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Allusion of Loha Concept by Maharshi Bharadwaj in Brihad Vimaana Shastra and Contemporary Concept of Alloys

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Abstract

Rigveda, the oldest compilation of human wisdom provides a repository of ancient knowledge in its unique way. It serves as a source that provides seeds of Bharat's religious, philosophical, and scientific development along with Bhartiya literature and spiritual culture. It is well-preserved language in the form of Sukta that comprises of mantras provides an insight into how knowledge was compiled for better understanding and literature preservation. The contents of Rigveda include many subjects under its umbrella. One such is ancient metallurgy that details about various alloys and metals their purification, synthesis, and applications during the Vedic age. Based on Vedic literature many ancient scientists (Rishi) have written books on Metallurgy. This review focuses on the alloys used in Vimaana written by Maharshi Bharadwaj and its comparison with the contemporary science. It also highlights the differences between the alloy making processes, materials and methodology practised now and in ancient Bharat. A clear view of the advanced ancient technology and innovative contemporary science of alloys is envisaged here.

Keywords: Alloys, Bhastrika, Crucibles, Furnaces, Loha, Moosha, Vimaana.

1.0 INTRODUCTION

An age-old relationship exists between Man and metals. The archaeological evidences and literary devices are evident of the History of Indian Metallurgy. Many direct and indirect forms of evidences in the form of Sanskrit language beginning from the Vedic times to medieval and pre-modern provide a glimpse of Metals and Metallurgy in a unique way. One can argue that most of the metal technologies mentioned in the Vedic times are not relevant or applicable now but it can re-energise the researchers for innovations that are sustainable for environment and mankind by utilizing the advanced age-old methods that were not detrimental to ecosystems. Metal technology, metallurgical challenges that helped developed ancient metallurgy and the scientific temper of
historic times is well illustrated in the review with the help of different alloys specially used in *Vimaana Shastra* then and now. Much of the research done in recent times by Dr. Prabhu [1], Dr. Sharon [2], Kavya Vadadi [3], Dr. Dongre [4] to develop the country's aeronautic system throw light on many interesting facts that are mentioned in ancient texts and validate it to certain extent. The approach of decoding the ancient texts by the researchers and Sanskrit scholars which are in the form of shlokas and conducting trials have come to fruition as per research study. Different alloys of varying purpose mentioned in the *Brihad Vimaana shastra* [5, 6] have been synthesized and put to application. Few of which is discussed in this review and its comparison with the modern science alloy has been focussed on.

The archaeological evidences, heritage sites, innumerable temples found in India provide valuable insight into the minerals, metals and ores that have been used in ancient India. The idols of gods and goddesses, stone and rock sculptures, the Sanskrit language used and encrypted on the discovered archaeological marvels, decode the realistic picture of ancient times. The ancient Indians were well familiar with the production of alloys and its application in various sectors. Thousands of Sanskrit texts are available in different books like- *Rigveda, Atharvaveda, Rasatantra, Lohatantra, Yantrasarvasva, Upanishads*, and many more in the list. These books provide the information in the form of hymns or mantras. Few of which are discussed in this review in relation to alloys. Based on Vedic literature many ancient scientists (Rishi) have written books on Metallurgy e.g. Acharya Nagarjuna wrote *Rasaratnakara* and *Rasendramangalam*. Following are three shlokas from *Yajurved* [7] pertaining to information about metallurgy.

[Hiranyam Ch me I Ayashch Me I Sisan ch me I Trapushch me I Syaman ch me I Loham ch me I]

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This hymn from *Yajurveda* clearly states the mention of gold, tin, lead, iron, and copper.

हिरण्यं च मे । अयश्च मे । सीसं च मे। त्रपुश्च मे । श्यामं च मे । लोहं च मे।

त्रपु सीसक ताम्राणाम् क्षाराम्लोदक वारिभिः।

भस्माद्भिः काम्स्यलोहानां शुद्धिः प्लावो द्रवस्य च॥

[*Trupu Sisak Tamranam Alkaramoldak Waribhi.*|

Bhasmaddhi: Kamsyalohanan Shudhih Plavo Dravya Ch. ||]

Whereas, the above hymn describes how metals like tin lead and copper were purified with alkali and acids whereas Iron bronze and copper alloys were cleaned using ash and water; prior to their use in making *Loha.*

Similarly there are many shlokas which describes the furnace (Bhastrika), crucibles (Moosha), vessel (Drav-Patra) used for removal of impurities from ores as well as for preparing alloys (Loha).

The list goes on as we decode the Sanskrit texts about alloys. Many alloys were used in construction of different types of Vimaana during the ancient times; few of which have been researched upon and validated by different researchers. To begin with the loha (alloys) that has been prepared is mentioned in a well-publicized report are *Thamogarbha loha, Rajaloha, Pancha loha, Chapalagrahaka loha, Araara Tamra* (Prabhu) [1]. In an effort to make Guha Garbha Darshan Yantra based on Vaimanik shastra by Maharshi Bhardwaj synthesis of *Panch-Loha* along with Pargrandhik Drav was used in making a photoelectrochemical cell that can detect hidden arsenal and signals it; is successfully prepared (Sharon et al 2008) [2]. This Yantra is an example that reveals about the Flux technology that was known to us just 50 years ago, but the ancient texts mentioned it more than 1000 years ago. It was well known to Maharishi Bharadwaj. The ancient text preserved in the form of Sanskrit language, clearly indicates the differences in alloys made during ancient times and the making of alloys in contemporary science. Surveying different books and research work highlights that the making of alloys in ancient times differ in classification of alloys, ingredients, process making, furnaces-crucibles used, manpower and so on as compared to recent times. Few of the key differences are discussed below in this review.

1. Classification of Alloys
2. Synthesis Process of Alloys
3. Variation in Materials and Equipment used
4. Heating Equipment and Heat Source (Furnaces and Crucibles)
5. The man-power
6.

1.1 Metals Mentioned in Brihad Vimaana Shastra

Maharshi Bhardwaj in his Brihad Vimaana Shastra encompasses almost all the aspects of aeronautical requirements, prevalent during his time i.e., main structure of different Vimaan, yantras or machines used in Vimaan, defense, attack, and the propellant systems. First mention of Loha is at the end of the first chapter of Brihad Vimaana Shastra (Lohaadhikaranam*)* in the "*Atha Yaana Lohaani*." (Sutra - 13) meaning "Metals for aero planes". For which he has given credit to Shownak Rishi. He has allusioned knowledge about metals and alloys or Loha; credited to three ancient scientists namely (i) Shownaka Rishi's, (ii) Manibhadra Rishi (in his Manibhadra Kaarika) and (iii) Samba Muni. All three sages commonly point to three kinds of root metals for aviation applications - Souma, Soundala, and Mourthweeka; and by mixing them in different proportions and treating then with different parameters, 16 kinds of heat-absorbing metals are produced.

