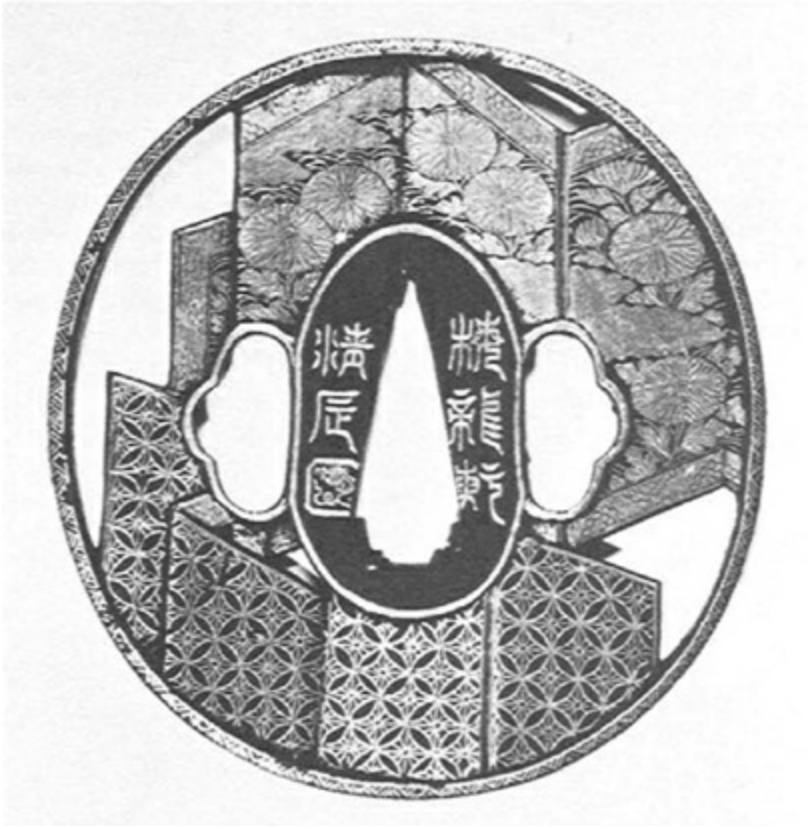
The concept of the process of *metal inlay* involves the permanent insertion of wire or sheet metal forms of one metal into an excavation created in the surface of an *already finished* metal object made of a contrasting colored metal. There are several methods by which this can be done, and they are described below. In traditional inlay work, the inlaid metal does *not* appear at the reverse surface of the work, nor does the inlay make use of heat as a means of joining the metals, though the results of these methods can *appear* to be inlay. The retention of the inlay depends instead upon the *mechanical holding action* of a *burr* raised at the edge of the excavation made to receive the inlay, and an *undercut* to hold it in place after the inlay has been forced into the recess. Most frequently, the inlaid metal is then made level with the surface of the parent metal, but several variations are possible in which the inlaid metal is in *relief*.

JAPANESE INLAY WORK (HON ZOGAN)

The process of inlaying metals is one that has been perfected and in wide use for centuries by specialists in Japan. Since jewelry worn by women in the Western sense was almost nonexistent in Japan in the past, the use of metal decorative techniques such as inlay was concentrated on objects used mostly by men. Foremost among these were the highly valued sets of sword furniture (collectively called *sorimono, kanagu* or *kodogu* for different sword types) used to decorate the swords worn by every samurai. These were often made to order by specialist artisans and their hereditary descendants who created schools in particular decorative techniques. The swords were decorated with subjects of significance to the owner and his family, such as the adopted crest (*mon*) of a clan to which he belonged, subjects from mythology, and symbolic themes. All the inlay techniques in practice, and there were many, were used to ornament the sword guard (*tsuba*). It had three holes, one for the sword blade, and the other two for the skewer (*kogai*) and a throwing knife (*kozuka*) to pass through and be held alongside the blade. The handles of the skewer and the throwing knife were also ornamented, and along with the pair of hilt ornaments (*menuki*) constituted a set (*mitokoro mono*) that were often done by the same family of craftsmen. The pommel cap (*kashira*) and the ferrule at the opposite end of the hilt next to the guard (*fuchi*) also made a set. The scabbard ornaments such as the end of the chape (*kojiri*) that covered the point, the ring for attaching it to a belt, and the ornaments at the open end of the scabbard (*koiguchi*) were all decorated. A study of these sword and scabbard parts reveals an astounding range of other decorative metal processes besides inlay. The scale of the decoration is so very small that a magnifying glass must often be used. Clearly both the makers and the users of these objects appreciated this exquisite attention to detail, careful workmanship, and great artistry.

In addition, inlay was also done on ritual objects, and objects made for secular use such as vases, decorative plates, boxes, and finger grips on the movable panels that are used in Japan to divide rooms.



8–36 JAPAN. Iron *kenjo style tsuba* by Bairiuken Kiyotoki, early 19th century. This type, given as a present to a superior, was always inlaid in geometric diaper or floral patterns with gold wire (*nunome zogan*). This style originated with Jiuchiya in Kyoto. This design represents a pair of ornamented folding screens. The signature seal of the maker (*kakihan*) is also inlaid in gold wire. Bequest of George Cameron Stone. *Photo: Cooper-Hewitt Museum, New York*

The processes described below are those that were practiced by traditional Japanese craftsmen of the past, and are still in use today. We are particularly indebted to Gene Pijanowski and Hiroko Sato Pijanowski, who have made a study of the Japanese inlay processes, and have so graciously shared their knowledge.

JAPANESE INLAY WORK TYPES

The general term for inlay work in Japanese is *hon zogan*, or *zogan*, which is equivalent to the Western term *damascene work*. Several specialized techniques of inlay work are recognized, and each has its established name, a circumstance unique to Japanese artisans.

Hon zogan (*hon*, "flush") is the general term for flush inlay made by first cutting grooves in metal, then undercutting them, and hammering in wire or sheet metal flat with the base metal plane.

Sen zogan is the flat inlay of round wire, flush with the ground, or in relief.

Hira zogan is the inlay of sheet metal flush with the base metal.

Takaniku zogan or *taka zogan*, literally "mound" inlay, is the inlay of raised or high relief forms made of solid sheet metal, repoussé-worked sheet, or cast metal forms. These forms can also be carved, engraved, or themselves inlaid.

Hira shizuku zogan is the inlay of dots made flush with the surface.

Shizuku zogan is raised dot or domed dot inlay, also called "raindrop," and "toad skin" inlay.

These processes are all described below in the demonstration process photos. In

addition, there are other forms of inlay work.

Nawame zogan is the inlay of compound, multi-metal twisted wire, inlaid as in *sen zogan*.

Uttori zogan is a form of *taka zogan* where large, thick pieces of cast metal are set in a surrounding flange. The projecting inlaid metal is then carved or inlaid with other metals, or it can have been carved or inlaid in advance.

Nunome zogan, literally "cloth inlay," consists of first engraving a flat surface with crosshatched lines with a serrated liner to raise a series of burrs on the entire surface and give it a texture that resembles woven cloth. On this prepared surface wire or gold leaf is then inlaid. The process is described below.

Kinkeshi zogan, ginkeshi zogan are respectively gold amalgam inlay and silver amalgam inlay (*kin*, "gold," *gin*, "silver," and *keshi*, "amalgam"). This process consists of inlaying a mercury amalgam of precious metals into grooves made in the metal, then volatilizing the mercury and leaving the precious metal behind. The process is described under Amalgam Inlay. Very small dots representing mist, and signatures were made in sword ornaments in this way.

Other processes that are not strictly inlay according to Western concepts of the process, but a form of mosaic, are classified by the Japanese as a form of inlay. *Kirihame zogan* or "sawing inlay" is a *pierced work inlay* in which parts of the ground are pierced through completely and replaced with parts having exactly the same shape, but of another metal, then soldered in place. The inserted inlay can be flat or in repoussé work relief. A variation is one in which a prepared mosaic of different colored metals is then inlaid in a pierced parent metal, and soldered in place. One type is a mosaic of alternating squares of contrasting colored metals, others are laminates of different metals.

METALS USED FOR INLAY

At the basis of the appeal of the inlay process is the contrast between the color of the metal inlaid and the ground metal. The greater the "palette" of metal colors used, the more varied the work can appear. For jewelry making, any combination can be used. In relief or sheet metal inlay, the metal inlaid can be of any contrasting color. In wire inlay, it is usual for the wire to be of either gold or silver or both, and the ground can be of any color that will contrast with these metals.

Fine gold, karat gold, fine silver, sterling silver, copper, brass, bronze, iron, steel, or the Japanese alloys *shakudo* and *shibuichi* all can be used in any combination.

THE GROUND METAL (jigane)

The minimum thickness of the ground metal should be 14 or 16 gauge B.&S., gauges thick enough to allow excavations to a depth suitable to receive the inlaid metal. Thicker metal can of course also be inlaid, as can cast metal pieces.

THE INLAID METAL (mongane)

The inlaid metal should always be *well annealed* to allow for maximum malleability so that it is easily spread into the undercut when struck, and takes on the form of the recess into which it is pressed or hammered. Fine gold and fine silver are well suited to use as inlay metals because they are naturally soft and do not become excessively work hardened when hammered. Round wire in gauges of 18 to 22 B.&S. are commonly used.

Much finer wire is used in the inlay process called *nonume*, where it can be placed anywhere on the surface, which is completely grooved. Sheet metal inlay in thicknesses of 22–24 gauge B.&S. are recommended. Sheet metal thinner than 24 gauge B.&S. may become too thin after leveling, and the inlay runs the risk of falling out of the recess.

