson, in Satow and Hawes: "A Hand-book for Travellers in Japan." 2nd ed. London, 1884, p. 103.

EAGLE IN WROUGHT IRON. FROM MIYÔCHIN MUNEHARU. ORIGINAL IN SOUTH KENSINGTON MUSEUM.

[*Page* 516.

generations, from the 15th to the 18th century. The eagle in the Kensington Museum, which is said to have been forged by Miyôchin Muneharu in the 16th century, and of which a woodcut after a photograph appears on plate XVI., belongs to the most admirable products of their art.

A large label attached to the work contains the following statement. "Model of an eagle. The bird stands with outspread wings upon a rock, and is made of numerous bits of iron, some cast, others carved or hammered and chased. It is the work of Miyôchin Muneharu, a celebrated Japanese metal-worker of the

Fig. 15.—CAST-IRON KETTLE, WITH INLAID WORK.
(*Original in Royal Industrial Art Museum, Berlin.*)

16th century. The width of the wings measures four feet four and a half inches (133 centimeters). Bought from Mitford's collection for £1,000." [1]

The Tetsu-bin or cast-iron kettle, which is to be found in every Japanese house for boiling the water for tea, is the only one

[1] In the year 1881, in company with a learned Japanese, I visited the Kensington Museum in London, and with the permission of the directors undertook

among all the iron house utensils which is often artistically ornamented. The cover is usually made of bronze, rich in copper, and sometimes the handle also. Most of the Tetsu-bin are cast in the three capitals, and are sometimes ornamented with inlaid work or with enamel. Among the older, richly decorated kettles, those of Kin-ju-do in Kiôto and of Riobundo in Ôsaka are most generally found in collections.

Fig. 15, p. 433, represents such an iron kettle. It shows above the out-jutting rim for holding it on the tripod, a rough surface, which looks as if hewn out of a rock. Tablets of copper plate surrounded by thick silver wire are inlaid in this surface. These copper tablets were previously inlaid with gold and silver. The forged iron handle is decorated also with inlaid work, likewise the dark copper cover. On the copper plate in front, resembling an out-spread fan, is the blooming Sakura with the Uguisu, *i.e.* the Japanese wild cherry-tree with the Japanese nightingale, in silver and gold. A narrow gold plate encircles the spout in the form of a ring.

Zôgan, or Inlaid Work on Iron.

Although inlaying in iron was known even at the time of the Kuwammu Tennô (782 to 807 A.D.), still it was not generally employed till the 16th century, when, under Ota Nobunaga (1542 to 1582), the iron breast armour, Jap. Oke-gawa (literally, tub-bark), the armour shirt or Kusari-katabira, of woven wire, had become a part of the warrior's armour. It then grew to be more and more the custom to decorate these pieces of breast armour and the helmet also with silver and gold inlay; just as in Europe and especially in Spain, during the Middle Ages, armour and weapons were often made very costly by this inlaid work. The finest Japanese armour was made in the time of Taiko-sama, that is, during the second half of the 16th century.

More surprising than the inlaid work on the forged iron armour and weapons, is its direct employment on cast iron Tetsu-bin, vases and other articles. As is well known, the cast iron cannot, on account of its hardness and brittleness, be worked with the hammer, chisel and burin. The way in which these properties are lessened by the reduction of the carboniferous contents has been

an examination of the origin and age of the Japanese metal articles. The glass case which covered this masterpiece, the eagle, was opened, the bird taken down from its pedestal, a rock of strong sheet iron, and thoroughly examined in all its parts; but we found no inscription, name, or sign, which would indicate its origin. We have also not been able to trace the history of this remarkable piece of art-industry, which Mitford, the former English Secretary of Legation in Japan, had brought with him. We then turned to the bronzes. Scarcely the third part of these bore name and date. But from them it was apparent that almost all these vases and other articles designated as "old Japanese bronze" were made in this century.

observed by Lehmann and Wagener in Kiôto.[1] It is a peculiar decarburising process, by which the surface of the kettle or pot receives a structure like to that of soft iron or steel, and can then be treated in the same way as in the Zogan-work on forged iron.

The process of decarburisation of the surface is called Yakeru (to burn), and is performed with primitive apparatus. Old damaged rice kettles out of which the bottom has been knocked serve as ovens. These are plastered over on the inside with a fire clay (Oka-saki-tsuchi and sand mixed in equal parts), so that a cylindrical space of the size of the hole in the bottom, remains open. The Kama or kettle thus prepared, is turned over upon a thick plate or slab, three or four centimeters thick, made out of the same fire-proof material, which serves as a grate, and is perforated like a sieve for this purpose. In order to give this plate greater firmness, it is bound around with an iron band. The holes have a width of about 1·5 centimeters. In order to give the air free play, several stones are laid under the edge of the slab. Then the Tetsu-bin to be burned, whose outside has been carefully cleaned beforehand from dust and sand, is placed in the Kama, directly on the grate.

The difference in size between the Kama and Tetsu-bin must be such that a space of at least five centimeters remains open around the latter. This open space is then filled with the best charcoal in pieces the size of a nut, till the Kama is filled to the rim, when the coal is kindled.

In order to increase the draught, two or three Kamas filled in the same way are set one over the other, forming a kind of chimney. When the coals have ceased glowing, others are put in, and when the second instalment is burned out, the Tetsu-bin are taken out and turned upside down (with the opening underneath), set again in the Kama and burned twice in this position. Under favourable circumstances, the surface is now sufficiently soft and tough, as is ascertained with a file. It is often the case that the furnace must be heated ten times. After the cooling the decorations are then carved as in forged iron, without danger of breaking the edges, or recoil of the burin.

