CHAPTER V

CASTING TECHNIQUE.

With the evolution of coinage in India, there appear two totally different manufacturing techniques - the Punch Marked, that changed into Die-Striking and the casting techniques. The present investigation is mainly concerned with the casting technique. The evidence available of coin moulds so far does not seem to go beyond circa 100 B.C. These coins, as their period of circulation suggests, originated prior to circa 400 B.C. and were in circulation up to 2nd and 3rd century A.D. Hence the evidences of coin moulds do not help in understanding the evolution of the process of manufacturing technique. No doubt it reveals that by the 1st century B.C. complex coin moulds (Casting of several coins in the groups together) were in use. This in itself suggests that the casting technique was in a developed form by 1st century B.C. which must have been preceded by a long history of the casting system.

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Thus a survey of the evolution of currency system from barter to money may be helpful in reconstructing the picture of casting method. The use of coins is preceded by a long history in the currency system which probably was first documented by Aristotle as one step in the development of trade from barter to the use of coinage (Politics). His elaboration of the process describes a mutually agreed-upon commodity, such as iron or silver, at first clearly defined by size and weight, but eventually stamped so as to eliminate having to measure it, since the stamp was the mark of value. But metal as the medium of exchange was the immediate predecessor of coins having some characteristics of 'general purpose money'. The "general purpose money or currency serves all of the functions of the currency used in developed market economies. It is defined as 'a means of exchange, a mode of payment, a standard of value' and a method of storing wealth. Special purpose money serves some, but not all, of the functions of general purpose money and its usually restricted to specific spheres of the economy. .... special purpose currencies show considerable variability and differ widely in the

degree to which they resemble general purpose currencies. Moreover, elaborate societies often possessed currency that had a greater number of general purpose characteristics than simpler societies.\textsuperscript{2} The use of metal even as special purpose currency was a much later innovation in economic transactions in Indian history. For a proper understanding of the evolution of the currency system for stages of development can be recognised.

The earliest evidence is of barter where necessities are exchanged. This is also reflected in gift system where an element of reciprocity is inherent. But in this system of barter means of exchange was very much restricted to the individuals' need, where one person's need was fulfilled by the surplus of the other. In the second stage of evolution this practice innovated the means of exchange so as to remove the coincidence of the needs of two persons. Therefore, materially valued and relatively important things for the society acted as gift and means of exchange. Such a means of exchange acted as 'special purpose currency' in a given society and was universally valued in that society. The value attached to the means of exchange was related to its inherent functional value.

\textsuperscript{2} Michael S. Bisson "Copper Currency in Central Africa: the Archaeological evidence" \textit{World Archaeology}, Vol.6, 1974, P.278.
Even in stone age culture indirect evidence of such special purpose currency is not lacking. "The Paleolithic and Mesolithic man, being essentially a hunter and food gatherer had not use for food production though it is suggested that some sort of rudimentary trade might have flourished even during this period to acquire suitable stone to make tools. ... a hypothesis which is corroborated to some extent by the recent discovery of a microlithic factory site in the Singrauli basin. 3 In the Neolithic economy" the tool making industry having fairly specialized required some sort of exchange between the manufacturers and the users giving birth to the barter system to facilitate a regular trade between the consumers and the factory sites. 4 "Speaking of the economy of late stone age cultures, we have to bear in mind that the size of the larger factory sites of this period found in parts of Central India, North Mysore and Ceylon was such that they must have served the needs of more than a single extended family, group or band. Either many groups may have visited them or those who lived near such sources of

4. Ibid. P. 300.
good quality raw material must have exchanged tools or pieces with people from other surrounding groups' (Allchin). ... A good deal of evidence points to mutual exploitation of certain large factory sites by hunters and settlers alike. More probably in the Indian milieu, the hunters exchanged stone tools for other goods, perhaps food, with the Neolithic settlers. In any case such exchanges would only have occurred during the final stages of the late stone age when Neolithic settlers moved into any region. Baskets, honey, venison and muhua flowers which Tribal people still barter with their village neighbours for food and cloth, may also have begun to change hands at this early stage. 5 We have evidences which indirectly indicate import of the necessary raw material in Gangetic plain from Vindhya hills. 6 Thus in the second stage of the barter the utility value of the means of exchange was acceptable though it varied according to the nature of a particular society. In Pastoral and Nomadic society like that of the Vedic Aryans cattle mainly acted as special purpose currency. But in the growing

5. Ibid. pp.300-301.
agricultural economic context metallic tools and pottery became more useful and were used as means of exchange. However, that even in an agricultural society cattle remained useful and therefore, acted as a means of exchange along with other metals for a long time is revealed by the Vedic texts.  