1.1.1 Souma Metals

As per concept of ancient literatures the word "Souma" consists of sounds, s, on, ma, and ha, "Paribhaasha Chandrika" and" Vishwambhara Kaarikaa" state, "The oceanic force and solar force instil 4 kinds of forces into root metals. The sum total of the forces is said, according to "Vaalmeeki Ganitha" to number 1,67, 768. Some of these forces are indicated by the sound "s" Some of the forces emanating from the sun and the elements are indicated by the sound "ou". Similarly other concerned forces are indicated by the letters "ma" and "ha". The Varuna and Soorya force contents of all root metals are of four groups. In each group the force content is said to be 1, 67, 768. Of the Koorma and Kashyapa forces of Vaaruna group, the67th from Ooshaa Koorma, and the 85th Kashyap force, called "Kaala", are indicated by the letter "Sa". Of the solar group of forces, Maranda and Bhoota 71st, and the Ruchika force 160 are indicated by the sound "ra". Similarly, of the forces of sun and stars in Aditi, the 9th called "Sundaa", and the stellar force 101 called "Bhowma" are indicated by the letter "Ma". And in the Dhruva Varga, Soma and Baadaba forces, 109 and 14 respectively, are indicated by the Visarga sound "ha. The four forces working inside the earth, by flux of time mature into the Souma type metal

According to Manibhadra Rishi, *Souma* metals are suggested to be the best for main body of Vimaan because of their lightness and metallic properties related to heat and other radiation absorbing/resistance. They had noticeably clear concept of the source and procurement of these metals e.g., it is mentioned that from which layer of mine which root metal should be mined or excavated. Their this concept was based on the knowledge which suggested that metal quality in a mine is affected by the gravity of the center of the earth, gravity of global earth, the solar flood, the air force, force emanating from the planets and stars, the sun's and moon's gravitational forces, and the gravitational force of the Universe, which enter the layers of the earth in the proportion and, aided by the heat and moisture therein, cause the origin of metals, of various varieties, grades and qualities. Souma metals are Sowmyaka, Soundaasya, Soma Panchaanana, Praanana, Shmkha and Kapila. These metals are used for making specific desired loha or alloys.

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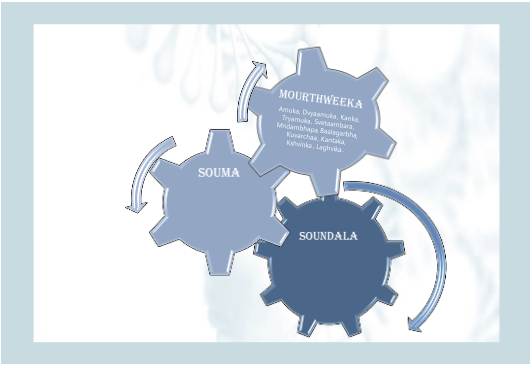

Figure 1: Three Beej-Loha containing different types of metals

1.1.2 Soundala Metals

In Soundala metal, the 11th force, Dhanada, in Koorma is indicated by letter "sa". The 110th Kashyap force, rook, is indicated by the sound "ow". The sun's 100 powered Dravamukhee shakti, and Bhoota-shakti known as Anvee 700 powered, are together indicated by the Anuswaar sound "m". The sun's kaantaa shakti 49, and the stars' 25 shakti, varchaa, are indicated by the letter "da". Similarly the soma forces in Dhruva Varga, is indicated by the long "aa" in "daa". The moon's 364 Ujwalaa and Baadabaa's 500 known as Kaala are indicated by the letter "la". That is "Soundala (Figure 1)

1.1.3 Mourthweeka Metals

"Mourthweeka", Koormashakti, Paarthiva 1300, is indicated by the letter "ma".Kaasyapa shakti, Kaalima 2001, is indicated by the sound "ow". Maartanda shakti, laaghava260, is indicated by the sound "r": Bhoota shakti, vaarchulee 37, by the letter "tha": stellar force, Rukshmaka 1063, is indicated by the letter "va". Arkashakti, Varuna 113, is indicated by the sound "e": soma force Rijukaa 8009, and Pooshnikaa 1012, are indicated. by the letter, "ka"

Each of these three loha has 11 types of metals classified under them (Table 1**)**

Table – 1: Three types of Core metals (Beej Loha) and metals under each category

2.0 ANCIENT CONCEPT AND CLASSIFICATION OF LOHA (ALLOY)

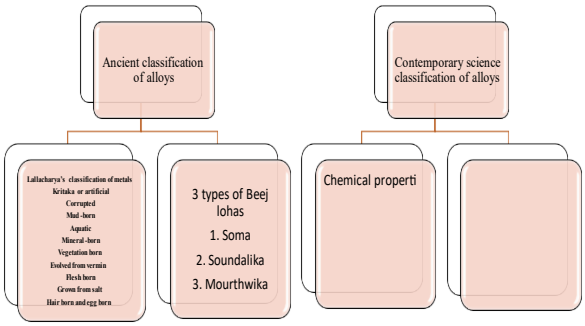

Figure 2: Ancient and Contemporary Criteria for classification of alloys

In this article ancient alloys are referred as LOHA and Iron was referred to as Lauha. According to ancient Indian metallurgy, in nature there are four Suddha loha or pure metals (Suvarṇa or gold, Rajata or silver, Tamra or copper, and Loha or iron). There are two Putiloha (Naga or lead and Vaṅga or tin) and there are three Mishra loha (Pittala or brass, Kansya or bell metal, and Varta-loha.Vedic metallurgy describes the term loha in a broader sense, it is not limited to iron only as described in modern science. The term loha had wide and different meaning -It is used for material or technically for the material which is used to do or create things. It is base material from which things are machined or cut out. In Vimaan Shastra seven metals (gold, copper, silver, lead, tin, iron and mercury.) have been used either as it is or in different Louha or alloys.

To obtain different alloys for manufacture of varieties of Vimaanas, sixteen types alloys have been stated to be processed from the three core metals by mixing in different proportions. These sixteen types of loha are categorized as: Agnitrit, Amlahana, Bhaarahana, Garalaghna, Panchagna, Raajaamlatrit, Sheetahana, Ushmambhara, Ushnaahana, Ushnapaa, Veeraha, Vijamitra, Vishalyakrit and Vishambhara

Two most prevalent classification in the ancient metallurgy are described in Lohatantra chapter of Vimaana Shastra**;** and the other by Lallacharya [8] written in his four books.

2.1 Ancient Classification of Loha as per *Lohatantra*

Lohatantra mentions classified Loha into three Beej Loha groups namely Somaka, Soundalika and Mourthweeka. According to Lohatantra. Beeja Loha are elements formed inside the earth during formation of earth's crust and by influence of cosmic rays coming from Sun, Moon, and other deep space objects. Different Loha was made by using different combinations and proportions of *Beeja Lohas* (Figure-1) to get Loha of desired advanced properties.

2.2 Ancient Classification of Loha by Lalla Acharya

Lall Acharya an Aeronautical Engineer and Astronomer of an Ancient India, mentioned by Bharadwaj in Vaimanik Prakaran; offered another form of classification that was based on the type of ingredients used in synthesizing loha, i.e. mud-born, aquatic, vegetation-derived, evolved from vermin, flesh as source, salt grown, hair born, egg born, corrupted and mineral born. Four books written by Lalla Acharya are the source of various loha; these books are

(i) Rahasya Lahari which describes secrets of aircraft in detail.

(ii) Lalla Karika mentions secret treaties for Pilots (Rahasyodhikari) on Metallurgy describes 12 types of alloys viz Kritaka , Apabhramshaka, Sthalaja, Khanija, Jalaja, Dhatuja, Aushadhivargaja, Kimija, Mansaja , Ksharaja ,Balaja , Andaja). It also covers about the food diet and clothing for Pilot.

(iii) Mukura Kalpa - Mukura means mirror. This book is about different types of Lenses (Mani) and Mirrors

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(Darpana) used in Vimaana. It is quoted in Darpana-dhikaranam chapter of Vaimanika Prakarana by Bhardwaj.

(v) Yantra Kalpataru describes Brakes or Padma-Sandhana for Vimaana designed by Lalla Acharya. All these books have encompassed various knowledge about Loha, used for different purpose.

