CHAPTER - V

INTRODUCTION OF METAL CASTING IN MANIPUR

Metal is hard in natural state, ductile when heated, melts at a higher temperature and solidifies when cooled came to the discovery and knowledge of men and its properties enticed man to make his weapons of defense as well as tools of craft and handicraft of livelihood. A man learnt that two or more metals can be combined to form an alloy, which is even harder than the parent metals, the knowledge and techniques of forging and casting were developed in man for his use.

Metal casting is a device to obtain a desired shaped or object of the metal worker. Man, being of thought and thinking power had planned out to obtain his choice and aspired weapon in the shape and size which so ever he intended from the metal work even when he was in the primitive stage. An example of statement is furnished below:

"The early man carved dugouts in stone negative form and filled it with molten metal and made simple one piece solid casting. Next he developed suitable clay compound prepared simple two piece moulds from an original for solid casting. He noticed that he could retain the contour of his castings and save metal by introducing a lump of clay
(core) and make hollow castings. The development of clay moulding technique ushered the invention of cire-perdue (lost wax) technique of casting”

The cire perdue technique of casting was spread to almost all the countries. This technique was divided into direct casting i.e. casting by modelling a wax original only for one cast and indirect casting in which the original is generally in clay and a plaster copy of it is obtained through the waste mould process. A wax replica of the plaster copy is obtained for cire perdue casting with a plaster mould or by flexible mould. Indirect casting can have a number of copies

The technique of sculpture casting came into use since the renaissance age in Italy. This civilisation also arrived in South and south East Asia since then or some 50 years or so afterward.

The introduction of the metal casting in Manipur as it was the root of the art and science of the subject, its study and observation are made to lead the typology and technology. Manipur being the meeting point of the east and west of the south and south-East Asia prior to the British occupation of the land had influx almost all the different culture of the arts and sciences of her east and west. This can be observed axially also on the typology and technology of the metal casting. Imphal, the capital city is the cradle of all the Meitei natives and foreign culture

2. Ibid. Introduction.
3. Ibid. 2.
whatsoever sprang up or arrived through their natural hill fortified barriers of all the directions. Even some of such culture were nipped in buds by the wheel of time and new revolution, the metal casting remains to shoot up its stem from its seed of foreign importation but none boldly forwarded it in spite of their hints of reports or information. This information as transacted on the chronicle of Manipur goes as under:

"...Ngangom Kabogi Kum Saka 1550...

Nongmei apunba hutpasung adugei hōë - e ⁴"

It says that the boring of big gun or canon was started in 1550 Saka (i.e. 1638 A.D.) in sponsored year of Ngangom Kabo. In this regard T.C. Hudson, explained as the Chronicle state that Khagemba, in 1627 A.D. experimented to make big guns and prepared one metal gun⁵. The pioneer British or whosoever researched on the Manipur metallic work paid no heed in the typology and technology as well as no such approach was made. But in a few items like coins and matchlocks, Dr. R. Brown the British political agent of Manipur (1867 - 75 A.D.) described the coin casting⁶ and T.C. Hudson, the matchlock making as they sow and examined the coin and gun.

No archaeological or scientific establishment is yet made regarding the introduction of the metal casting in Manipur. Therefore it is

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4. I. & K. op. cit. p.37
6. R. Brown: Statical Account of Manipur, Delhi, and p.89.
urged to depend upon the literary sources of the Meitei royal chronicle and annals of Manipur. But as exhibited in the sculptural history so far activities of Kings of Manipur as provided in the history of achievements and sculpted in Manipur (Ningthourol Lambuba) is appeared to have been happened to be the memorial image of the Meitei lord Kainou, Erenga (984 - 1074 A.D.). But as the literary account, N.L. was of the treasure of literature of the 19th century A.D. (as the writer of this compilation was expired in 1853 A.D.\textsuperscript{7}) the culture or the art may not be credited to that the 10th and 11th century A.D. It is observed that the metal casting in Manipur is an information of technology & typology of Myamma casting heritage encroached through the eastern hill tracks. The Myamma heritage is presented as: -

... Images of Gautama, some of vast size, are cast in brass, and pious persons give silver and gold to be added or even throw jewelry in to the molten mass. A mould is made of clay, and it is coated with wax, the wax varying in thickness according to the thickness desired for the walls of the image, over the wax is placed a thick coating of clay and chopped rich straw with holes at intervals for pouring in the metal and with straw introduced as channel for the escaped of air. The metal is poured in from small crucibles and at first lowest row of holes then in the next and so on so that the image is built up. When it is cool the outer casting in taken off, the flows and the holes fill up and the whole

\textsuperscript{7} I. & K. op. cit. p.319
polished so as to hide any defects in the workmanship.  

