JAPANESE SWORDMAKING.—II.

BY E. H. TILDEN.

In no country of the world, perhaps, has the sword played so great a part in the history of the people or been regarded with such reverence as in Japan. Nowhere also, I venture to say, has the "white arm" reached such a pitch of excellence in quality, shape, and efficiency, as in the Empire of the Sun.

While living in Japan I took lessons in fencing and the study of the Japanese sword was suggested to me by a Japanese friend of mine, Mr. Okakura, director of the school of Fine Arts at Uyeno, Tokyo. I adopted the suggestion, had a forge erected on my place in Tokyo, and engaged the services of Mr. Sakurai Masatsugu, professor of swordmaking at the Fine Art School, as instructor.

The forge was a square, one-roomed edifice about 18 feet on a side. On one side of the room was the bellows, and directly in front of the nozzle of the bellows was scooped a trough in the earth, which served to contain charcoal and constituted the furnace in which the steel was heated. The anvil was a block of iron about 5 x 16 x 20 inches in size let into the earth, and the top of it having been hardened. Upon the wall at this side of the room were hung a kakemono representing Kaneyama-hiko-no-kami, the patron god of swordmakers, and another bearing in Chinese characters the name of Amaterasu-sumara-o-kami, the Goddess of the Sun, the chief goddess of the Shinto cult. Around what corresponded to the cornice in a European room was looped a straw rope from which were suspended at intervals wisps of straw and the zigzag-shaped pieces of white paper peculiar to Shinto and known as *gohei*. These are supposed to act as charms which keep off evil demons and spirits. No woman or female child is ever allowed to set foot within the building constituting the forge, for women are supposed to be attended and followed by troops of demons, whose presence would be detrimental to the quality of the swords manufactured.

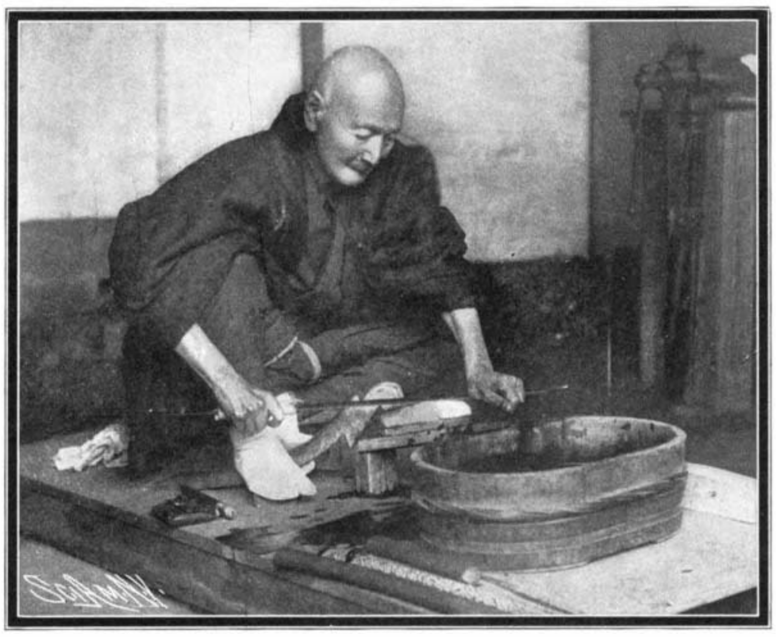
The chief instruments used in making swords are two large sledge hammers weighing 12 pounds each and a smaller one weighing 2 pounds, which is used by the chief swordsmith. Before work at the forge is begun, prayers are offered up to Kaneyama-hiko-no-kami, the patron god of swordsmiths. Prayer finished, the work begins. The metal used in swordmaking is Japanese steel, and I was told that it was made by melting iron ore in a charcoal furnace and dropping it into cold water. The carbon derived from the charcoal causes the formation of steel. It comes in lumps which average about 1½ pounds apiece, and about 15 of them are required to make a sword blade weighing when finished, without sheath or mountings, from 1½ to 2 pounds.

The charcoal used in the furnace of the forge is made of pine wood and is softer than the charcoal used in cooking.

Analysis shows the composition of Japanese steel used for swordmaking to be unusually free from foreign matter, excelling in this respect even the best Swedish steel.