3.0 CONTEMPORARY CLASSIFICATION OF ALLOYS

In contemporary classifications of alloys (Figure 2) are based on several factors, such as their composition, properties, and intended applications. Some common classifications are;

(i) Based on Metal Combinations include Ferrous alloys which contain iron as the base metal, such as steel and cast iron. And Non-ferrous Alloys, which do not contain iron as the base metal, rather they have copper and zinc (i.e. Brass) or (copper and tin (called Bronze).

(ii) Based on Composition classification have mostly three types of alloys i.e. Binary-Alloy (composed of two elements); Ternary-Alloys (composed of three elements) and Multicomponent -Alloys (composed of more than three elements).

(iii) Based on Atomic Arrangement are two types pf alloys; Substitutional-Alloys: here atoms of the alloying element replace some of the host metal atoms in the crystal lattice and Interstitial Alloys in which the smaller atoms of the alloying element fit into the spaces between the larger atoms of the host metal.

(iv) Based on Microstructure alloys could be either Solid Solution Alloys having a single-phase microstructure, where atoms of different elements are uniformly distributed, or Intermetallic Compounds having a more ordered structure with distinct chemical compounds formed between the constituent elements.

(v) Property based alloys are High-strength Alloys engineered for superior strength and durability; Heat-resistant Alloys designed to withstand high temperatures without significant deformation or degradation; and Corrosion-resistant Alloys formulated to resist corrosion and degradation in harsh environments**.**

(vi) based on Synthesis Method it could be either Casting Alloys primarily used in casting processes, such as sand casting or investment casting; or Wrought Alloys that are shaped by mechanical processes such as rolling, forging, or extrusion. Finally there is

(vii) Application based alloy they are Structural Alloys used for structural purposes, such as in construction and engineering; Functional Alloys designed for specific functional properties, such as electrical conductivity, corrosion resistance, or magnetism and Decorative Alloys used for aesthetic purposes due to their color, lustre, or other decorative properties.

However, it must be said that These classification methods are not mutually exclusive, and alloys can often fall into multiple categories depending on how they are analyzed.

4.0 ALLOY SYNTHESIS DURING ANCIENT AND CONTEMPORARY PERIOD

Synthesis of Loha is mentioned in various ancient metallurgy books such as Lohadhikaranam, Lohakalpa, Bodhananda vritti, Manibhadra kaarika, Kunda Nirnaya, Kunda Kalpa, Bhastrika nibhandana and many more.

Basic requirement for tailoring specific alloys, as we know today involves combining different elements to create a material with desired properties, which needs elements that are preferably purified, taken in proper proportion, thorough mixing to get homogeneous mixture, precise controlled temperature, duration of heating reaction , time and rate of cooling to get finer microstructures or even an amorphous structure, some processing parameters (pressure, inert atmosphere for preventing oxidation), and any additional treatments like heat treatments or mechanical working to further refine the properties of the alloy. After synthesis, need for characterizing the alloy to ensure it meets the desired specifications is of utmost importance. This may involve testing mechanical, chemical, and physical properties to verify the alloy's performance and suitability for its intended application.

4.1 Ancient Synthesis Protocol for Loha

Alloys its use properties and synthesis methods are mentioned in brief in table 1. There are many materials in recent times that are mentioned in table above and their comparison is made with that used in ancient times.

To reprise the basic facts the Standard Methods for Preparation of Alloys are same for contemporary and ancient Indian methods, however the tools used were slightly different (Figure 3).The touchstone or standard methods used by ancient Indians Metallurgists to synthesize Loha involved: Ingredients → Purified → Taken in Crucible → Placed in Furnace → Heated to desired temperature → Poured into mould → Cooled.

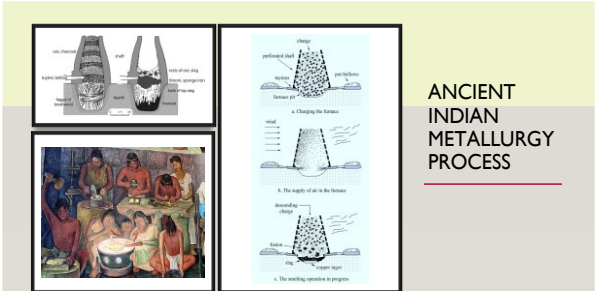

Figure 3: Representation of Ancient Indian Metallurgy process

Using this concise method we elucidate two alloys, having specific properties which will be in demand in present day aeronautics and space vehicles; i.e. It is

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1. Badhir loha (a sound proof alloy used in Vimaana for effectively controlling and mitigating the unwanted noise. Soundproofing materials work to reduce the sound pressure created from the source to the receptor. The ingredients as per shlokas given in Vimaana Shastra, in making Badhir Loha is given in table 2. It is composed of few metals but mostly plant derived ingredient. It is very different from the sound proof alloy used now-a-days i.e. Aluminium , Nickel-Titanium, Fiber-glass, Foam and Glass-wool. In contemporary methods no organic or plant materials are used.

Figure 4: Types of yantras used for different processes in metallurgy in ancient India.

2. Thamogarbha Loha is used in preparation of Thamoyantra i.e. darkness creating yantra that makes the aircraft invisible. Its synthesis ingredients and procedure are mentioned in 1 – 5 shloka of Yantrasarvasva written by Maharshi Bharadwaj. This loha is also prepared by using metals and natural organic and plant-based material

Not only these two, but there are many such loha that mentioned in Vaimanik Shastra that provides insight into the use of organic as well as inorganic materials in alloy making process which differs from the contemporary methods and so on. The above-mentioned Loha and their ingredients are evidence of the use of organic materials in the ancient times as compared to only inorganic materials preferred today.

4.2 Ancient Methods of Purification of Metal Prior to use

All metals of ancient times prior to use were subjected to varying treatments and after very high degree of purification , it was employed for alloy making process. For purification, process slightly varied for different types of metals.

4.2.1 Purification of Soma Metals

Soma metal is taken in a wide-brimmed vessel, to which Jambeera or citron juice, Likucha or lime juice, Vyaaghra or castor, Chinchaa or tamarind, and Jamboo or rose apple juices are added boiled to 27th degree for a day. Then the metal is taken out and thoroughly washed, treated with 5 oils of (Gunjaa or wild liquorice, Kanjala, Castor, Kunjara, & Karanja), followed by with four acids (Praana-kshara, Viranchi, Kanchuki, and Khura acids). Finally it is purified with seven decoctions of Hing, Parpata, Ghontika, Jataamaansee, White gourd or Vidaaraanginee, and Matsyaakshee.

4.2.2 Purification of Soundala Metals

Similar to Soma metal; Soundala Metal is taken in a wide-brimmed vessel to which citron juice, lime juice, castor, tamarind, and rose apple juices, are added, and boiled to 27th degree of heat for a day. After taking the metal out it is thoroughly washed. Unlike Soma metal, these are treated with seven oils (of Ingaala , Gouree or reddish herb, Couries, Grapes, Rata, Aapya, and Ulbana oils), followed by 6 acids (ankola, mushti, shankha, bhallaataka, kaakola, virancha acids). Finally it is purified with five decoctions of kuluththI, nishpaava, mustard, aadhaka, and wheat or gruels.

4.2.3 Purification of Mourthweeka Metals

Mourthweeka metal are first baked and then boiled in a wide-brimmed vessel with the same ingredients and in the same method like Soma and Soundala metals. After taking out the metals are thoroughly washed. It is again boiled with Shivaari oil, followed by treatment with Kudupa acid and then with Vishambharee leather decoction.