Until some twenty years ago, the decoration with such inlaid work was limited to places on iron kettles. At that time several skilful workmen, formerly armourers of Kiôto, especially Komai and Iyenori, turned their attention to the work, and have developed since then this branch of art industry in an astonishing manner, decorating large vases, smoking utensils, plates, dishes, and other articles of cast-iron with remarkable artistic skill, hitherto unknown The heliotype of plate XVII. represents a cast-iron vase of Komai in Kiôto, adorned with such Zogan work.

In the summer of 1875 I obtained from a dealer in Kiôto the

[1] I am indebted to the kind communications of these gentlemen (Engineer Lehmann and Dr. Wagener, both now in Tôkio) for the items given here.

first pair of such vases—a work which at that time, in Tôkio, attracted great attention among Japanese and foreign connoisseurs. They are now in the Royal Industrial Art Museum in Berlin. Later on a second pair with similar work was sent to Germany, acquired by Dr. von Brüning, of Frankfort on the Main, and presented to the Industrial Art Museum at that place. These vases are designated by the authors as "the united work of Komai Yoshitaka and Komai Yoshihiro, inhabitants of Kiôto, province of Yamashiro." They are among the most beautiful works of this description, although they are the first of the above-named masters. The four fields, two on each vase, represent silk culture. The picture before us shows the end of the process. One girl is busy with the hurdles upon which the worms have been grown ; a second collects the finished cocoons ; a third brings them away ; a fourth sits at the old simple reeling apparatus, a little stove with a coal fire, on which the water is being heated in the iron pan placed above it. She has thrown in a handful of cocoons and is about to reel off the silk threads. A fifth girl is busy hanging up the strands of reeled silk to dry. The fineness of the embossing goes so far as to give the pattern of the clothing, which is recognisable even in the small scale of the picture. Many of these newer Zogan-works on cast iron are rendered more prominent through the steel blue or dead-black groundwork, a peculiar kind of "Niello," which is made of lacquer putty, or Shakudo, and produces an effect like the works of Zuloaga of Madrid, whose name is known to every friend of art industry and visitor at the great exhibitions, by its magnificent inlaying of iron.

Copper (Aka-gane, Dô), the most widely distributed, and next to iron the most important metal of Japan, is said to have been found here first in 708 A.D. But without doubt it was known to the inhabitants much earlier, as is indicated by prehistoric discoveries. Among these and side by side with stone weapons and coarse earthen vessels, are also copper swords and small round bells (Suzu) of copper plate, and other bells (Tsuri-gane) of considerable size.[1] Copper probably came first with Buddhism from China and Corea to Japan. It is certain that it has served for the ornamentation and outfitting of Buddhist temples and pagodas, as in India and China, in manifold forms, from the first introduction of Buddhist teaching till the present time.

If it does not play in Japanese religion and in the household so prominent a part as in India, where copper and brass vessels have served for ages the manifold purposes for which we, generally, use wooden, clay and glass ware, it is nevertheless in Japan often substituted for the earthen vessel as well as for iron, zinc and tin. Among other useful copper utensils, I mention only the Yatate or portable writing-case, in which the Japanese business man carries

[1] See Kanda Takahira ; "On some Copper Bells." "Transact. As. Soc. of Japan," vol. iv. p. 29 to 33.

PHOTOTYPE BY STRUMPER & CO., HAMBURG.

INLAID VASE OF CAST-IRON.

Original in the Royal Kunstgewerbe Museum Berlin.

with him his brush and fluid India ink, the Kana-darai, the wash-dish of brass or copper, and the Yuwakashi or copper kettle for boiling water.

Copper cannot be cast like iron and bronze, because it makes bubbles and forms holes in stiffening. It is therefore worked up into wire and sheet form. It is very much used in this form for mounting fine boxes and cabinets, with holds and cramps, which are most tastefully decorated by engraving of arabesques, flowers, birds, and other things.[1]

I will give here another method of treating copper, which has not yet been mentioned anywhere else. I first became acquainted with it through the celebrated bronze manufacturer, Kanaya Gorosaburo, in Kiôto. Besides many sorts of bronze ware, he makes also small copper water-kettles, holding from a half to a whole liter, in which only the revolving knob of the cover and the two soldered handle-ears, are made of a brass-like bronze. The forms of these kettles are extraordinarily pleasing, including the handle, whose upper part is finished with a beautiful plaiting of rattan. The ornamentation of the simplest kettles consists of a lustrous dark coffee-brown patina, after whose preparation vine decorations and other light and pleasing designs are engraved upon it. The reddish brown copper colour which appears in the engraved leaves and flowers and also in the lustrous dark brown ground colour is very effective. The richer ornamentation consists of inlaying and encrusting with silver and gold. The inside of the kettle also generally receives a silver plating, as a protection against acids. The dark coffee-brown colour of copper and bronze, as I saw it on a copper Yuwakashi, is obtained in the following manner. Equal weights of green vitriol (Rôha), copper vitriol (Tampan), and sulphur (Iwô), are respectively mixed with water. The copper article is then dipped in this bath, which must be often stirred on account of the finely distributed sulphur, and then rinsed in a second bath prepared in the same way, but very much thinner. This process is repeated till the necessary corrosion is attained, which is recognised by long practice. The vessel is then brought to the Hibachi or fire-pan, and heated here on an iron grate, whose bars are from eight to twelve centimeters distant from each other, and with frequent turning. In order not to endanger the soldering, these bars are sprinkled from time to time with water in which Kariyasu (*Calamagrostis Hakonensis*, Franch. and Sav.) has been boiled. The vessel is now rubbed with a cloth, then painted lightly with Ki- (or Seshime-) urushi, rubbed again with the cloth, painted once more and now heated until the sprinkled Kari-yasu water rolling

