How to Make Fine Jewelry
How to Make Fine Jewelry
How to Make Fine and Costume Jewerlies

Subjects
- Background/ The History of jewelry.
- Tools and Equipment and their uses.
- Gold and Alloy (Gold conversion)
- Alloying (Gold testing)
- Melting/ Sheet Casting
- Annealing & Pickling
- Hammering
- Sawing and Cutting (Blade Preparation)
- Forming and Embossing
- Soldering and Assembly
- Filling

Polishing and Electro Plating.

Activities
- Lecture
- Lecture
- Lecture
- Actual demonstration (hands on)
- Process of changing solid state of metal to liquid then poured to a prepared mold of any form.
- Process of applying heat to casted sheet to preserve the metal and avoid tiny cracks and becoming brittle.
- The process help to produce high brilliance to finished product eliminating the microscopic size of pinholes.
- Blade preparation is an improvised jeweler's saw out of ordinary spring wire.
- One of the important part of the process where a special skill to follow pattern line is needed.
- An art of adding detail on flat cut out sheet with an aid of punchers and dies.
- Process of joining two or more parts using a lower melting alloy of gold as binder.
- Finishing touches to add emphasis to the design by proper shaping and filling.
Introduction:

During the early years, people showed great interest on decorative ornaments believing these possess magical powers to ward off evils. From collection of boar fangs, beads, polished quarts, eventually to finely handcrafted gold and silver jewelries mounted with precious gemstones. Treasured antique collection these ornaments dating back the twelfth centuries proved that the early craftsmen of this trade possess the skill and dexterity that can rival our modern day craftsmen.

It was during these period when it was believed that our ancestors practiced barter trade with our Asian neighbors, especially with the Chinese. It was said that gold was used as our main barter against their valuables such as silks mirrors, porcelains, and other products which were not available in our islands during the early centuries.

Some people believed that the expedition of Magellan ending the discovery of the country was influenced by the account of Marco Polo in his Books of Marvels, written in circa 1300. The said books described the gold barter between China and some small island in Asia. It farther described the famous legend of the valley of diamond which according to him, "was patrolled by the birds of prey in the air above and guarded by snakes with murderous gaze upon the ground". This valley, according to the books, was situated on the Khorasan Frontiers and was said to be carpeted with gold and diamonds.

Also, during the same period, it was believed that some Chinese jewelry makers migrated to the islands whom we credited the greatest influence of the country’s jewelry making industry of today. It was recorded that these migrants were responsible of minting the early coin produced in the country thus ending the historic Galleon Trade in the Archipelago. These Chinese settled in the northern part of the country where they practiced their trade with the help of the natives. Our forefathers inherited the trade and skills which were later handed down to their successors through generations until our present craftsmen of today.

From our past to the present times, jewelries were treasured and loved. Not only as a decorative ornament for self satisfaction, but as symbol of love, power and as a gainful investment. In love, Arduke Maximillian used a gold ring set with diamond as he proposed his betrothal to Mar: of Burgandy. Gold wedding rings were symbols of eternity, a circle with no beginning nor end. For powers, kings and ruler of different kingdom used a signet ring to enact the law of the land. Being crafted with one of the most expensive metals of today, and usually set with rare gemstones, it was noted to appreciate value while others suffer for depreciation. To date, jewelries were considered a hedge against inflation. It was proven to be a safe investment that can rival the most commodities in the wall street.
JEWELLERY MAKING TOOLS AND EQUIPMENTS

In this line of art, craftsmen are trained to make their own improvised tool although some equipments are imported from abroad. Jewelers, during their apprenticeship, they were taught to improvise drill bits, saw blades, dividers, engraving tools, and other small manual hand tools which are not available in the market. Tools and equipments that are listed below are manufactured locally:

Working Table – Durably built in solid hard wood with no less than two inches solid top and equipped with different drawers and pin vise for more convenient working.

Roll press – A small geared machine used for pressing metal plate into desired thickness. Commonly used for soft metals like gold, copper, silver, and other alloys.

Gasoline Blow Torch – Instant flame producing tools for melting, soldering and other heating process. It is an improvised tools which is capable of heating or melting non-ferrous metals. Composed of four parts:
   A. Gasoline Tank - Serves as fuel reservoir
   B. Air Pump - for air supply
   C. Torch - Produces the needed flame
   D. Rubber Hose - Air hose connecting parts

Wire Draw Plate – A piece of forged steel plate with a set of holes of varied diameters where pre-formed metals are forced to pass, producing uniform sizes of wires.

Hand Drills and Bits – Used for boring necessary holes in the process. There are two types of hand drills used in the process: a) IMPROVISED - for delicate and rounded surface and b) GEAR TYPE - for thick and flat surfaces.

Anvil – A must in jewelry making, it is used for hammering thick sheet metals. This is done to avoid or eliminate pin holes in the metal which is common cause of tarnishing in finished product.
Ball Hammer - Used for hammering thick sheets and other heavy hammering purposes.

Jewelers’ Saw - An improvised tool for cutting patterned or imaginary lines, bladed with ordinary spring wire with fine teeth - a product of the ingenuity of our local goldsmith or platero.

Jewelers’ Pliers - Used in holding small metal part in forming, cutting, filling and other purposes that needs strong grip. There are wide arrays of jewelers’ pliers but most commonly used are: a.) flat nose, b.) long nose, c.) round nose.

File - This is for shaping, forming and removing unnecessary excess metals in the products. Most commonly used are: a.) flat bastard, b.) half round, c.) knife file, and d.) set of needle files. In local plateros’ parlance, they are termed pambanhay, meda cano, pambukas, and vallorbe consecutively.

Rounding Block and Bar - For rounding ring ball and other thick part. It is commonly built in hard steel to withstand heavy hammering.

Sears and Scissors - For cutting straight pieces of thin sheets. This is to avoid using jewelers’ saw that produces metal dust which is common cause of loss of metal in the process.

Small Hammer - Used in light hammering purposes, like stone setting, engraving and making improvised saw blade.
Sheet Mold — Composed of two sheets of thick iron clamped together with a "U" shaped GI wire in between. When molten metal is poured into the opening, the metal is moulded into a sheet according to desired shape, size, and thickness of the shaped GI wire.

Weight and Scale — Used in weighing precious metals using unit of grams. (1 Troy ounce = 31.1035 grams).

Polishing Motor — An electric motor equipped with a spindle to hold wheel brushes, chuck to hold small bushes and sometimes flexible shaft for more convenient polishing. It has to be 1/4-1/2 HP. Preferably with two speeds.

Gold Test Kit — A set of test stone, nitric acid and gold pattern for analyzing gold karat.

Dapping Dies — Used for rounding half-sphere, embossing and repossing designs with the aid of improvised dapping or embossing tools (pantukol).

Electroplater — A unit of rectifier, converting AC to DC, used in plating small items like jewelry and other decorative items.

Other Miscellaneous Tools

1. Tweezer — for holding tiny pieces and heated items.
2. Tracer — for tracing pattern and imaginary lines.
3. Compass — for making round patterns and dividing spaces.
5. Pan - used for accumulating metal dust.
6. Magnet - for separating ferrous from non-ferrous metals.
7. Paint Brush - for gathering metal dust from hand and took.
8. Borax Plate - used for holding borax and boric solution.
9. Clay Pot - for holding molten
10. Thread Holder - for mounting thread for manual polishing
11. Soldering Block - a piece of fire brick used as a soldering platform.
12. Spring Wire - used for making saw blade and drill bit.
13. Boiling Cup - used for boiling dilute acids and other detergents.
14. Lamp - used for boiling diluted acids and other detergents.

supplies:

1. Borax - used to avoid oxidizing of metal during heating procedures. Avoids thin film to oxide on metal during molten stage.
2. Boric Acid - same use as borax. This more commonly used in alloyed metals with zinc and nickel.
3. Sulfuric Acid - use as pickling solution (10% in sulfuric plus 90% of water is recommended.)
4. Nitric Acid - use for washing white gold dust commonly used in diluted form. When added to muriatic (45-55) will produce aqua regia that can dissolve gold.
5. Salt - used for binding metal dust during melting process.
6. Sandpaper - for further smoothing the fused item and to remove undesired scratches.
8. Silver Solder - for soldering or joining two or more parts. (2 parts silver and 1 part brass).
9. Plating Solution - for plating gold or lower karat gold. Produces very thin gold film that adhere to the items to be plated.
10. Anode - a sheet of platinum approximately 2 grams, pressed into thin sheet, placed in the positive terminal of the plating.
11. Caustic Soda - for softening hard dirt by boiling in a solution of teaspoon of caustic soda to 8 ounces of water.
12. 3 B - paste used in polishing rough surface of the newly finished product.
13. Gold Rouge - for further fine polishing into high brilliance.
TYPES OF JEWELLRY
(DESIGN AND APPROXIMATE WEIGHT)

RINGS

MEN'S RING

DOMINO – Designed mostly with square or rectangular top with a cluster of nine to twelve small diamonds ranging from .06 to .30 ct. Approximate weight 9 to 12 grams.

HORSE SHOE – Symbol of good luck. Its design is copied from the original shape of a real horse shoe. Set with 7 to 9 pieces of small diamonds ranging from .03 to .10 carat on the sides and accented with a center diamond of approximately .25 ct. to .50 ct. to look more elegant. Approximate weight 10 to 12 grams.