One of the original lumps of steel is heated to a very high degree of temperature and beaten out into a flat slab measuring about 6 x 4 x 1-3 inches. This slab when red-hot is plunged into cold water, which treatment renders it brittle. It is then broken up into twenty or thirty small pieces. Each of these bits of steel is then inspected. If its edge of fracture is dense, granular, and homogeneous in structure and of a dull gray color, the steel is regarded as good. If, on the other hand, the edge of fracture is cracked, glistening and of uneven color, the bit of steel is condemned and rejected. It is this retention of good and elimination of bad steel which is the reason that so much steel is necessary for making a good sword.

After a sufficient number of these small pieces of steel of good quality have been accumulated, another of the original lumps of steel is heated and beaten out into a flat slab. This slab, while red-hot, is creased in two parallel straight lines by pounding the edge of a hatchet into the flat surface of the slab with a hammer. The slab of steel is then rendered brittle and broken along these creases, forming a rectangular slab of steel some 2½ or 3 inches wide. This piece is then taken and upon it are piled up as closely together as possible a number of the small fractured bits of steel. When enough of these have been piled up to make a heap about 2 or 3 inches high, the whole is sprinkled first with straw ashes and then a mixture of earth and water is poured over it. This serves to cake the small bits of steel together and keeps them in position.



Putting an Edge on the Sword.

This is seized with the tongs, heated up to a very high degree of temperature, removed from the furnace, sprinkled with straw ashes and beaten with sledge hammers, until the small bits of steel are united with each other and with the slab upon which they rest, into one mass. The reason for putting on the straw ashes is to prevent the sparks and incandescent particles of steel from flying about too freely while the steel is pounded. The ultimate result of all this pounding is an ingot of steel from four to six inches in length by about one and a half in width and three-fourths of an inch thick.

This is then, while red hot, creased with a hatchet in the middle, at right angles to its long axis, bent over and the two halves then beaten together until they unite and form one solid mass, borax being used as a flux, if necessary. This cutting, doubling over, and pounding is repeated many times, from twenty to thirty perhaps.

Three such ingots are taken and welded together and to a bar of old iron, which serves as a handle. This is then taken in hand by the chief swordsmith, who with his small hammer, and aided by his assistants, gradually beats this mass of steel into the shape of a sword blade. This is a process requiring great manual dexterity acquired only by long practice, and the result is wonderfully accurate, when one considers that nothing is used but hammer and anvil. When the finishing touches are being put upon the blade the work is done entirely by the chief swordsmith, who employs nothing but the small hammer. This hammer is repeatedly dipped into cold water while the fashioning of the sword is going on. The use of water serves to cleanse the surface of the steel of dirt and also causes a thin layer of oxidized or burned steel to scale off, thus insuring a thoroughly clean surface to the sword when beaten into shape.

Offering Prayer to the Sword God Before Beginning to Forge the Sword.

The sword is then completely fashioned by the use of files and an instrument resembling a carpenter's drawing knife. The next process, that of hardening, is peculiar to the Japanese sword and is looked upon as the most important part of its manufacture, while the person who does the hardening is regarded as the maker of the sword, it being his name which is inscribed upon the hilt. His spirit, his character, his individuality, are supposed to enter into the blade which he hardens and the blade is good or bad accordingly.

The blade is covered all over, with the exception of the hilt, to the thickness of about ⅛ inch, with a rather thick paste, made by mixing with water a certain kind of fireclay.

The edge and point of the sword are then scraped clean and recovered with a much thinner layer of clay containing proportionally more water than the clay which has been already put on. All openings into the forge are closed so as to exclude the light, for darkness is necessary in order to determine the proper temperature of the blade to be hardened. Two extra nozzles are fitted on to the bellows in order to insure a wider and more equable distribution of the outcoming blast of air. Prayer having been offered up, the chief smith takes the clay-covered blade, pushes it gently into the furnace and moves it slowly to and fro in the blazing charcoal until the whole blade is uniformly heated from end to end, no one part being hotter than another. The test which determines the proper degree of temperature is when the whole blade attains that degree of redness which is seen when one looks at the bright unclouded sky (not the sun) with the eyelids closed. With a shout of exultation, the red blade is then quickly plunged into the water, of a temperature of 100 deg., and is kept moving to and fro therein, in the direction of its long axis, until all sizzling ceases. The sword now goes into the hands

Forging One of the Ingots From Which the Sword is Made.