PITCH: The traditional ground metal holding surface

The working surface most favored for inlay work has always been pitch (*yani*). This material firmly holds and supports the ground metal which is cemented to it, and offers just the right amount of resistance to the impact blows of the tools used. Pitch is used for the same purpose in repoussage, and the reader is referred to that section in Chapter 5 for a discussion of pitch and pitch compositions. In the Table, "Typical Pitch Repoussage Compositions" , "Hard pitches" are listed that are suited to inlay work. The pitch composition used for inlay must be harder than for pitch used for repoussage, because in inlay work the ground is not altered in shape and the pitch serves only to hold the metal firmly in place during the inlay process; while in repoussage it must give to the shaping of the metal. If the pitch is too hard, however, the work may spring from the ground when the metal is struck. It may be necessary, as in repoussage, to alter its composition somewhat to render it suitable to seasonal temperature changes.

Inlay work can be done with the metal placed on the pitch in a pitch bowl that rests on a circular cushion. This allows the work to be angled to whatever position may be necessary, and makes it easier to do inlay work on convex surfaces. Traditional Japanese inlay workers, however, use a special maple or other hardwood board (*yani dai*) approximately 5 in × 8 in × 2 in (12.7 cm × 20.6 cm × 5.1 cm). To give the board weight, a rectangular hole is made in the center of the board, and chipped stones or pebbles are placed in it, or lead about 1 ¼ in (5.7 cm) thick is cast in the hole. The cooled but still viscous pitch is poured over the hole and spread over the rest of the board with a stick to a thickness of about 1 in (2.54 cm), this being the limit of the depth of the metal shape placed upon it. Objects of greater depth can be accommodated by mounding the pitch at the center. The concave part at the back of the work must be completely supported or the ground metal will move when struck. Avoid pouring the pitch while it is still too hot, or it will run off the board.

To secure the ground metal to the pitch, heat the pitch surface with a soft flame just enough to soften it. Place the ground metal on the pitch and press it in at its center with a hammer handle until the entire undersurface is in total contact with the pitch. Avoid sinking the metal into the pitch. Allow the pitch composition to cool and solidify. It is then ready for the inlay work to start.

When the time comes to remove the work from the pitch, heat the work only enough to allow it to be pried loose from the pitch (do not burn the pitch), then lift it away with *tweezers*. To remove pitch from the inlaid metal when the work is completed, *never use heat* as this might cause the metal to warp and destroy the inlay. Instead, with a wooden stick, scrape off as much of the pitch as possible while it is softened. The rest is dissolved by using a pitch solvent such as lacquer thinner in which the article can soak, or by

rubbing it with a wad of cotton soaked with turpentine.

THE INLAY TOOLS

Three basic tools are used in the inlay process: the metal-cutting *chisel (tagane*), the *hammer (kanazuchi*), and blunt, noncutting *repoussage* or *chasing punches* (also called *tagane* with modifying adjective). Chisels are made of high-carbon cast tool steel, and are used to make the incisions in the parent or ground metal into which the inlaid metal will go. The hammer is used to propel the chisel, and to strike punches for various functions.

CHISELS IN GENERAL

A *cold chisel* is a sharp-ended steel tool forged from a bar of tool steel containing 3.5% nickel or chrome in the alloy. It has three parts: the *striking end*, the *shaft*, and the *cutting edge* or *blade*. Chisels are used to bevel, carve, cut, chip, dress, engrave, gouge, pare, pierce, remove, rout, and shape metal, and in a special form, to turn solid metal or other material on a lathe.

THE STRIKING END A metalworker's chisel, unlike a woodworker's chisel, does not have a tang that fits into a wooden handle. Its working end, which is where it is struck, is blunt and flat, and usually is the *same* in section as the stock; *smaller* in section in the case of chisels with tapered stocks; or *larger* than the stock, tapering outward. If an outer taper develops at this end during the course of long hammering and use, it is termed a *mushroom head* because of its shape. This sharpened form is undesirable as it may weaken the tool and be the cause of accidents to the hands, and is removed by grinding it off. In some cases, such a head may be formed deliberately to provide a chisel with a larger striking surface. To make the chisel penetrate the metal, it is struck with a *hammer, stick*, or *metal bar*. The striking end is left soft to better take the impact since it might break if it were hard and brittle. When cutting metal with a chisel, watch the cutting end, not the striking end.

THE SHAFT, STOCK, OR TAPER This is the tool's handle. The *blank* or unshaped or unfinished bar of tool steel from which a chisel is made can be square, rectangular, hexagonal, octagonal, or round in section. It can be straight its entire length, or it can be given a taper toward the working end, the striking end, or both, by drawing it down when forging the tool. Tapering can also be accomplished by grinding or drawfiling when shaping the tool. The shaft corners are smoothed down to make the tool more comfortable to grip.

THE WORKING END This is the part of the tool that cuts into the metal when the chisel is used. To make the cutting end better able to penetrate the metal, the last 1½ in (3.8 cm) of the cutting end is tempered and hardened, then repolished before final sharpening and honing.

The concept of the chisel shape is based on the principle of the *wedge*, a shape that,

when held at a suitable angle, allows it to enter the metal by its sharpened edge, the smallest part of the wedge shape. This is called the *nose* or *blade* of the tool and has been bevel sharpened to shapes and dimensions suited to the usual cutting tasks demanded of chisels. Its function and shape determine the angle of the bevels. They are created by working the tool on a water- or oil-lubricated whetstone while holding it at the desired angle, then honing it on a *leather sharpening strop* coated with a suitable fine abrasive such as diamantine. A sharp, properly hardened and tempered chisel can enter into and completely penetrate metal of relatively great thickness and of any hardness less than that of the tool itself, which is to say all metals ordinarily used by jewelers.

COLD CHISEL TYPES

Most cold chisels (so called because they are used on cold work), are named after their shape or use, and almost all chisels are made in several sizes of each shape, used according to the dimensions needed. Some of the more common forms are the following:

Flat or chipping chisel: A flat chisel used for general purposes, for chipping, cutting thick sheet, and for excavating straight-sided, flat grooves. Its corners are slightly curved so that it does not dig in excessively. It should be held firmly about ½ in (1.3 cm) from the striking end, and its edge should be slightly lubricated. The metal removed comes off in curls or chips.

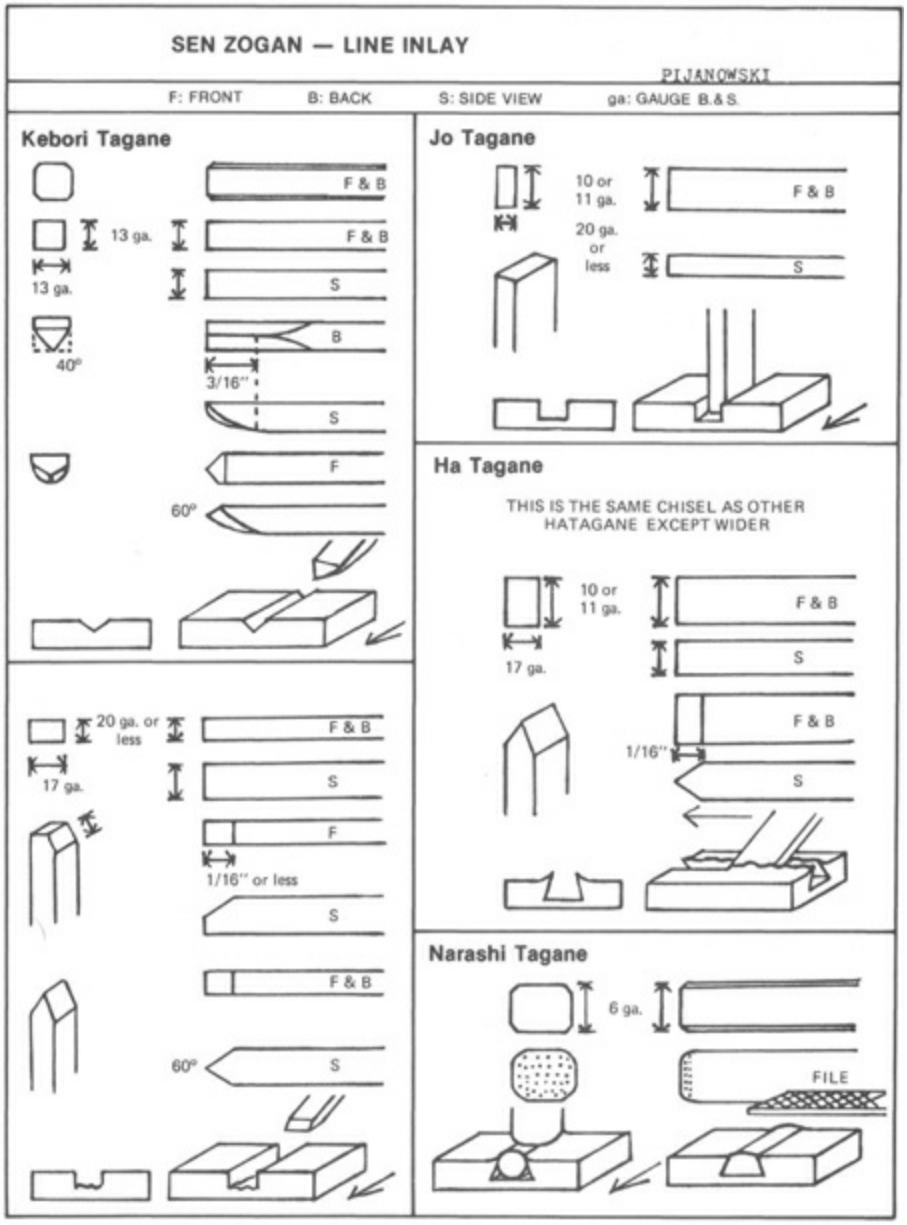
Crosscut or cape chisel: A straight-edged, narrow blade used for cutting grooves and slots. When removing a large area, its edges can be cut first with a crosscut chisel, and the waste metal between excavated with a flat chisel.