4.3 Inclusion of Organic Materials in Alloy Making

As per Contemporary methods synthesis of metallic alloy generally Organic materials are not used as constituents. Alloys are typically composed of metallic elements or compounds, which are combined through various physical or chemical processes to create materials with desired properties. However, organic materials can play indirect roles in alloy synthesis, particularly in processes involving organic solvents, binders, or additives. In some synthesis methods organic solvents are used for dissolving metal salts or compounds before alloy formation. These solvents help in preparing precursor solutions or facilitating chemical reactions, but they do not take part in alloy formation as reactant. In powder metallurgy techniques or metal injection molding, organic binders are often used to hold the metal powders together before sintering. While the binder itself is not part of the final alloy, it aids in shaping and consolidating the metal particles. Organic compounds may also be used as additives or modifiers to influence specific properties or processes during alloy synthesis. For instance, organic surfactants or stabilizers can be employed in colloidal synthesis methods to control particle size and shape. However, in the context of the final alloy material, organic components are typically removed during processing steps such as heating, sintering, or chemical treatment, leaving behind the metallic alloy structure. The resulting alloy is predominantly composed of metallic elements or compounds, with any residual organic content typically reduced to negligible levels. Unlike contemporary methods during ancient times most of the Loha (alloys) making involved use of organic materials. The reason for inclusion of organic materials and its significance seems much advanced than recent times, maybe it was as a catalyst or for imparting specific properties to alloys; or their use was very judicious

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and sustainable needs to be verified. Few alloys of ancient and modern times with same purpose but differing in their ingredients are presented in Table -2. It also mentions that these loha were used for different yantra (Figure 4)

Table -2: Alloys Used in Vimaana That are mentioned in Vimaana Shastra by Maharshi Bharadwaj (as well as other sources that he followed)

5.0 BASIC EQUIPMENT USED IN SYNTHESIS OF LOHA BY ANCIENT AND CONTEMPORARY METALLURGISTS.

Metallurgy is a combination of scientific knowledge, practical skills, and specialized equipment to create alloys that meet specific requirements. The common tools or apparatus that has been used or are being used includes are: weighing or measuring apparatus, grinders for powdering, churner or mixing vessels with stirrers, heat resistant crucibles or Moosha to hold metals during melting or alloying process, for heating or annealing Furnaces or Bhastrika.

5.1 Furnaces/ Bhastrika and Heating System

Concept of furnace has been same for contemporary as well as ancient metallurgists. A furnace is an appliance that generates heat. It includes several different parts to create heat and then distribute it through your air ducts to make it warm. When activated by a thermostat, a furnace ignites fuel (such as natural gas) to produce heat. The heated air is then circulated throughout the space, ensuring comfortable temperatures indoors. However, the heating system and source has been very different in ancient methods.

Ancient scientists mention 532 varieties of Bhastrika or fire-places. Of them Koorma-Vasatika, or tortoise-shaped fire-place is best suited for melting the seed-metals for the Vimaana. Kunda-Kalpa or the art of furnace construction mentions 532 kinds of furnaces. They are divided into seven classes, each including 76 varieties. As per the texts provided by Moosha Kalpa ancient metallurgists seem to have developed a wide variety of crucibles to suit each process. The process of manufacture of Antarmukha [Inward looking] crucible stated to be prescribed for preparing metals for Vimaana is given in detail. Thirty types of furnaces or heating equipment called *Bhastrika* are used for making parts of Yantra in Vimaana are mentioned in Brihad Vimaana Shastra (Table 3). An imaginary figure of ancient furnace is presented in figure 5.

Table -3: List of Thirty Types of Furnaces mentioned in Brihad Vimaana Shastra

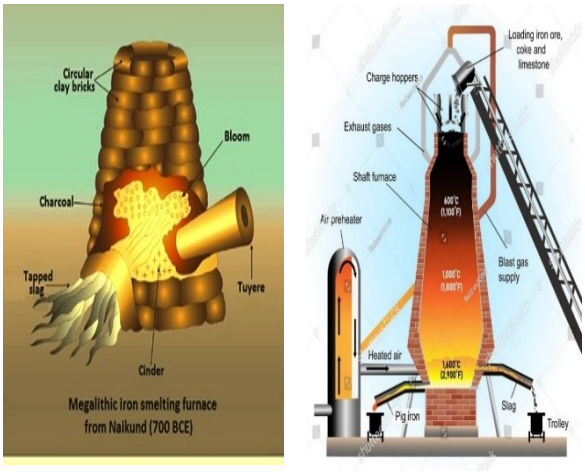

Figure 5: Type of furnace used by (left) ancient and (right) modern metallurgists

5.2 Crucibles or Moosha

A crucible is a specialized container used for high-temperature processes, particularly in metallurgy. It withstands extreme temperatures without melting or reacting with the substances inside. Now-a-days it is made of ceramic, graphite, or refractory metals. The alloying elements are placed in the crucible, and the base metal is added. The mixture is heated until it reaches the melting point, allowing thorough blending. Once molten, the alloy is poured into molds or shaped as needed. Now-a-days types of commonly used Crucibles are made of:

1. Alumina (Al_2O_3) Crucibles for material having high MP & relatively chemically inert. Tolerates up to 1750°C
2. Nickel crucible resistant to chlorine & gaseous HCl acid. Bur not suitable for Organic, Sulfuric, & hydrochloric acids. Withstands 600°C,
3. Sintered Vitreous Carbon crucibles are is resistant to 3000°C in inert gas.
4. Tungsten Crucible - Tungsten is a rare & hard chemical element having highest MP, high tensile strength, high density, & low vapor pressure can tolerate up to 3,400°C
5. Porcelain Crucible is made of Clay, Quartz & Feldspar ($3Al_2O_3 . 2SiO_2$). It is 99.96%. resistant to Alkalis, and 99.99% to Acids. It Can be used to 1200°C
6. Platinum crucible is made of pure platinum or alloys with varying levels of rhodium or gold. Accordingly it can tolerate from 600 - 1600^0 C.
7. Carbon-bonded and ceramic-bonded clay graphite & silicon carbide crucibles are best for melting & holding Al & Al- alloys, Al-bronze, Cu & Cu-based alloys, Cupro-nickel and Ni-bronze alloys, precious metals, Zn & ZnO.(Can respectively tolerate 400 -and 16000 C
8. Ceramics such as Alumina, Zirconia, & especially Magnesia tolerate up to 2000°C.

The ancient Sanskrit word used for crucible was Moosha. According to "Nirnayaadhikaara", the melting of the superior, medium, and inferior kinds of metals is to be done in 407 different kinds of crucibles. They are divided into 12 groups.

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For the melting of the root-metals the second group of crucibles is considered the best. Lallacharya [7] also states that different classes of crucibles are to be used for melting different kinds of metals. In the second class of crucibles there are said to be 40 varieties. Of them, number 5, known as Antarmukha or inward-mouthed, is prescribed for melting the root-metals. The ancient scripts serve as supporting evidence and mentions the design of furnaces and crucibles that were made or formulated as per need. The furnaces in ancient times were mainly made of clay, charcoal and wood as compared to what is used today i.e steel and ceramic fibres. Though ancient literatures mention of 407 kinds of crucibles only 22 - types of crucibles are used for making alloys, glass, mirror and crystals and/or for melting metals for yantra. They are : Antarmukha, Karpala, Lotus Shaped, Manduka, Matsya, Meayooka, Mritkundala, Mrugendra, Beaked, Padma, Padmasya, Samavargika, Sarpasya, Sarpmukha, Shasha, Shukti, Shundaalaka, Simhika, Triyuti, Uraana, or at places just -Moosha is mentioned.