The introduction of metal as a means of exchange thus marks the third stage of evolution in the currency system. The antimony rods found in abundance in excavations at many sites may suggest its use as a universally acceptable special purpose currency having more characteristics of general purpose currency than the stone tools, cattle and grains. An example from Zaire and Zambeii basins suggests rods, ingots and wire bangles as the main forms of copper currency. "In a wide belt stretching from the northern bend of the Zaire river to its delta the most common units observed by ethnographers were rods or brass wire, 25cm. long and bent into an elongated U - shape. Larger rods, in fact, bent ingots were worth about 160 small rods in 1900"8. Such available copper materials in our excavations throughout the entire 

7. See for details D.R. Bhandarkar, Ancient Indian Numismatics (I to IV camichael lectures 1921), (Calcutta, 1971), and Rajendra Singh and Satya Prakash, Coinage in Ancient India (Delhi, 1968) pp. 238-248.

8. n.2 p.280.
region may also suggest its similar use in the Indian context. The copper coin, which came in to use along with the appearance of the coinage, as is revealed by excavations, may have its origin in the numerous copper antimony rods, bangles etc. found in excavations. However, such origin of PM silver coins is traceable from evidences available in recent excavations in Iran. "In the excavations at Nus-i-jan near Malayir was found a hoard of silver objects in a bronze bowl buried under the floor level of a structure which can be assigned, on the basis of stratigraphical and other evidence, to the period of the Median Kingdom during the 7th century B.C. Among the contents of the hoard are a few bar ingots of silver of which only three are intact. It is pertinent to note that such bars have not so far been reported from any other site in the eastern Mediterranean region. These bars bear a striking resemblance to the earliest Indian coins which are known as bent bars. But the specimens from Nush-i-jan hoard are simple bars they do not bear any stamp or mark of the issuing authority in sharp contrast to the Indian bent bars which are usually stamped with solar or wheel symbol." This evidence would indi-

cate that some metal of a specific weight was used as special purpose currency prior to the advent of coinage. The element of 'specific weight' in course of time led to the system of adding certain marks or symbols revealing its value or weight. Addition of symbols or marks was made not only for attesting its weight but later on for the attestation of the purity of metal and its specific value backed by an authority. This was the fourth and final stage in evolution process, leading to the emergence of coinage.

Thus we find that primarily the symbols were used for two reasons; denoting its specific weight; and later on probably for attesting to its purity and/or acceptance by the people based on the authority of issuing authority. This suggests that in all probability the symbols on PMC and EUCCC acted as code which carried implicit meaning about the weight or value of the coin and identity of the issuing authority which indirectly is attestation of its purity. To this, in course of time, may have been added symbols revealing place, religion etc. Hence it would appear that a correct interpretation of the symbols can be made only with a proper understanding of the weight denomination and the relation between the real value of the metal and its face value. The face value and the real value of the coin were largely dependent upon the value
of the metal.\textsuperscript{10} Thus it can be said as Seltman remarked, "metal when used to facilitate the exchange of goods is currency; currency when used according to specific weight standards is money; money stamped with a device is coin. Metal intrinsically valuable, weight deliberately adjusted, the mark or device of a responsible authority, all three are needed to make a coin."\textsuperscript{11}

Use of coins, related with the economic activities of men, suggests that by the time it came to exist the society became more developed and consequently specialized in any crafts and industry. Thus a relationship between the evolution of coinage and its manufacturing technique is directly related. With the appearance of coinage we find that in archeological excavations the EUCCC and PMC present as the earliest coinage of ancient India. In excavations where both the coinages are found together in stratified layers, little attention has been paid to the exact precedence of one over the other. The evidences of hoards on the other hand can not be considered archaeologically for they are no more than pits as they suggest a deliberate burying by the owner. Moreover, most of such hoards as found from Bhirmound (Taxila), Patharaha (Purnea), Gorhoghat (Saharasa), Tong (Rajasthan)

