

ANCIENT INVENTIONS FOR TOOLING THE SURFACES OF OBJECTS IN SOFTER METALS

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Collectors of ancient Greek copper coins have often been puzzled by central pits that they find in the metal of their specimens. The pits are deliberately made with tools, so they must have a purpose. They have nothing to do with the design of the coin types or images, so they must relate to some other field of manufacture or custom. They are ugly—perhaps not so much puzzling as even grievous or vexing—and seeming blemishes of such seriousness must have played a part of some importance in the active life of the coin. Most collectors, it is true, get used to them and accept them as a normal and not too depressing attribute of an ancient Greek copper coin; but there is always a hankering to know more about why they are there, and since the attention of professional numismatic scholars is usually fastened upon grander things, little enough has been written about these marks.

They are called central because they usually appear more or less at the center of the coin disk; conical because they descend into the metal conically toward a point, as though they had been produced by the tip of a rotating drill or of a hammered nail-set; and cavities because of their nature as holes, pits, or depressions. Thus they are known in full

as central conical cavities.

In 1908 (*Rivista Italiana di Numismatica*, pp. 157-168), the Italian scholar G. Dattari put forward the thesis that these cavities first appear on copper coins issued during the reign of Ptolemy II, king of Egypt. This was the son of Ptolemy I, a Macedonian general under Alexander the Great, to whom Egypt had fallen during the break-up of Alexander's empire which followed upon his death in 323 B.C. Although Ptolemy I issued many copper coins during his reign which lasted till 285 B.C., it was not the practice to create such pits upon them. But by the time of Ptolemy II, himself a great administrator who reigned 285-246 B.C., the practice was common.

Dattari believed that the purpose had to do with coin-making technology. He thought (and it is now recognized) that the blanks or "flans" for these copper coins, which were often of great size (sometimes the biggest ones weigh 100 grams or about a quarter of a pound and they are nearly two inches across), were cast in moulds of various descriptions, but usually in gang-moulds that were open at the top so that the molten metal flowed via narrow necks from one individual circular coin-recess to another, and on solidifying the metal surface was approximately at one level



eighty percent, with some broken or mutilated coins falling even lower. Thus it seems best to conclude that trimming, and not also exactly balancing weights, was what the Egyptians sought in the coin blanks.

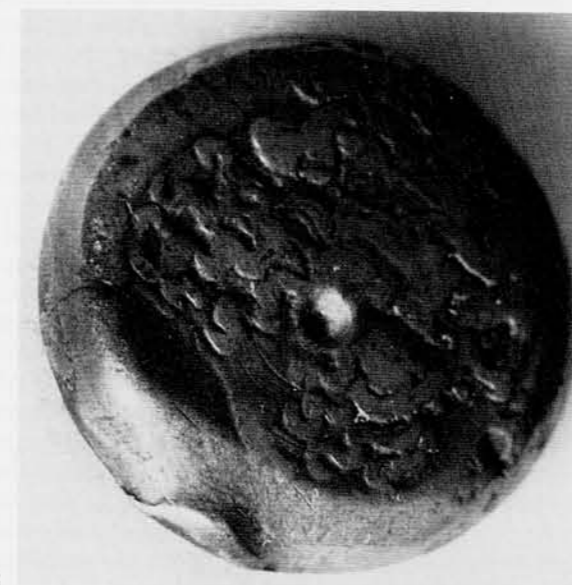
Solid metal of a rather easily-worked copper-tin alloy could easily be given a rough trim or finish by a turning process. This would not be like the turning of a table-leg in a wood lathe where the long blank is held between two centers; it is more like the face-turning of a plate-like workpiece.

What kind of device did the Egyptians use for this purpose? Three similarities can be suggested: something like the turntable of a phonograph, or like the cast-iron disk that is used by a diamond polisher, or like an amateur potter's wheel. Mendel Peterson of Washington has suggested the last similarity, which is perhaps the best, in some detail: there could have been a circular turntable, quite small in dimensions to suit the relatively limited diameter of even a large coin blank; a spindle running from beneath it through a wooden workbench-top and nearly to the floor level; and just above the floor a rather large horizontal disk on the spindle, heavy like a grindstone, to provide inertia and serve as a speed-governor—the operative could provide its motive power by kicking at this flywheel's edge, as a potter does with his wheel. The little turntable could be faced with leather, rough skin-side upward to increase the friction-hold of the turntable against the metal coin disk upon it.