SOLO – Commonly designed with round, oval or square top with one big diamond on the center. Stone is set in either burnished or pronged type. Like other men's rings, its weight ranges from 10 to 12 grams.

BIRTH STONE RING – Its shape follows the shape of the birth stone to be used. It is mostly set with synthetic or imitation stone. Design is varied and it has no official design.

INITIAL OR IDENTIFICATION RING – Designed with the initial of the owner. This initial is set with tiny diamonds that add glitter to the finish of the ring. Like others it weighs 10 to 12 grams.
LADIES RINGS

TIFFANY — Used by ladies to represent that they are engaged to be married. Basically designed with elevated solo diamonds then adorned with small add elegance to the design. Designs are so varied that it is almost impossible to see the same design in two stores. Approximate weight is 2 to 3.5 grams.

PINKY RING — Because of the high cost of gold and diamonds, this ring dominates the local and international market of jewelry. It is designed sometimes in abstract, architectural or with it uses minim: amount of gold, small diamonds, acid glitter to a girl’s finger. Approximate weight is 2 to 3 grams.

LADIES INITIALS — Unlike men’s ring, this initial ring weighs much less due to its size. Ladies love to wear dainty streamlined jewelry which makes this ring very saleable. It is very seldom that this is set with diamonds. Approximate weight is 3 to 4 grams.

COCKTAIL OR LEAF DESIGN RING — This design were at a boom during the 60’s. These design includes one or more medium size diamonds.

MODERN DESIGN — Due to expanding international jewelry, we have to follow trends in design and taste of the consumer or user. We can not give exact description of this type. Weight varies from 4 to 8 grams.

SIGNET RSNC — Bearing an emblem, sign of zodiac according to the order of the customer. Design is varied and most of the time exclusive to the owner. Because of the various designs available, its weight ranges from 10 to 12 grams.
EARRINGS

DE KAHÁ OR PICAPORTE - An old way of making lock for earrings. Design in this earring should be at least not too big to match this lock. Approximate weight is 3 to 6 grams.

FRENCE LOCK OR DE PALTÍC - Used in big design earrings. Like dangling or designs that match cocktail rings. Now it is very seldom we use this lock for it hurts the ear of the wearers. Approximate weight is 6 to 8 grams.

CREOLLA - Loop like design that locks itself into a holed ear. Designs are varied that no definite number of stones are required. Weight also varies from 6 to 8 grams.

DERMILONA - Basically, the design is composed of three parts.
1.) FACE, sometimes set with one small stone up to the most intricate design with the biggest diamond available
2.) POST, termed by local craftsmen as "pakaw"
3.) TSAPA, serve as lock of the earring and it is placed behind the e.m. Approximate weight is 3 to 5 grams.

NECKCHAIN

MENS - Only two designs are practically used by men: 1) square; and 2) rope. Both weigh approximately 7 to 20 grams.

LADIES' - Women have varied designs in neckchain, Designed with different charms and beads. It is so light such that it is also saleable. Approximate weight is 2 to 14 grams.
Gold in pure state is too soft and subject to deformation and scratches if converted in pieces of jewellery. Too soft that it is very hard to polish and not strong enough to hold precious gemstones. Due to this reasons, our jewelers add other metals to increase malleability and hardness of gold. Alloying was done by fusing considerable amount of other metal to pure gold, but by doing so, this eventually reduces the KARAT of gold. Karat, internationally known unit of measuring quality and/or content of gold in an alloy. Representing 100.0% pure is 24K which is the highest karat on its row, but for some technical reason, the highest purity met in our modern way of refining is only 99.95% pure. Karat is represented by a letter K and this is entirely different from the word CARAT (Ct.) which is used as the unit of weight for precious gemstones.

To meet desired hardness and malleability, Silver and Copper are fused or melted with gold. Color tones were met through proportion of this alloy. In case of white gold alloy, Nickel and Zinc were added to alloy to produce white tone. From highest karat of 24, it can be reduced to any lower karat desired according to its needs. Most often, Jewelleries were made of 22K, 20K, 18K, and due to very slight difference in color and other distinguishing property, 16K was avoided and instead, conversion jump down to 14K, 12K, 10K, then 8K and lastly, 6K.

COLD CONTENT

To know amount of gold present in any karat, simply divide any karat in mind by 24 (the highest Karat) and answers will represent amount of pure gold in the alloy. Such as:

- \[ \frac{24K}{24} = 1.00 \text{ or } 100.0\% \]
- \[ \frac{22K}{24} = 0.917 \text{ or } 91.7\% \]
- \[ \frac{20K}{24} = 0.833 \text{ or } 83.3\% \]
- \[ \frac{18K}{24} = 0.750 \text{ or } 75.0\% \]
- \[ \frac{16K}{24} = 0.683 \text{ or } 68.3\% \]
- \[ \frac{14K}{24} = 0.583 \text{ or } 58.3\% \]
- \[ \frac{12K}{24} = 0.500 \text{ or } 50.0\% \]
- \[ \frac{10K}{24} = 0.417 \text{ or } 41.7\% \]
- \[ \frac{8K}{24} = 0.333 \text{ or } 33.3\% \]
- \[ \frac{6K}{24} = 0.250 \text{ or } 25.0\% \]

Percentage representing amount of gold was farther subtracted from 100.0% to find amount of other metals in the alloy. Manufactured jewels were hallmarked with the gold content of materials used instead of its karat such as 18K, 585 for 14K, 500 for 12K and so on. Same thing can be found in some government controlled refined gold bars where we can note the number 999 or 99.9% pure.
ALLOYING

The international unit for the weight of precious metals such as Gold, Platinum, and Silver is Troy Ounce (T. Oz.) This is equivalent to 31.1035 grams. Fraction of a gram is termed as Milligram (thousand part of a gram).

Converting pure gold on hand by percentage of gold in any desired karat and quotient represents the total mount of converted gold alloy.

Example: 100.0 grams of pure gold to be converted into 14K gold alloy.

Procedure:

\[
\frac{100.0 \text{ g}}{1.563 \text{ or 58.33}} = 171.5 \text{ of 14K}
\]

To find needed amount of alloy or other metals, subtract amount of pure gold from total amount of converted gold alloy.

thus: 171.5 grams - Total amount of converted gold alloy

(-) 100.0 grams - Amount of converted pure gold

71.5 grams - Amount of other metals needed to mix with pure gold.

In alloying or converting yellow gold alloy, the usual "other metals" used are Silver and Copper. In its proportion, different tones of color are produced by jewelers. In some cases, minute amount of Zinc, Tin, and Aluminum are added for a richer color tone. Adding these metals in the alloy should be done with great care for it can make the alloy brittle and almost impossible to work with. In cases of white gold alloy, Nickel, Zinc and Copper is used as alloy. This should be treated with great care for a tiny particle of contamination of other metals or chemicals may lead to severe brittleness as mentioned above. Unlike the yellow gold alloy, white gold alloy can only produce a tone, so variation in proportion of alloy is not needed. The amount of alloy is as follows:

a) Nickel 65% - Used to give white color in the alloy.

b) Zinc 25% - Makes the melting temperature of the alloy lower.

c) Copper 15% - To make the alloy more malleable.

- during the process, pure gold must be heated first using boric acid as flux. Place the zinc on top or beside heated gold then apply more heat on the gold. NOT ON THE ZINC. If there are signs that mid starts to melt, stop applying heat and agitate crucible in a forward/backward motion. When Zinc is fully fused with gold, place the nickel on top of the alloy and apply more heat. Add more boric acid as flux.
### Alloying Gold and Silver (by weight)

#### In Grams:

<table>
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<tr>
<th>ALLOY</th>
<th>COLD</th>
<th>SILVER</th>
<th>COPPER</th>
<th>ALUMINUM</th>
<th>NICKEL</th>
<th>ZINC</th>
<th>TIN</th>
<th>TOTAL WEIGHT</th>
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<td><strong>22K (917)</strong></td>
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<td></td>
<td></td>
<td></td>
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<tr>
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<td>Very Red Gold</td>
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<tr>
<td>Red Gold</td>
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<td></td>
<td></td>
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<td>14K for Casting</td>
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<td>0.473</td>
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<td>0.219</td>
<td>0.473</td>
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<td>14K with Tin</td>
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### Notes
- Values in the table are precise to British and European Standards.
- (that is ¼ karat purer than American Standard)
COLD KARAT CONVERSION

in process of jewellery production, alloyed gold left-overs can be recycled for future job-orders. These can be converted into any desired karat but it needs proper knowledge in formulating conversion. This is to control quality of metal used in finished products. Conversion can be done from high karat gold alloy to lower karat according to needs and specification of the job orders, and farther. can be done vice-versa.

CONVERSION OF HIGH KARAT TO LOWER KARAT. • This was usually done by adding more base metal to gold alloy. These base metals were Silver, Copper, Nickel and/or Zinc, according to color of the alloyed gold. Proportion of these metals are computed based on computation of alloys mentioned in the earlier part of this manual.

EXAMPLE: 25 gms. of 18K gold to be converted to 14K gold.

a. Take the amount of pure gold in the alloy by multiplying total weight by the karat gold percentage. The product will represent amount of pure gold in the alloy.