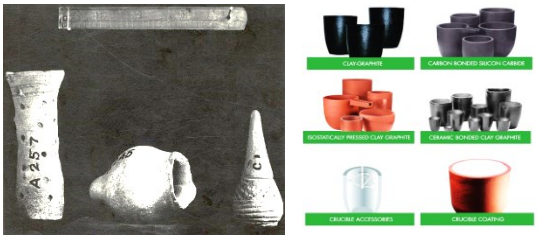

Figure 6: Crucibles during (Left) ancient Harappan era and (Right) modern times

5.3 Role of Man-power

The manufacturing of alloys in recent as well as ancient times proves the role of skilled man power was pivotal especially as a collaborative team for smooth alloy manufacturing. Of course the role of researchers who developed the methodologies for synthesizing was crucial, but role of skilled man-power to carry it out at the production level was also very important. Though many automated machines are available now to carry out different processes; it was not the case during the ancient times; they required more skilled personnel to handle the process at each and every step; be it blowing through the bellows manually to increase the temperature or casting the alloy and so on. Manual operation was more favoured than machines that regulate it now.

In ancient metallurgy, manpower was crucial for various purposes, right from the mining operations to extract ores from the earth. Miners work was challenging as they used hand tools to dig out ore veins; to transportation from the mine to the smelting facilities. This could involve carrying ore over long distances or using simple carts or sledges. Taking ores for the smelting process, which involved heating the ore and to high temperatures to extract the metal. Manpower was needed to operate bellows or other devices to supply air to the furnace and to manage the fuel and ore inputs. Finally adding different metals and other herbal and organic ingredients and heating it to form the alloy. Shaping and refining was the product finalization stage, this could involve hammering the metal into shape or casting it into molds. Skilled metal workers would use their hands and simple tools to achieve the desired shapes and finishes. In addition to metal production itself, manpower was needed for constructing and maintaining the infrastructure associated with metallurgy, such as mines, furnaces, workshops, and transportation networks. Overall, manpower played a central role in all aspects of ancient metallurgy, from mining and extraction to processing and shaping the metal into useful objects. Ancient metallurgists were contributing to purification, grinding mixing, churning, heating, pouring into molds; cooling etc. with controlled quality at every stage. This is generalized in the figure – 5.

6.0 POTENTIAL OF THE ANCIENT LOHA FOR PRESENT DAY SCENARIO.

The ancient texts in Vaimanik Shastra represent various alloys or loha used for different purposes.

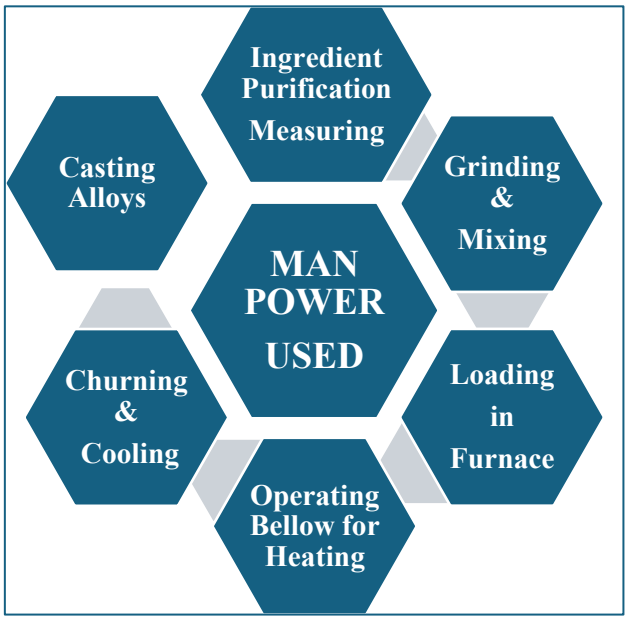

Figure- 7: Use of Man power in alloy making process during ancient times

There are many loha that may offer potential for its use in present day scenario and needs to be explored e.g. (i) Badhir Loha which is used in making Sound proof yantra, (ii) Thamogarbha loha used for making Thamo yantra that is used for camouflaging or hiding the Vimaana from enemies-defence mechanism, (iii) Chapalgrahak Loha that is used in making Shakun Vimaana possessing foldable or retractable wings, and in generating electricity. (iv) Ghantarava Loha that can records all sounds and are highly sensitive to different types of sounds, (v) Krowncha Loha to protect from water and rain, (vi) Kundodara Loha it can withstand up to 2000^0C heat and a blow from cannon, (vii) Panchdhara Loha, it is highly malleable and resistant to corrosion, NaCl, and H_2O, (viii) Shaitya Grahak Loha it can be used for thermal insulation and heat sink to overcome high temperature risks; etc.

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Moreover, loha can be explored for its use in devices used for energy sources in the form of hydro, crystals, and solar energy and many more such things that can be applied in recent scenario for innovative and sustainable purposes. The ancient loha are also indicative of bearing unique properties that can be used for creating new machineries that are novel and cost effective holding a great potential in nations economic development in the present-day scenario. Moreover it may help in understanding the significance and preferences of certain ingredients used in making alloys, the pyrometry used then and now. The ancient texts may act as a probe to gain insight into BEEJ loha, novel ways of alloy making along with discovering new metals thus accelerating the science of metallurgy that unfolds the secrets of Vedas for sustainable developments in near future.

7.0 CONCLUSION

This article has briefed ancient knowledge of metallurgy used in Vimaana. The ancient knowledge about loha, based on their properties, have provided a very systematic classification of metals known to them. Ancient metallurgists have provided a new angle to look at the purification of ingredients to be used in alloy synthesis. Moreover, we also get the glimpse of their knowledge about furnaces, crucibles, heating system etc. Loha or alloys synthesis for the betterment will be an on-going process and so its application for varying reasons. One must decide its application based on the legitimacy and repercussions; here one has to critically think about unearthing our ancient knowledge and learn to create things in a manner that is not against the nature. This article on comparison of alloys in recent scenario with respect to ancient times is an eye opener for researchers to reconceptualize and create things which is -for the nature, of the nature and by the nature

REFERENCES

1. CSR Prabhu, "High Technology in Ancient Sanskrit Manuscripts" National Informatics Centre, A Report, Hyderabad
2. Maheshwar Sharon, A. Sundaresan, Madhuri Sharon, A study on Chumbakmani as described in Brihad Vimaana Shastra. Indian Journal of Energy 2(1): 90-95, 2013 http://ije.informaticspublishing.com/
3. Kavya Vaddadi, "Research on Rukma Vimaana", 2nd International Conference on Recent Advances in Design, development and operation of micro air vehicles (ICRAMAV), JNTU, Hyderabad.
4. Dongre, N.G.(1994)," Dhvantapramapaka Yantra of Maharshi Bharadwaja", Indian Journal of History of Science,29(4), pp 611-627.
5. Maharshi Bhardwaj. Brihad Vimaana Shastra, Translated by Swami Braha Nuni Parivrajak, Sarvdeshn Arya Pratinidhi Sabha, New delhi-1, 1959
6. Shastry, Subbaraya; Josyer, G. R. (1973). Vymaanika Shaastra - Aeronautics by Maharshi Bharadwaaja. Mysore: Coronation Press
7. Ved Vyas, Yajurved, Translated by Rekha Vyas. Sanskrit Sahitya Prakashan, New Delhi
8. Sri Kutupananda Nath, Lallacharya – An Astronomer & Aeronautical Engineer of an Ancient India, Pondicherry , India

List of Tables:

Table – 1: Three types of Core metals (Beej Loha) and metals under each category.