JAPANESE SWORDMAKING.

of the professional polisher and sharpener of swords, which is a separate branch of work.

The blade leaves his hands a resplendent, beautiful, and deadly weapon, with an edge of incomparable hardness and keenness and a strength of structure unequaled in other swords. The Japanese sword is not flexible or elastic. The extent to which it may be bent and afterward spring back into its original position is very slight, and if bent beyond this point it stays bent.

I had a Japanese blade about seventy years old, and of not particularly good quality, broken up and analyzed as to its chemical composition and anatomical structure, together with a lump of Japanese steel. The following is the result of the examination:

	Original Lump of Steel.	Hardened Edge of Sword.	Inside of Sword.
Combined carbon (by color)	1.20 p. c.	0.60 p. c.	0.60 p. c.
Manganese	none	none	none
Phosphorus	0.017 p. c.	0.007 p. c.	0.011 p. c.
Sulphur	0.009 "	0.003 "	0.003 "
Silicon	0.03 "	0.12 "	0.12 "

The above results point to a metal of great purity in its unusual freedom from sulphur and phosphorus. Such metal would be neither "red short" nor "cold short" and must of necessity be very tough. "Red shortness" is a tendency to crack or crumble while being forged or rolled while heated to redness. "Cold shortness," on the other hand, is the property of being brittle when cold.

When the sword is finished, the kakemono representing the god chosen is suspended upon the wall and in front of this is placed the sword to be consecrated, together with offerings of *sake*, rice, and sweetmeats. Prayers are offered up to the god and then the neighborhood is invited to the festival. Everyone has a good time and the sword must be left in the presence of the god all night and not removed until the next morning, in order that his influence may enter into the blade and sanctify it.

THE BATTLESHIP "MIKASA" IN ACTION.

We have so recently described the military features (guns, armor, speed, etc.) of the "Mikasa," the largest and most effective battleship in the Japanese navy, that it will be sufficient here merely to reiterate briefly the principal characteristics of the ship, and then pass on to give some idea of what takes place when she is leading the battleship line in a hot fleet engagement.

There are no fanciful ideas or untried novelties about Japan's greatest warship. She is simply an embodiment of the very latest improvements in guns, armor, and ship construction. Her one unique distinction is that she is, just now, the largest battleship in commission in the world. Her leading particulars are: Length over all, 436 feet; beam, 76 feet; draft, 27¼ feet; and displacement on this draft, 15,200 tons. Her battery of twenty-five Belleville water-tube boilers and two sets of triple-expansion engines have driven her for six hours, with an average indicated horse-power of 12,236, at a speed of 17.3 knots, the coal consumption of this speed being only 1.53 pounds of coal per horse-power per hour—an economy which has only been exceeded by a warship in one single instance. When using forced draft she indicated 16,400 horse-power, and maintained a mean speed of 18.6 knots per hour. At the water-line she is protected by a belt of Krupp steel varying from 9 inches amidships to 4 inches in thickness at the ends. Above the main belt amidships a side wall of armor 6 inches in thickness is carried up through the height of two decks to the main deck. Behind this protection are mounted, on the gun deck, ten 6-inch, 40-caliber guns, five on each broadside; on the main deck above, two forward and two aft, are four 6-inch guns in 6-inch armored casemates. Forward and aft are a pair of 12-inch, 40-caliber guns protected by 10-inch hoods or shields and by 14-inch barbettes. There is also a battery of twenty 3-inch guns, six 3-pounders, and six 2½-pounders. Below the water, two near the bow and two toward the stern, in the wake of the 12-inch gun barbettes, are four submerged torpedo tubes. Altogether, the weight of armor worked into this great ship is 4,600 tons. The machinery weighs 1,335 tons; she carries a maximum coal supply of 1,500 tons, and is manned by a complement of 730 officers and men.

The very spirited picture shown on our front page represents the "Mikasa" leading the Japanese fleet of battleships and armored cruisers in column into battle. She has started the forced draft, and is forging ahead at a speed, say, of 17½ knots an hour, in order to secure some advantageous position for herself and her consorts, where the fleet may bring its guns to bear with the best effect upon the enemy. The Russian fleet may be formed also in column, and possibly the same tactics are being pursued by each side, namely, that of concentrating the fire of the fleet as far as possible upon the leading ship of the enemy, with the idea of disabling his ships one by one. Hence the "Mikasa" is the target for a perfect hail of projectiles, great and small.