\textsuperscript{10} This aspect is not being presently investigated.  
\textsuperscript{11} As quoted in n.1 p.293.
etc. are dated more on the basis of their contents than on the stratified layers. The evidence from Nus-i-jan (Iran), Chaman Huzuri (Kabul), and Mir Zakah (Afghanistan) hoards reveals "a clear transition from the plain bar currency of Persia to the stamped (Punched) bar coinage of the Indian type. It therefore, seems likely that the Indians borrowed the shape of the bar currency from the Achaemenians and that they stamped it with their own symbol... the possibility presents itself that currency in the form of bars circulated in the Indian plateau and Eastwards well before the rise of the Achaemenids and that the Indian bent bar coinage represents a development from this. In the Indian sub-continent the bent bar coins are found only in the Gandhara region whereas the Punch Marked coins usually rectangle or oval pieces of silver Punched with symbols, are widely found."¹² This evidence Mr Dhavalikar takes to suggest foreign influence on the origin of Punch Marked coinage and consequently on its manufacturing technique. But the symbols punched on these metal pieces were Indian in origin which carried some code value, and as the evolution of the currency system would suggest, must have been in use prior to the advent of the punching technique in India.

１２. n.9. pp 335-336
So far as the antiquity of casting technique in India is concerned, it goes back to the period of Harappan culture. Even the fabrication technique of the Punch Marked coins examined by H.C. Bharadwaj reveals use of casting technique. The Punch Marked coin must have been obtained essentially from cast metal pieces of appropriate composition. There is no evidence of cold working (hammering etc.). However, there is evidence of minor amount of compression as evidenced by unidirectional orientation of micro-constituents. These coins were probably clipped from a cast sheet and slightly hammered to give uniform thickness. The cast sheet might have been obtained by pouring the super hot melt on the flat substrate. The Punch Marks might have been incorporated by striking with hard dies made of bronze at room temperature as testified by the curving of the micro-constituents around the Punch Marks.

This suggests that the PM technique should not be considered more archaic than the casting technique and therefore the argument based on technological aspect in favour of PMC being earlier than cast coins seems out of context. It seems, that the earliest cast coins were also produced in the same manner. The flat substrate, was used

13. For details see J.Marshall *Mohenjo-daro and Indus Civilization* (London, 1931) and M.S. Vats *Excavation at Harappa* (Delhi, 1940).

14. H.C. Bharadwaj *Aspects of Ancient Indian Technology* (Delhi, 1979), p. 122
of a clay coin socket with symbols engraved, without any feeding channels, in which the molten metal was poured. Another socket like a lid was placed above it with or without the reverse impression. Therefore, the coins produced out of such moulds do not reveal the casting process clearly. The edges of such coins are sharp, without any mark of protuberances and are nearer to the Die-struck coins. (But symbols on these coins, occurring generally in the centre would suggest that the casting method was adopted in their manufacture. However, since no such coin sockets of the early period have been reported from excavations only a hypothetical recount of the casting process can be made.

The evidences of coins revealing such characteristics are available which may suggest a corroboration of the above stated method. The sharpness of the edges and fineworkmanship of finishing may also be obtained by subsequent treatment with chisel etc. However, such practices

15. The coins discussed in ch.IV category-3, Group B S.Nos 1 to 11 are with such characteristics. S.No.1 to 10 are discussed in J.N.S.I. Vol.I 1939 pp.5-8. S.No.11 was found in the early levels of period II, in excavation in Sonpur dated between circa 650 B.C. and 200 B.C. some of the coins consulted in the Museum Collections of Delhi and Patna also reveal similar characteristics.
do not seem to have been followed in those days as numerous copper coins found show protuberances and uneven edges, even in some cases with parts of other coins still attached to it. The micro-structure study of Rajghat coins also suggests simple casting clay moulds without any subsequent treatments. Thus the possibility of simple casting method in the earliest period can not be ignored. The simple method of casting in course of time gave way to the complex method in which feeding channels were used to feed the different coin sockets at a time. The micro-structure study of the EUCC from Kausambi suggests the use of clay moulds, probably with a cooling device which caused rapid cooling of the molten metal. This suggests that the moulds after being fed with the molten metal were put into water or wet clay or were so arranged to get into water for cooling process. After some time the coins were collected from such places, where automatically the moulds were destroyed. This method may explain why no such coin moulds are found in excavations of the early periods. Later on this practice seems to have given way to slow cooling process where moulds were covered with wet clay mixed with green vegetable matter. The wet clay with vegetable matters dried in the process.

16. n. 14 p.100
17. Rajendra Singh and Satya Prakash Coinage in Ancient India (Delhi, 1968) p.467.
of receiving the molten metals by the coin sockets, leaving moisture which helped in the cooling process and releasing of gas formed in the process.\textsuperscript{18} Thus the gradual change from simple to complex casting process, producing coins in a lot, was achieved prior to circa 100 B.C. as the earlier stated evidence would suggest. However, the protuberances left on some coins, on one or two sides may suggest the use of the complex mould much earlier than circa 100 B.C.