[1] I have never observed in Japan the Indian and Persian method of decorating copper vessels, by giving them a coating of tin in which the ornamentation is engraved or carved down to the copper ground. On the other hand, the enameling borrowed from the Chinese is well known and practised. Fuller details in regard to this will be found in the last chapter of this section.

away in balls, indicates the amount of heat. The copper article is then taken from the grate with a pair of tongs and coated with a mixture of raw lac (Ki-urushi) or Seshime and lamp-black (Yuyen-sumi). It is then heated again up to the point where the water rolls away in balls, brushed over and painted anew with the lac mixture, and so on, till colour and lustre have the desired shade, whereupon the work is finished and the article is set aside for a second cooling.

Kanaya Gorosaburo told me that he obtained the same patina with bronze by a quite similar process. He maintained further that many workmen used vegetable wax instead of lac, but that such an Iro-tsuke (process of colouring) could not be recommended. It is striking, however, that the lac or its substitute is not carbonized by the heat.

Fig. 16 is a woodcut showing a copper box; and fig. 17 (p. 439) shows its cover. The box is plated on the inside with thick silver

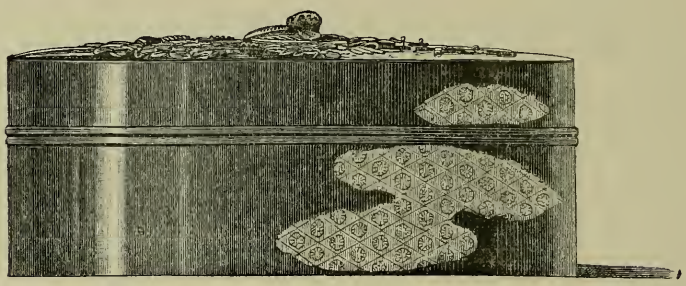


Fig. 16.—COPPER BOX WITH INLAID WORK.

(*Property of the Royal Industrial Art Museum, Berlin.*)

plate, and the outside coloured a dull greyish brown. Its inlaying of the clouds on the sides is done in gold.

The most beautiful part is the ornamentation of the cover in surface-relief, showing a hill with a rivulet winding around it. The prominent figure well placed, chased and represented for raised inlaid work (in which both the gold and silver alloys, Shakudo and Shibuichi are used) is the cock; his comb and the short tail-feathers which are seen on the wings and back are of natural copper colour; the copper tail is bronzed in blackish brown. Wings, cheek and throat are of several shades of gold-yellow, also the legs; the feathers of the back arranged like a row of tiles, are coloured silver-grey by means of Shibuichi, likewise the little chicken hurrying to the water, all except the gold-coloured legs. The artist, in order to represent the sun shining upon its head and throat, has used pure glistening silver. The Wistaria, which gives the picture a beautiful finish, has its stems and under leaves

covered with light yellow gold ; the rest of the leaves and tendrils with dark yellow, the blossoms with silver, Shibu-ichi and copper. On one side of the rivulet may be seen a blooming dandelion whose leaves are inlaid with light gold and the blossoms of dark gold. The whole has a wonderful effect, full of life and force.

The following are the most prominent of the numerous copper alloys (Maze-gane), which have to be considered in Japanese Art Industry.

1. Shin-chiu, brass. This contains usually thirty per cent. of zinc to seventy per cent. of copper.

2. Kara-kane (literally China-metal), bronze. Bronze is under-

Fig. 17.—COVER OF THE BOX, WITH INLAID WORK AND CHASING.

stood now-a-days to indicate the many different alloys of copper with tin, with tin and zinc, with tin, zinc, and lead, to which antimony may sometimes be added, but in all of which copper is predominant. These bronzes serve many different purposes, and are employed both in art and for practical objects.

3. Shibu-ichi, an alloy of copper and silver, in which the latter varies from 6 to 32 per cent.

4. Shaku-do, copper, in which from 2 to 5 per cent. of gold is mixed.

Besides the common brass that is used for wash-dishes, fire-pans, hoops around large rice bowls, bindings of chests and several other purposes, an alloy is prepared, by the name of Kô-dô, of both

metals, with 35 per cent. of zinc, and is worked up in a similar manner. The Japanese do not share the predilection of the Indian people for brass utensils, but they nevertheless employ great skill and care in ornamenting the few they do use. Alloys which are made up in the manner of the Indian Bidri wares, in which zinc amounts to 90 or 95 per cent. and copper forms but a small constitutent, are not known in Japan. Here, for ages past, the most various metallurgic skill and ornamentation is concentrated upon—

Kara-kane. Bronze.

This alloy has an old history. Besides serving manifold technical purposes, it has been for ages the favourite of artists, the material in which art made her first attempts and obtained her highest triumphs. Weapons and working utensils of bronze, made very hard by repeated hammering, were preferred by many nations to those of iron. So also in Japan. The oldest prehistoric metal discoveries in this country are bronze bells and arrow heads, concerning whose origin and age we can only speculate.

Bronze shares with iron and brass the great advantage of being much more fluid in a molten state than copper, and in casting to perfectly fill out the mould, and therefore to reproduce it exactly, besides presenting on cooling a close homogeneous texture. Most of the bronze alloys shrink much less than cast iron ; the decrease of volume, however, which accompanies gradual cooling has no such great influence upon the clear outline of the casting, as that shrinking which takes place in the sudden solidifying of many metals.