But almost all the Hindu icons are appeared to have been brought in Manipur from the west i.e. mostly from Bengal by the middle of the 15th century A.D. or after the date up till the 20th century A.D. In India Bengal had the advanced technique in the metal casting of both the techniqués. According to M.V.K. the learned scholar, as he had studied the ancient work in Sanskrit describes the technical process as

1. Modelling: - Concerned with the preparation of a wax model.

2. Moulding:- Concerned with the preparation of clay negative (mould) of the wax modal for casting.

3. Casting: - This can be subdivided into a number of successive processes such as: - (a) ascertaining the rate of different metals in proportion to the weight of wax modal, (b) draining out the wax from inside the mould (dewaxing), (c). melting process - temperature required for melting the different metals , (d) casting process, (e). releasing the cast from the mould (devesting).

4. Finishing: - Concerned with the perfecting of a metal cast.

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10. M.V.K.op.cit. P.1-7
The above Indian process of casting is also appeared to have been coincided with the Burmese process even when there were some difference in material used for casting. There is also the solid casting process in India and an image of Gouranga or Gourai Pravu is still existing in Manipur Uripok Basaspatimayum or Laisram Gourachandra Pravu in Manipur of Uripok Maisnam Leikai. This icon was brought in Manipur by 1861 A.D.\textsuperscript{11}. So from the evidences provided by Meitei Scriptures, the casting in Manipur in its local style and model is appeared to have been started since the regime of King Khagemba (1597-1652 A.D.) probably some 10-20 years ahead of his experiment of casting the metal breech-loading gun in 1627 A.D. as interpreted and pleaded by R. Brown & T.C. Hudson in moulding the big gun by Khagemba.

**Typology of Meitei Metal casting prior to the reign of Gambhir Singh**

The facet of the cultural heritage of Manipur prior to the Hindunisation of the Meitei is supposed to have been alighted on the direction of the east even when the inflation of Hindus from the direction of the west was current from the regime of the Meitei Lord Kiyamba (1457-1508 A.D.). So the Meitei used to cast metal images in facial anatomy of their gods and goddesses as it were done elsewhere in the South-east.

\textsuperscript{11} C.K., op. cit. p. 308.
Asia\textsuperscript{12}. No complete anthropomorphic figured icons whether of small or of big sizes were not casted prior to the event of the lost of the idol of Ramaji Pravu, Sita and Lakshmana during the regime of Raja Gambhir Singh (1825 - 34 A.D.)\textsuperscript{13}.

The Meitei has closed relation with the Myamma people even when they had constant wars with them. Almost all the industrial workers in the enterprise such as Selheibam, Senjam, Konsam, Aheibam etc. were immigrants from Kabo valley\textsuperscript{14}. So the typology of the Meitei native metal casting even though those Hindu icons brought in Manipur were of Indian Bengal typology, was of the South East Asian or Myamma typology of metal casting.

**Technology of Meitei metal casting**

The tradition of casting the facial anatomy of their gods and goddesses in metal (specially in belmetal) of South East Asia encroached in Manipur in the last decade of 17th century. The event is described as: -

... Shairom Mansheigi Kum Shaka 1621 Poinu Tha 6ni Eraida Panthoibigi Murti heigadabagi Aheiba Hanjaba Tarina Leimi Tame E, 11 ni Yumshakeishada Panthoibigi Murti Hei-E\textsuperscript{15}.