Now, when stripped for a fight, the modern battleship will present a different appearance from that to which civilians are accustomed in time of peace. Everything that can be removed will be taken down and stowed as far as possible below decks. The hand railings, stanchions, etc., will either be sent ashore, or laid down flush with the deck, leaving the latter to form a glacis over which the great 12-inch guns may sweep and deliver their fire without obstruction. The boats, which would simply afford food for fire, or splinters for the wounding of the crew, will, at the approach of a battle, be lowered, tied together, and temporarily set adrift to be picked up after the fight is over—if possible. "Seamen's dunnage," that is, chests, lockers, and what-not, are cleared away; either stowed below decks or pitched overboard. The furniture of the officers' cabins, which might provide food for a conflagration, is similarly dealt with; and as a gladiator is stripped to the skin, so the ship is stripped, as far as possible, to the naked steel. This, by the way, is not so big a task as once it was, for naval constructors have learned to cut out every bit of wood or inflammable material that can possibly be dispensed with, and steel decks, or fireproofed wood, are the order of the day.

At the moment depicted in our drawing Admiral Togo will be standing out in the open on the after bridge, where he can obtain an unobstructed view of the whole field of battle, and with him will be the flag lieutenant, who will transmit by means of signals the instructions of the Admiral to the various vessels. Upon the fore bridge will be the captain of the ship (unless, indeed, he prefers the shelter of the conning tower), who is responsible for the fighting of the "Mikasa," just as the admiral is responsible for the whole fleet. With him are the navigating officer and at times the executive officer. The captain, by means of various telephones, speaking tubes, etc., gives instruction to the officers and chiefs from one end to the other of the great floating war machine. Within the conning tower, or in the pilot house, with his hands on a small, steam steering wheel, is the quartermaster, who keeps the vessel on its course.

A most difficult and complicated task is the control of a battleship in the climax of a great sea fight. To the engine room by means of the telegraph or telephone must be sent the instructions "stand by," "go ahead," "half speed," "reverse," etc., while to every gun station must be sent the correct instructions as to the particular ship which is to be attacked, and as to what part of the enemy's ship, if the range is short, each gunner is to aim at.

They must also be told from time to time what kind of ammunition to use, whether armor-piercing or common shell, etc. Hence it can be understood that at close range, when the storm of projectiles renders the bridge untenable, and the ship must be fought from behind armor protection, there is no more serious blow that can be delivered at a ship than a well-aimed heavy projectile, striking and wrecking the conning tower. It requires a cool head, steady nerves, and some quick thinking to handle a great modern fighting machine like the "Mikasa," especially if the enemy has got her range, and is raining a stream of lighter projectiles and an occasional 12-inch shell upon the ship. Not only is there the incessant din of the discharge of the ship's own guns, but what is infinitely more distracting, there is the clash and jar of the impact of striking projectiles of the enemy, to say nothing of the poisonous fumes from the high-explosive shells. It is this hammering, indeed, that forms the most distracting din in battle, for it is second only in its bewildering and stunning effect, to the death-dealing burst of a shell that has gone through a ship's plating or thick armor.

Far different from the pandemonium going on above decks is the comparative quiet and steady routine of work below the water-line. Thus, in the case of the great 12-inch guns which are shown so conspicuously in our drawing, the men whose duty it is to keep these guns supplied with ammunition do their work from thirty to forty feet below the gun and several feet below the water-line. Immediately under the protective deck, and vertically beneath the center of the turret, is a square chamber known as the handling room, into which open by doorways various compartments, in which are stored separately in racks ranged against the walls of the room bags of powder and the massive projectiles. Suspended overhead are steel tracks with little traveling trolleys and sling chains, by which the powder and shell is picked up from the racks, wheeled out into the center of the handling room, and placed in ammunition cages, that are attached to elevators, by which the ammunition is hoisted to the breech of the big guns. By the time it reaches the guns, the breech plug has been swung open, and a powerful rammer thrusts first the shell and then the powder charge, which is done up in several bags, into the powder chamber. The breech is then swung to and closed; the gun meanwhile is ranged and sighted on the enemy, and instantaneously with the command to fire, an 850-pound shell is hurled at a speed of half a mile a second against the enemy. In the meantime the ammunition cages descend to the handling room, where they are immediately loaded for another journey to the turret. Similarly from other decks lower down in the magazine compartment of the ship, the 6-inch and 3-inch and small rapid-fire gun ammunition is sent up the various ammunition hoists to be distributed to the different gun stations.