A further advantage of bronze lies in the fact that it is so easy to be worked upon with hammer, chisel and burin. Its hardness is similar to that of antimony and lies in most cases, as also in brass, and especially in the old copper bronzes of Japan, between 3 and 3·5. The hardness is therefore greater than that of the single constituents of the alloy, including copper. The colour, ductility, texture and hardness are all dependent on the composition of the bronze. Among all the Japanese bronzes (the old copper bronzes not excepted) which I have been able to examine I found none whose hardness equalled that of fluor spar, while (according to E. Reyer[1]) the hard bronzes of the ancient nations, which were free from zinc and lead, had a hardness of between 5 and 6. The cause of the greater density and hardness of these old bronze pieces, as axes, chisels, arrow heads, swords and other weapons, is doubtless to be found in the fact that they were made with the hammer, as castings of a similar composition do not show

[1] E. Reyer : "Hartbronze der alten Völker." *Journal f. prakt. Chemie.* Bd. 25, 1882, p. 258.

these qualities.[1] Nevertheless, the closeness, hardness, toughness and other internal properties of the Japanese bronze are not the ones by which they are especially distinguished and excel those of the Chinese, but rather their colour and ornamentation. The colours range through all the shades of brown and grey from light yellow to the finest and most effective dead black, and are distinguished by great uniformity, such as is possible only when this proceeds from a natural chemical re-action, which is dependent on the composition and not on painting.

When one considers the small technical aids which the Japanese can rely upon in his bronze work, his remarkable accomplishments in patina-work are the more surprising.[2] The dead-black bronze articles which have come in ever increasing numbers within the last few years to Europe, have especially attracted the attention of interested circles, because of their novelty and striking beauty, and have led also to thorough analyses and experiments. This has been done principally in Paris, the city which for three centuries has rejoiced in the well-founded reputation of being able to execute in bronze industry the best that Europe could offer. The researches of H. Morin,[3] Christofle and Bouilhet,[4] and E. J. Maumené[5] were particularly notable.

In Germany, the unsatisfactory state of many public bronze monuments led to thorough investigations of the formation of patina, among which those of R. Weber[6] are especially noteworthy. The collective result of all these studies may be summed up as follows :—

By the terms patina, antique patina or "noble rust" (*Ærugo nobilis*), formerly only the malachite green or blue-green efflorescence of carbonate of copper was understood, as it is often found on old bronze and copper works. This patina is always smooth, but does not cover the article evenly, as the metal always gleams through it. It is also found in modern bronze monuments, for instance in the statue of the Great Elector at Berlin, in the equestrian statue of Elector Johann Wilhelm in the market place at Düsseldorf, and in the monuments of Louis XIV. and Louis XV. in Paris.

[1] This proves at least their greater density, while another molecular arrangement must account for the greater hardness, though I do not know that this can be effected by simple hammering.

[2] G. Bousquet remarked upon this in his very interesting article, "L'Art Japonais," *Revue des Deux Mondes*, 1877, tome xxi. p. 323, as follows : "On ne saurait s'imaginer dans quelles misérables échoppes et par quels moyens primitifs ils obtiennent ces resultats."

[3] "Sur quelques bronzes de la Chine et du Japon à patine foncé." *Compt. Rendus*, t. 73, 1874, p. 811.

[4] "Notes sur des réactifs permettant d'obtenir des patines de divers couleurs à la surface des bronzes." *Compt. Rend.*, t. 72, 1874, p. 1019.

[5] "Notes sur les Bronzes du Japon." *Compt. Rend.*, 1875, t. 80, p. 1009.

[6] "Ueber Patinabildung," von Prof. R. Weber, *Dingl. Polyt. Journ.*, Bd. 245, 1882, p. 86.

This patina formation is due partly to the composition of the bronze and partly to the atmosphere. Precious copper bronze consisting of copper and tin only, is marked by it more than other kinds. A large amount of dampness in the atmosphere, and salt, together with rain and frequent washing, favour its production, while coal-dust, sulphide of hydrogen and sewer gases hinder it.

The black coating of many bronze monuments, which so often takes the place of the beautiful colour of the fresh casting, is not due usually to sulphide of copper, but to particles of coal and dust, with a small mixture of oxides. A watery solution of carbonate of ammonia put on with a brush, is excellent for removing this,[1] while the artistic production of the patina is best done by means of acetic ammonia of copper-potassium. Zinc alloys, especially brass, blacken easier than those without zinc. Copper containing arsenic also shows greater inclination to blacken.

Now-a-days patina is understood to include every accidental or intentional colouring of a metal or an alloy which differs from the original. Chemical analysis has shown that the beautiful dead-black colouring of many of the Japanese bronzes, which sets off so finely its decoration of inlaid work, incrustation and other ornamentation, is due to the lead in the alloy, which usually amounts to something over 10 per cent. and in single instances sometimes to 20 per cent. as shown in table B at the end of this chapter. Of the old bronzes only the small Egyptian idols, of which table A 5 gives an analysis, exhibit as high and still higher percentage of lead. When the alloy contains so large a mixture of lead it becomes very brittle, while the Japanese bronzes with 9 to 14 per cent. of lead, 7 to 2 per cent. of tin, and a corresponding amount of zinc, satisfy all claims, as they are easily cast, form a homogeneous mass, and by this means, as well as by their even hardness, are easy to work, which is not possible when the zinc is left out. The fine dead-black patina is produced by simple heating in a close furnace, and is caused in part by the formation of a sub-oxide of lead. Christofle and Bouilhet have shown, however, by their investigations, that a fine black patina may be obtained without lead. Their process amounted to the same thing as forming a sulphide of copper on the surface of the bronze. Brown, red and orange-yellow tints were also produced, which answered every purpose.