Thus: 25.0 gms. 18K x .75 or 75% (percentage of gold in 18K) = 18.75 gms. (amount of pure gold in the gold alloy)

b. As mentioned above, this 18.75 gms. represent total amount of pure gold in the alloy. This amount of gold is then divided by percentage of gold of desired karat. (in this case, its 14K)

Thus: 18.75 gms. 24K ÷ .583 (gold percentage in 14K) = 32.16 gms. 14K

c. 32.16 gms. will be the total amount of gold alloy if converted to 14K. The given amount of 18K must be deducted from these amount of 14K and difference will be the additional needed alloy or "other metals."

Thus: 32.16 - 25.0 = 17.16 gms additional base metals or alloys.

d. In cases of yellow gold alloy, these additional base metals needed in the alloy must be silver and copper. Commonly used proportion of these alloy is 50-50 ratio, meaning 50% Silver and 50% Copper.

Thus: 3.58 gms. Silver (50%) + 3.58 gms. Copper (50%) = 7.16 gms. Alloy (100%)

And in cases of white gold alloy. Nickel 65%, Zinc 20% and Copper 15%.

Thus: 4.65 gms. Nickel (65%) 1.43 gms. Zinc (20%) 1.08 gns. Copper (15%)
CONVERSION OF LOW KARAT INTO HIGHER KARAT. In this process, gold is added instead of base metals. Due to some reasons, jewelers find hard time doing this conversion that they just keep this alloy for future use.

EXAMPLE. 32.0 gms. of 10K gold to be converted into 14K.

a. Take the pure gold content of the gold alloy by multiplying total weight by its karat gold percentage. Thus: 32.0 gms. 10K x .417 or 41.7% (percentage of gold content, 10K)
   = 13.34 gms. 24K (amount of pure gold in alloy)

b. Only 13.34 gms. of pure gold is in the 32.0 gms. of 10K gold alloy. This pure gold must be converted to 14K and it can be done by dividing it by percentage of gold content of 14K (58.3%)
   Thus: 13.34 gms. 24K ÷ .583 or 58.3% = 22.88 gms. 14K

c. Deduct the computed amount of 14K gold conversion from original total weight of 10K to be converted to higher karat and difference will represent excess alloy or base metals.
   Thus: 32.0 gms. 10K - 22.88 gms. of converted 14K = 9.12 gms. of excess alloys.

d. To find needed amount of gold to match excess alloy, divide excess alloy by needed amount of ease metal per gram of 24K.
   Thus: 9.12 gms. excess alloy ÷ .715 gms. (base metal needed per gm. 24K to be converted to 14K)
   = 12.75 gms. 24K (amount of pure gold needed to match excess alloy)

e. To find needed alloy or base metal per gram of 24K, divide desired karat minus 1 equals amount of needed base metal per gram of 24K gold. For instance:
   (18K) 1 ÷ .75 = 1.333 - 1 = .333 gms.
   (14K) 1 ÷ .583 = 1.715 - 1 = .715 gms.
   (12K) 1 ÷ .50 = 2.0 - 1 = 1.0 gms.
   (10K) 1 ÷ .417 = 2.4 - 1 = 1.4 gms.
   ( 8K) 1 ÷ .333 = 3.0 - 1 = 2.0 gms.
   ( 6K) 1 ÷ .25 = 4.0 - 1 = 3.0 gms.

Add original weight of alloyed gold to be converted into higher karat plus additional amount of gold needed to find total weight of newly converted gold alloy.
   32.0 gms. 10K + 12.75 gms. 24K (additional pure gold)
   = 44.75 gms. 14K
GOLD TEST AND KARA'T DESTINATION

Gold is the only yellow metal that cannot be dissolved by single acid. Acids were classified single acid if its contain only one element such as Sulfuric, Nitric, Hydrochloric acid others. If we have subscribe to the above idea, then we can be confident that any piece of yellow metal with out reaction to these mentioned acid are to be concluded as COLD. The expected reaction from non-gold metals are "bubbling" if applied by such acid or discoloration of metals. If bubbling occurs during application of acid, we are viewing a sign that acid was dissolving the metal. So we can farther conclude that metals tested are, NOT GOLD.

Other thing to remember in gold is that it always appear in metal form. Unlike other metal which can be found in ores. So if found any metal in yellow, it can be tested if it is in metal form by hammering. Non-metal form will break into pieces while metals will be flattened.

In some laboratories, testing or assaying a pieces of metals or gold alloy are done in the following ways:

a) Grinding part of metals into minute particles.

b) Place ground materials in a slide usually made of glass.

c) Apply chemicals which has reaction on the said metal.

d) Observe reaction using a patterned reaction with standard mathematical computation suggesting amount of different metal in alloy.

Maybe, due to handicap in financial side, and to understand some of these mathematical computation, Jewellers have no intension to change their inherited way of gold Karat testing. THE TOUCH STONE METHOD. This method is widely accepted worldwide and believed to be used by majority of jewelry producing company. It is farther believed that this method handed down from generation serves the purpose and it can guarantee to guide us not to be deceived by the glitters that usually distract a layman's eyes.

As it was done in some laboratories, gold was grinded into minute particles, the touch stone method did the same way. Alloyed gold were pressed hard enough into a piece of BLACK TESTING STONE, back and forth leaving traces of lines of the alloy in the surface of stone. This black testing stone serves as grinder and slide compared to laboratory procedures. Its black color provides a good contrast against the color of gold. These color contrast helps a lot for us to see reaction if we apply NITRIC ACID on gold lines. Note: THERE IS NO SUBSTITUTE TO NITRIC ACID IN COLD TESTING.

There are varied reaction expected if we apply Nitric acid on different karat of gold alloy, and this will be discuss in the following pages. It is adviceable for a beginner in this field to used a pattern of different karat of gold alloy for them to compare reaction against their materials being tested. This GOLD PATTERN will be very helpful in giving decisions specially doing actual business.
White gold alloy were likewise tested in same manner. In the process "other metal" in the alloy was attacked by Nitric acid and what were left on sight were the amount of gold in the alloy. Due to differences in amount of gold left in test stone and to some slight chemical reactions, color of these sample gold lines varies from each others. These made easy to distinguish its karat. Constant practice is very much necessary to able to distinguish color produced in test stones. To do this, one must observe the followings.

TESTING PROCEDURES

1. Press an edge of any piece of jewelry you wish to test on the Black Testing Stone leaving traces or lines of the metal on it. Do the same procedure on each gold tip of your pattern. Traces of metal from your jewelry should appear, in parallel under the gold lines of the pattern. In order not to be confused, the five parallel lines of the pattern should start from 18K down to 8K.

2. Wet the cap of the acid bottle by gently shaking it thus leaving small amount of acid in the cap. Take the cap and gently apply the acid on top of the lines in the stone tester. Examine the lines carefully and observe which line on your pattern is the closest in appearance to the lines of the item to be tested. Wipe the acid hard enough by a tissue paper or a piece of cotton cloth and again carefully compare the difference. You will notice the following:

- **18K** - the lines are almost without difference from the original
- **14K** - the lines of gold are left though very slightly thinner
- **12K** - only half of the original lines are left
- **10K** - very small traces of gold lines are still visible
- **8K** - no more traces of gold are still visible.

4. In cases of 18K and 14K, the difference is very slight that it is almost negligible to the beginners. If still in doubt, here, we will repeat the first and second procedures then we will add a small amount of ash (preferably cigarette ash) to activate the acid in the test stone. Be sure to apply sufficient amount of acid to completely wet the ash. Wash the stone with running water (do not wipe) and observe the following:

- 18K - traces of gold are still visible due to high content of gold
- 14K - only traces of black lines are left.

5. As mentioned earlier, while gold is just the same as yellow gold in karat and quality. With the use of the same testing procedures we can also distinguish its karat. The gold lines will turn yellow unlike other metals where the color remains white even with nitric acid.

Imitation, Costume, or Fancy jewelries have never been manufactured in gold but due to the modern technology of electroplating, they appear like solid jewelries, deceiving common eyes. This is now termed as GOLDFILLED. Commonly, these jewelries are coated with gold, thick enough to withstand constant use for several years. To test these jewelries if they are made of gold, we have to file a portion of the item to see the inside or base metal. Apply a small amount of nitric acid to the exposed base metal to see if bubbling will occur; thus concluding if it is gold or not.
MATERIALS AND TOOLS USED IN COLD KARAT TESTING.

BLACK TESTING STONE - Ordinary black stone found in mine river beds with no traces of spots. It must be fine not to destroy or finish products in taking some sample of metal. It may be used in free-form or in slabs which was usually sold in some jewellery tools supply.

NITRIC ACID IN AN ACID BOTTLE - The acid bottle must be capped with glass which is used as applicator for acid in the test stones. As mentioned, only Nitric acid can be use for this purpose. Acid must technical grade or concentrated pure. "This should be handled with much care for it might cause severe burn skin contact.

KARAT GOLD PATTERN - A set of different karat of alloyed gold mounted on tip of its holder to provide an easy use. Usual set range from 24K, 22K, 20K, 18K, 14K, 12K, 10K, and 8K. This is advisable to beginners who wishes to enter this trade. It can be purchased from the local jewellery tools supply or can be requested from a goldsmith. (When ordered from goldsmith, be sure that karat is in the right standard.)