\textsuperscript{12} Michael Macintyre: Spirits of Asia, 1980, p. 250.
\textsuperscript{13} L. Mangi Singh: Manipuri Devalaya Grantha; 1976, Imphal, p. 21.
\textsuperscript{15} I & K, op. cit. p. 62-3.
Transcreation

Tari, the head of the moulding office, moulded negative clay mould of the wax modal for casting her divine Panthoibi on Friday the 6th day of the Meitei lunar month of Poinu (December) in 1621 Saka (1699 A.D.). The image of Panthoibi was casted on Wednesday instant.

From this statement of the annals of Manipur it is obvious that the technique used in casting the sculpture of facial anatomy of her Divine Panthoibi was in the process of the lost-wax technique of metal casting. The technique is used both in India and South East Asia or Myanmar. Manipur as a part of both the countries and lands followed the suit of the technique but it is appeared to be in the crude form.

The Meitei also casted the head or the skull anatomy (Kon-Lu) of their gods and goddesses in the same typology and technology even when they had casted in miniature anthropomorphic sculptures. This statement is evidenced by:

When two sculptors -Pukhrambam Balhaba and Likmabam Mantri had finished to sculpture the Anthropomorphic idols of Khoriphaba of Phoiging (hillock), it was avoided as it were unwillingness or unpermissible by His divinity and treated as a sin against His divinity. Hence only the head or skull anatomy of the deity was sculpted on Sunday, the 24th days of the Meitei lunar month of Thawan (August -
September) in 1771 Saka (1849 A.D.)\(^{16}\).

With the roll of time, the advance knowledge of metallurgy and metallic techniques entered into the soil of Manipur and the Meitei grow up to cast the complete casting or anthropomorphic sculptures in due course. Thus images of divine Sanamahi, Rama, Sita, Lakshman, Garibaniwaza (in the temple of Ramjee Prabhu in Ningthem Pukhri Mapal, Imphal) etc. were casted and they are all the living examples of Meitei metal casting.

CONSERVATION, PRESERVATION AND RESTORATION OF THE BRONZE OBJECTS

Conservation :-

The term conservation is the implying of certain treatment to a damage object to prevent from further deterioration. In considering what treatment to apply, preliminary physical examination is of greatest importance. Methods of treatment are based upon this preliminary assessment.

Metals posses the characteristics to eventually revert to products similar to the mineral ores is termed corrosion. In other words corrosion may be defined as an unintentional attack on a metal through

\(^{16}\) Ibid. p. 293.
reaction with a surrounding medium. The extent and the rate or corrosion depends on various, factors the main among which are the nature of the metal, methods of its fabrication, the environment in which it is presently kept.

Types of Corrosion:

A. Uniform or Universal Corrosion:

It is a type of corrosion proceeding uniformly over a metal surface. This corrosion normally found where a metal is in contact with acid or a solution. The corrosion product may either form a protective layer on the metal and slows down further corrosion\(^{17}\).

B. Galvanic Corrosion:

Galvanic corrosion occurs when two dissimilar metals are in contract with each other and exposed to a conductive environment a potential exist between them and a current flows. The less resistant metal becomes anodic and more resistant cathodic. Attack on the less resistant metal increase, while on the more resistant one it decreases. This attack is known as galvanic corrosion because entire system behaves as a galvanic cell.

\(^{17}\) Stambolov, T.: The corrosion and conservation of Metallic Antiquities and works of Arts, (Central Reaserch Laboratory for objects of Arts & Science, Amsterdam).
C. Intergranular Corrosion:

Intergranular corrosion is caused by an improper heat treatment or heat from welding that causes the precipitation of certain alloy compounds at the grain boundary. This precipitation causes a depiction of corrosion resulting elements in the area surrounding the grain boundary and this area becomes anodic to the remainder of the grain.

D. Localised Corrosion or Pitting Corrosion:

Under certain condition, anodic areas on a metal surface remains stationary rather than shift about. When this occurs, corrosion takes the form of pitting rather than general thinning. General corrosion becomes pitting when the anodic and cathodic sites stop shifting and becomes fixed on the metal surface.

E. Crivice Corrosion:

Crivice corrosion is a special type of pitting concentrated in holes, flange, joints and bolt heads. The anodic of a corrosion cell is fixed by the geometry in crivice or under deposit.