Diamond: A diamond-pointed, square-sectioned chisel, used for cutting square corners.

V-shaped chisel: A chisel that cuts V-shaped grooves, often as an initial groove. It is followed by chisels having edges of other shapes to alter the shape of the groove.

Round-nosed chisel: A chisel with a hollowed, rounded cutting edge, used for making round-bottomed incisions.

Half-round chisel: A chisel with a solid section and round-bottomed cutting edge, used to cut curved grooves, and to cut out holes by chipping.



THE JAPANESE INLAY PROCESS

DEMONSTRATION 12

HIROKO SATO PIJANOWSKI inlays a pendant
Photos: Gene Pijanowski
Japanese terminology supplied by Hiroko Sato Pijanowski

THE BASIC JAPANESE CHISELS USED (tagane)

The Japanese inlay chisels are made in five graduated sizes, Nos. 1–5.

Kebori tagane: A bellied, V-shaped grooving chisel with straight sides used to cut into the metal to make the initial inlay groove, then followed as a guide by the next chisel used. When a wire is to be inlaid, the chisel's width must be equal to that of the gauge of the wire. When a shape is being excavated, the outlines are first made with this chisel, and the metal between them is then excavated.

The faces of the point must be formed symmetrically and true or it will not cut a

straight groove, but will favor one or the other side. If the front triangular bevel is not at a sufficiently steep angle, it will bury itself in the metal and possibly break. If it is too shallow an angle, it will slip on the metal and not cut.

Ha tagane: A straight chisel, square in front view and triangular in side view, with faces beveled to a knife edge. This chisel follows the *kebori* chisel. In its narrowest size, it is used to deepen the perpendicular-sided groove in the metal. Its width must equal the gauge of the wire to be inlaid. In a wider width, it is also used to excavate surplus metal when preparing a recess for a sheet metal shape to be inlaid. It is also used to undercut a groove and raise a burr.

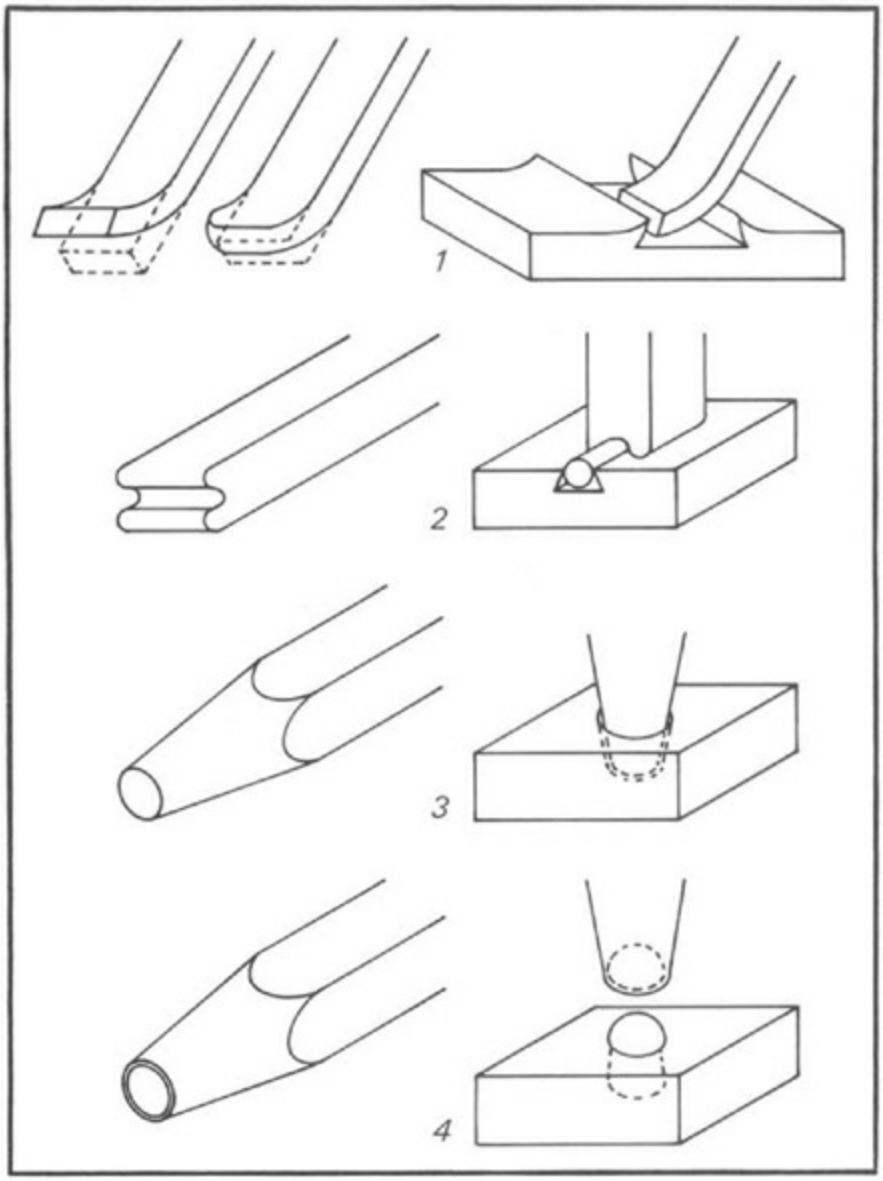
PUNCHES USED FOR INLAY

Punches are tools that plastically deform metal without cutting or removing any metal. In Japan punches and chisels are both called *tagane*. Each chisel and punch has its special function and a word that describes its use is added to the generic term *tagane*, as for example: *narashi tagane*, "leveling punch." All these Japanese tools have their Western equivalents in chasing (*ukibori*) and repoussé work (*uchidashi*).

PLANISHING PUNCH (SOBAYOSE TAGANE) A bent-ended punch used in wire inlay to straighten the burr raised in a groove to align it or make it more vertical. This is done by inserting the end into the groove under the undercut and tapping it along. It is made with a flat end for use in straight lines, and a curved end for use on curved lines.

EMBOSSING, CUSHION, OR MATTING PUNCH (NARASHI TAGANE) A blunt, flat-ended, round-edged leveling punch, used while held in a vertical position at the juncture of the burr and the inlay to tap down or level a burr over the edge of the inlay. It is also used to push down an inlay into its groove. The working end must be wider than the wire gauge being set down, and it is sometimes roughened before tempering by striking it with a coarse file to prevent its slipping off round wire when hammered.

TRACER PUNCH (JO TAGANE) A rectangular-sectioned, flat-ended punch (*hira jo tagane*) whose width is narrower than its depth, used to set down and flatten the bottom of the groove made in the ground to better accommodate the inlay, as in wire inlay. Its width must correspond to the gauge of the wire being inlaid. In another form it is a curve-ended, crescent-shaped punch used for deepening curved grooves (*magari jo tagane*).



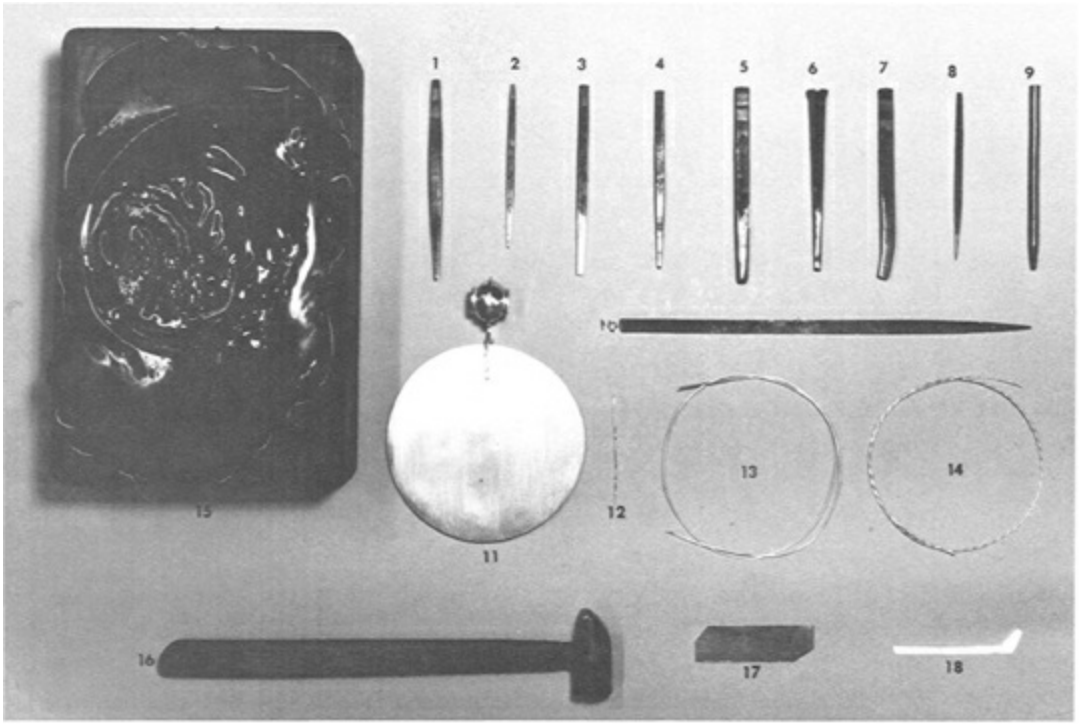
8–38 *INLAY PUNCHES WITH SPECIAL FUNCTIONS*

1. *Planishing punch (sobayose).*
2. *Hollow-ground tracer (tunnel narashi tagane).*
3. *Round punch (maru jo tagone).*
4. *Round hollow punch (nanako).*

HOLLOW-GROOVED TRACER (TUNNEL NARASHI TAGANE) A tracer with a longitudinal groove in its end, used to set down a wire inlay yet leave it raised from the surface of the ground.