Thus an examination of the coins found in different layers in excavations may also reveal the manufacturing technique involved. However, as such a study is based presently on the photographs available of the coins in the published reports, the margin of error can not be minimized. One of the coins found at Hastinapur from an early level of Period III dated Circa 600 B.C. to 300 B.C. is without any protuberance and does not reveal the inflow of molten metal through channel.\textsuperscript{19} This again is the case with another coin of the same variety but found in the late level of Period III (Ch.IV. Cate. I, Gr.A, Var.I, S.No.1). But in the late level of Period III another coin indicates detachment of semi-molten metal on one

\textsuperscript{18}Birbal Sahni \textit{The Technique of casting coins in Ancient India} (Bombay,1945), pp 18-19, 58

\textsuperscript{19}B.B.Lal "Excavations at Hastinapur and other explorations in the upper Ganga and Sutlej basins 1950-52..." \textit{Ancient India} Nos 10&11 1954-55 p.102,S.No.5 Pl.LVIII. B.4.(Ch.IV.Category-1, Group A.Variety-I,S.No.2.)
This may still suggest the use of simple casting method as followed in the early period but probably two or more such coin sockets were fixed side by side which caused one side of it to become irregularly detached from the other. But a coin from early level of Period IV dated between Circa 200 B.C. and late A.D. 300 reveals protuberance on one side only, the other three sides with smooth edges. The protuberance left on one side suggests that the coin socket was fed by a channel of very thin diameter and that the coin socket was not used as a feeder for another socket. Thus at the site of Hastinapur evolution in the method of casting technique seems to reveal three stages from early level of Period III to the early level of Period IV. However, the coins available at the site do not suggest any abrupt end of one practice after the emergence of another.

At Pataliputra also a somewhat similar process is revealed in period I dated between circa 600 B.C. and 150 B.C. like that of Hastinapur. Some of the coins found are without any marks of protuberances with smooth edges suggesting simple method of casting. The next

20. Ibid. p. 102. S.No.1 Pl.LVIII.B.1 (Ch.IV.Cate.1 Gr.A. Var.E.S.No.8)
21. Ibid. p. 103. S.No.6. Pl.LVIII.B.5 (Ch.IV.Cate.1.Gr.B. Var.C. S.No.1)
stage is revealed by a coin belonging to the same period which bears on one side the incurved cut mark.\textsuperscript{23} This reveals that the extra metal attached with the coin was clipped off leaving a mark on it and is similar with the third stage of casting at Hastinapur. Another coin from Period I itself reveals the fourth stage in the evolution process of casting method with protuberances at least on two sides with two broken corners.\textsuperscript{24} This coin reveals that the coin socket also acted as feeder for another socket or sockets. The coins available from early levels of Period II at the site dated to circa 150 B.C. to A.D. 500 represent mixed examples of the above stages, some with blurred symbols and in broken conditions. This may suggest that the coins of Period I remained in circulation in early levels of Period II but were out of effective production in this period.

At Vaisali also in Period II a similar process is revealed. The Period II is dated circa 600 B.C. to 200 B.C., and it seems that within this time bracket the process of development in the casting method reached the stage of industrial production in a lot at a time. The other sites like those of Sonpur, Maheshwar and Navadatoli, Besnagar, Sravasti etc. also confirm these stages of development, though at these sites all the four stages are not

\textsuperscript{23} Ibid. p.50. S.No.11 (Ch.IV.Cate.1.Gr.A.Var.B.S.No.165)

\textsuperscript{24} Ibid. p.49 S.No.9 (Ch.IV.Cate.1.Gr.A.Var.B.S.No.163)
represented. This is also in conformity with their period of circulation and at all sites all stages are not likely to have occurred. Thus now it seems that the coins found at various sites are also useful in reconstructing the method of production involved. The first stage appears to be the simple casting method in which the molten metal was poured in a socket with symbol marks and another half of the socket was placed after pouring in of the metal. In this practice no feeding channels were used. Probably for cooling purposes the sockets were placed in the water or wet clay which destroyed the moulds. The edges of such coins are smooth and thus have the appearance of Die-struck coins. Coins with such characteristics are represented in the collections of the National Museum, Delhi and Patna Museum, Patna. These coins may be taken to represent the early stage of casting technique.