The Japanese have an expedient for shading according to taste the colour obtained in the tempering of the bronze, which has not been known nor tried elsewhere. This is by a kind of grass, called Kari-yasu (*Calamagrostis Hakonensis*, Fr. and Sav.), a corrosive substance of astonishing effectiveness. By boiling its roots and applying the liquid to the bronze, they obtain the said effect. An exact chemical analysis of this substance has not yet been made, but very possibly it may have some importance for our bronze industry.

[1] According to Brühl in *Dingl. Polyt. Journ.* 1882, p. 256.

We recognise in the artistic treatment of Japanese bronze vases at least three periods, which naturally are less sharply distinguished in time than in fashions, following close upon each other.

The alloys of the old bronze vases and bronze castings generally are almost always rich in copper, while lead and antimony appear as only accidental constituents. Among their manifold forms the broad long-necked flasks with cone-shaped bodies seem to rule, also the shape of a mortar, among the forms of handles the imitation of elephant's trunk. Generally the very tasteful decoration is simple, and executed mostly in surface relief by chasing and engraving. Arabesques and the elements of the Meander in manifold combinations are the ruling designs; clouds and waves and small landscapes also appear. The principal effect is wrought by well designed alternation and symmetrical arrangement. Inlaying and enamel are entirely wanting.[1] A second tendency of taste, which likewise originated in China, ruled in Japan during the last century, and is still powerful there. It is distinguishable from the first, not so much in the composition and figure of the vases as in their ornamentation. A high relief obtained by casting and chasing, with which the vases are often overgrown and overloaded in wild confusion, something like the flowers of our porcelain vases, which singly often show great artistic skill, and which are often beautifully raised up on the well designed dark background, but which confuse by their own fulness of decoration and entirely conceal the character and form of the vase.

The latest period, whose beginning does not date very far back of the time when the country was opened by Commodore Perry, indicates unmistakably great progress in Japanese bronze industry. This is especially found in the tasteful arrangement of colours and in a better sense of the right amount of ornamentation. The high reliefs do not play such a prominent part, while inlaying and incrustation are combined very effectively with chasing and engraving. Such decorations on dark bronze containing lead have been brought from the towns Kanazawa and Takaoka in Kaga and Echiu, but are now also made considerably in Tôkio. Kiôto, the old seat of Japanese industry, has not stopped behind; here too, the effort to accomplish a shading of the colours and choice

[1] These characteristics of the old Japanese bronze vases agree entirely with those of the Chinese, in the Middle Ages. I have such a one in my possession made in the 15th century. It is only 18·5 centimeters high, has in general a four-sided prismatic figure with a rectangle as cross section; it increases in width from the middle toward the top and still more toward the bottom, where it is provided with rounded corners and ends with a small foot. Elephant trunks as handles cover two-thirds of the narrow side from top to bottom. The decoration consists of two sorts of Meander figures (רנרנרנרנ), which are separated by a smooth band at the narrowest place. The inscription runs in Sinico-Japanese: "Dai-Min Sen-Tok-Nen-Sei," *i.e.* manufactured in the Sen-tok period (1426-1435 A.D.) of the great Ming dynasty.

arrangement has found new ways and means. This is shown by the vase on Plate XVIII.[1] The flowers (Camellia Sasanqua) and leaves are raised from the dark brown ground in lighter colours; the bird and the spider-web inlaid with silver wire are well represented. The work is new and wrought entirely in the Kiôto style. Here bronze containing lead is less used, but there is much relief-inlaying and incrustation.

Among the useful bronze articles seen in the homes of well-to-do Japanese, are the flower vases (Hana-ike), the censers (Ko-rô), braziers (Hibachi) and mirrors (Kaga-mi), while common people must content themselves with the much cheaper earthen and other substitutes. Artistic bronze work finds its most important and many-sided employment in the manifold decorations of Buddhist temples. Here various Buddhas and other idols astonish and impress the beholder chiefly by their colossal and exceedingly fine casting, which is even more notable in a number of gigantic bells. The monuments of the Shôguns at Nikkô and at Shiba in Tôkio, lanterns and a number of smaller articles of bronze, as vases, candlesticks, censers and several others, also attract the attention and furnish proof that bronze industry has reached its highest development, principally in the service of the Buddhist religion, and that a considerable amount of copper has been used in its alloys.

Many of these prominent monuments were ordered to be cast by princes who wished thereby to make themselves acceptable to gods and men; others are presents of private persons, or the results of public collections, which the priest stimulated as much through ambition as pious feeling. So long as these last were common among the higher classes of society, the gifts for the maintenance and adorning of the temple and cloisters flowed in abundantly, while since the political revolution, the greatest indifference to all these things has been manifest.

Among the Dai-Butsu or "large Buddhas" of bronze, those of Nara in Yamato and of Kamakura in Sagami are most prominent of all because of their enormous dimensions. The Nara-no-Dai-Butsu is in a spacious temple hall, 88·4 meters long, 51·8 meters broad, and 48·2 meters high, whose roof is supported by 176 pillars. It represents Rochana (Vairochana), sitting with legs crossed under him, upon an open lotus flower. The left hand of the idol rests upon the corresponding knee, the right is raised with its back turned towards the upper arm, in such a way, that the points of the three out-stretched fingers reach almost to the height of the shoulders, while the thumb and index finger are bent toward each other. Buddha is represented in this manner as a teacher. The idol was cast between 741 and 749 A.D., by the order of Shomu

[1] This was most kindly lent me for the illustration by Herr Paechter (R. Wagner, Kunst- und Verlags-handlung, Berlin, Dessauerstrasse 2), from his rich and choice collection.