ROUND PUNCH (MARU JO TAGANE) A solid, round section, flat-ended, tapering punch, used to make round depressions for the inlay of round wire.

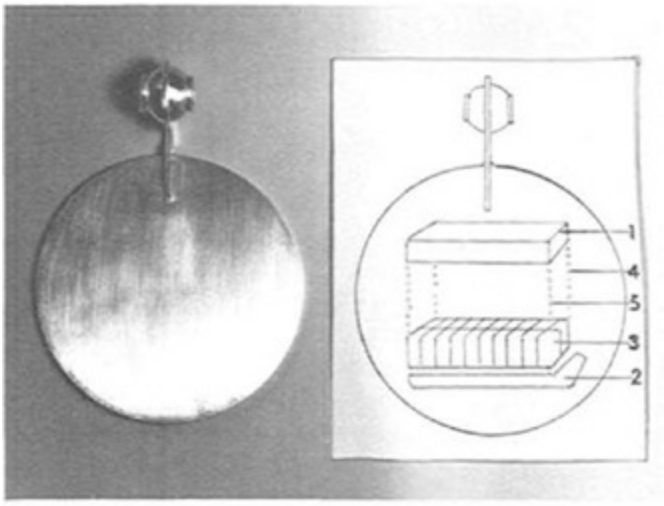
ROUND, HOLLOW OR CUPPED PUNCH (NANAKO TAGANE) A round-sectioned punch with a hollow end, used to shape a small dome on inlaid wire as in *shizuku zogan*, or to imprint series of small circles called *nanako*, "fish roe," as when texturing a ground. Nanako circles of minute, sometimes almost microscopic size were spaced at equal intervals in linear, geometric, or random patterns.



1

1 Tools and materials used for the inlay demonstration.

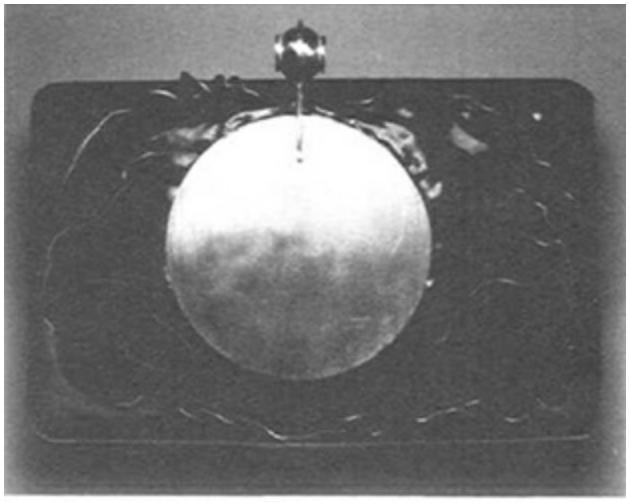
1. *kebori tagane*. 2. No. 1 *ha tagane*. 3. *jo tagane*. 4. No. 2 *ha tagane*. 5. *narashi tagane*. 6. No. 3 *ha tagane*. 7. *sobayose tagane*. 8. *moru jo tagane*. 9. *nanako tagane*. 10. file (*yasuri*). 11. ground metal (*jigane*). 12. 18 gauge B.&S. round fine gold wire (*kin sen*). 13. 20 gauge B.&S. round fine silver wire (*gin sen*). 14. 20 gauge B.&S. round twisted copper and fine silver wire (*nawame sen*). 15. pitch spread on a board (*yani dai*). 16. Japanese hammer (*kanazuchi), otafuko* No. 6. 17. inlay metal (*mongane*). 18. 22 gauge B.&S. shakudo inlay shape (*mongane*).



2

2 This diagram illustrates the different types of inlay work that will be done on the demonstration piece.

1 Line or “wire” inlay (*sen zogan*)
2 “Flat” or flush sheet inlay (*hira zogan*)
3 “Mound or high relief” inlay (*takaniku zogan*)
4 “Flat dot” inlay (*hira shizuku zogan*)
5 “Raised or domed dot” inlay (*shizuki zogan*)

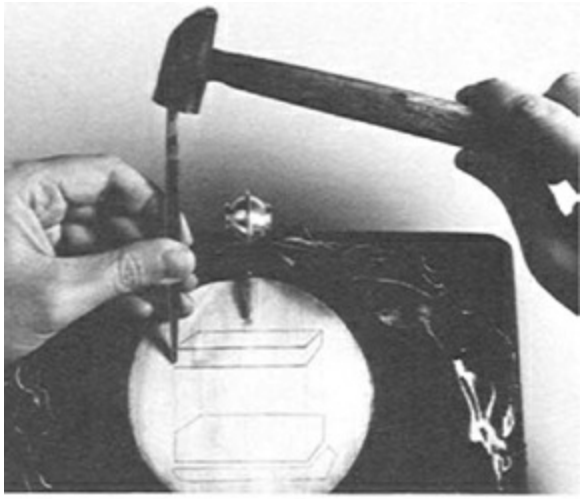


3

3 The finished 16 gauge B.&S. copper disc ground metal (*jigane*) is fixed in the pitch. Because no heat process can be used on the object after inlay, it must be finished in every way, except for final polishing and coloring. The base metal should be at least two gauges thicker than the wire to be inlaid in it.

FLUSH WIRE INLAY (sen zogan)

CUTTING THE INCISION



4

4 Draw the design on the metal with a *steel scriber (kegaki*). Carve a V-shaped channel in the metal ground following the line which goes in a direction straight toward the worker with a *V-shaped chisel (kebori tagane*). Slant the chisel's striking end *away* from you. Move the chisel at an angle of 30–40° along the line toward you by hammering it with light taps on its striking end with the hammer that hits at an angle of 90°. This forces it forward while it removes a curl of metal from the sheet.

DEEPENING AND BROADENING THE INCISION

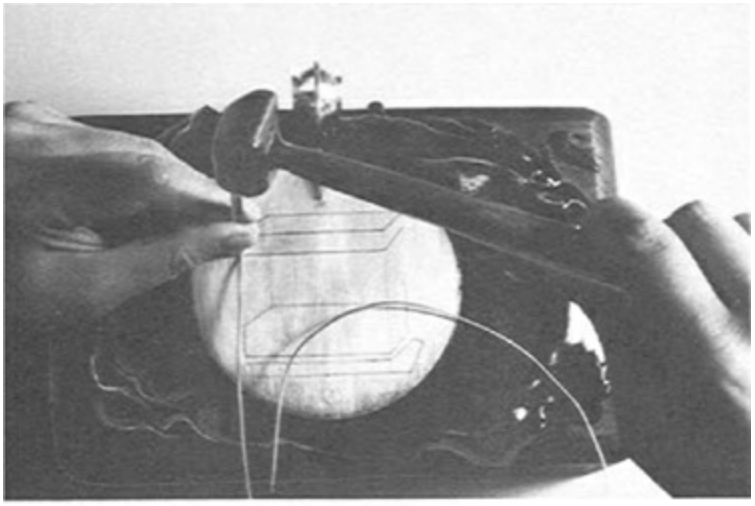
After the V-shaped groove is made, to deepen the groove, hammer a square-ended excavating chisel (width No. 1 *ha tagane*) whose cutting edge width is equal to that of

the wire gauge being inlaid into the groove. Work in the same direction as before. The bottom of this groove may now be rough. Smooth and beat it down to a depth equivalent to two-thirds of the wire's thickness with a *square-ended tracer punch (jo tagane*) held perpendicular to the metal and moved along the line toward the worker. Its size must also just fit the groove so that no alteration of groove width occurs.

UNDERCUTTING THE INCISION

Shift the work 90° so that it crosses in a direction in front of the worker. The undercut of the incision is done with a *flat cutter chisel* with a sharply beveled knife edge (width No. 2 *ha tagane*) by setting it inside one side of the groove at an angle of 30–40° from the groove bottom, then driving it down the line. While making the undercut, it also raises a burr along one side of the line. Turn the work 180° and do the same with the same tool along the other side of the line so that both sides are now undercut and with raised burrs. Straighten the burr and make it point in a more upward direction by using a *bent-ended planishing punch (sobayose tagane*), a straight one for straight lines, and a curved one for curved lines.