In the second stage also there does not seem to be any evidence of the use of channels for feeding the coin sockets. At this stage two or more coin sockets were placed together, open and probably side by side. Thus


the coins produced through this method reveal evidence of detachment in semi-molten stage on one or more sides, as a thin layer of metal would remain between two coin sockets. However, this practice does not seem to have been widely followed. The coins with such characteristics are also represented in the museum collection. There are three coins in Patna Museum collection, two of square shape and one round which are left with the extra metal between the two coins. On these coins the extra metal is still left attached which may be the part of other coin.27 Another coin, of which the three sides present evidence of forcible detachment probably in semi-molten stage suggests that probably six coin sockets were placed together.28

The third stage seems to be represented by the use of channels. The coin sockets were fed through channels which were connected with a main channel. The coins produced out of such moulds are with protuberance or mark of protuberance on one side. The other sides are smooth and sharp.

At the fourth stage of casting - the coin socket acted as the feeder for another socket or sockets. It seems that the third and fourth stage remained in practice for a long period as is revealed by the evidence of coin moulds found in different localities. The protuberances left on many coins also reveal the diameter of the channel used, particularly of those connecting one coin socket with another. However, a measurement of the diameter here is not included, still the placing of the channels in the disc connecting the coin sockets is suggested. One of the coins in the National Museum Collection, Delhi, reveals that while preparing the channels on the disc, the coin socket was pressed on one corner, probably to adjust the length of the channel. It resulted in pushing the symbols downward diagonally, however, still corresponding with the border. But the pressed corner covered the symbol on other couple of the socket. Therefore, on obverse of the coin round portion of the taurine is out of flan and on reverse the Three-arched-crescented Hill and Hollow-cross is pushed downward and Tree-in-railing is diagonally placed. Similarly pressed corner though without disturbing the symbols are found on many coins, some of which may be representing broken corner in Museum collections.

29. Ibid. S.No.43
On one coin the protuberance is on the corner about 6 cm. thick, 31 thus suggesting that the coin sockets were connected with the feeding channel on the corner of square of rectangular coins. But many coins also reveal protuberance on one or two sides in the centre. Thus the sockets with coin impression seem to have been connected with channels at any point. On round coins generally two such connections of channels with the sockets seem to be placed on two opposite sides, 32 but on some it is placed at a distance of a quarter. 33 However, the bulk of the round coins reveal protuberance on one side only.

The protuberances left on the coins always do not suggest the thickness or diameter of the channels, but some times are left due to the defects in the coin sockets. If the couple of sockets i.e. the mould couple are not set properly (face to face) the molten metal overflowed from the gap, creating irregular side or sides. 34

31. Patna Museum, Patna. S.No.1159. (This coin is not included in Ch.IV. as the symbols are completely blurred.)
32. Ch.IV.Cate.1.Gr.A.Var.H.S.No.1; Cate.2.Gr.B.S.Nos.2&3.
33. Ibid. Cate.2. Gr.A.Var.E. S.No.1.
34. Ibid. Cate.1. Gr.A.Var.A.S.No.34; Cate.1 Gr.A.Var.B. S.Nos.5,23, 45,55,64 and 82; Cate.Gr.A.Var.C.S.No.4 and 19. (Apart from these are many other coins in Museum Collections with similar characteristics.)
Some of the round coins are attached with each other through the extra metal left in the casting process. On one specimen, while the protuberance suggesting the use of channel on one side seems to be of very thin diameter, the central one covers almost one fourth of the coin. Thus the extra metal in the centre, though connecting the two coin sockets, seems to have been deliberately created, probably to produce the double of one coin. The mechanism involved seems to have been simple, the two coin sockets were placed side by side and the connecting part of both the sockets were pressed on the disc to allow the molten metal to cover both the sockets. Thus in the centre no channels were used, though one socket acted as a feeder for the other.

Now it seems, that the evidences available of the coins from stratified layers and museum collections suggest that the life of EUCCC witnessed the evolution of casting technique from simple to complex method. The discs with one coin socket connected with the channel and with many coin sockets connected with the feeding channels to the main channel are available, which reveal the manufacturing technique of the coins. Though such moulds available are of late periods, they reveal the complexities.

35. Ibid. Cat.e.1. Gr.A. Var.H.S.No.11.
involved in casting process. The EUCCC also witnessed all the four probable stages in the development of casting technique. Therefore, the moulds found of late periods may be considered relevant for reconstructing the picture of manufacturing technique of latter two stages of EUCCC.