Bronze Vase from Kioto.

Wilhelm Engelmann, Leipzig.

Tennô. In 1180 a fire destroyed the head. The present ugly one was cast in 1570, at a time when art industry was in a very low state. The oldest part of the body and the lotus flower consist of plates from 18 to 30 centimeters thick, having a surface of 30 to 36 centimeters, which are soldered together at the edges with Handaro (tin-solder). The entire height of this Buddha is 16·05 meters (53·5′), the length of the face 4·80 meters (16′), the width, 2·35 meters (9·5′), the width of the shoulders 8·61 meters (28·7′), the length of the middle finger 1·5 meters (5′), that of one ear 2·55 meters (8·5′). The halo which surrounds the head has a diameter of 23·4 meters (78′) and each of the 16 figures which appear in it, a length of 2·4 meters (8′).

The total weight of this Buddha is estimated at 450 tons. In its casting, which did not succeed until after several vain attempts, copper, tin, quicksilver and gold are said to have been used.[1] If the quantity of these metals be reckoned as they are given, in kilogrammes and per centage, the alloy will be found as follows:

Copper	447,273 kg.	=	98·06 per centage
Tin	7,633 „	=	1·68 „
Quicksilver	977 „	=	0·21 „
Gold	227 „	=	0·05 „
	456,110	=	100·00

and therefore 456 tons as the weight of the metal used.

The great Buddha of Kamakura which is so often copied (see vol. i. p. 460) is not so large as that of Nara, but far excels it in artistic execution. This bronze figure represents Amida sitting on a lotus flower, but without the aureole. The nobly formed head is most symmetrically built and well proportioned in all its parts. The artist has succeeded in lending to the expression of countenance, and to the whole bearing, the blessed peacefulness of Nirvana. The hands lying in the lap with the finger tips touching each other, heighten the indications of restfulness, which are unmistakable.

This Buddha also, which was cast in 1252 A.D. by Ôno Gorôye-mon, does not consist of one piece only but was put together from many plates of about three centimeters thickness, with such care and skill, that those seams only can be recognised which have been exposed by the weather during the course of time. Many of the foundation stones of the great building which formerly enclosed this monument are still preserved, and on these stood the sixty-three massive columns of Keaki wood, which supported the roof. This Buddha also consists mainly of copper. Its height is 15·11 meters, the circumference at the base 29·6 meters, and the distance

[1] I do not know the chemical analysis. As Japan furnishes no quicksilver and does not use it in other bronzes, its employment in this case is doubly striking.

from ear to ear 5·4 meters. It is said that the eyes are of pure gold, and that the knob on the forehead contains thirty pounds of silver.

The statue which is found in the temple Yaku-shi-ji at Nara is much smaller than the preceding, but is nevertheless one of the finest and most interesting bronze statues of Japan. It represents Yaku-shi (Bhâishagyaguru) and originated at the close of the 7th century. In design and execution it belongs to the most notable productions of bronze casting in Japan. To these also belong the great Tsuri-gane or hanging temple bells, of which several of the finest (as for example, that of the Zozo-ji at Shiva in Tôkio), have perished in the flames within the last twenty years with the temples and many other art treasures.

The largest of the still existing bells (Kane) is to be found in the temple San-jiu-san-gen-dô in Kiôto. This is 4·27 meters high, and 2·74 meters wide, with walls 27·4 centimeters thick. Its weight is estimated at 63 tons.[1] Several other old bells are about 3 meters high and correspondingly wide. The most beautiful and interesting of these belongs to the finely situated old monastery of the Tendai sect, in the wood not far from Mii-dera at Otsu on Lake Biwa. This great bell is said to have been made by Hidesato, a celebrated hero of the 10th century, and is the subject of many stories and legends of the vicinity. Its beautiful tones belong to the eight wonders (attractions) of the Biwa Lake. When heard on a summer evening, sounding far over the lake through the peaceful country, they make a never-to-be-forgotten impression upon the mind of a stranger.

These colossal temple bells, and a number of smaller ones, are usually decorated on the outside with Chinese proverbs, and with Ten-nin (angels in Nirvana), in rows of regular knobs, and in many other ways. Usually several dragon heads form the ears on which they are hung very low, under a scaffold and roof in the temple court. They have no clappers but are struck from the outside by a beam hanging and swinging from two ropes, in a place which was raised up in the casting for this purpose.

While some of these very old Tsuri-gane astonish the beholder by their remarkable casting and size, there are 16 smaller bells (Kane) in a neighbouring building of the temple at Nikkô which no less awaken our surprise. These are just alike externally in form and size, but when rung yield distinctly and with finest effect all the tones of two octaves.

Mirrors, Japanese Kagami, have been from olden times cast from bronze in the countries of Chinese civilization, owing to the lack of proper glass. On the back they are decorated with reliefs

[1] This bell has almost the same dimensions as the big one in Peking, which the emperor Yungloh ordered to be cast in 1406. This is said to weigh 60 tons, to be 4·27 meters high and 10·30 meters in circumference at the rim. Its surface is covered with Chinese characters.

representing mythological persons, birds, flowers, weapons and pithy expressions. This is done after the front of the casting has been polished off till from 0·5 to 2·5 millimeters thick, and finally coated with an amalgam which is composed of from one to two parts tin, and one part of quicksilver. These metal mirrors are generally circular in form with a diameter of 15·5 to 16 centimeters. There is at one side a staff-shaped handle, with which they are held.