Down on the platform of the vessel, 25 feet below the water-line, the stokers feed coal to the furnaces, and go about their routine duties exactly as though the vessel were on her ordinary cruising duties in time of peace, the signs of battle that reach them being the muffled booming of their own guns, or the sharper rattle and crash of the enemy's shell as they pierce and burst from 25 to 60 or 70 feet above; unless, indeed, the rapid-fire guns are playing havoc with the smokestacks, tearing great rents in them, or even blowing parts of them bodily overboard, in which case steam pressures will begin to fall, and the anxieties of the engineer-in-chief will begin to multiply. In the engine room there will be noticed the same steady following out of routine, except that there will be that extra alertness that is visible in any engine room, say, for instance, when the ship is laboring in heavy weather, and special watch is being kept upon the throttle valves and governors. In one particular, however, the engineer will be especially watchful; that is in seeing that his bilge pumps are in perfect order, ready for the call which may come at any moment for driving them to their full capacity, in case the ship is hulled at the water-line, or torpedoed. Men will be found stationed at water-tight doors, or rather such of them as are not already closed, and must, perhaps, be kept open until the last emergency demands that they be shut.

It is popularly supposed that the men below decks run the more serious risk, because of their liability to be engulfed and carried down with the ship in some sudden catastrophe. Such, however, in a vessel of the size of the "Mikasa" is not the case. Even if she were struck by a torpedo, which is the most mortal blow that a warship can suffer, the chances are that not more than one compartment would be flooded. The men who happen to be in this compartment would, of course, be caught in the sudden inrush of water, a liability that is increased by the danger of their being knocked into insensibility, or bewildered by the terrific shock accompanying the blowing in of the side of the ship when the torpedo strikes her. Outside of this, so large is the "Mikasa," that it is questionable whether a single torpedo would suffice to sink her. The great reserve of buoyancy in a 15,000-ton ship, coupled with the large capacity of her pumps, would give her, unless, indeed, one of the bulkheads was involved in the explosion, a good fighting chance to limp home to the nearest port in Japan for drydocking.

It is a curious fact that in spite of the great activity of the Japanese fleet, it being continually under fire, there has been received no authentic account of injuries to the Mikado's ships. This, we take it, is a tribute to the efficiency of Japanese censorship, more than any evidence that her vessels have not received, as well as given, many hard blows; but for such information we shall probably have to await the termination of the war, when there will be a vast amount of valuable technical data to be distributed by the various naval *attachés* and qualified war correspondents.

New Railway up Vesuvius.

Messrs. Thomas Cook & Son have just constructed a new electric railway up Vesuvius from Pugliano, the northern quarter of Resina, to the terminus of the old funicular railway, which was made up the cone to the crater twenty-three years ago. This new line is nearly four and three-quarter miles long. Except for a section in the middle, it is laid with a ruling gradient of one in 12½, and the cars run by adhesion. In the middle portion the gradient rises to one in four, an incline as great as that of the Righi line, and in consequence it has been necessary to use a rack-rail, the Strub system having been selected, as on the Jungfrau railway. On this rack-rail section the cars are pushed up by a four-wheel locomotive provided with two 80-horse-power motors, and fitted with an elaborate system of ordinary and emergency brakes. On the other sections the cars, which seat 24 passengers and can accommodate six more on the platforms, are propelled by their own motors, the current being supplied through overhead trolleys, as is also the case for the rack-line locomotives. The generating station stands at the foot of Monte Cateroni, close to the point where the rack-rail section begins. Pugliano is already connected with Naples by electric tramway, with the exception of a short length which has still to be finished, and the old funicular line up the cone has been reconstructed and equipped for electrical working; hence it will soon be possible to travel by electricity all the way from Naples to within 250 yards of the crater, a good deal more quickly and comfortably than is permitted by the present means of transport.