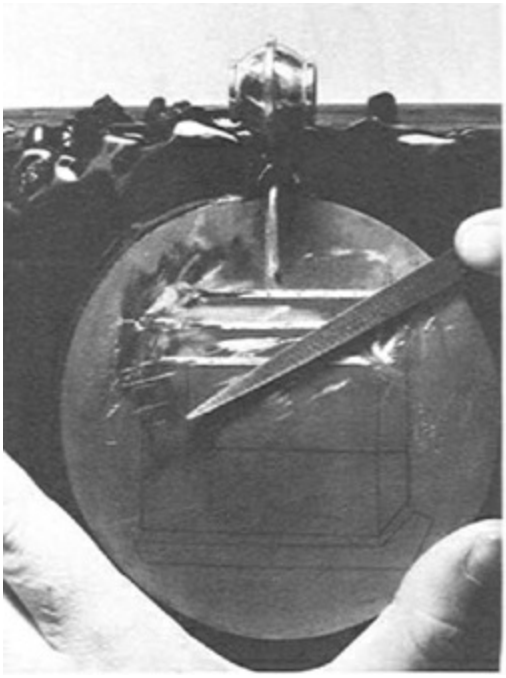
INLAYING THE 20 GAUGE B.&S. FINE SILVER WIRE



5

5 Turn the work so the line points straight toward the worker. File flat the end of the fine silver wire to be inlaid, and insert it in the groove at the start of a line by tapping it in lightly with a flat-ended *embossing* or *cushion punch (narashi tagane*) whose end is wider than the wire. Hold the punch above the wire in a vertical position. Move the punch along its length, and with each blow, force the annealed and softened wire into the groove to make it take its shape, and fill in the undercuts so that it cannot come out —the basic system for holding all inlays. A *hardwood punch* with the proper end shape could also be used for this function. At the same time that the punch is pushing the wire into the groove, it is also flattening the burrs on the wire edges, helping to hold the wire in place. At the end of a line, use a sharp-edged cutting chisel (*ha tagane*) to cut off the wire.

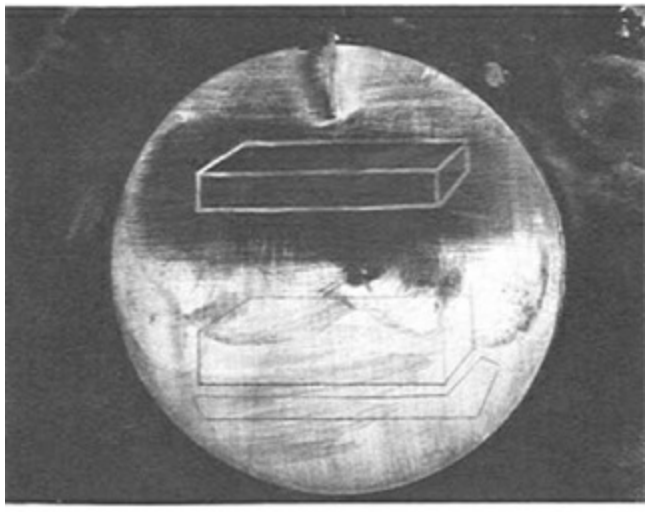
LEVELING THE WIRE INLAY AND SETTING DOWN THE BURR



6

6 Level the wire inlay to the plane of the ground, by first filing, then sanding it with a *400* or *600 grit sandpaper*. If the purpose is to shape the wire longitudinally to raise it in relief, this can be done with a polished *hollowgrooved liner punch*. First smooth the edges along the wire with fine emery cloth. Then place the punch so that its groove is over the wire and its edges straddle the wire. Then hammer the punch along the line forcing the wire into the groove and at the same time pushing down the burr on its edges. Once the wire is flat, remove marks left on the outer edges by the tool with a smooth-faced leveling punch (*narashi tagane*). Hold it perpendicular to the ground and close to the wire, and with light taps work it along the length of the inlay. Avoid heavy blows as they will cause marks that are difficult to remove.

FINISHING THE SURFACE

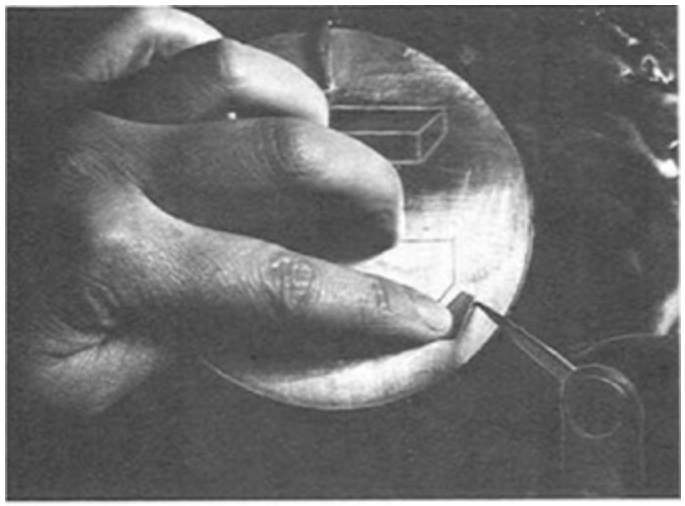


7

7 Here we see the finished surface after sanding with the positions of the shapes of the

sheet to be next inlaid marked on the ground with a *scriber*.

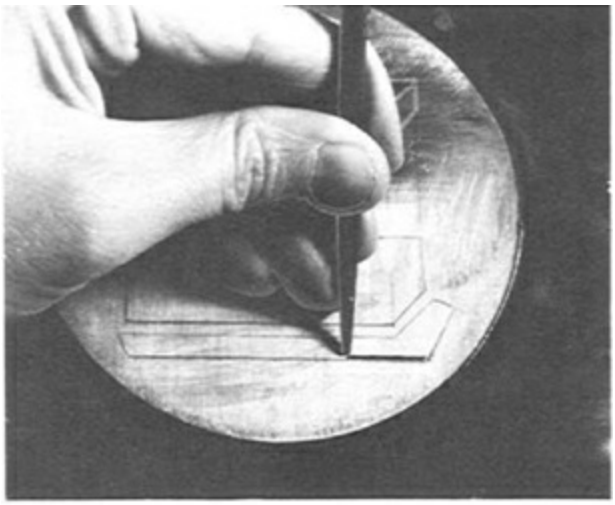
FLUSH SHEET METAL INLAY (hira zogan)



8

8 The metal of this shadow form to be inlaid is 20 gauge B.&S. shakudo. The inlay is to be flush with the ground, therefore this gauge is adequate. The blank is sawed out with its edges at a 90° angle to the horizontal plane. Its upper edges are then beveled with a *file* to an angle of 20–30° from the vertical. Anneal the blank.

Align the blank to *one line* in its enscribed position, and deepen that line with a scriber held at an angle so that its point touches the point of contact between the blank and the base. Place the work, now mounted on the pitch board, so it is perpendicular in front of you. Hold a cutting chisel (width No. 2 *ha tagane*) between the thumb and first two fingers with its striking end slanting *away* from you and its cutting edge on the line, and drive it toward you along the line. The incision should be neither too deep nor too shallow. The cut raises a burr along the marked line.

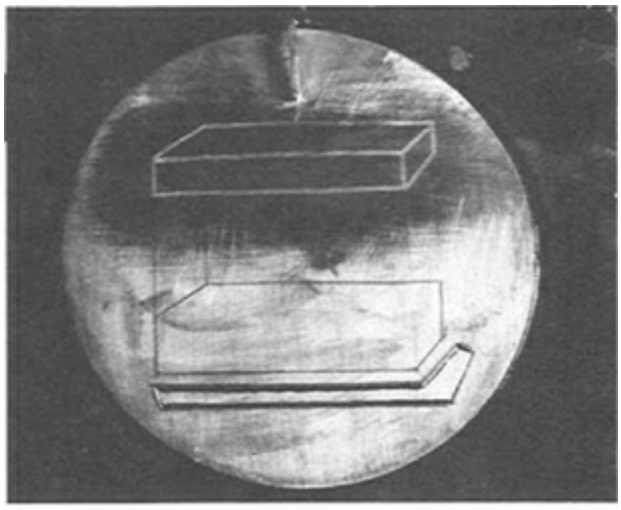


9

9 When one line is done, return the blank to its position against the newly raised burr, and draw a second line along its next side, as before. Turn the work so this next line points toward you and make an incision as before. Continue in this way until all

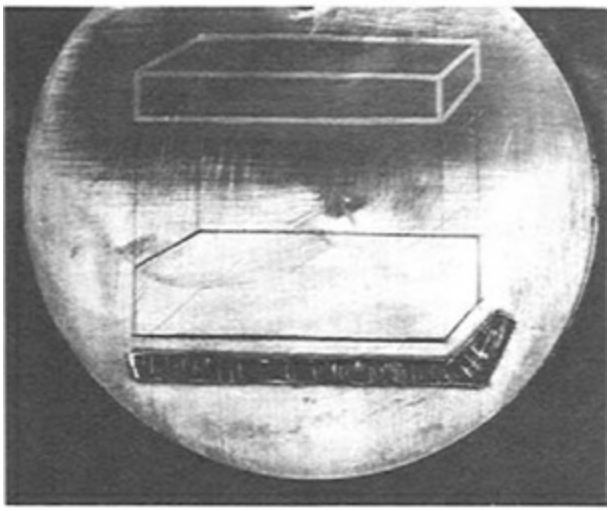
the lines enclosing the blank are incised.

The purpose of this procedure is to be sure that the shape within the incisions exactly fits that of the blank so that it will not be loose. If the excavated space is too wide, which tends to happen if the entire outline is made in *one* tracing, the blank will be too small and cannot be inlaid.