The moulds found at Nalanda, Rajghat and Sunet are with single coin sockets on one disc. The Nalanda coin mould of Jayagupta coin "is a clay cylinder of Ca. 3 cm. diameter, 13 to 17 mm. high, with a flat bottom. The coin socket is placed eccentrically on the upper end; it communicates with the exterior through a rather wide channel which expands outward like a funnel, with the outer opening nearly twice as wide as the inner... there are two slightly oblique-key lines on the cylindrical exterior..." 36 At the same site another coin mould found was of Narsimhagupta with essentially the same feature as that of Jayagupta described above. These two coin moulds found are dated to A.D. 625 to 675. The coin mould of dark grey colour found at Rajghat is in broken condition and does not reveal the manufacturing technique. 37 But the coin moulds found at Sunet of third-fourth century A.D. present a detailed picture of the manufacturing. The Sunet moulds "bear the coin impression only on one face, 36 n.18. p.37 37. Ibid. p.39
the other being either flat or slightly convex. The clay is some times of a grey colour, sometimes red. The average diameter of the disc is ca. 28 mm., and of the coin socket 23 mm. Round the coin socket there is a raised rim 2 to 3 mm wide which, ... has a rough fractured surface except for a smooth gutter-shaped channel leading across the rim into the socket. It was along this rim that the disc was coupled with another bearing the opposite design; the two appressed rims enclosed the coin socket, the two half-channels together forming a circular inlet for the metal. The fractured surface of the rims is due to the disc having been split as under to take out the coin.\(^38\) Altogether 82 discs were found at the site. The complete discs (obverse and reverse impression facing each other) were probably placed parallel to one another so as to make up a cylindrical pile as the adhering remains of plaster on the back of each disc would suggest. Some of the discs were found joined in the above mentioned manner revealing the way it was placed. It seems, as Birbal Sahni would suggest, that the discs were placed one over the other in a series and covered with the clay mixed with cow dungs, vegetable matters

\(^{38}\) Ibid. p.35.
and husks on the outside leaving the mouth of the channels. The channels were connected with one main feeder. The series of discs were placed either vertically or horizontally as the case may be, according to the shape and function of the main feeder. Thus, the Sunet moulds reveal clearly that though one disc carried only one coin socket still many coins were produced in a single operation.

At Rohtak were found discs having several coin sockets impressed on both sides. The moulds found at the site have been dated to 100 B.C. and it seems to represent the earliest available mould of ancient India. "The mould was made up of a series of discs placed in a vertical column like a pile of coins. The whole pile was plastered over with clay, only a funnel like crater being left at the top for receiving the molten metal. The crater led vertically down into a central canal, like the shaft of a mine. From this canal, ... horizontal channels led out at different levels, and these opened into the coin sockets. At each level eight such channels radiated from the central shaft, and opened into as many coin sockets arranged in a ring. The coupled faces of contiguous discs bore the negative impressions of the obverse and reverse, respectively, and were so placed
as to make the opposing sockets coincide exactly. \(^{39}\)

The process of manufacturing was a complex one and several coins were to be produced in a single operation. Though the discs were impressed with coin impression on both sides, still one set of discs was separated from successive sets by a dusting powder spread between their blank contiguous faces. The complete set was plastered over with clay mixed with vegetable matter and husks which kept the set firm and porous and helped in releasing the gases formed in the process. Only the crater was left above through which the molten metal was poured in, which flowed into the feeding channels at different levels.

The number of set of discs used in a single operation is not known to calculate the number of coins produced in one operation. On each disc eight coin sockets were placed probably by pressing the coin or the coin model into wet clay. Similarly for making the eight radial channels a special model with eight spokes was pressed on the clay connecting the sockets with the main feeder. 'Probably before the final set of casting the entire mould, with its clay luting was put in a furnace which hardened the discs and burned the vegetable matter in the luting, thereby making it porous enough for escape of gases.' \(^{40}\) Thus

39. Ibid. pp.18-19
40. n.17. p.220.
it seems that the Rohtak mould presents a detail picture of the complexities involved in the multiple casting of coins.