PATINAS:

The corrosion layer covers objects made of copper and copper alloys are called patinas. The Romans called it aerugo or bronzing which Chinese called it hisiu, or rusting. There are two types of patina,
one is called Noble patina and the other is called Malignant patina.

**Noble Patina:**

In air especially in close spaces, the reactions, which change the bronze surface, will proceed at a slow rate and the layer thus formed may appear as a thin, smooth coating which allows all the original profile of the object to remain distinguishable. This layer which are free from chlorides are called Noble patina. The noble patinas are malachite \((\text{CuCO}_3 \cdot \text{Cu(OH)}_2)\), Azurite \((2\text{CuCO}_3 \cdot \text{Cu(OH)}_2)\) and some other like stannic oxide \((\text{SnO}_2)\), ferric oxide \((\text{Fe}_2 \text{O}_3)\), Cuprite \((\text{Cu}_2 \text{O})\) etc. They are comparatively stable and do not change under normal condition.

**Malignant patina:**

Sometimes light green or green powdery spots appear on patinated bronzes, which grow radially and also depth consuming thus the metal under them in a manner similar to putting. It is a form of pitting corrosion where the inner region under the cuprite film is actively dissolving (anodic area) and the corrosion products are deposited in a mountain cathodic area above the \(\text{Cu}_2 \text{O}\) film. These corrosion outburst are referred to a malignant patina or Bronze Disease i.e. Atacamite \((\text{CuCl}_2 \cdot 3\text{Cu(OH)}_2)\). The cause of bronze disease was assured to involved by the contamination of the patina with chloride derived from the environment during burial or exposure to marine air.
These are quite unstable and dangerous to copper and its alloys and it should be removed clearly.

**Colours of patina:**

**Blue:**

These patinas are the products of interaction between oxide layers on bronze and an ammonia-containing environment. These patinas consist of basic copper carbonate in which ammonia, stannic acid and basic lead carbonate are also present. It can deeply penetrate to the metal but is fragile and flakes off easily.

**Green:**

Green patina consists of basic copper carbonate but often contain copper chloride and basic copper sulphate as well as and can be formed in the air or underground and have normally a compact structure, slow developed patina in air resembles enamel.

**Black:**

White patinas caused by tin oxide.

**Red or Orange:**

Caused by cuprous oxide (cuprite).
Grey-wax-like:

Caused by cuprous chloride (nantokite).

Treatment (Cleaning) for Conservation:

Cleaning:

Cleaning is the removal of all extraneous matter that has accumulated on the specimen by contact or contamination with foreign incrustation or stains and disfigurement appearing as a result of changes brought by the agencies mentioned above.

Antiquities of copper alloys are specially difficult for cleaning because they are usually covered with thick uneven corroded crusts of different deposits and they can also very heterogeneous in structure. This may be due to the mixture and coating of other metals.

There are three possible methods\(^{18}\) of cleaning or treatments.

They are: -

(a) Cleaning by chemical.

(b) Cleaning by reduction method.

(c) Cleaning by mechanical.

The use of chemical reagents and reduction methods are each dependent for ultimate success upon the application of certain forms of mechanical treatment and there are many cases where the best results can be obtained only by a combination of all the three processes.

In considering what treatment to apply a preliminarily physical examination and how much to clean is of greatest importance. This is carried out with the help of lens, if necessary, by exploring with a needle or in the case of ferrous metal by using a magnet. Very often the metallic carvings and designs are fully corroded, and if removed during the process of cleaning the object will be reduced to a lump of metal with no archaeological or historical significance. For this reason, it is very necessary to examine the object very thoroughly making sure that none of the corrosion products which are important from the point of view of designs are removed. Quite often such a situation be achieved only by mechanical means because chemicals may take away all the corrosion products. Examination of the corroded surface can be done by x-rays, Scanning Electron microscope without destructing the object.

a. **Cleaning by chemical:**

When the incrustation on a bronze object is unsightly, actively corroding or may be covering inscriptions or concealing decorative details, it will be advisable, to stripe the bronze, i.e. remove all the
incrustation, provided, of course, that there is a solid core of metals still remaining.