TESTING 24K, 22K, and 20K GOLD - Normally, Acid is not necessary in testing this high karat gold, it is only its appearance in teststone that will help us in distinguishing its karat or gold content.

24K - When press in test stone using usual forward/backward motion, it will leave a very light and insignificant gold lines in the stone. This is due to its softness (same as lead), lines were so dull even using much pressure.

22K - Like 24K, the minute particles left in test stone is dull but are more visible than the first. This is due to some alloy that fused with the gold that make it a bit harder.

20K - This karat produces an obviously visible ample in test stones. We can not mistook it for 18K because of some loose particles on sight which is only available in this three higher karat. Best is to compare this three karat of gold using the gold Pattern to distinguish the difference.
TESTING 18K, 14K, 12K, 10K and 8K. These lower karat are tested by the use of Nitric acid. This acid being noted to dissolve almost all metal except some few namely, Platinum, Palladium. Titanium, Stainless, and GOLD. Among the few metals mentioned, one would notice that only gold is yellow. When alloyed gold was rubbed against test stone, it will leave traces of the alloyed gold. Due to very minimal quantity of the alloy left in stones, acid can easily "attacked" non-gold metal thus leaving only gold in test stones. As mentioned earlier, there are some slight chemical reactions during the process that leads to some discoloration of the minute particles of metals that enables us to distinguish differences of various karat being tested. After application of Nitric acid, one would notice the followings:

18K. Due to high presence of gold in the alloy, it can “protect” non-gold metal and one would notice there will be no difference at all. It was further tested by adding small amount of ash (preferably cigarette ash) or small amount of salt (Sodium Chloride). With these, it will be noticed that presence of gold is still visible in the traces of gold in test stones. This helps us conclude that metals we are testing are 18K.

14K. Just like the above, this gold alloy can withstand acid, but when applied with ash or salt, it will turn gray leaving no trace of gold on test stone. With these, we can easily detect it is not higher than 14K, but we have to be sure that there was no change if only Nitric acid was applied. A minor change of color means that it is lower than 14K.

12K. A trained eye was very much needed in this karat to detect the difference with 14K and 10K. Due to fact that it only contains one half gold of total alloy, there is a very slight discoloration one will notice if examined very carefully. If acid stays longer on top of tested traces of metals, it can be noticed that asid metals became dull although presence of gold is very much intact as if nothing has changed.

10K. With this karat, anyone could tell the difference for it gradually become reddish. This may take some few seconds but to be sure, it was advised to wipe test stone with a cloth or tissue paper and one would notice traces of gold are still visible in the stone.

8K. Equally as easy with 10K, the traces of gold in test stone will instantly turn reddish and no traces of gold is visible when wiped with cloth or tissue paper.
MANUAL PROCESS

The manual process in jewellery production was often viewed as an obsolete way that cannot meet demand of today's market. The truth is that the craftsmen treated this trade as an art. An art that gives a feeling of enjoyment in expressing skills and dexterity. Craftsmen, aided with some improvised hand tool and unsophisticated machineries plus their noted ingenuity, can create finest jewelleries compare to fine jewelleries manufactured by sophisticated machineries of our modern industries.

This process only require few steps brit to develop skills needed in this process needs some month of constant practice. Mastery of this trade needs years of understanding the trade. One must learn to improve his own tools which were commonly not available in market. It was our sincere desire to present some basic steps in this manual process in jewellery production although we firmly believed there were no better way to explain this trade than by actual demonstrations.

MELTING AND SHEET CASTING: In some countries, jewellery workers purchased their needs of materials (gold alloys) in any desired Karat, Thickness and Size in any form. Unfortunately, it is not same here locally. It was the craftsmen who prepared these thing in their ingenious ways. In this first part of the process, which may be considered to be one of the most important part of jewellery production, this id done by changing solid state of the metal into liquid by fusion or direct application of heat using some home made furnish or blow torch. When metals or alloys are in liquid form, it was then casted into a sheet mold. Proper melting should be exercised to minimize if not eliminate presence of pinholes in casted alloy sheets, that regularly appear in any casted metals.

This process regularly started with a piece of G.1. wire formed in "U" shape, clamped between two pieces of iron sheets to form a mold. This improvised sheet mold can be purchased locally or fabricated by the craftsmen themselves. As for melting crucible, locally manufactured can also be purchased although some craftsmen use side of an ordinary clay pot for this purpose. The side of clay pot was cut and trimmed into desired shape to fit needs using an ordinary plier or a thong at handle and presto .... they have now a crucible for melting gold alloy. Pure gold with other base metals will be place here and application of heat will start.

Melting temperature of gold alloys varies from 927°C to 1079°C. For heat supply, home made furnish can be made using manual fan in this purpose and charcoal as fuel but in some cases, an ordinary gasoline blow torch was used for it can also reach said temperature by constant application of direct heat or flame. By the use of Borax or Boric acid as Flux, Craftsmen can recognized a properly molten metal or alloy which according to them, appears like a clear water. Fluxes
were applied during the process to eliminate thin film of oxide which usually appear in molten metals. When molten gold alloy appear like clear water in fluidity, it can be poured in the sheet mold. It was during the preparation of sheet mold that it was pre-heated to avoid some mini-eraptions due to sudden change of temperature. Casted alloy sheets were farther re-heated into red hot to regain malleability and ductility of metals that was lost during the process. To remove oxide that form during the re-heating process, metal will be pickled or boiled in a solution of diluted sulfuric acid. Re-heating is done repeatedly during the pressing of metal into desired thickness, to ensure proper malleability is met and to avoid cracking of metal in future process.

SAWING AND CUTTING: • Manually made jewelleries usually comes from sheet that was farther cut into shapes, formed and embossed. Then soldered together forming a piece of intricately designed jewellery. To cut this metals, a jeweller's saw was used. I some cases, jeweller himself improvised the saw blades that fits his needs. Through that rooted ingenuity, craftsmen can turn an ordinary piece of spring wires into saw blades. Skill in this process is very much needed in jewellery production, for curved and imaginary lines and so many other uses. Learning this skills, a craftsman can produce so many kinds of designs and making different parts of jewellery. Cutting was used in two ways, outside cutting which tend to cut different shapes of cut outs used to adorned products and inside cutting which is used for making designed holes usually known as Calado. It can be remembered that jewelleries in past generations were adorned by this piece looking metals and was made possible by the skills of our past jewelers in doing this job. It was only in the late 60's, this design gave way to the modern and architectual concept not mentioning the abstract but it was felt lately that there was a tendency that our custumers, especially from other country, once more recognize the beauty and elegance of past masterpieces.

Beginners were advised to practiced themselves in cutting brass to acquire this skill. This metal resembles in hardness compare to gold alloy. In making an improvised saw blades, fines spring wires are recommended, especially in Callado, were gauge 01 is recommended. For ordinary cut outs, gauge 02 will fit the works. Practice was usually done by cutting straight lines and advices from learned goldsmiths are highly needed. To add dimensions to cut outs, punchers and dies were commonly used. This embossing tools is commonly used with help of a mallet for this purpose. The cut out were farther filed to remove some excess metals in its sides and to farther re-shape into a finer finish.

SOLDERING AND ASSEMBLY: • As explained earlier, jewelleries were usually made of pieces of cut outs joined together to form pieces of intricately designed pieces or ornaments. Joining two pieces of this cut out needs another skill, SOLDERING. To do this, gold alloys of a lower melting temperature were used to bind these parts and this is called, GOLD SOLDERS. This plays a major part in jewellery production and craftsmen in this art cannot miss this skill. This is
being done by applying direct heat to this tiny parts of jewellery making it red hot thus allowing solder to flow and creep in between joint. It needs precision in timing and exact calculation of heat to be applied to avoid melting of part to be soldered. Fluxes play an important part in this process. It minimizes oxidation of metals during heating process and it helps easy melting of solders.

Pre-mixed solders of standard karat were available in some local suppliers but due to its prohibitive cost craftsmen tend to rely on their own mixture of gold/silver/brass alloy of lower karat gold solder. The usual composition of this solder can be made as follows:

1. Silver Solder - This composition of solder is commonly used for soldering non-gold ornament except for low-melting metal such as: Lead, Tin, Zinc, Antimony, etc. This is used as main alloy for gold solders, and this is as follows:

   Silver ...... 2 parts
   + Copper ...... 1 part

   = Silver Solder 3 parts

2. Gold Solder - Some locally produced jewelleries become inferior in quality due to use of lower karat gold solder. Maybe due to lack of proper knowledge for our craftsmen to produce standard karat low melting gold solders. Here are some basic formulation in producing a standard karat gold alloy for solder:

   **18K GOLD SOLDER**
   24K Gold .......... 10.0 gms.
   Silver Solder ...... 3.0 gms.
   Cadmium .......... 0.3 gms.
   ---------------------
   13.9 gms.

   **12K GOLD SOLDER**
   24K Gold .......... 10.0 gms.
   Silver Solder ...... 9.5 gms.
   Cadmium .......... 0.5 gms.
   ---------------------
   20.0 gms.

   **8K GOLD SOLDER**
   24K Gold .......... 10.0 gms.
   Silver Solder ...... 18.5 gms.
   Cadmium .......... 1.5 gms.
   ---------------------
   30.0 gms.