And now for the central conical cavity: the coin blank could be held much more firmly in place by the addition of a movable dead-center, brought down upon the coin disk from above. Imagine something like the elbowed arm of an adjustable electric lamp as now used by architects and draftsmen, but having instead of the present bulb and shade merely a weighted metal rod with a conical

throughout the chain of blanks. Then the coin-disks were broken apart at the "necks"; this left a rough projection. In addition, when the metal solidified on cooling its surface might be puckered or affected by gas bubbles, and it would have picked up some of the impressions of the grains of casting sand. In these large coins it would be convenient to cut away these surface imperfections so that the eventual product would be neater and smoother.

Dattari had another idea in this connection—that the purpose was also to reduce all members of a set of coin-blanks to a very close range of weights. But this does not seem to hold up. If one takes a considerable number of surviving specimens from within any one issue of these large Ptolemaic coins, it will be found that the weights are not all very close together. Instead, it is likely that weights starting at one hundred percent will go down by rather gradual and even steps to about



1
Obverse of a Ptolemaic copper coin, not precisely identified.

2
Obverse of a copper coin of Ptolemy VI, King of Egypt (Svoronos 1424).

point. The central cavity would be struck, or else perhaps lightly drilled, into the center of the coin blank, and the conical point of the dead-center could rest within this cavity, with weights upon it to hold it firmly in place.

Set up in this way and put into motion, the device would rotate the coin blank evenly and firmly. The person running it could then apply both hands to controlling a chisel with a very narrow flat point, with which he would chisel the surface of the coin blank in an extremely gradual spiral, producing, as it were, light regularly-spaced grooves as on a phonograph record. The resultant surface would be at least somewhat more regular in contour and in consistency than the original surface left by the mere casting process; and much of the remaining irregularity, the pattern of grooves, would be reduced or eliminated by the subsequent striking of the blank with the coin dies.

We can see that not all of the groove

pattern was removed every time by the striking. Figure 1 shows the obverse side of a large Ptolemaic coin retaining some of this pattern even after striking (precise identification of this particular coin by weight and size is not available). The worn, corroded, chemically cleaned outline of an extremely hirsute male head facing right is faintly visible. There are profuse curls of hair on the head, and there is a very large curly beard. This is the conventional head of Zeus Ammon which appears on a great proportion of Ptolemaic copper coins. Unfortunately the face is the faintest part of the image.

Upon—or rather, through—this picture one sees a relatively regular and complete pattern of grooves left by the chisel. These grooves are circular, and may spiral very gradually—preservation is not quite complete enough to demonstrate that they actually do spiral. At the center is our cavity.

The center has a peculiarity—a crater-like rim has been thrown up around it, as can best be seen through the shadow cast by this rim immediately below the depression of the cavity itself. This cannot have survived the heavy blow by means of which the die images were struck upon the coin. It must have arisen after the coin had been struck. The coin, already with its image, must have been put back on the turning device for some purpose, and the weighted point of the dead-center must have ground, or spun, the cold metal so heavily that this little rim was thrown up. The purpose of this further processing can only be guessed at. The bevelled edge of the coin (shown mostly shadowed in the figure) may have needed some attention, too. Perhaps it was more effective to tool it after the coin had been struck, when there would be no further spreading at the edges of the coin surface. At any rate, concentric lines do appear faintly on the beveled coin rim, these being most visible

Credits

No. 1, photograph by Bluford W. Muir; Nos. 2, 3, 4, 5, photographs by David F. Stover.

in the upper left-hand quadrant of the edge. A rough place depresses the rim at the top—this may be what remains of the place where a “neck” between two coin-blanks was broken in two, the subsequent tooling of the edge failing to remove the stub entirely.

Other means were sometimes employed to give a better trim to the beveled edge of these coins. Our second figure shows the obverse side of a coin of Ptolemy VI of Egypt (181-146 B.C.), of the class identified in Svoronos's work on the Ptolemaic coins as No. 1424. The photograph has been taken obliquely to show especially the edge below the cut-off of the Zeus Ammon head (the features appear well to the right and slightly above center), and the conical cavity is well off center downward; some chisel-scorings will be seen concentric to the cavity. At the bottom edge some more or less straight and parallel markings appear; these are evidently the strokes of a file. No effort seems to have been made to remove the stub of a spur where a “neck” was broken through. It is tempting to suppose that instead of a file, a milling device geared to the rotatory system of the turntable on which the coin was laid may have been used; that would imply the invention of a machine tool, surely an important innovation if this could be demonstrated. But I have been unable to persuade myself, in this and other cases, that there is sufficient evidence to allege such a thing. Till much clearer evidence becomes available one must hold that all tools used in these operations, even though they may have been steadied against a rest, were hand-held and not geared to the rotary motion.