Table -2: Alloys Used in Vimaana That are mentioned in Vimaana Shastra by Maharshi Bharadwaj (as well as other sources that he followed

Table -3: List of Thirty Types of Furnaces mentioned in Brihad Vimaana Sharta

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TABLE 1

Serial Numbers Allotted to each Metal	Souma Metals	Soundala Metals	Mourthweeka Metals
1	Souma,	Viranchi,	Amuka,
2	Sowmyaka,	Souryapa,	Dvyaamuka,
3	Soundaasya,	Shanku,	Kanka,
4	Soma	Ushna,	Tryamuka,
5	Panchaanana	Soorana,	Svetaambara,
6	Ushmapa	Shinjika,	Mridambhapa,
7	Shaktigarbha	Kanku,	Baalagarbha,
8	Jangleek	Ranjika,	Kuvarchaa,
9	Praanana,	Soundeera,	Kantaka,
10	Shankha,	Mughdha,	Kshvinka,
11	Laaghava	Ghundhaaraka	Laghvika.

TABLE 2

S.N.	ALLOY/LOHA	PROPERTY	USED FOR	INGREDIENT	SYNTHESIS METHOD	MENTIONED IN
1.	*Aathapaashaana -Loha* .	Light, Orange colour, Heat proof, Unbreakable	Surgaathapopasamhara yantra in Tripura Vimana	Prescribed ingredients in specified proportions Purified and Mixed	Filled in crucibles; Placed in Nallika furnace Using Mooshakasya bellow Heated to 725° Churned & Poured liquid in the cooler. Further purification as per Kriyasara	Kriyasara.
2.	*Araara Alloy:*	Copper containing alloy, Golden yellow (Hema-Varnam) Light, Brittle, Dridhan (very hard) Young's Modulus 16.9	Vakraprasaarana yantra. It is used to make a Wheel Which is installed in the bottom of the Eesha- Danda axle	Sulphate of iron, Peepul gum, and Copper 16 parts, Krishna-guru or black sandalwood 3 parts, Zinc 5 parts, Collyrium 1 part,	All the ingredients should be purified, mixed Boiled at 100 degree Aaraara copper alloy will be formed	Yantra Sarvasva
3.	*Badhir Loha or*	Sound Proof Or Deaf proof metal .	Shabda Kendra Mukha yantra	Panchanana metal or iron Camphor, Jack-fruit, Kuravaka or gigantic swallow-wort, Laguda or Sweet-scented oleander, Lime fruit, Luntaaka, Maaloora (Bengal quince), Rishika (water-calteop), Sarpaasya (*Mesua ferrea)*, Vaakula (*Surinam medlar),* Varasimhika(*Solanum xunthokurpum),* Vatika (*Salvinia cusullata),*	All ingredients taken in equal parts, Cleaned, Purified & Filled in Triyuti Crucible, Placed in furnace Heated – Casted in receptacles Produced metal	Loha Tantra OF Yantra Sarwaswa

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				Virinchi		
4.	***Byndala Loha***	Copper containing alloy, Fine Light, Blue colored.	Shabhdaakarshana yantra.	Zn, Cu, Hg, Fe, Brass, Steel, Mica, Sharakara, Shilaarasa, Benzoin, Dimbhaari, Areca-nut, Karagrathinee, Virinchi, Sal tree, Long blue Cucumber, Gumbhalee, Dumbholika alloy, Kshaara (Ammonium Chloride) Kraantika, Simha, Momordika, Dalinee, Eye-black powder, Kshonika, Red-lead, Yellow thistle, Madder-root, Mridarutee,	All ingredients are purified, Powdered, Taken in equal quantities in Shashamoosha crucible, Placed in Mandooka furnace, with 5-mouthed bellows Heated to 200^0 degrees And melted to eye-level, cast yields Bydaala alloy.	Loha-sarvaswa.
5.	*Chapalgrahak Loha*	Resistant to all acids A fine porcelain type ceramic OR Soft Glass of low temp. melt. Refractive Index 1.684	Vessel for storing Electricity generated from the dynamo	Quick-lime, Marble stone, Lac, Sowraashtra earth, Glass, Root of Elephant-trunk tree, Bark of karkata tree, Cowries, Cubeb pepper gum, Taken in the proportion of 8, 11, 7, 27, 8, 5, 3, 7, and 12 parts of tankana or borax,	Filled in Uraana crucible Placed in Kundodhara furnace Using 3-faced bellows Melted at 427° Poured in to receptacle and cooled to yield Chapalagraahak Loha	Lohatantra
6.	*Dambholi Loha*	A Thunderbolt Metal	Vidyutdwadashaka yantra. wheel	Urvaaraka, Kaaravika, Kuranga, Shundaalika, Chandramukha, Virancha, Kraantodara, Yaalika, Simhavaktra, Jyotsnaakara, Kshwinka, Pancha-mourtwika,	These metals after purification Taken in Mandooka-or frog-crucible, Placed in the five faced furnace, Using Panchamukha or 5-mouthed bellows Heated to 500 degrees, Yield the Dambholi alloy.	Lohatatitra-Prakarana.
7.	*Dhoomagarbha alloy:*	It ejects smoke fumes with speed of 2113 linkas. from dhooma yantra is	Dhoomodgama yantra of Sundara Vimana.	Himasamvardhaka, Soma, Sundala. in proportions of 32:25:38	Filled in pipe crucibles Placed in Chakramukha furnace Using Ajaamukha bellows	Yantra-sarvaswa

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					Heated up to 712° Properly churned	
8.	*Ghantarava Loha*	Fine, Light, Scarlet Red color, Records all sounds Highly sensitive to different types of sounds	Shabd Akarshana Yantra.	Bell-metal, Aaraara, Ruchaka, Emerald, Shalyakrintana, Panchaasya, Veerana, Gold, Shukatunda, and Sulochana,	These 10 metals are purified, Powdered and Taken in proportion of 5, 3, 12, 2, 3, 7, 5, 30, 4, 24, in Shukti crucible, which was wrapped all round with earth & Placed in Alaabu shaped furnace, Heated to 500 degrees & Molten liquid is poured into the mould. Yields a scarlet metal	Lohatantra.
9.	*Haatakaasya Loha*	Copper alloy with golden color.	Mast of Shakuna Vimana	Suvarchala (Natron)(8), Laghu Kshwinka (Light Zinc (16), Laghu Bambhari (6), Copper (100)	Filled in crucible Placed in Yasastika furnace Using Mahormi bellows Heated to 507^0	Lallacharya. Yantra-kalpataru, Lohatantra.
10.	*Krowncha Loha*	Light, Strong, Honey coloured, Rain- water and heat impregnated	Rain-protection yantra, in Tripura Vimana.	Prescribed ingredients in specified proportions purified and mixed,	Filled in Crucibles Placed in Padma furnace Using 3-face bellows Heated up to 512° Poured in to churning yantra and cooled	Yantrasarvasva
11.	*Kshoundeera Loha:*	Protects vimaana from enemy planes	Apasamara-Dhooma-prasarana yantra	Zn 8 pt, Hg 5 pt, Steel 3 pts, Ag 4 pt, Krowncha alloy 7pt, Madhaweeka 1 pt, & Ruru 5 pts; All 7 are purified	Filled in crucible, Placed in Chhatreemukha furnace, Using Surashi bellows heated to 100^0 Poured in mould – yielding Kshowndeera alloy.	Loha tantra.
12.	*Kundodara Loha*	A blue, Fine, Light alloy Can withstand up to 2000^0 Glass proof against canons, Withstands bombardment from Shatagni / Sahastragni	Chaturmukha-ooshnasya yantra of Sundara Vimaan	Soma, Kanchuka Soundala in proportions 30:45:20	All are cleaned Filled in Padma crucible Heated in Chatraamukha furnace Using Vasuki bellows Heated to 727° Poured for cooling	Lohasarvasva.