   **14K GOLD SOLDER**
   24K Gold .......... 10.0 gms.
   Silver Solder ...... 6.7 gms.
   Cadmium .......... 0.4 gms.
   ---------------------
   17.1 gms.

   **10K GOLD SOLDER**
   24K Gold .......... 10.0 gms.
   Silver Solder ...... 13.0 gms.
   Cadmium .......... 1.0 gms.
   ---------------------
   24.0 gms.

   **6K GOLD SOLDER**
   24K Gold .......... 10.0 gms.
   Silver Solder ...... 27.5 gms.
   Cadmium .......... 2.5 gms.
   ---------------------
   40.0 gms.

Note: Additional Cadmium may bring the alloy to lower melting temperature but it may also lead to partly fusion of item to be soldered during the process. Too much Cadmium may lead to severe brittleness.
To practice soldering, one must be equipped with gasoline blow torch, a soldering block, a tweezers, borax and boric acid in a plate, above mentioned gold solders and some items to be soldered. The process is different from ordinary tin-lead soldering for this needs more heat to bring items to be soldered into red-hot temperature. Items to be soldered must be properly applied with fluxes (borax and/or boric acid) ensuring to be protected to oxidation during heating process. Usually, these fluxes were dissolve in a small amount of water to make it easier to apply. A piece or pieces of solders cut into tiny sizes are placed on top of joint then application of heat will start. In controlling heat, it is advised that application should not be concentrated in one part. The flame from the torch will just momentarily pass an joint which will in turn become red-hot and solder will eventually melt that will flow and creep to joint. To avoid excess solder, especially in recess areas, it is advised that exact amount of solder should be fused. As a general rule, all item to be soldered must be cleaned and must be free of grease to meet a good soldering result. Constant practice is advised to master this port of the art.

FILLING AND FORMING: A piece of jewellery is admired and treasured because of its elegance and beauty and especially in its craftsmanship. We may have the finest diamond in town but if it is mounted in a crudely made piece of jewellery, its beauty was destroyed. The piece of art did not give justice to beauty of the gem. More often, finished products were rejected by supposed to be owner not because of gold content, nor because of its color, but many times, due to poor craftsmanship, because it is not properly filed in form. There were times that we commented a piece of jewellery is CUTE and there were times we say its BULKY. It is because of its form. Here really lies the art of jewellery making. One must properly file in form a piece if his work to make it attractive on the eyes of consumer. This needs also some moths of constant practice and better understanding of his art.

A craftsmen in jewellery production is always equipped with different files for shaping and forming small parts of jewellery. From Flat Bastard for filing huge excess of metals to tiny needle files for small intricately designed part of jewellery. Guidance from an expert is suggested for the beginners but most important part is knowing Secret of each design.

STONE SETTING AND ENGRAVING: Regarded most risky part of jewellery production. This is to be done only by highly trained expert in this field. This is the process where gemstones were set in place by means of gently pushing or hammering prongs to hold stone. This must be expertly done with surgeons precision lest risk of breaking stones into pieces. To train people into this kind of job, longer period of time is needed to cope with the old and new styles of the setting trend of the market. Sophisticated machineries can be developed in this line but due to scarcity of users, our present day craftsmen still rely on old traditional tools they inherited from their past generation.
To set and engrave a piece of jewellery, it should be embedded in a shellac or some locally manufactured compound used in this purpose. This shellac was mounted on top of a heavy iron ball or anything that will hold the paste steady enough to hold firm while doing the slight hammering. This paste became soft or slurry when its hot and return to its hardness to a normal temperature. As pieces of jewellery were stuck to it, this will hold the pieces firmly that will avoid “drumming” while setter continue hammering the prong to hold gemstones. This paste is very important in this type of job to avoid breaking of the gems into pieces.

As for the types of setting, various designs were made to hold the gems. Most commonly used was the prong type, where claws were ready made and all the setter has to do is to bend it against the stones and some minor reshaping. To set tiny or small size diamonds or faceted gems, this was done in a way called embedded setting or invitido. A hole was bored in the surface of the metal and by means of skills in using different simple engraving tools, a prong will be “lifted” from the surface of the metal and this will hold the gems. As explained, there were so many way of setting a gemstone to jewellery and much more to engrave. One has to be prepared to long practice and hard work if interested to learn this part of the job. Expert on this line is one of most regarded people in jewellery production.

JEWELLERY ELECTROPLATING: Recently, there have been several contribution in this art of jewellery production, but most important was the recent contribution: Electroplating. The experiment in electro chemistry by Michael Faraday started in early part of 19th century, but it was only lately that electro deposition on metals has been applied into jewellery production. This is the application of metals coating by means of electro-chemical process. This requires a direct current source and a solution, usually water solution of metallic salt. The current can be supplied by a dry cell or more practically by an electro-plating rectifier, a device that change an alternating current (AC) to a direct current (DC). As for the solution, there are two kind of plating bath used in this process, Cyanide solution and Acid solution.

GENERAL PLATING PROCEDURES:
1. The pre-plating treatment stages are of great importance.
2. Before loading or dipping items to be plated, current must be switched on.
3. Set on low voltage which are sufficient to promote immediate deposition so that surface of the metal will not be attacked by solutions.
4. Plating current should be maintained without interruption.
5. Rinsing between different stages is very essential to ensure satisfactory results.
FACTOR THAT AFFECT ELECTRO-PLATING:

1. **Temperature** - Every plating bath or solution formulation, there is always a required temperature which should not be lower or higher otherwise, it may lead to dark or powdery deposit.

2. **Current Density** - This is the quantity of current on a specified area. It is usually expressed in amphere per square foot (A/ft²) or amphere per square decimeter (A/dm²). An amphere is the rate of flow of electricity. Current density varies on the size of the surface area of the article to be plated. Usually, current density is higher in protruding area than in recessed areas.

3. **Agitation** - It is necessary that the solution be agitated during the process for a uniform distribution of metallic ions in plating bath or solution.

4. **Solution Composition** - A plating bath is made of the following constituents.
   a. Plating chemicals, which are the sources of ions.
   b. Additional agents, organic in nature such as brighteners, which enhance the appearance of plated articles.
   c. Water, which is the largest tonnage in materials used in plating bath or solution.

HOW TO PREPARE COLD POTASSIUM CYANIDE

1. Roll press 2.0 gms. of 24K gold into paper thickness and cut it into small pieces.
2. Mix two parts of Muriatic acid (HCL) to one part of Nitric acid forming AQUA REGIA or royal water. Take 10 to 20cc of solution and place it in a beaker with gold.
3. Apply heat by using hot plate or bunsen burner. Note the bubbling of solution that indicate dissolving of gold. Let it boil until all red smoke disappear or turn white.
4. If some metallic gold still exist in solution, add small amount of Muriatic acid until all metals were completely dissolve.
5. Take away solution from hot plate or burner and let it cools to room temperature. Add equivalent amount of water to deluted solution.
6. To precipitate gold from solution, mix sufficient amount of strong ammonia solution and notice the precipitation until precipitate turn brownish in color.
7. To clean precipitated gold or gold oxide, transfer solution in a bigger container then add to fill water. Let oxide settle at the bottom of the container then slowly pour water. Repeat process to ensure that there is no more presence of acid and ammonia. When the gold oxide is totally cleaned, transfer again in a beaker, most preferably in a conical flask, with minimal amount of water, add two grams of potassium cyanide to dissolve gold oxide turning solution clear.
8. Heat solution to dry, leaving white powder called Potassium Gold Cyanide.
GOLD PLATING SOLUTIONS:

1. **24K GOLD PLATING BATH**
   - Potassium Gold Cyanide AuKCN: 1.0 - 3.0 gms.
   - Potassium Cyanide KCn: ........ 7.5 gms.
   - Potassium Carbonate K\(_2\)CO\(_3\): 15.0 gms.

   Temperature: 60 - 70°C
   - Current Density: 1.08 - 4.3 A/dm\(^2\)

2. **PALE YELLOW GOLD PLATING SOLUTION**
   - Potassium Gold Cyanide, AuKCN: 2.0 gms.
   - Potassium Nickel Cyanide, NiKCN: 1.25 gms.
   - Potassium Copper Cyanide, CuKCN: 0.50 gms.
   - Free Potassium Cyanide, KCn(free): 9.43 gms.
   - Potassium Phosphate, K\(_2\)PO\(_4\): 14.8 gms.

   Temperature: 54 - 65°C
   - Current Density: 4 A/dm\(^2\)
   - Anode: Platinum

3. **GREEN GOLD PLATING SOLUTION**
   - Potassium Gold Cyanide, AuKCN: 3.0 gms.
   - Potassium Silver Cyanide, AgKCN: 0.5 gms.
   - Free Potassium Cyanide, KCn(free): 7.43 gms.
   - Potassium Phosphate, K\(_2\)PO\(_4\): 55.0 gms.

   Temperature: 54 - 71°C
   - Current Density: 0.5 - 2.7 A/dm\(^2\)

4. **PINK COLD PLATING SOLUTION**
   - Potassium Gold Cyanide, AuKCN: 1.5 gms.
   - Potassium Copper Cyanide, CuKCN: 2.5 gms.
   - Potassium Nickel Cyanide, NiKCN: 1.0 gms.
   - Free Potassium Cyanide, KCn(free): 3.7 gms.
   - Potassium Phosphate, K\(_2\)PO\(_4\): 14.8 gms.