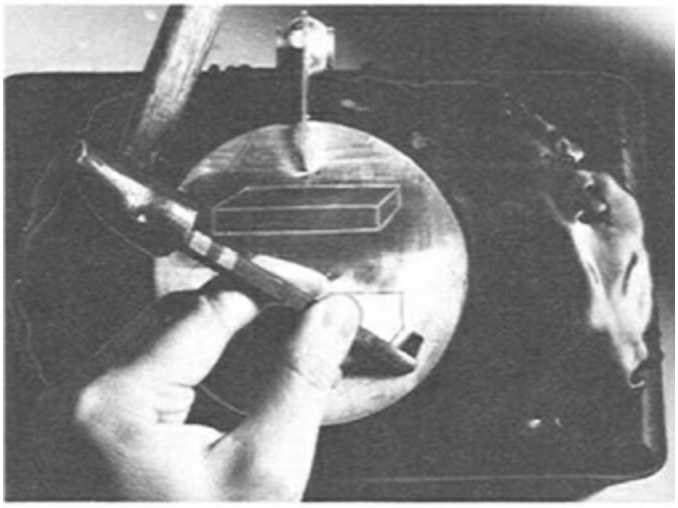
10

10 Here we see the work with all four incisions made. Place the blank in position to test its fit within the raised burrs. Make any necessary adjustments carefully.



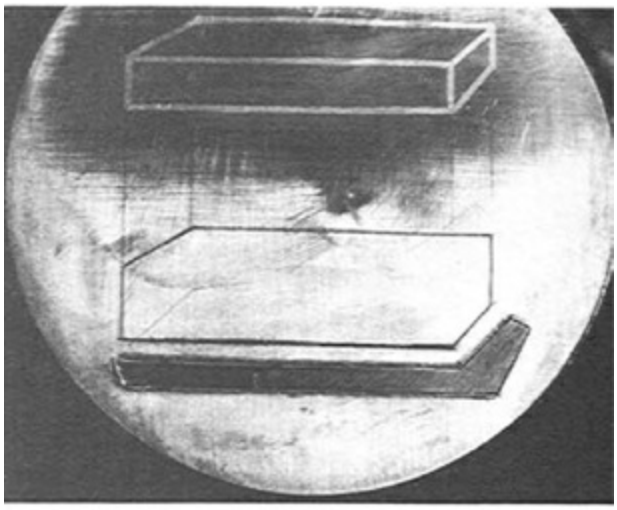
11

11 Excavate the metal between the burrs with *cutter chisel* (width No. 3 *ha tagane*) to form the recess. The depth of metal removed should equal that of the thickness of the inlay blank so that it will be flush with the ground when finished.



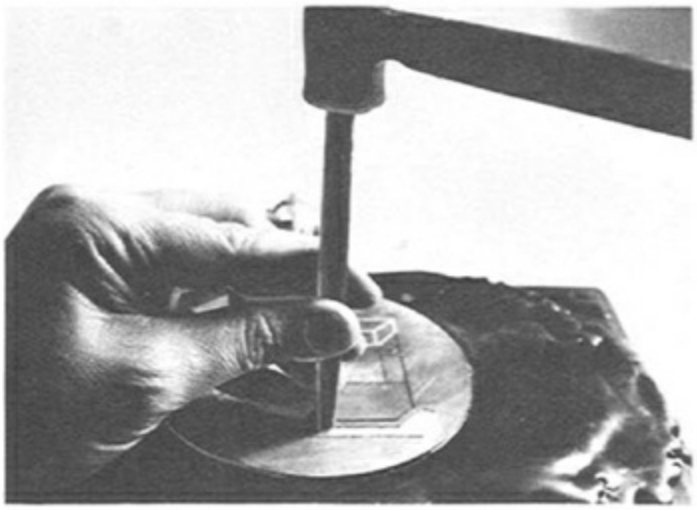
12

12 Smooth and straighten the burrs with a *planishing punch (sobayose tagane)* by placing its working edge against the *inside wall* of the recess and tapping it lightly. Take care not to increase the dimensions of the incision.



13

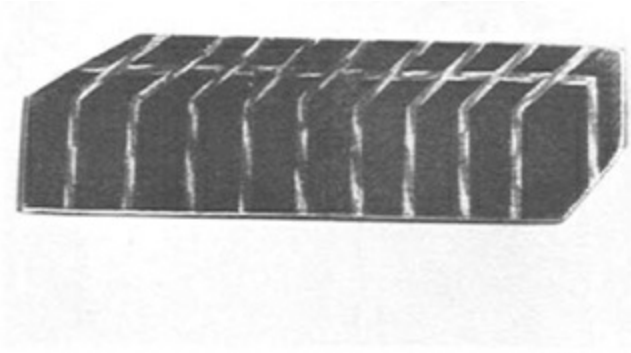
13 Again place the shakudo blank in the recess in the ground to see if it fits properly, and make any necessary adjustments.



14

14 With light taps, hammer down the burr on the blank with a *cushion punch (narashi tagane*) held vertically with its face over the burr along the edge of the inlay blank, moving it along until the entire burr is set down. Level the surface with a file followed by fine abrasive papers, or by a *horizontal belt sander* if this is available.

RELIEF OR MOUND INLAY (takaniku zogan)



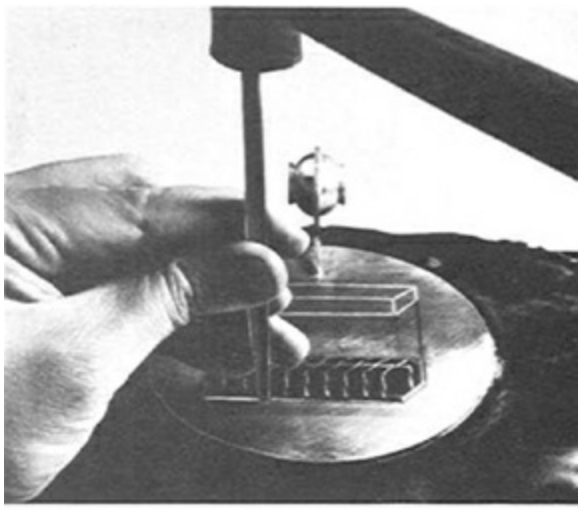
15

15 Relief or "mound" inlay is almost the same in method as flat sheet inlay, with the difference that the finished inlay is in relief above the surface of the ground. The recess does not have to be excavated as deeply as in flat inlay.

A shakudo blank is prepared in this case from 18 gauge B.&S. in the same manner as described for the last. A heavy gauge is used as this inlay will project in relief *above* the surface of the base.

MULTI-METAL WIRE INLAY (nawame zogan)

The shakudo blank is seen here with an inlay of a patterned wire made of round twisted copper and fine silver already in place. Both wires were originally 20 gauge B.&S. After being tightly twisted together, they were drawn through a *draw plate* until they were 20 gauge B.&S. The place between the two metals is then flooded with easy-flow hard solder to unify and strengthen the wire which can then be treated as a single wire, and inlaid by the wire inlay method (*sen zogan*). The use of such patterned wire in inlay is called *nawame zogan*, (*nawame* = rope).



16

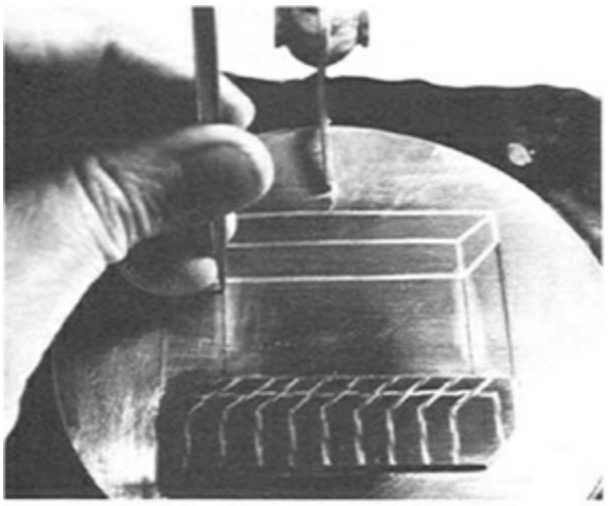
16 Chisel a groove and excavate the surplus ground metal, then raise and straighten the burr in the manner described on this page for Photo 12. File the edges of the blank to a bevel, and place the blank in the excavation. Here the burr is being pushed down alongside the inserted blank with a vertically held *tracer punch (jo tagane)*, not an

embossing punch.

In some cases, the form of the inlay may be made *convex* by hammering it from the back before placement to dome the shape somewhat. After it is placed, it is hammered down to force it into the undercut, then the burr is set down. It is also possible for the inlay to be a casting in relief, repoussé-worked sheet metal, or layers of sheet metal soldered to each other. In all cases, their edges are beveled to an angle, and the form is then inlaid in the manner described for sheet inlay.

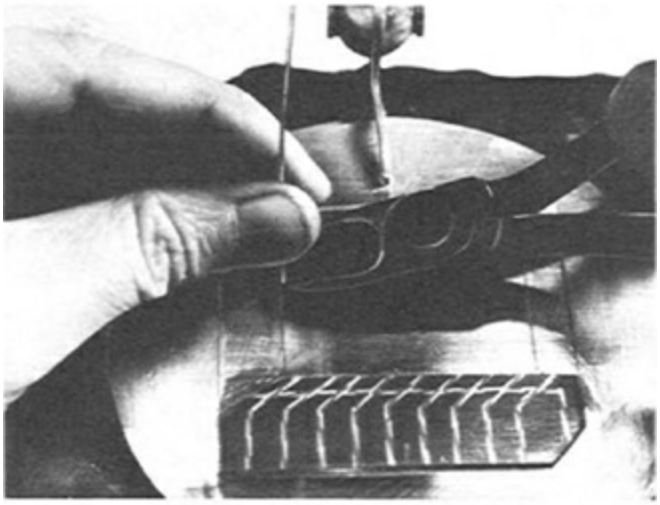
FLUSH DOT INLAY (hira shizuku zogan)

In this process, wire is inlaid *endwise* into the ground, so that when the inlay is completed, as round wire is used, it is a flush round dot. The ground should be at least 16 gauge B.&S. and the wire used here is round, 20 gauge B.&S. pure gold. Finer wire can also be used but requires smaller tools and greater care.