It was known to the Chinese many centuries ago, that some of these mirrors when they reflected the sunlight on the wall, mirrored at the same time the raised figures on their backs, more or less distinctly.

These mirrors are found also in Japan. The property mentioned was long ago discovered accidentally by Japanese ladies, as Muraoka[1] has pointed out. Atkinson,[2] however, was the first to call general attention to this phenomenon, while Brewster[3] published a work on the magic mirrors of China in 1883. In modern times these mirrors have been investigated by several physicists. We are indebted especially to the larger works of Ayrton and Perry,[4] Govi,[5] and Bertin,[6] all of whom agree in the explanation of the phenomena.

It was thought formerly that the pictures and decorations at the back of the mirror plate were inlaid with some other metal, or that by beating the mirror with a hammer at these figured places a greater density was produced, or the peculiar property was attributed to the composition of the alloy itself. All these explanations have proved false on closer investigation. The analyses show that the mirror bronzes have often a very different composition, as is seen in table C.

The Italian Govi has pointed out convincingly that the peculiar property of the magic mirror proceeds from the polishing, and is accidental, but can be easily produced. It is due to the unevenness in the convex arching which the reflecting surface receives in polishing, in consequence of the uneven pressure from the back, and is entirely independent of the chemical composition. Later on Muraoka and others proved experimentally that mirrors can be made not only of bronze and brass, but also of simple metals which will exhibit these magic properties in like manner. They are shown even more beautifully than in the sunlight, when a

[1] "Erklarung der magischen Eigenschaften des japanischen Bronzespiegels und seiner Herstellung." "Mittheil. der deutsch. Gesellsch. Ostasiens," Heft 31, 1884.

[2] *Nature*, vol. xvi. 1877, p. 62.

[3] *Philosophical Magazine*, vol. l.

[4] "On the Magic Mirrors of Japan." "Proc. Roy. Soc." xxviii. pp. 127–142.

[5] "Les Miroirs magiques des Chinois." "Ann. de Chim. et de Phys." 5 Série. T. xx. 1880, pp. 99–110.

[6] "Etude sur les Miroirs magiques." "Ann. de Chim. et de Phys." 5 Série. T. xxii. 1881, pp. 472–513.

number of divergent rays fall on the mirror and are projected upon a white wall. In this way the forms of the figures and designs are seen sharply outlined in a bright light, while they are not to be found on the surface of the mirror.

Shiro-kane-dzaiku,[1] *i.e.* white metal work, is the collective name for the many small metallic ornaments which were used formerly for the decoration of swords, Netsukes, and many other purposes; but in modern times are exported and highly prized in Europe as brooches, medallions, cuff-buttons, ear-rings, bracelets, etc.; for they belong at least in part to the finest works of Japanese art. The care and skill with which these articles are chased and engraved, incrusted and inlaid, is astonishing and pleasing, and no less the extremely tasteful and effective combination and shading of colours, which our jewellers have not been able to obtain till quite recently.

SHIRO-KANE MEDALLION.

In these Japanese works, the before-mentioned alloys, Shaku-dô and Shibu-ichi, are employed chiefly. The dark blue to dead black of the first, is very uniform and is especially effective as ground work, likewise the silver-grey of the Shibu-ichi. The shading in this work, as in bronze, is best done by a decoction of Kari-yasu. Besides the two mentioned gold and silver alloys, precious metals also in their pure state are used in this work. Gotô Yu-jô, who died in 1513 at the age of seventy-eight, is regarded as the founder of this school. For a long time the art was employed principally on Menuki and Tsuba for the decoration of sword handles. Shiuraku and Temmin are regarded as the

[1] We sometimes confuse this word with Oki-mono. The Japanese give this name, however, to knicknacks of all kinds, such as little carved figures, larger than Netsukes and not bored through; also to the lacquered In-ro, or medicine boxes, and many other things.

great masters in this art, as well as in making of fine metal Netsukes.

Pure silver or gold wares, or a combination of the two, were formerly seldom manufactured. This has changed, however, since the Japanese have visited the great International Industrial Exhibitions. Lately the exhibitions in Nuremberg and other places have shown in an astonishing manner how skilful the gold and silversmiths of Kiôto and Tôkio are in treating these easily worked and most responding of all metals, and in the effect which they are able to lend to their artistic workmanship.

As an Appendix to this Section, the following analyses of Japanese and Chinese bronzes are given, together with those of other bronze castings, for the sake of comparison. I call attention to the following explanation of the tables :—

Table A. Nos. 1,2,3,4, are analyses of old bronzes from the Japanese temples, by Maumené in "Notes sur les bronzes du Japon," par M. E. J. Maumené. *Comptes Rendus*, t. 80, 1875, pp. 1009 and 1010.

No. 5 is the analysis of a small Egyptian figure of Isis, by W. Flight in the *Journ. Chem. Soc.*, 41, p. 134.

Nos. 6, 7, 8. These analyses were published by E. Reyer in the *Journal für praktische Chemie*, Bd. 25, 1882, p. 258, under the title, "Hartbronze der Alten Völker."

No. 6 refers to bronze of Cyprus in the time of Alexander the Great.

No. 7 is the analysis of an axe found at Limburg, a reddish, gold-yellow alloy, that was coated firmly and toughly with thick, green patina. It could be scarcely scratched with fluor spar.

No. 8 is the composition of a chisel of Peschiera, a mixture of deep yellow colour, and having a hardness like the preceding.