   Temperature: 60 - 71°C
   - Current Density: 0.7 - 4.3 A/dm\(^2\)
   - Voltage: 1 DC Volts
   - Anode: Platinum
## Cyanide Plating Baths

### Grams per Liter

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<th>COPPER</th>
<th>BRASS</th>
<th>SILVER STRIKE</th>
<th>SILVER PLATE</th>
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<td>Common Rochelle</td>
<td>Common Rochelle</td>
<td>(Steel)</td>
<td>Jw</td>
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<tr>
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<td>Rochelle Salts, NaKC₅H₆O₆·2H₂O</td>
<td>42</td>
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<tr>
<td>Carbon Disulfide</td>
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### METAL CONTENT

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<tr>
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<th>Copper</th>
<th>Silver</th>
<th>Zinc</th>
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<th>Bath Temperature, °C</th>
<th>Current Density, cathode sf</th>
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<td>10-13-10.7</td>
<td>30-40 50-70</td>
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<td>10-13-10.7</td>
<td>30-40 50-70</td>
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<td>4.5</td>
<td>10.3-10.7</td>
<td>45-60 55-55</td>
<td>25 25 25 25</td>
<td>Cu, Cu-Zn</td>
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### Anodes

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<th>Cu-Zn</th>
<th>Cu-Zn</th>
<th>Fe</th>
<th>Fe</th>
<th>Fe</th>
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WORKING WITH PRECIOUS METALS

HACKING, CUTTING, MELTING

SAWING, CUTTING, SOLDERING, AND ASSEMBLY

FORGING AND ENGRAVING

FILING

STONE SETTING AND ENGRAVING

POLISHING AND PLATING
I. MANUAL PROCESS

Gold & Alloy Computation → Melting/Sheet Casting → Roll Press → Cutting/Sawing → Cut out/Sheet work Shaping → Emboss/Repoussé

II. LOST WAX CASTING PROCESS

Master Pattern Making → Rubber Mold Making → Wax Injection → Investment Moulding → Metal Casting → Filing → Wax Assembly

III. DIE CUT & STAMPING PROCESS

Sheet Casting → Roll Press → Die and Molding → Stamping → Filing → Soldering and Assembling

IV. FINISHING

Polishing and Cleaning → Stone setting & Engraving → Fine Polishing & Plating
JEWELLERYCASTING (LOST WAX PROCESS)

Termed as lost wax casting process dates back in time beyond Egypt's pyramids. This way of jewelry production was based on this basic principles: first, a model or a pattern was made in wax and this pattern was embedded in a creamy investment plaster called that hardened to form a mold. Second, this mold was heated and wax melts away and "lost". And, lastly, metals is then casted into the cavity left by the lost wax thus duplicating original wax pattern. The mold is then destroyed to recover casted metals.

Basically, this process is so simple that can be easily learned by those who have no experience in this craft. The reason for this simplicity is that the creative work is done in wax that are readily handled and can be corrected or change as work progresses. After final form is completed in wax, the procedures in converting into metal of your choice is a routine. Once you have learned basic steps in following pages, possibilities of design and accomplishment are unlimited.

PATTERN MAKING: Anyone can develop his or her skill in wax pattern making, with an idea for a piece of jewellery in mind, it is but helpful to be familiar with available waxes, wax forming tools and alternate wax forming techniques and equipments. It is important that care be taken for pattern making for finished models will ultimately be recreated in metals when casting was completed. Rubbing the pattern with a piece of nylon cloth or any soft cloth dampened with solutine is an excellent technique to achieve smooth pattern surface. Wax can be filed away but an unwanted depression cannot be filed with metal after casting. Therefore, it is best to take special pain with wax pattern so to minimize finishing later.

(FOR MASS WAX FORMING)

WAX INJECTOR

RUBBER VULCANIZER
SPRUING AND PATTERN MOUNTING: Sprues are wax wires to support wax pattern in desired casting position. During the "burn out", these wax sprue were "lost", leaving passageways through which molten wax escapes from mold. Later during casting, this sprue system provides passageways through which the molten metal flows into mold, thereby duplicating pattern in metal.

The main sprue (or sprues) is attached to thickest part of wax pattern with a heated spatula. The number of sprue and gauge of wire wax used in this purpose depend on the size and shape of the pattern. Sprues should be as smooth and as straight as possible that molten metal can flow into wax pattern with a minimum turbulence which often cause air entrapment or porosity in finished casting. Further reason to avoid sharp bend in sprue system is greater risk of molten metal to break off a piece of investment mold as it travels past on severe curve. Also, sprue should be attached smoothly to pattern to avoid such investment breakage. This loose investment may be inbedded in finished casting that may result a casting failure.

To mount wax pattern, first select the proper flask and its compatible sprue base. The flask is the container that hold moki material or investment. Stainless steel flask is recommended, since they are rust and corrosion resistant. The size of the flask is determined by the size of wax pattern. When placed in flask, wax pattern should be centered so as to be a minimum of 3/8 of an inch from side and 1/2 inch from top. Several wax pattern may be sprued together forming a "wax tree", and cast in one flask, provided that the wax pattern all rest within proper distance from end and side of the flask. At no time should wax pattern extend below the top level of the center cone of sprue base nor multiple pattern be closer to each other than 1/4 of an inch in sprued position.

The sprue base may be made of metal or rubber. When metal sprue base are used, it is necessary to seal sprue base to the flask. This is to avoid wet investment leak when it is poured to flask.
MEASURING METALS FOR CASTING

There are two ways to determine the amount of metals needed in the casting. In each instance, wax pattern must be considered, its sprue and "button" as basis for measurement. The button is the reserve metal at the base of the sprue system. The first method is to weight wax on a precision scale. The actual weight is then multiplied by specific gravity of metal to be used. The specific weight of selected metal are shown below:

<table>
<thead>
<tr>
<th>Metal</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>18K</td>
<td>15.6</td>
</tr>
<tr>
<td>14K</td>
<td>13.4</td>
</tr>
<tr>
<td>10K</td>
<td>11.6</td>
</tr>
<tr>
<td>Silver</td>
<td>10.6</td>
</tr>
<tr>
<td>Brass</td>
<td>8.5</td>
</tr>
</tbody>
</table>
The second method is called water displacement. Attach a fine wire in pattern, holding wire, immerse the pattern (complete with sprue system) in a cylinder two-third full of water. When raised water is noted, remove wax and add sufficient amount metal to cylinder bringing water in same level. In both method, all wax that you will convert into metal must be weight or displaced, this include entire wax pattern, with its sprue and sufficient allowance to fill the button. Note: Wax is to be measured before pattern is encased in investment mold.

Investing: Wax pattern is now ready to be encased in a heat resistant plaster called: INVESTMENT. This plaster will hardened in flask and will produce a smooth mold against wax pattern. This mold can be subjected to the bum out heat without cracking or distortion. When bum out is completed, wax pattern will lost leaving every detail you created in wax pattern. To start investing, following items are needed:

a. Pattern sprued on sprue base.
b. The proper size flask.
c. Water
d. Investment powder
e. Mixing equipment e.g. rubber mixing bowl, Spatula, and
f. Vibrator or Vaccum investing unit.

The investment material used in making mold is mixed with water and set like plaster of Paris but unlike plaster, it will withstand the high heat of the wax eliminating process. When mixed to the specified water/powder ratio, it will form a strong smooth mold and will produce consistent excellent casting results. Both water and investment powder should be at room temperature (approx. 72° F). Water will normally reach room temperature if drawn from the faucet and
allowed to stand at least one hour before using. This will allow contain less entrapped air than the water used directly from faucet. Both investment and water be mixed with the ratio of 100/40 respectively. Pour the measured amount of water into rubber mixing bowl, then add measured amount of investment to water, using mixing spatula, to blend the two. Take care to blend mixture as thoroughly as possible until a smooth creamy slurry is formed. Mixing take three to four minutes.

IMPORTANT:
* Use care to measure accurately the water and powder ratio. Too much water could result a weak investment mold. Too little water will make two thick.
* Add powder to water NOT vice-versa. In this way, water is more evenly distributed throughout the powder, making more smoother, more creamy mix.

IF INVESTING BY HAND:

At this point, it is desirable to remove air that may have been incorporated in mixed investment and to do this a vibrator is needed. If vibrator is not available, this can be done by tapping edge of rubber mixing bowl by a spoon to produce vibration on mixture. Air bubbles from vibrated mixture will rise to the surface in approximately one minute and investment is ready to pour into the flask. Be sure that flask is firmly in place on sprue base then slowly pour investment slurry into flask. By holding flask in an angle, investment can be poured along the inside edge, allowing mixture to creep up and around pattern side. As pattern is enclosed in the investment, flask should be set on a level surface and filled to the top with remaining mixture.

To be sure that no air bubbles adhere to invested wax pattern, flask should be vibrated mildly by means of hand. Excessive movement may cause pattern and sprue to be jarred loose from sprue base. Smaller investment flask should be allowed to set for at least one hour while larger flask takes two to six hours to set. It is extremely important that flask must not be touch or jarred in any way until investment has hardened. If flask is disturbed, while investment is setting, it is possible that mold will crack, resulting in an unsatisfactory casting.