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		(artillery attack)				
13.	*Naaga Loha*	Is a Lead alloy	Peetha or foot plate for Vyswamaara Naala yantra. Provide fire for travellers in vimaanaIt is sed in making Prajwalakamani, Mahoshmikamani, Manjishta acid, Jwalinimukhimani	Ingredients not given	Process not given	Yantra-sarvasva
14.	*Panchdhara Loha*	5-Metal Copper Alloy Golden Yellow (Hema-Varnam) Strong, Heavy, Highly malleable, Corrosion-resistant to NaCl, & H_2O	Best for Shankus or Pivots for Guhaagarbha-darshana Yantra, Also as electrode	Purified & powdered Cu, Kshvinkaa, Fe-pyrites, Indra, & Ruruka,	Filled in Mrugendra moosha (crucible) Boiled to 300 degree using beaked bellows, Yield a 5-metal alloy, which is strong and heavy.	Lohadhikaran
15.	*Raj Loha*	Main body of Vimaana	Light weight. Durable, Sustainable Heat-resistant formability Weldability, Corrosion resistant	Silver Bhasma of 17 Pt, Garada or Aconite 8 Pt, Kshaara-traya (3salt:natron,salt-petre, Borax) 28 Pt, Maakshika (iron pyrites) 6 Pt, Naaga or lead 20 Pt, Mercury 15 Pt, Panchaanana or iron 20 Pt, Panchaanana or mica 20 Pt, Praana-kshaara (ammonium chloride) 4 Pt, Sea-foam 16 Pt, Shashakanda (or lodhra?) benzoin? 18 Pt, Wild Bengal gram 32 Pt, Panchaamrit (Curd, Milk, Ghee, Sugar, Honey).	These should be filled in the melter, And after boiling, and Drawing the liquid through two outlets, Filled in the crucible and Place in furnace, and Blown to 800^0, and Then transferred to the cooler.	Lohaprakarana Bodhananda vritti Maharshi Bharadwaja's Yantra Sarvasava
16.	*Shaitya Grahak Loha*	Cold absorbing alloy Can be used as Thermal insulation and Heat sink to overcome high temperature risks.	Shakti-Udgam yantra.	Blue lotus, Rhinoceros horn, Somakanda, Vishwaavasu, Moon stone, Crownchika alloy, Vaardhyashvaka alloy, Varuna tree, 5 Kudmalas, Simhaasya, Shankhalavaa, & Goose-berry,	Are purified Taken in equal quantities In Shundaalaka crucible, Placed in Chanchoomukha kunda, Using Panchaanana bellows for heating It yields a alloy.	Lohatantra
17.	*Shaktiskanda Loha* .	It is a steel alloy. .	For Rods used in electricity Storage vessel.	Ingredients not given	Prescribed ingredients in specified proportions	Lohatantra.

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			It is passed from the wheels inside the Aavritta-naala to the keys of the wheels in the churning yantra		Purified and Mixed, Filled in Uraana crucible Placed in Kundodhara furnace Using 3-faced bellows heated up to 427° to melt Poured in to receptacle and cooled	
18.	*Somanka Loha*	A special Fine alloy Light, Electricity-impregnated loha	For housing Electric Generator of Tripura Vimana This loha is used to make Pattikas with kuttinee yantra, or hammering yantra. A cradle-like vessel, made out of it, and covered with Pattika with hinges.	Lead, Panchaasya, & Copper, 7 parts each, Chumbaka or loadstone 9 parts, Nalikaa or Indian spikenard bark, sharaanika or rubus salt?, and borax, in equal parts.	Prescribed ingredients are to be filled in Sarpamukha crucible, Placed in Naagakunda furnace, filled with coal, Heated to 353 degrees with shashamukha bellows. When it melts Liquid is filled in the mixer, and churned Then poured out to cool. The resulting metal is Somaanka loha	Lohatantra
19.	*Somasa-loha:*	A fine, Light, Suitable for use in electrical machinery.	Vidyut yantra For housing in electric generator in third floor of Tripura Vimana	Ingredients not given	Prescribed ingredients in specified proportions Purified and Mixed, Filled in Sarpamukha crucible Placed in Naaga furnace Using Shashamukha bellows Heated up to 350° Churned the molten metal in mixer and poured	Lohatantra
20.	***Thamogarbha Loha***	Basically a Pb alloy, Light-Wt, Black, Acid-resistant, Absorbs light & creates darkness., makes Vimana invisible;	Thamoyantra	Black lead, (Graphite or Black Silver or Pb lead) Vajra-tunda. Aanjanika (Collyrium or may be Boric acid, sodium borate or sodium chloride.), Equal quantities of each is powdered & mixed,	Taken fish-shaped crucible Placed in Crow shaped furnace, heated to 100^0, Poured into cooling receptacle Yields Thamo-garbha loha, [darkness impregnated alloy metal, which is light, strong]	Yantrasarvasva

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21.	*Tri-Netra Loha* .	Soft Bluish like peacock feather, Very light. Fire resistant Heat resistant, Un-burnable, Indestructible, Water impregnable, Withstands wind & explosion	Construction of Tripura Vimaana To travel on Land, Sea & Sky Powered by sun's rays	Jyothismati-loha (10), Kantha-mitra (8), Vajra-mukha-loha (16) filled in crucibles add Tankana or Borax (5), Trymika (7), Shrapanikaa (11), Mandalika (5), Ruchaka or Natron (3), Mercury (3),part	Filled in crucible Placed in Padmamukha furnace Heated to 631° using Trimukhi bellows Resulting liquid is poured into cooler.	Explained by Shakatayana
22.	*Ushnambhara loha*	They are heat-proof	Used Wherever heat prof Yantriki are required	Mixing numbers 10, 5, 8 metals of Soma, Soundala, Mourthweeka groups respectively in the proportion of 1, 3, 7, Then mixing with one third the quantity of Tankana or borax To melting in the crucible. Similarly taking metals no, 3, 5, and 7 respectively in the three groups in the proportion of 4, 1, and 8, and mixing with tankana, and melting in crucible, the metal Ooshma is obtained. [Metal Ooshmahana is produced by melting metals 2, 5, and 9 from the three groups in the proportion of 6, 3, and 7, with tankana.]	All these three groups when taken in a crucible and to then Tankana or borax is added , it melts. Different types of Ooshmapaa metals are made up of 3 metals	Bodhaananda Vritti
23.	*Vaatadhaarana Loha*	Nice, soft, strong, c Cool, Light	Panchavaataskanda-Naala	Iron rust, Shaarana, Copper, Suvarchala salt, ALL taken in equal parts,	Prescribed ingredients in specified proportions purified and mixed – Filled in Mayooka crucible Placed in Jamboo-mukha furnace Using Kakamukha bellows Heated up to 102° & cast in the yantra.	Yantrasarvasva
24.	*Vaatamitra Loha* or air-companion	Nil	Vaataprasarana yantra An Air Spreading Machine in Sundara Vimana. To enable the vimaana to ascend, vaataprasaarana yantra is necessary	13 parts of Rasaanjanika or extract of Indian berbery, 27 parts of prabhanjana, 37 parts of Paraankusha, Are purified & mixed	Mixture is filled in Sarpasya or serpent-faced crucible which is Placed in Chakramukha furnace Using Vaaranaasya	Lohatantra.