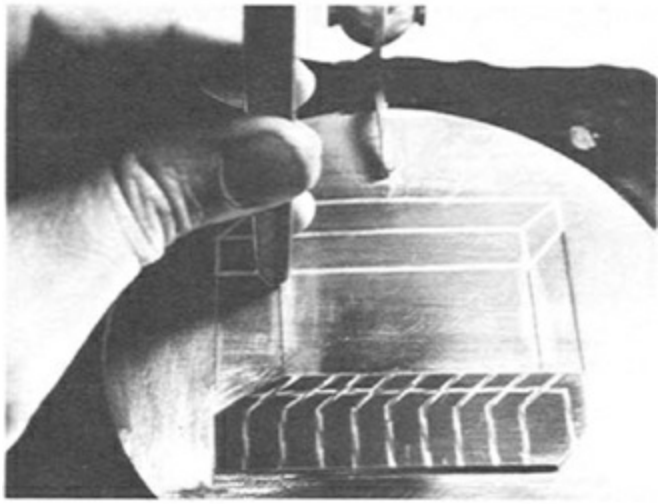
17

17 Punch a hole straight down in the ground metal to half the depth of its thickness with a *flat round punch (maru jo tagane*) whose diameter is one gauge smaller than the round wire being inlaid. After punching, rotate the tool clockwise while tapping it lightly so that an undercut is formed. At the same time, the size of the hole is increased to 20 gauge B.&S. which is the size of the inlay wire used. *File* off one end of the annealed wire flat, and place it in the hole.



18

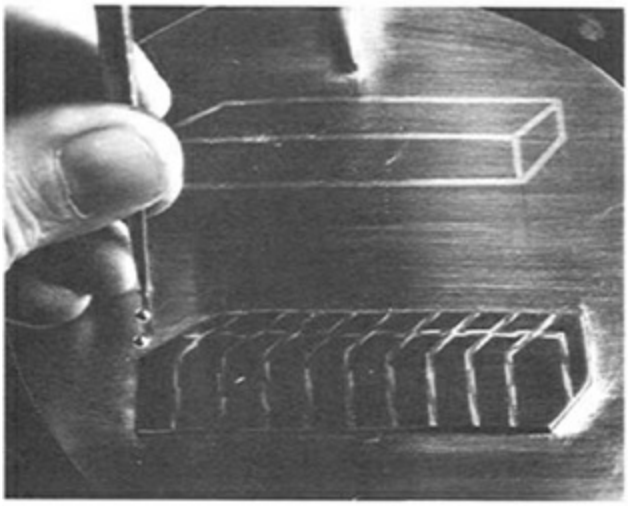
18 Cut the wire off with *side nippers* a little above the level of the ground, and file the cut end flat. It is also possible to precut a length of wire, file both ends flat, and place it with *tweezers* perpendicularly into the hole.



19

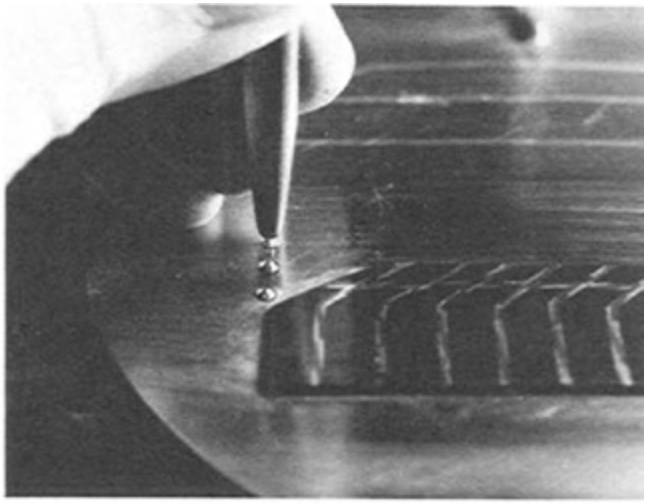
19 Place a *blunt-ended embossing punch* with a face large enough to cover the wire and tap the punch to force the wire to fill the circular recess. *File* the surplus metal off to level the dot inlay flush with the ground, then sand the surface smooth.

RAISED DOT INLAY (shizuku zogan)



20

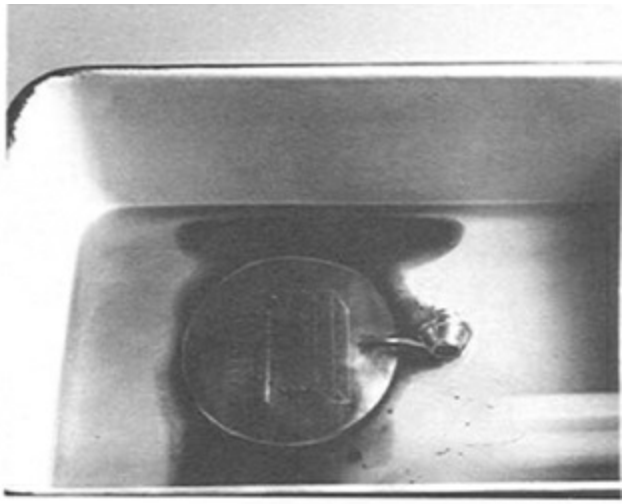
20 This inlay process is started in the same manner as flush dot inlay. First hammer the round punch straight down, then rotate it clockwise while tapping it with a hammer to make an undercut and enlarge the hole slightly to the desired diameter.



21

21 The wire used for these raised dots is pure gold, 20 gauge B.&S. Place the wire upright in the hole and cut it off a little *above* the level of the ground. To create the domed, rounded end, a *round hollow-ended punch (nanako tagane)* is used. Hold this vertically over the wire end and tap it straight down. In the hammering, the wire end fills the hemispherical depression in the punch and forms a dome. After the first few taps, rotate the punch while tapping it to round the raised dot evenly.

The same round, hollow-ended *nanako punch* is commonly used in Japanese metalwork to create a ground pattern, surface decoration, or texture by striking series of small circles in straight or diagonal lines one next to the other, the effect called “fish roe surface.” The diameter of the dot varies between 0.04–0.08 in (1–2 mm), the small size making it necessary to place them entirely by touch. In some cases, a flat inlay of different colored metals is gone over with a continuous *nanako* pattern that passes over from inlay to ground without interruption.



22

22 Remove the piece from the pitch and place it in a lacquer thinner (acetone) to remove the pitch. Do not use heat in cleaning the work as it might cause the inlay ground to warp and the inlaid metal to fall out.

POSTINLAY PATINATION

When the inlay work is finished, polished, and cleaned, it is then patinated. The natural color range of the metals and alloys used can be increased considerably by the use of chemical coloring agents. This is one of the reasons that in Japan, metals that accept chemical patination well are favored for inlay work. Foremost among these are *shakudo* and *shibuichi*, both discussed under Mercury Amalgam Gilding. When these are treated with the favored coloring chemical *rokusho* , shakudo takes on a rich purplish black color, and shibuichi a grayish silver color. The same chemical, rokusho, reacts differently in the same bath with copper, giving it a reddish brown patina, while it does not affect the pure gold and pure silver. Another coloring solution used is a combination of 50% ammonia and 50% liquid soap which gives shakudo a brown color, improved by rubbing. The Japanese call metal inlays of several alloys on one object *iroye* (“colored picture”) because besides natural color differences, each metal develops its own color under patination.

23 The finished pendant, ground metal disc, copper, 16 gauge B.&S., diameter 3 in (7.4 cm).

Technique	Part	Metal (B.&S. gauge)
Wire inlay (*sen zogan*)	upper box	fine silver, 20 gauge
Flush sheet inlay (*hira zogan*)	lowest shadow form	shakudo, 20 gauge
Relief inlay (*takamiku zogan*)	lower box form	shakudo, 18 gauge
Rope wire inlay (*nawame zogan*)	compound wire on lower box form	fine silver and copper, 20 gauge each, drawn to 20 gauge
Flush dot inlay (*hira shizuku zogan*)	flush dots	pure gold, 20 gauge
Raised dot inlay (*shizuku zogan*)	raised dots	pure gold, 20 gauge

VARIATIONS OF INLAY

INLAY IN A CROSSHATCHED GROUND (nunome zogan)

In this inlay process, instead of cutting grooves and recesses for the inlaid wire and sheet, the entire ground surface or selected areas on it become the field for a freely placed, normally precious metal inlay, though soft brass or copper can be used. The surface or areas are *crosshatched* to make a rough texture capable of holding an inlay that can completely or partially cover the ground into which it is hammered. This system is called *koftgari* in Trivandrum, India; *tela-kubi* in Qasvin, Iran, where it is used to inlay gold wire on three-dimensional steel animals carried in Moharram processions; *taraceado* in Toledo, Spain, where steel jewelry and ornamental objects are produced; and *nunome zogan* in Kyoto, Japan, where it is used for the decoration of jewelry and objects. Old armor from East and West was commonly ornamented by this technique, and examples are preserved in many museums. Surprisingly, this alternative to the more time-consuming inlay technique already described is referred to in some sources as "false damascene," a derogatory term. Both techniques are valid, and each is capable of its own perfection. The crosshatched ground inlay method described here is practiced by the highly skilled craftspersons of the Amita Jewelry Corporation in Kyoto, Japan.