![Investment Mixer](image)
IF WESTING BY VACUUM

Vacuum investing is a very good way to remove entrapped air from investment slurry. Eliminating air minimized the possibilities of bubbles forming around wax pattern. If not eliminated, these bubbles will be converted into metal nodules on finished casting.

When bowl of investment is mixed, place it under bell jar on the vacuum pump. The reduced air pressure under the jar causes entrapped air to rise in the surface of the investment. This is called "vacuum rise". As air is released from the investment, slurry will also rise and fall back or break. Ten (10) seconds after investment breaks, vacuum should be released and pump turn off. Remove the bowl from under bell jar and slowly pour investment slurry into the flask, as previously described. A wetting agent is necessary to ensure that investment will adhere in wax pattern. Denatured alcohol is commonly used for this purpose. If this will mix with slurry, it will cause mixture not to hardened. In this case, an excess mixture is needed to over fill flask allowing a small portion to spill to ensure that alcohol goes with spilled investment.

Note: Whether investing by hand or by vacuum, the entire investing procedure should be completed in approximately nine (9) minutes. This is known as the "work time" of the jewellery investment material. This period start as the powder is added with water. The investing procedure is completed when the flask is filled with investment and left undisturbed. This procedure should be timed to consume nine minute; since it is possible that this could cause cracks in the moki material as it is hardening.
REMOVING THE SPRUE BASE

Approximately one hour after the wax pattern has been encased in the investment, the sprue base may be removed. This is accomplished by holding the flask and slowly turning the sprue base in the palm of your hand. When the seal breaks, the base can be pulled away. This leaves a small cavity in the center of the mold. At this time, any excess investment on the edge and sides of the flask should be removed. The sprue which is attached to the base will be visible at the center of the cavity. Care should be taken to brush loose particles of investment away from the area. During the casting, it is this cavity which becomes the feed area for the molten metal. Any loose investment particles remaining in this area may be carried into the pattern chamber with the molten metal.

It is recommended that 1 hour for the small flask and 2 - 6 hours for larger flask elapse between investing and placing the invested flask in the furnace for burnout. This permit the investment to acquire increased mold strength. If burnout is not convenient at this time, the invested flask should be wrapped in a damp cloth. This will prevent the mold from drying out and possibly cracking during burnout. Should an invested flask be allowed to dry, immerse it in a pan of water until air bubbles stop rising. This is to moisten investment before proceeding with the burnout.

BURNOUT: The burnout (wax elimination) process should be initiated only when it is prepared to complete the casting process. At no time should be the invested flask heated, then cooled below 500°F and then reheated again. This will lead to mold cracking. The flask was placed in the burnout furnace with two primary objectives in mind: to eliminate wax from mold and to bring the mold to proper casting temperature.
CHART FOR DETERMINING INVESTMENT AND WATER REQUIREMENTS FOR VARIOUS SIZE FLASK

Top figures: Investment
Lower figures: Water

Heights of the Flasks

<table>
<thead>
<tr>
<th>Size</th>
<th>2&quot;</th>
<th>2 ¼&quot;</th>
<th>3&quot;</th>
<th>3 ¼&quot;</th>
<th>4&quot;</th>
<th>5&quot;</th>
<th>6&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>2&quot;</td>
<td>5 oz.</td>
<td>6 oz.</td>
<td>7.5 oz.</td>
<td>9 oz.</td>
<td>10 oz.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>57 cc.</td>
<td>68 cc.</td>
<td>85 cc.</td>
<td>102 cc.</td>
<td>114 cc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3&quot;</td>
<td>8 oz.</td>
<td>10 oz.</td>
<td>12 oz.</td>
<td>14 oz.</td>
<td>16 oz.</td>
<td>20 oz.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>91 cc.</td>
<td>114 cc.</td>
<td>136 cc.</td>
<td>160 cc.</td>
<td>182 cc.</td>
<td>228 cc.</td>
<td></td>
</tr>
<tr>
<td>4&quot;</td>
<td>12 oz.</td>
<td>15 oz.</td>
<td>18 oz.</td>
<td>21 oz.</td>
<td>1 ½ lbs.</td>
<td>30 oz.</td>
<td>32 oz.</td>
</tr>
<tr>
<td></td>
<td>136 cc.</td>
<td>170 cc.</td>
<td>205 cc.</td>
<td>240 cc</td>
<td>274 cc.</td>
<td>340 cc.</td>
<td>410 cc.</td>
</tr>
<tr>
<td>5&quot;</td>
<td>1 lb.</td>
<td>1 ¼ lbs.</td>
<td>1 ½ lbs.</td>
<td>1 ¾ lbs.</td>
<td>2 lbs.</td>
<td>2 ½ lbs.</td>
<td>3 lbs.</td>
</tr>
<tr>
<td></td>
<td>182 cc.</td>
<td>228 cc.</td>
<td>274 cc.</td>
<td>320 cc.</td>
<td>364 cc.</td>
<td>456 cc.</td>
<td>548 cc.</td>
</tr>
<tr>
<td>6&quot;</td>
<td>18 oz.</td>
<td>23 oz.</td>
<td>27 oz.</td>
<td>2 lbs.</td>
<td>1 ½ lbs.</td>
<td>3 lbs.</td>
<td>3 ½ lbs.</td>
</tr>
<tr>
<td></td>
<td>205 cc.</td>
<td>262 cc.</td>
<td>308 cc.</td>
<td>364 cc.</td>
<td>410 cc.</td>
<td>546 cc.</td>
<td>637 cc.</td>
</tr>
</tbody>
</table>

NOTE: to determine the number of pounds of investment to fill any particular flask divide ounce content by 20
To eliminate the wax from moki, flask is place with the sprue hole down. The sudden change of temperature will result in immediately burning or melting of the wax. The bulk of wax will begin to flow and "lost" as it drain from the mold. Not all wax were eliminated at once. A small amount of carbon build up as wax vaporized and continue heating the flask is necessary. That is to complete elimination of the residue. Dark areas on the surface of the investment indicate insufficient burnout. Using an electrical or gas burnout oven is suggested but in cases that this equipment is not available, an improvised charcoal furnace will be a very good substitute. We can select the proper burnout cycles according to the size of the flask:

<table>
<thead>
<tr>
<th>Flask up to 2 1/2&quot; x 2 1/2&quot;</th>
<th>Flask up to 3 1/2&quot; x 4&quot;</th>
<th>Flask up to 4&quot; x 8&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5 HOURS CYCLE</strong></td>
<td><strong>8 HOURS CYCLE</strong></td>
<td><strong>12 HOURS CYCLE</strong></td>
</tr>
<tr>
<td>1 hour 300°F</td>
<td>2 hours 300°F</td>
<td>2 hours 300°F</td>
</tr>
<tr>
<td>1 hour 700°F</td>
<td>2 hours 700°F</td>
<td>2 hours 700°F</td>
</tr>
<tr>
<td>2 hours 1350°F</td>
<td>3 hours 1350°F</td>
<td>4 hours 1350°F</td>
</tr>
</tbody>
</table>

All burnout cycles must be reduced the flask temperature into proper casting level* by one hour except for the 12 hours cycle, by two hours.

* Mold temperature for ladies rings and lacy or intricate designs . . .
  1000°F to 1100°F
* Moki temperature for men's rings and other items with heavier designs . . .
  700°F to 900°F

Note: Furnace temperature should never exceed 1450°F as this may affect the investment. Furnace should be pre heated for all burnout cycles.

METAL CASTING: With the burnout of flask is completed, it is now ready for the casting procedure using centrifugal casting machine. The centrifugal casting machine is operated by an over sized steel spring and it requires no motor and a minimum maintenance. Attached to the base is a horizontal arm assembled with two ends; one containing the flask cradle and crucible and the other supporting the counter weight. The side holding the flask cradle and crucible is a secondary arm pivoted at a right angle of the main arm. This secondary arm or swing arm keeps the centrifugal force in line and reduced the risk of molten metal spill over when casting was done.

The objectives of casting machine is to revolve horizontally and push molten metal from the crucible into mold by centrifugal force. The metal is held there until it solidifies to form a dense casting. There are also type of vertical revolving
until it solidifies to form a dense casting. There are also type of vertical revolving machine. It is very important to balance casting machine prior to casting. A properly balanced machine minimized the possibility of metal spilling from the crucible as well as undue machine bearing wear. Be sure to do this before burnout as there is no time to work with a heated flask between its removal from furnace and the casting procedures itself.

In balancing casting machine, place invested flask prior to burnout in the cradle with open end (when wax is exposed) facing the blackplate on crucible carriage. Looking through the hole in clay crucible, the sprue wax should be visible at the flask opening. This allow to see the direction the metal will travel into the center of the mold during casting operation. Next, slide the crucible in its carriage against flask and cradle as tightly as possible. Place the quantity of metal needed in crucible. This casting end is now ready to balance against the counterweights on the straight arm. To wind the machine, hold the counterweight end of the arm assemble and make three complete clockwise turn of the arm. The heavy duty spring in the machine will require more force as you wind. The release of this force later causes casting machine to act on the operation. Pull the stop rod in base of the machine and allow the arm lock in place against the rod.