This can be done by using chemical reagents such as Alkaline Rochelle salt or Alkaline Glycerol to removed the basic cupric carbonate, dilute sulphuric acid to remove cuprous oxide (cuprite), followed by electrolytic reduction to eliminate cuprous chloride.

b. Cleaning by Reduction method:

There are two types of reduction:

(i). By Electrochemical reduction

(ii). By Electrolytic reduction

(i) Electrochemical reduction:

The method can be carried out when the object is enough metallic core or incrustation. In this method of reduction nascent hydrogen acts as the reducing agent but the generation of the nascent hydrogen involves the use of zinc and caustic soda (10%) in contact with the metallic object undergoing treatment so that an electro chemical process is also involved. The reaction is carried out in Pyrex beaker or enamelled container with the aid of heat. Heat promotes chemical action.
(ii) **Electrolytic reduction:**

This method of reduction involves the use of an electric current. The corroded metal object is made the negative electrode (cathode) in a suitable electrolyte such as 2% NaOH solution, the positive electrode (anode) usually being of stainless steal, under these circumstances the reducting action is then dependent on the application of an electric current. When current passes, hydrogen is evolved at the cathode with result that the incrustation is gradually reduced and saline matter eliminated. As the reduction progresses chlorides are transferred from the cathode to the anode. This method can be very effective in cleaning badly encrusted metals of all kinds. The use of the strong electrolyte and too high current density is avoided.

When an incrustation has been broken down by reduction these will remain on the surface of the metal a sludge of insoluble oxides and metallic powder, this will also contain chlorides as well as a residue of the electrolyte employed is removed by brushing the object under running water, even then it will retain a residue of chloride that are not easy to remove. They can be eliminated by heating then cooling. The presence of chloride can be tested by taking the wash water in a test tube, then add some drops of dilute nitric acid and finally add five drops of 2% silver nitrate solution, if there is no change of colour, confirmed the absence of chloride.
c. Mechanical cleaning:

When a metal is showing signs of active corrosion, there can be no question that the only way of checking the activity and effecting a permanent cure is to employ chemicals, but this involves using certain mechanical operations as well, in order to facilitate the action of the chemicals and their removal at the conclusion of the treatment. Mechanical methods may be employed directly for cleaning oxidized or tarnished metals, where it is merely a question of removing surface staining, they may also be employed in dealing with rust fragments that are completely oxidized and no longer subject to chemical change.

When Patina or Incrustation should be preserved:

More difficult problems are presented by well-patinated bronzes showing bronze disease. Bronze disease is nothing but the localised deep corrosion. The patinas on objects particularly of oxides, carbonates are the ones which are safe and should be retained. They form a protective layer on the object and at the same time add to the visual pleasure of the viewer. Bronzes were so extensively mineralised that no solid core of the metal remains. If such objects are in need of treatment, the aim must be to stabilise then by arresting the corrosion while retaining their general character. Three general methods can be used for this purpose. These are as follows:

19. Ibid.
(i) **Use of sodium sesquicarbonate:**

In this method the object is first given a preliminary mechanical cleaning then allowed to soak in successive baths of 5% sodium sesquicarbonate solution until a stage is reached when the solution is shown to be free from chlorides.

After sesquicarbonate treatment is completed, the object is washed in changes of cold distilled water until the final bath is shown to be neutral.

(ii) **Use of silver oxide:**

This method is for the spot treatment of bronze disease by using of silver oxide. To achieve this all the spot of bronze disease are first excavated with a sewing needle ground to a chisel-edge under a low power microscope, care being taken to ensure that the loose green powder that is removed does not lodge in areas of sound corrosion. Then pure silver oxide is pasted into the excavated area by a match stick moistened with mythylated spirit. The treated object is deliberately expose to a relative humidity of about 78% by placing it in a close space which is placed in a dish containing a slurry of crystalline “hypo” (sodium thiosulphate) for 24 hours. Here the cuprous chloride will react with the silver chloride. If the treatment has not been adequately carried out, light green spots of corrosion will appear, and it will be necessary to repeat the treatment. This dry method of treating bronze
disease should be used in cases where the object can not be safely exposed to aqueous solutions.