All the bronzes mentioned here, show a very complicated composition. It would be a great error to assume that they originated purposely from the weighing and smelting together of the constituent parts. The opinion of Maumené, that they have been obtained by mixtures of the ores of copper pyrites, galena containing antimony, and blend found in them, seems to me equally erroneous. The metallurgic process of the ancient nations, Japanese included, was not adapted to furnishing chemically pure metals; and thus we have the small proportions of iron, nickel, cobalt, antimony, sulphur, etc., simply as impurities of copper, tin, zinc, and lead. The same is true of the exceptions in which bronze analyses show traces of precious metals.

Table B. Nos. 1–7, are analyses of Japanese bronzes with dark patina, published by H. Morin. *Comptes Rend.*, tome 78, 1874, p. 811. "Sur quelques bronzes de la Chine et du Japon à patine foncé." The large proportion of lead which distinguishes nearly all these beautiful alloys, approaches in No. 5 to the little old Egyptian bronze figure, as given in Table A, No. 5. It is not surprising also that Morin found traces of arsenic and sulphur in

most of the before-mentioned analyses, and in two of them, gold and nickel also.

Table C give the relative amounts of the metals which are used in bronze mirrors. No. 1 is the analysis of such an alloy, according to Champion and Pettet, Nos. 2 and 3 the composition of the mirror-bronzes of Kiôto, and No. 4 an analysis by Atkinson. The rest are taken from the "Annales de Chimie et Physique," t. xx., 1880, p. 136. Iyo-shirome and Tori-shirome = Antimony from Iyo and from Tori.

Table D needs no explanation.

Concerning Table E, I note that most of the analyses taken from *Dingler's Polyt. Journal* are chiefly the work of Prof. R. Weber. No. 1 is a natural bronze by Elster; 2, the composition of the "Grosser Kurfurst"; 3, Friedrich Wilhelm; 4, the Horse Tamer; 5, the Statue of Brandenburg in Berlin; 6, gives the analysis of the equestrian statue of the Kurfürst Johann Wilhelm in the market place at Düsseldorf; while 7 and 8 show the composition of two bronze statues in Paris, of Louis XIV. and Louis XV.

A. ANALYSES OF OLD BRONZES.

	1	2	3	4	5	6	7	8
Copper . . .	86·38	80·91	88·70	92·07	68·42	81·76	83·65	88·06
Tin	1·94	7·55	2·58	1·04	0.94	10·90	15·99	11·76
Zinc	3·36	3·08	3·71	2·65	—	—	—	—
Lead	5·68	5·33	3·54	—	22·76	5·25	—	—
Antimony . .	1·61	0·44	0·10	—	0·67	—	—	—
Iron	0·67	1·34	1·07	3·64	4·69	0·15	traces	traces
Nickel . . .	—	—	—	—	0·78	traces	0·63	traces
Cobalt . . .	—	—	—	—	—	1·22	—	—
Sulphur . . .	—	0·31	—	—	—	—	—	—
Arsenic . . .	—	—	—	—	1.48	—	—	—
Phosphorus .	—	—	—	—	—	—	0·05	0·03
Silicic Acid .	0·10	0·16	0·09	0·04	—	—	—	—
Loss	0·26	0·79	0·21	0·56	0·26	0·72	—	0·15
	100·00	100·00	100·00	100·00	100·00	100·00	100·32	100·00

B. ANALYSES OF CHINESE AND JAPANESE BRONZES, WITH BLACKISH PATINA.

	1	2	3	4	5	6	7
Copper	82·72	82·90	81·30	83·09	72·09	72·32	71·46
Tin	4·36	2·64	3·27	3·23	5·52	7·27	6·02
Zinc	1·86	2·74	3.27	0·50	0·67	6·00	5·94
Lead	9·90	10·46	11·05	11·50	20·31	14·59	16·34
Iron	0 55	0·64	0·67	0·22	1·73	0·28	0·25
	99·39	99·38	99·56	98·54	100·32	100·46	100·01

C. Mixtures for Chinese and Japanese Bronze Mirrors.

	1	2	3	4	5	6	7	8	9
Copper . .	50·8	80	80	76·3	75·2	81·3	87·0	81·3	71·5
Tin . . .	16·5	15	—	23·6	22·6	16·3	8·7	—	—
Zinc . . .	30·5	—	—	—	—	—	—	—	—
Lead . . .	2·2	5	10	13·1	—	—	—	—	—
Iyo-shirome	—	—	10	—	—	—	—	—	—
Tori-shirome	—	—	—	—	—	—	—	16·3	28·5
	100·0	100·0	100·0	113·0	97·8	97·6	95·7	97·6	100·0

D. Metal Mixtures of Kanaya Gorosaburo in Kiôto.

	Japanse Names of Bronzes.							
	Kô-dô.	Tô-dô. Sei-dô.	Kio-dô.	Kô-tô-dô. Kin-shi-dô.	Kuro-dô.	Sento-ku-dô-mo.	Kara-kane.	Sento-ku.
Copper . . .	65	80	20	60	80	48	60	35
Tin	—	—	70	15	6	10	30	17
Zinc	35	—	10	25	—	32	—	48
Lead. . . .	—	20	—	—	14	—	—	—
Antimony . .	—	—	—	—	—	10	10	—
	100	100	100	100	100	100	100	100

E. Mixtures of German and French Bronze for Statues.

	1	2	3	4	5	6	7	8
Copper . . .	86·6	87·79	87·44	84·55	89·15	71·74	91·40	82·45
Tin	6·6	8·20	3·20	0·14	1·76	2·37	1·70	4·10
Zinc	3·3	1·77	8·89	15·63	8·59	25·58	5·35	10·30
Lead. . . .	3·3	2·20	0·65	0·16	0·32	0·91	1·37	3·15
	99·8	99·96	100·18	100·48	99·82	100·60	99·82	100·00