After preparing for the machine, burnout will take place, and you are now ready for melting metal in the fire clay crucible. The type of melting equipment to be used in melting metal may be oxygen and gas mixture or even an ordinary gasoline blow torch will serve the purpose. Some used a compressor in place of a footpump in their blow torch unit for more convenience, to make a mirror like furnace on the molten metal, sprinkle borax as flux. This will reduce the oxidation as well as it will help the fluidity of the metal. Now you are ready to cast, continue covering the metal with flame, with the right arm, pull against and hold the weight end of the casting arm just enough to release the stop rod. Raise the flame away and release the casting arm from your right hand grasp. Let the machine spin until it stop itself, at the same time the metal will cool and solidifies in mold.
Large casting machine mounted in tub; metal being melted with an acetylene gas torch (for rapid and efficient melting).

Grinding burrs, used with an electric hand piece, remove excess metal. Cloth buffing discs help to polish the casting.

True button and feed lines were cut from the casting with a jeweler's saw.
OUTLINE

**LOST WAX INVESTMENT CASTING**

1. Finish wax pattern, polish and clean thoroughly.
2. Select suitable flask and sprue base. Sprue pattern generously.
3. Determine the amount of metal needed.
4. Attach sprued pattern to sprue base and fasten the flask to sprue base.
5. Use wetting agent.
6. Measure the water and powder to the recommended ratio for the flask.
7. Mix investment, adding powder to water, Stir well to eliminate bobbles.
8. Use vibrator or vacuum if available.
9. Pour the investment slowly to the flask and do not disturb until set.
10. Allow flask to set 1-6 hours depending on the size of flask.
11. Remove the sprue base and scrape the excess investment off the flask.
12. Balance the casting machine with invested flask before burnout.
13. Complete the burnout and prepare casting.
   a. Wind the machine arm and lock on stop rod.
   b. Remove the flask from the furnace and mount in cradle toward the crucible.
   c. Push the crucible carrier toward the flask.
   d. Melt the metal as directed, fluxing when necessary.
   e. When metal is properly melted, release the stop rod while heating continued.
   f. Simultaneously raise heat from metal and release the machine arm.
   g. Allow machine to spin to complete stop. Do not stop it.
   h. Remove the flask with tongs, hold until button loses glow.
   i. Quench the flask in water.
   j. Clean off investment residue in the metal cast.
   k. Pickle the casted item in a solution of 5% sulfuric acid and water.
   l. Rinse with water and dry. (neutralize acid by dipping in a solution of Bicarbonate of soda.)
   m. Casting is ready for finishing.
CASTING CHECK CHART

CASTING DEFECTS AND POTENTIAL CAUSES

1. "Fins" or flask on cast (added thin metal extension)
   a. Incorrect water/powder ratio, weak investment mold.
   b. Investment improperly stored.
   c. Investing extended work time of flask disturbed while investment was setting.
   d. Flask dropped or otherwise mishandled.
   e. Flask placed in furnace with insufficient setting time.
   f. Flask heated too rapidly.
   g. Flask allowed to dry and not reheated before burnout.
   h. Flask burnout and allowed to cool before casting.

2. Non-fills or incomplete casting
   a. Pattern improperly sprued.
   b. Incomplete wax burnout.
   c. Mold too cold when cast.
   d. Insufficient metal by weight.

3. Shiny cast before pickling

4. Darkened rough cast which resists deoxidizing in pickling solution.
   a. Burnout temperature too high, exceeding 1450°F.
   b. Metal overheated.

5. Porous cast (fine cavity in the metal)
   a. Pattern improperly sprued.
   b. Incomplete wax burnout.
   c. Metal overheated.
   d. Mold too hot.
   e. Too much old metal in the cast. (more than 50%)
   f. Metal insufficiently flux.

6. Portion of investment moves with in the mold or spauling
   a. Sharp corners and bend in the sprue system.
   b. Flask place in the furnace with insufficient setting time.
   c. Flask heating too rapidly.
   d. Sprue hole not checked for particles after sprue base was removed.

7. Foreign particle inclusion in cast.
   a. Crucible too old and disintegrating or insufficient flux.
   b. Flask contain rust or is uncleaned from prior cast.
   c. Sprue hole not checked for particles after sprue base was removed.

8. Bubbles or nodules in cast
   a. Wax pattern not properly treated with wetting agent.
   b. Investment slurry not sufficiently mixed, vibrated or vacuumed.
# Specific Gravity and Melting Point of Metals and Alloys

<table>
<thead>
<tr>
<th>Metal</th>
<th>Melting Point °F</th>
<th>Melting Point °C</th>
<th>Specific Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>1220</td>
<td>660</td>
<td>2.7</td>
</tr>
<tr>
<td>Antimony</td>
<td>1167</td>
<td>630</td>
<td>6.6</td>
</tr>
<tr>
<td>Beryllium</td>
<td>2462</td>
<td>1350</td>
<td>1.8</td>
</tr>
<tr>
<td>Bismuth</td>
<td>520</td>
<td>271</td>
<td>9.8</td>
</tr>
<tr>
<td>Cadmium</td>
<td>610</td>
<td>321</td>
<td>8.7</td>
</tr>
<tr>
<td>Carbon</td>
<td></td>
<td></td>
<td>2.2</td>
</tr>
<tr>
<td>Chromium</td>
<td>3326</td>
<td>1830</td>
<td>7.1</td>
</tr>
<tr>
<td>Cobalt</td>
<td>2696</td>
<td>1480</td>
<td>8.9</td>
</tr>
<tr>
<td>Copper</td>
<td>1981</td>
<td>1083</td>
<td>8.9</td>
</tr>
<tr>
<td>Gold</td>
<td>1945</td>
<td>1063</td>
<td>19.6</td>
</tr>
<tr>
<td>18K Green</td>
<td>1810</td>
<td>988</td>
<td>15.9</td>
</tr>
<tr>
<td>18K Yellow</td>
<td>1700</td>
<td>927</td>
<td>15.6</td>
</tr>
<tr>
<td>18K White</td>
<td>1730</td>
<td>943</td>
<td>14.6</td>
</tr>
<tr>
<td>18K Red</td>
<td>1655</td>
<td>902</td>
<td>15.1</td>
</tr>
<tr>
<td>14K Green</td>
<td>1765</td>
<td>963</td>
<td>14.2</td>
</tr>
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</table>
1. Turnistis ng pahaba ayon sa sukat ng dalir
2. Bilugin ng Rounder.
3. Hinangan
4. Bilugin sa Talag.
5. Para sa may pelete, paraanan ng bandili ang magkabilang gilid
6. Para sa gulgod pagong Kikilin ng paayon.
PENDANT

PROJECT # 2

PROCEDURE

1. PLANTSA
   G-20
   1STISIN NG BANDILI

2.  

3. IKAKALIKID SA PAMAMASITAN
   NG BARENA (HAND DRILL)

4.  

5. TIRIN NG SANDILI

6.  

7.  

8. LIHAHIN

HINANGAN
TIFFANY
PROJECT # 3

PROCEDURE

1. Burnilog ng pa wede ring.
2. Pitpitin sa halos ka hati ng laki
4. Iporma ang magka bilang dulo bat hina
5. Para sa Victory, Tin sa drowing at pagko pos ay ilapat na ar braso at pang-ibab
6. Lihahin,
LADIES RING
PROJECT # 4

PAGGAWA NG BARASO

PAGGAWA NG INGASTE

TUBO/INGASTE → G-28

ITATALI BAKESO KIHINANYA

MATAPAS M-TUYO AT TUMIGAS ANG ESKAYOLA, AALISIN NA ANG PAKET AT KIHINANYA NA
EARRINGS
(PROJECT # 6)
(LIGID)
(PICAFORTE)
MEN'S RING  DOMINO
PROJECT # 7

PROCEDURE

1. PAG-SAWA NG PANGIBAW
2. PAGHIHINANG NG PANGIBAW SA BARASO
3. ALUKIN NG ROUND-ER

G-10

PIT-PIT
3-23

BARASO

PANS IBABAW
G-16
PELETE
G-20
TABING
G-10
BARASO
G-16

4. PASILAGAY NG TABING
G-20

5. TITISTIGIN NG BANDIL PABISOG

CILABAT
NA ITO

6. ISASALUGA
LILIMAHIN
**MEN'S RING**

**OVAL**

**PROJECT # 8**

- **Frame**
  - G-23

- **Baraso**
  - G-16

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**PROCEDURE**

1. **PASSA NGA PANGIBABA**
   - **PITPIT**
     - G-23

2. **PASABASA NG LAGAYAN**
   - **Frame**

3. **TUTUKULANG MASKABILANG DULO**

4. **ILAPAT SA BARASO**
   - **At Talian Pagkataros**
     - **HINANG**

5. **PASASA LUGAR LAGayan**
   - **NG PELETE**
     - **LIHANIN**

---

**Pattern**

- S-16
MEN'S RING
PROJECT #9

1. Pattern

2. AAUKIN AT IHINANG

3. BASAWA NG INGAHENG PANG-6
AYON SA SURAT NG BATO

ASAWA NG BARASO AT "KING: BASAWA AYON SA SURAT NG BATO"
SET ROSITAS
PROJECT # 10