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					bhastrika or bellows heated up to 216° Then filled in the Sameekarana yantra or churner, and next poured out and cooled, it will yield vaatamitra loha,	
25.	*Vaaruna Loha:*	A light, Smoke coloured, Impregnable alloy.	Tripura Vimana air force reducing yantra. is made of Vaaruna loha	Vaaripanka, Vishaari, Borax, Jaalikaa, Mango, Vishodara, Vaaripanchaka, Kshaarasaptaka, Kshona, Manjula or Madder root, Godhara, Vaarunaasyaka, Paarvana or *Chlorodendrum phlomoides*, Aruna, Kaakatunda, Bhoodhara, Vaarunaabhraka, Natron, Kundaaleemukha, Llodhra or benzoin, Varikudmala or water flower, Shaarikaarasa, Panchabaanasahodara, Lead 5 parts, Soorana or Tacca, Honey 8 parts, Vaata, kankanikodara, Sunda, anjana or eye-black, Kukkutaandaka, Khaadira or brown-barked *Acacia loddhruka*, Simhikaa-mukha, Koormajangha, and Masoorika or lentil,	All ingredients are cleaned, purified and mixed and filled in crucible, Placed in Padmamukha furnace, Heated to 700 degrees using 5 faced bellows, Poured into liquifying yantra and churned, will yield Vaaruna loha Further purification of metal is done as per Kriyaasara: First, place it in shundeera acid (great-leaved laburnum?) and boil for 3 days, and then with kuttinee yantra beat it into flat pattis, Then thick decoction of soorana root or tacca, is made & smeared it to 1 inch thickness on it and heat it for 3 yaamaas or 9 hours. Then mritsaara, vaagura, opium, should be boiled together for a day. The concoctions will become red like lac. The metal patti should be smeared with it and heated in the taapana yantra for a yaama or 3 hours. Then keep it in the sun for a day.	Bodhaananda Vritti: & Kriyasaara

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					Then kantaka or small caltrap, heranda, dhavalodara, and chaaraka, and gingelly should be mixed together, and the oil extracted. The metal should be smeared with it and kept in the sun for 3 days, Then heated in the sun for a day. Then paste the gum of kankola or cubeb pepper 1 inch thick, and stick into it thumb-sized vaatakuthaaraka manis, place in furnace of brown-barked acacia and cooled for 9 hours. The metal will become like diamond. Out of this a cover should be made for the Vimana	
26.	*Vaataayanee Loha*	Shining like gold. Fine Window metal	Naalapanchaka or Five tubes: to remone fume from Kitchen on the Vimana Pinjoola Adarsha Yantra window metal	Magnetic iron, Pinjula mica, Ghontaara metal, Dhoomapaasya metal, Tortoise shell, taken in the proportion of 1, 7, 5, 5, 8,	All ingredients are purified, Filled in crucible, Melted with 100 degree heat, when cooled, Yields Vaataayanee Loha	Nil
27.	*Vajeemukha Loha*	Copper alloy, Light reddish-brown color.	Shabhdaakarshana yantra Having goblet like vessels	Cu 3 pt, Fe-pyrite 2 pt, Zn 8 pt, Black metal 2 pt, Steel 3 pt Bs, bambhaarika 1pt, Kamsaarika 3 pt, Panchaanana 6 pt, Gowreemukha 2 pt, Shundaalaka 6 pt,	These 10 ingredients are purified and Filled in Shundaalaka crucible, Placed in Shoorpaasya furnace & Heated using Vajraanana bellows till melts It is poured in Vajraanana yantra & churned for proper cohesion of liquid, Yields Vaajeemukha Loha	Yantra Sarvasva

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28.	*Vakratunda Loha*	Nil	Sthambhana Yantra It protect Vimana from the attacks of giant wind blasts It is placed on peetha of Vakratunda Loha	Ingredients not given	Method not given	Kriyasaara
29.	*Vaatastambhan Kosha Loha*	Cu, Fe, Pb alloy Controls speed	Vaatastambana naal yantra's Tube	Dantee or croton seeds, Suvarchala or sun-flower salt, Mayoora or sulphur, Lohapanchaka or copper, Brass, Tin, Lead, Iron, Bhrisundika, Suranjika or sulphate of Hg Yaraahaanghri loha, Virohina or *Creya arboria*, Kuberaka, Muraarikaanghri metal, Ranjika or phosphorus, Suhamsanetraka, Dala or *Folia malabathy*, Courie sea-shell, Mrinaalikaa or lotus stalk,	All ingredients to be cleaned, purified, and powdered, cleaned, Taken in equal quantities In Matsya or fish-shaped crucible, Placed in Maaghima furnace, With the aid of vijrimbhana bellows Heated till melted, Molten liquid is poured into the mould Allowed to cool Will yield an excellent vaatastambhana loha	Lohatatvaprakashik a. Yantra sarvaswa "Gati-nirnaya-adhyaaya"
30.	*Vishakantha Loha*	Protects Shiraahkeelak a yantra from lightening	Shiraahkeelaka yantra. Ribs & Umbrella made of Vishakantha Loha	Ingredients not given	Process not known	Nil
31	*Vrishala Loha*	Nil	Pranakundalini yantra. Peetha	Ingredients not given	A square or circular peetha or stand 3' diameter & 3' high, , is made of Vrishala metal	Yantra-sarvasva

TABLE 3

S.N.	TYPE OF FURNACE	USED AT ^{0}C	USED FOR MAKING
1.	*Aatapa*	100	Shaktigarbha Metal:
2	*Alabu*	500	Ghantarava Loha
3	*Bhastrika* (Furnace)	800,	Shaktyaakarshana darpana, & Vyroopya--darpana
4	*Chakramukha*	216 and 712	Vaatamitra Loha & Dhoomagarbha alloy
5	*Chanchumukha*	100 and 716	Shaitya Grahak Loha & Kundodhara Loha
6	*Chandodara*	800	Vishwakriyaa darpana
7	*Chhatrimukha*	100	Kshowndeera Loha
8	(Crow shaped)	100	Thamogarbha Loha
9	*Jambu Mukha*	100	Vaatadhaarana Loha
10	*Koorna (Tortoise Shaped)*	100	Sunda-mud glass &Purified oil soaked silk, cotton, moss, hair, mica, and leather,
11	*Kula kundika*	300	Shaitya Grahak
12	*Kundodhara*	427	Chapalgrahak Loha & Shaktiskanda Loha
13	Lotus Shaped	323	Drava-Patra
14	*Maghima*		Vaatastambana alloy
15	*Mandooka* (Frog-shaped)	200 and 500	Byndala Loha, Shaktya-akarshana darpana
16	*Naaga*	350	Somasa-loha
17	*Naalika*	99 and 725,	Aathapaashaana-Loha & Pingala Darpana
18	*Padma*	512 and800	Krowncha Loha

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19	*Padmamukha*	631and 700	Tri-Netra Loha & Vaaruna Loha
20	*Padmakara*	300	Anti-Lightning [lightning proof] glasses & Sheetaghna Glass: Cold-proof Glass
21	*Panch Mukhi or Panchanana*	500	Dambola Loha
22	*Samavargika*	315	Pratibimba-arka-kirana-akarshana Naala
23	*Shashamukha*	350	Somasa Loha
24	*Shinjeera*	700	Kuntinee darpana
25	*Shoorpasya*	Till melts?	Vajeemukha Loha
26	*Shuka-Mukha*		Suryashaktyaprakaashana Darpan
27	*Varaaha*	100	Suranjitaadarsha Darpana
28	*Varrathakunda*	200	Abhra-mrid-darpana, or mica-sand glass
29	*Vishwodara*	200 and 500	Rowdree Darpana & Vidyut Darpana
30	*Yasastika*	507	Haatakaasya Loha
	Heating/Boiling Vessel	**300 and 100**	**Panchdhara Loha & Patadarpana**