However, the moulds found at Taxila dated to circa 150 B.C. do not present a similar detailed picture. The quality of the clay, mode of construction of the mould together with its finish is of much inferior type than that of Rohtak. The discs found are of two sizes one about 4" in diameter, the other about 3" in diameter, with one face blank of each discs. A V-shaped inlet was pressed on the disc which narrowed into a fine canal feeding the nearest coin socket placed in the centre. This coin socket acted as feeder for another socket connected by channels.41

At Mathura were found moulds of PM coins which Late Mr. Durga Prasad observed as "an attempt to fake silver Punch-marked coins by casting, and prepared these compound moulds from very fine clay, but he made the impressions from worn coins which are now available, not knowing that he was using coins of three different periods..."42 The one complete disc available reveals the manufacturing process employed. The discs bear impression of five coins, each connected by a feeding channel

41. n.18.p.41
42. Quoted in Ibid. p.47.
with the main channel. The main channel is V-shaped at the top. The complete set includes three discs, the middle one with coin impression on both sides, while the other two discs carry coin impression on one side only. The middle disc shows V-shaped cut on both sides for the inlet of the molten metal. The clay of these moulds is of an unusually fine grain, and the discs are perfectly made. "Very likely the same discs were used again and again. With the luting applied in such a thin layer it must have been possible to dismantle the mould without damaging the discs."  

Two similar PMC moulds were found in the excavation at Sisupalgarh in layers dated to circa A.D.300. Of the two discs found one was fragmentary revealing only part of three coin sockets. "The complete disc (2.7" diameter) shows sockets of eleven coins with designs completely worn out presumably by repeated casting operations, but the irregular shape of the sockets ... leaves no doubt that they were meant to produce Punch Marked coins."  

However, as the available figure would suggest, at least two coin sockets are exactly round, though of di-

43. n.13, p.46  
45. Ibid. pl.XLIX.A.
fferent diameters. Thus probably Die-struck coins were also used in preparing the coin sockets. So far the mechanism involved suggests a similarity with the Mathura moulds of PM coins. The Sisupalgarh disc reveals "at its rim a V-shaped notch with a straight channel for the inflow of the molten metal. The channel on it is not connected with the coinsockets by means of feeders, which may be presumed to have existed on the missing couple of the disc. ... No luting was detected adhering to the edges of either discs." 46 Thus it seems that some what an identical process was employed at Mathura and Sisupalgarh for casting the PMC. This reveals that PMC were in circulation even in A.D. 300. Probably these moulds were to produce PMC copper to be coated with silver and pushed into circulation.

At Ataranjikhera Kushana coin moulds of bright red colour and of rectangular shape were found. "In the middle of one of the four sides there is a large expanded opening from which several canals branch out to supply the coin sockets. These canals, however, only feed the nearest sockets, which also communicate with

46. Ibid. p.99
one another through short connecting channels. The sockets further removed from the main opening are supplied indirectly, through the nearer opening. This mould has been dated to A.D. 200 and is differently made than the multiple moulds found at Rohtak, Mathura and Sisupalgarh. Here the coin sockets are used as feeder to another socket. Only eight coin sockets on one fragmentary disc available are visible. Four canals connected at the top to receive the molten metal are connected with the four coin sockets in a row. These sockets are also connected with the nearest two coin sockets. The four sockets in second row, available only partly, are connected through channels with the upper coin socket. Thus the coin sockets in this mould show connecting channels on four, three and probably two sides of the sockets.

The four moulds preserved in the Museum at Sanchi and labelled as 'clay seal' represent 'single coin discs of terracotta about 21 mm. in outer diameter. The coin sockets vary from 13 to 13.5 mm. On all these specimens there is an U-shaped cut leading to the socket, to serve as an inlet for the molten metal. The U-shaped cut goes

47. n.18. p.43. pl.VI. Fig.126.
right across the thickness of the disc, suggesting that the discs may have been combined as in some Roman moulds in two or three piles with a central crater at the top. In the mould probably three such discs were placed in a rounded manner, making a triangular gap in the centre. This type of complete set was placed one over the other with a canal to feed the different coin chamber, placed in the centre. The mould impressions found represent the coins of Western Kshatrapa dynasty.

Some moulds were found at Kondapur and Kadakal, but the details about the working of these moulds are not available. Some of the Kondapur moulds "like those described from Mathura, were meant for fabricating Punch-Marked coins, others recall those from Sanchi, Sunet and Nalanda... But no really useful comparison can be made until we have a further knowledge of the material." 49

Two fragmentary coin moulds were found in excavation at Bhokhardan. "The mould when entire, was provided with five coin sockets on one face, the other being plain. The extent fragment contains only two full sockets

48. Ibid. p. 48
49. Ibid. p. 61
and a part of the third. The molten metal passed to the coin sockets through feeders which in turn received their supply from the main channel. The two fully preserved sockets are inter-connected with each other by a feeder. Part of the principal channel is also visible. The margin of the disc is slightly raised, a device aimed at ensuring a close coupling with the missing couple. The shapes of the two coin sockets are different, one round and other being oval with some legible symbols. The third coin socket is only partially preserved and much worn out.