The other side of the same coin (Figure 3) shows rather peculiar accidental phenomena. It is more unusual for the reverse side of a Ptolemaic coin to show marks of tooling, but here the marks are extremely clear—more so, perhaps, than the type, which is of the usual eagle standing on a thunderbolt and with an almost totally mutilated inscription which originally read ΒΑΣΙΛΕΩΣ ΠΤΟΛΕΜΑΙΟΥ. Concentric tooling with the chisel was in this case very carelessly done. One sees at the bottom edge some tracks that show the whole breadth of the chisel's blade. That breadth is found to be about one-half of a millimeter or two one-hundredths of an inch. Tiny though that dimension is, the blade was cutting deep enough for it to be subjected to excessive strain, and as a result it “chattered”—the concentric cuts are barred across with little hatchings that show where the chisel jumped as chips of metal were torn in very rapid succession from the metal's face. I am inclined to believe that these barred tracks were produced with the coin rotating counter-clockwise, and that the coin was held by a right-handed man, a little oblique to the circu-

lar course of the track; others might argue differently.

After this very carelessly executed job of tooling was done, this face of the coin was struck with the eagle die. It was not struck hard enough to eliminate the marks of tooling; not hard enough, indeed, to fill with copper all the recesses in the die's face. The coin was, in the parlance of collectors, “not struck up.” It was nevertheless released into circulation.

Metallurgical studies performed by M. Julien Guey and M. Maurice Picon in France have brought clearly to light the main processes (the above ones included) that were used in manufacturing large Ptolemaic copper coins. But central conical cavities appear abundantly on small coins of the class as well. Yet since these small Ptolemaic coins often have conical cavities very far from center, and never show the concentric marks of chisel-tooling, it is not known for what purpose the cavities were applied. It may be remarked here that in Egypt the use of these cavities is carried on through the reign of the last Ptolemaic sovereign, the famous Cleopatra (VII) whose Egyptian coinage came to an end with the arrival there of Julius Caesar in 46 B.C. The Romans coining in Egypt apparently did not make use of the central conical cavity on any appreciable scale thereafter.

Meanwhile, use of the central conical cavity had been borrowed by the Seleucid kings of Syria—descendants of Seleucus I, another of the generals of Alexander who shared in the partition of his empire. Seleucid copper coins were smaller, as a general thing, than the Egyptian ones, and the cavity seems to have been used for the first time here only in the coins of Seleucus II, 246-226 B.C. It does not seem to appear after the coins of the second reign of king Demetrius II (129-125 B.C.). I am not aware that hitherto any marks of concentric chisel-tooling have ever been found upon the faces of Seleucid copper coins, so the purpose of their application might have had to be left as remaining a mystery. Fortunately, however, it is now possible to present as Figure 4 a photograph of the reverse side of a coin of Demetrius I (162-150 B.C.). It comes from his mint at Tyre. It bears a date, year 154 of the Seleucid era (159-158 B.C.). Numismatically it is described as No. 770 in E. Babelon, *Rois de Syrie*. The image it bears is that of the stern of a war galley. There is a small cavity slightly above center of the coin disk, and concentric to this (but not to the disk!) there are tracks of a chisel used to smooth the surface of the disk before striking—they can be seen best just above the letters [B]ΑΣΙΛΕΩΣ of the inscription, near the top. This is, I believe, at the same time the smallest coin (about 21 mm. or less

than an inch) upon which such concentric tracks have thus far been found, and the first coin of one of the Seleucid kings of Syria on which they have been found.

In Hellenistic times, coins bearing the central conical cavity were also found more or less frequently in Cilicia right next door to northern Syria, and on occasion at Cyzicus, on the south shore of the Sea of Marmora. In Cilicia they were presumably a result of Syrian influence, and at Cyzicus they may have been. Finally, there were cases in cities of the Greek Peloponnesus. Two young friends of mine are now preparing doctoral dissertations upon separate aspects of this last field, and these when finished should throw light upon the chronology of the Peloponnesian coins that bore this cavity in the first century B.C.