8–39 TORAHIKO MINAI, damascene inlay artisan working at the Amita Jewelry Corp., Kyoto, Japan. Because steel is the base metal of the damascene work produced here, to hold work in progress, a *permanent magnet chuck* is used, manufactured by the Kanetsu Kogyo Co. Ltd., Osaka, Japan (Model KMT-1018 shown). The steel ground form is placed on the flat upper slab, and magnetic action is activated by a lever. Reversing the lever position deactivates the magnet,

allowing the release of the steel. *Photo: Oppi*

PREPARING THE GROUND METAL The ground metal used in Kyoto is a flat *mild steel*, approximately 16 gauge B.&S. Other hard metals or alloys capable of being "toothed," such as bronze or a nickel alloy, could be used. Domed or dimensionally formed grounds can also be inlaid in this method, but flat grounds are not made dimensional *after* inlay because of the risk of loosening the inlay. To prepare the ground, a very *finely serrated liner chisel* (a *liner graver* could also be used) is hammered in one direction over the entire ground or a part of it, raising straight, very fine, parallel serrations with continuous burrs left intact. A second series of lines is made at an oblique angle *over* the first, creating a surface like a double-cut file. (Surface preparation is also done mechanically today on large sheets which are then cut into shapes.) The surface now has a texture resembling a finely woven cloth. The result is lightly etched in a nitric acid solution, and overetching is avoided to retain burr sharpness. The metal is washed and dried.

8–40 AMITA JEWELRY CORP., Kyoto, Japan. Their inlay process in four simplified steps, from left to right: 1. Lines are chiseled by hand with liner chisels on the steel ground in two opposing directions. 2. The design in 24K or lesser karat golds and fine silver wire is hammered into the crosshatched surface. 3. The surface is acid etched, cleaned, rusted, and passivated, then coated with four layers of black lacquer. 4. The lacquer is rubbed with powdered charcoal as an abrasive until the precious metal design is exposed. Enough remains to leave the ground a matte black, the lacquer protecting the steel from rusting. *Photo: Salmi*

INLAYING WIRE OR SHEET IN THE PREPARED GROUND The ground is anchored in a *pitch bowl* or on a *board* spread with pitch, or is *clamped* to a *steel block*. The design is drawn on the toothed ground in pencil or waterproof ink. Inlays of fine precious metal wire or sheet need no annealing. Lower quality metals should be preannealed to increase malleability. Three basic inlay tools are used: a *small-peen hammer* to hammer in wire, a *pointed tool* to help guide wire directionally, and a *sharp chisel* to sever a wire end. Thin sheet is cut out or stamped to shape before inlay.

The wire line start is anchored in place simply by tapping it with the hammer peen. Thereafter, while leading the wire along the design line with fingers and pointed tool, hammering follows, tapping it permanently into place. Wire line width can be increased by placing wires alongside one another, or a whole area can be filled this way. Cut-out sheet metal shapes are inlaid by hammering them in position. Only finished inlaid areas are *burnished* to further force the inlay into the toothed ground whose serrations and burrs hold the inlay in place. Finished fiat work is held on a *surface block* and completely planished with a *planishing hammer* to eliminate any remaining *nunome* ground texture.

8–41 MITSUKO KAMBE SOELLNER, U.S.A. Hair clip and hairpin of mild steel, inlaid in the Japanese damascene (*zogan*) manner with 24K and 18K gold and fine silver. The ground is covered with black or brown lacquer. *Photo: Walter Soellner*

Steel grounds left untreated and exposed might eventually develop rust. Japanese craftspersons cover grounds with a protective organic lacquer coating. To first clean and prepare the surface, it is painted with an alkaline solution of 18 grams of powdered ammonia dissolved in 180 cc of water. After two hours, a second coat is applied. The rinsed, cleaned object is then left submerged in water for 48 hours to brown it or build up an even layer of rust or hydrated red ferric oxide on its surface. To seal it from further rusting or corrosion, and to arrest, fix, and passivate the oxide rust formation, it is placed in a solution of 15 grams of tannic acid to 5 liters of water. (In an older method, a strong solution of green tea, which contains tannic acid, was used.) This is brought to a boil, and after 15 minutes the rust is converted to black iron oxide, and the object is removed, rinsed, and dried.

APPLYING THE LACQUER (URUSHI) Immediately afterward, to avoid contamination and assure good adhesion, the *entire surface* is coated with a natural organic resin lacquer (*urushi*) made from the milky sap tapped from the Japanese varnish tree *urushi-no-ki (Rhus verniciflua*), then boiled, skimmed, and filtered. Its chief component is *urushiol* ($C_{21}H_{32}O_2$), a water-soluble phenol that is poisonous in liquid form. As contact can cause

skin inflammation, hands must be protected with *rubber gloves*. To color the naturally brownish lacquer, dry dye pigment, usually black, is added, though other colors can be used. A little water as a solvent extender liquefies it to an oily, flowing consistency, and the lacquer is then brushed over the entire surface. Normally it is dried in a humid atmosphere, but it can also be heated to about 320° F (160° C) and dried without harm. (Remove it from the heat when vapors cease rising.) Once dry, the result is hard, and resistant to acid, alkali, and humidity. Lacquer is applied in four layers. Each application is dried with heat, then rubbed with powdered charcoal and water as an abrasive to prepare the surface for the next coat. The final coat is rubbed down to the metal inlay level which is higher than the ground, therefore exposed first, leaving the ground covered with lacquer. The inlay is *burnished* where desired for selective matte and polished effects. Sometimes bright line details are engraved into the inlay. The surface is finished with rubbed-on paste wax, or sprayed with a clear lacquer. Units meant for jewelry are mounted in gold-plated bezel settings or frames.

TOLEDO CROSSHATCHED GROUND INLAY

The crosshatched ground inlay done in Toledo, Spain, follows the same basic inlay procedure, but the steel ground is heat oxidized black instead of being lacquer covered. Some special techniques are used here. Different weight wires and different colored golds are combined in the same work. Silver wire often outlines patterns. After inlay, lines are sometimes patterned with a *round hollow-ended punch* struck once, then moved to the next position. A series of tiny half-dome shapes are raised on the inlay. The effect is like an inlay of beaded wire. In the opposite manner, a small, *round-ended punch* is used to stamp semicircular depressions in unburnished (therefore matte) wire inlays. The depressions appear as a series of bright, concave spots in a matte ground. These effects greatly enrich the surface appearance of the work. The backs of the steel ground metal are highly polished and lacquered.

8–42 TOLEDO, SPAIN. Contemporary steel brooch inlaid with silver and gold wire in two colors, typical of the geometric style of much Toledo work. The ground is given a black patina by heat. Ø 2⅜ in. *Photo: Oppi*

ENCRUSTATION OR OVERLAY

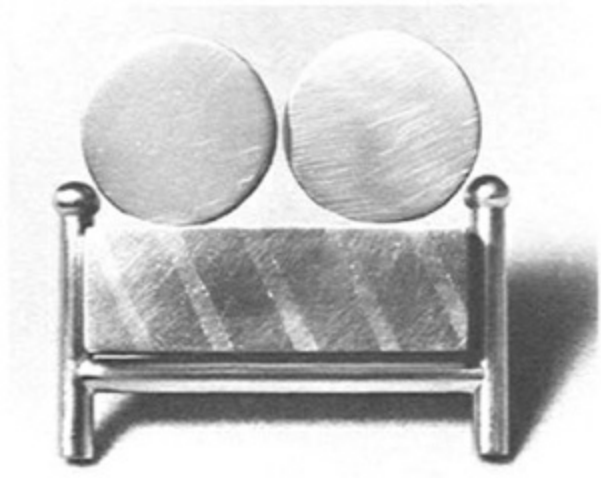
A distinction must be made between the concept of *inlay* and *encrustation* or *overlay*. Very often both words are applied indiscriminately to the process of inlay. Inlay and encrustation are related in that a second material is physically joined to the surface of the first. In metalwork, an inlay is introduced *into* the ground and held *mechanically*, that is, by an incision and undercut. An encrustation can be held to the ground *chemically*, that is, by the addition of a third substance, most usually with the join made by *soldering*—as when joining metal to metal—but it can also be done by *adhesives* or *cements*—as when joining nonmetallic substances to metal, or metal to nonmetallic substances such as shell, tortoiseshell, ivory, etc. It can also be held *mechanically* by rivets. But by strict definition, in all cases it rests *on the surface* of the ground.

METAL MOSAIC

A distinction must also be made between *metal inlay* and *metal mosaic*, which can appear the same from the front. In metal inlay, a supporting ground runs beneath all the inlaid metal. In a metal mosaic, different metals are *butt joined edgewise* to each other by soldering to form one continuous surface (which may be partially raised), but there is no underlying, supporting metal sheet, and the joins can usually be seen at the back. When the work is done carefully, a mosaic can be reversible.

METAL MOSAIC (KIRIHAME ZOGAN) In this process, a ground metal sheet is saw pierced, and into that opening, a second metal of the same shape and size is inserted and soldered. In Japan this is referred to as a form of inlay, but it is termed a *mosaic* in the West. A related Mexican technique is called “married metals” (*metales casados*). The same pattern appears on both sides, a fact that can be used to advantage in a piece of jewelry where both sides are seen when it is worn.

8–43 JAPAN. Shakudo *tsuba* inlaid with multicolored sheet metals in the iroye or "colored picture" style. The leaves and blossoms are engraved after inlay. Signed: "Saiya" (Shonai School), 17th century. *Photo: Victoria and Albert Museum, London, Crown Copyright*



8–44 PETER SKUBIC, Austria. White gold brooch with a butt-soldered mosaic sheet of striped white and yellow gold. Size 38 × 38 mm. *Photo: Narbutt-Lieven & Co.*