Thus on the basis of the evidences of mould available a reasonably fair picture of the casting process can be reconstructed. It seems that the disc with one coin socket and with multiple coin sockets were in use, side by side, so far as, the chronological aspect is concerned. But the multiple discs mould, such as from Rohtak, were probably to be used only once. From the evidence of luting around the complete set of mould it is obvious that none of the discs can be removed intact, and there can, therefore, be no question of their being capable of use for repeated castings. This was a limitation which

51. n.17. p.221.
kept the comparatively simpler moulds like those from Sisupalgarh, Nalanda, Mathura, Taxila and Sunet continuously in use. The simpler moulds as the thin layer of luting would suggest, had the advantage of repeated use.

Although the metal left in the channels was probably reused, still accuracy of weight was greater and non-wastage of metal was possible under the punching technique. This may perhaps have been an important reason for the absence of silver cast coins in the early period. For the exact accuracy of weight punching technique was required, which is in accordance with the rare metal like silver. In the mould, though the coin sockets were prepared to produce a coin of fixed weight, still the extra metal left attached with the cast coins suggest "that moneyers of ancient India were rarely careful about about the weight of copper coins they manufactured."\textsuperscript{52}

The casting technique in those days was therefore, confined to copper coins alone.

The copper metallurgy in India is developed from the time of Harappans. The copper mines at Khetri in Rajasthan probably acted as sources for the Harappans. The copper

mines in South Bihar were probably exploited after circa 1100 B.C. "There is likelihood that copper smelting started in the area of Singhbhum positively by the time of copper hoard people (ca.1100 to 800 B.C.). The famous copper hoard site of Gungeria yeilding 424 copper implements and the copper hoards from Manbhum Dist., Hazaribagh Dist., and Ranchi Dist., etc. are indicators of the exploitation of rich copper belt of Singhbhum in Bihar." 53 The evidences available from Sikkim and Singhana suggest the primitive smelting practices. 54 Thus it becomes sufficiently clear that to start with the casting technique the necessary metallurgical knowledge was available to understand the complexities involved in casting. Silver was a comparatively rare metal in the country and probably imported. Therefore, copper acted as the main metal to be used as the means for transaction. Gold though available was not suitable metal for smaller transactions and further it was considered as export metal, however, gold currency is mentioned in our Vedic literature. "The total absence of references to silver currency in the Vedic literature is obviously due to the fact that silver was extremely rare in the country. Even

53. n.14. pp 94-96
54. Ibid. pp 91-92.
today we do not produce enough silver; the only mines that are presently being worked and yield silver are those at Zawar near Jaipur in Rajasthan. Further, since the Indians regarded silver as inauspicious as it 'sprung from tears of Rudra' and in Vedic literature it is known as 'white gold', without any proper name, it seems logical that this metal was imported from outside and could not have formed the backbone of the currency system. As such, gold for heavy transactions and copper for smaller transactions, acted as currency of the period to which silver was added in course of time.

To conclude, it can be said that the evolution of the currency system and the art of manufacturing metallic pieces gave birth to coinage in a comparatively developed technological stage. The simple cast pieces of metal produce from the ores available, which acted as currency prior to its attestation of weight and purity with the help of symbols. Thus, these symboled pieces are the Archaic coins of ancient India. There are three such coin types known as Punch Marked, Die-struck and Uninscribed Cast Copper. In Punch Marked the pieces were impre- 332-333.
ssed with symbols with the help of different punches made of bronze or iron. In the Die-struck technique on a single die were impressed the whole set of symbols. This die was pressed on metal in a semi-molten stage, placed in a socket of definite shape. In the casting technique the molten metal was placed in a socket to get the definite shape and symbols. Thus, the punching and casting technique are the two main technological advancement introduced in the manufacturing of coinage. The Die-struck technique, an improvement in the punching technique with involvement of casting method was also being followed in those days. The similarity of manufacturing process between the earliest stage of casting technique, where the metal was poured in a socket with symbols, without the help of channels and then was covered with the other pair of the socket probably also with symbols and the Die-struck technique where molten metal was placed in a socket and in semi-molten stage it was struck with symbols, is obvious.