The purpose of this article is technological rather than historical, but I do find it necessary, in moving toward a concluding technological case, to describe very briefly the time and space frame of the use of this cavity in the Greek world under the Roman emperors. The usage was confined to that part of the empire. Under Julius Caesar and Augustus it was limited to very few places. Under Tiberius and Caligula it disappeared except for the mint of Corinth. Thereafter it commenced to pick up ground very gradually and by the reign of Hadrian it was fairly flourishing in Asia Minor. From that point onward to the close of the so-called “Roman Provincial” and “Greek Imperial” coinages about A.D. 275 this practice was widespread in Asia Minor and Thrace, and abundantly evident where it was used at all. Its processes and purposes are for the most part mysterious, and explanation would call for much separate study of the issues of each mint.

Figuratively we have a picture of this

usage of the central conical cavity that resembles an hourglass, both in time and in space. It was used abundantly in Hellenistic times only in Egypt and Syria; with the Roman conquest of Egypt it dwindled, becoming an extremely tenuous waist at Corinth alone in the reigns of Tiberius and Caligula. Thereafter it spread gradually northward and eastward, again assuming proportions of pronounced magnitude from A.D. 150 to 275 in an entirely different region, namely Thrace and Macedon to the north and Asia Minor to the east.

Among technological vagaries which I am inclined to regard more or less as freaks, there is nevertheless one line of material evidence during this late period that reflects the use of another mechanical invention. This is the holding of a disk-shaped work-piece at its edges alone, for face tooling without any central retentive spindle such as was held as a socket by the conical cavity on the large Ptolemaic copper coins.

In 1968 Messrs. Picon and Guey printed a note in the *Bulletin de la Société Française de Numismatique* (No. 10, December, pp. 336-337) in which they called attention to later third century coins of Asia Minor which showed marks apparently of circular tooling, but which did not have central conical cavities. They cited actual coins in the French National Collection which are presumably unpublished, but in this connection they referred to publications of analogous coins from the same mints. As regards their references to published photographs of coins in the von Aulock collection, I do not find those illustrations by any means a satisfactory demonstration of the tooling the French scholars have discovered in actual coins.

On the other hand, I am fortunately in a position to offer here a photograph of an



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3
Reverse of coin No. 2.4
Reverse of a coin of Demetrius I, King of Syria, from the mint of Tyre. (E. Babelon, *Rois de Syrie*, No. 770).



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actual coin that exhibits brilliantly the phenomenon which the French scholars had observed on the Paris specimens. This example (Figure 5) shows the reverse of a coin issued at Samos, a large Greek island off the coast of Asiatic Turkey, in the time of the Roman emperor Philip the Arab (A.D. 244-249); the coin is described numismatically as Mionnet, *Description de médailles antiques grecques et romaines*, Vol. III, Samos, No. 255. The obverse shows a bust of his young son, known as Philip II; the present reverse shows a warrior standing facing the viewer, with his open right hand raised and with a shield on his left forearm; the prow of a miniature war galley is at his feet. Motifs of a young warrior with a war galley are familiar among coins of Samos for Philip II, and since the thousandth anniversary of the founding of Rome fell in this reign, I have been inclined to believe the coins may represent the young prince in the role of Aeneas just after landing on the shores of Latium. It is clear that strong circular lines of chisel-tooling appear on this coin both between the head and the shield and also crossing the knees, but there is at the same time no central cavity as a resting-point for a dead-center in the tooling machine. Since the circular marks are concentric not to the outline of the coin blank, but instead rather to the type which has been stamped upon the coin, one might argue that the circular tooling was done upon the die used to strike the coin, and not upon the coin blank. But the grooves of the tooling actually run across the modelling of the figure at its knees, where the metal has not been fully struck up into the negative relief of the die. I do not think this could have happened if the die had been tooled, rather than the coin blank. However this may be, it seems to me that this coin affords clear proof that the blank has been supported solely by being contained at its edges, by some sort of wedge-like props (to compare this apparatus with the three-jawed chuck as used on a modern face lathe would be adventurous), and that the ancients of this place and period knew how to tool the faces of flat circular objects without holding them down by means of a pin bearing against the center. The invention may seem a modest one, but it is at least something that should be placed on record.