(iii) Use of Benxotriazole (BTA):

At first the object is mechanically cleaned to remove adherent soil etc. paying particular attention to areas of corrosion and any previously applied lacquer or wax is removed by soaking the object overnight in a mixture of equal parts of acetone and toluene. Then the object is immersed for 24 hours in 3% solution of benzotriazole in industrial methylated spirit under vacuum. The vacuum is then released, the object removed dried and wiped with a swab of cotton wool moistened with industrial methylated spirit to remove any excess of benzotriazole on the surface of the object. The object is then exposed under normal ambient conditions and examined to see if any spots of corrosion reoccur. If this happens, the above treatment is repeated until no further corrosion is evident. The object is then in a stable condition. This method is quicker to carry out than the sodium sesquicarbonate method.

It would seem, therefore, that a preliminary washing in sodium sesquicarbonate solution to remove the major part of the chlorides followed by the benzotriazole treatment may prove the most satisfactory method for treating badly corroded bronze objects.
REMOVAL OF CALCAREOUS DEPOSIT BY USING OF

SODIUM HEXAMETAPHOSPHATE (CALGON)

Bronzes are sometimes covered with calcareous deposits. These calcareous deposits can easily be removed by soaking the bronzes in a 5% solution of Sodium Hexametaphosphate (calgon) which in time releases the deposits of calcium and magnesium salts by complexing them to form soluble salts. Strong solutions up to 15% may be used.

Preservation:

After the metallic objects have been clean, it is absolutely necessary to see that all the chemicals used have been completely washed out from the antiquities, because any trace left inside the core will start attacking the metal and diseased spots will grow progressively. The object should be thoroughly washed by alternative heating and cooling in the distilled water thereby testing the presence of chlorides. Then the objects are dried at 100-105°C in oven or in desiccator.

After the object is completely dried, preservative coatings are applied in order to save from further deterioration. The most common preservative coating is that of synthetic resins e.g. polyvinyl acetate (PVA) in toluene. Before applying PVA, 2% BTA, solution in spirit was applied. BTA has been used as corrosion inhibitor for copper and copper alloys to prevent corrosion. The effect of the addition agents in
reducing corrosion is called Inhibitor. Benzotriazole \( \text{C}_6\text{H}_5\text{N}_3 \) forms a protective thin film on the copper and its alloys after reaction with benzotriazole and also produces a barrier to the corrosion environment. Then after complete drying of BTA solution 2% PVA solution in toluene is applied for two times. For porous objects are preserved under vacuum so that they get deeply impregnated and consolidated.

Restoration:

Many times it is necessary to do restoration of the antiquity in order to give it proper strength and shape. After the fragment has been pieced up together, the missing gaps have to be restored to add strength to the fragile and fragmentary pieces. Restoration, as a matter of fact, should be restricted to the bare minimum.

According to the kind of object, the missing areas are, when necessary, filled with transparent material either left clear or match to the adjoining areas by dusting with pigment.

For protection of bronze object, a vapour phase inhibitor paper has been recommended. A mixture of 60 parts of dicyclohexyl aminitrite +21 parts of cascin and 120 parts of water is prepared and applied on absorbent paper. The paper is dried and use for packing metallic objects. Finally, the treated objects are stored or displayed in a clean and dry atmosphere i.e. the recommended RH level between 0-45%.

light 50-100 lux and temperature 18°c-21°c\textsuperscript{21}.

**Methods apply in Manipur:**

Inspite of all these above methods of cleaning and preservation, the Manipuries follow their own method. This may be because of the fact that since the idols have been worshipping in their respective temples, they need to maintain the original brightness of the same. Hence the worshipper cleaned their idols mostly by lemon (citrus) juice or lemon juice with the addition of chandol (yellowish cream mud) or Heinajom (Averrhoa carambola, L) juice or simply brick dust when the colour are reduced. Nowadays cleaning of the idols were done by brass show, which is the easiest method.

In Manipur the bronze specimens are not in plenty and not so old or fragmenty. Private worshipping icons are free from scientific restoration. Only Manipur State Museum specimens are displayed in their show cases in the above mentioned clean and dry atmosphere.

\textsuperscript{21} Agarwal, O.P.: Care and preservation of Museum objects (National Reasearch Laboratory for Conservation, Lucknow, 1977.)