Technical Examination

KATE C. LEFFERTS

Conservator, The Metropolitan Museum of Art

THE FIGURINE stands 15.9 cm. high, and with the vase in position the overall height is 16.4 cm. The position of the vase is determined by the small spots of original solder that remain on the sides of the vase and on the inside of the hooves on the animal's forelegs. These held the vase in place.

During removal of the silver corrosion products from the surface, it became possible to detach the head so that the body and the head could be studied from the inside as well as the outside to ascertain more completely the method of manufacture. Preliminary radiographs had already given us considerable information about the technique employed, including the fact that the head was a separate piece inserted into the neck of the animal to a distance of 6 to 8 mm. (Figure 15).

The hollow figurine is made up of fifteen, and possibly seventeen, pieces of flat silver that were rolled into the approximate rounded shapes, scarf joined by overlapping the metal, and then soldered along the lap. The solder is a good quality hard silver solder that has neither changed color nor become more deeply corroded than the silver itself.

The solder that joined the head to the body was analyzed by thermal neutron activation by Dr. Pieter Meyers; the results are given in the table on p. 23. Presumably the next to last soldering operation would have been the soldering of head to body. We were able to take a sample, since the solder did not run as freely in this area, possibly because the craftsman was fearful of spoiling his earlier joins in reheating the silver. Dr. Meyers also analyzed a specimen of the solder on the proper left side of the vase (see table). The solder on the vase would have been of lower melting point so that the earlier joins would not fail. Attaching the vase would have been the last operation.

Though the general shape was not executed by raising, there are tool marks inside the body and the head. They occur in areas where the modeling is carried out in greatest detail and are found not only on the single sheet of metal, but also on top of the overlapped soldered areas. Presumably after the general shape had been executed by rolling and soldering the metal, the finer modeling, particularly where there is an abrupt change of plane, was executed from the inside with a small blunt tool. Any indication of modeling on the outside surface would now be lost. The final design elements were executed on the surface by chasing.

So much of the original surface was corroded and the present surface is so pitted that the chased design is not as sharp as it would have originally appeared. However, the cleaning brought to light many further details of the design and the splendid modeling of the head originally much obscured by the layer of corrosion products (Figure 17). In a few areas tool marks can be studied. The vertical lines of the pattern on the animal's garment were made by a rectangular tool 3.5 mm. in length. The tool marks run lengthwise with the line. They show most clearly behind the proper right shoulder (Figure 18). The geometric pattern between these lines was made with a smaller tool, about 2.5 mm. in length and oval-ended. Each line, at right angles to the next, was made with one strike. There is variation in the depth of the grooves and in the angle at which the tool was worked (Figure 19). A small triangular tool less than 1 mm. in length was used to create the fringe along the edges of the garment.

The body of the animal was made in three pieces. One piece includes the bottom and the sides to the widest section of the haunch. At a height of 2 to 2.5 cm. the upper edge of the horizontal 7-mm.-wide lap is

FIGURES 15, 16

Radiographs of the Metropolitan Museum's silver animal figurine. The profile view shows how the hollow horns and ears pierce the head. The overlap at the neck, solder at the join of the forelegs and the shoulder openings, the horizontal overlapped join of the two pieces of the body, and four pebbles are clearly seen. The frontal view shows the vertical overlap down the center of the body as well as the overlap across the haunch. Radiographs by Conam Inspection Co., 1968. Source: iridium 192; distance 21 in., Kodak M film, 2½ minutes

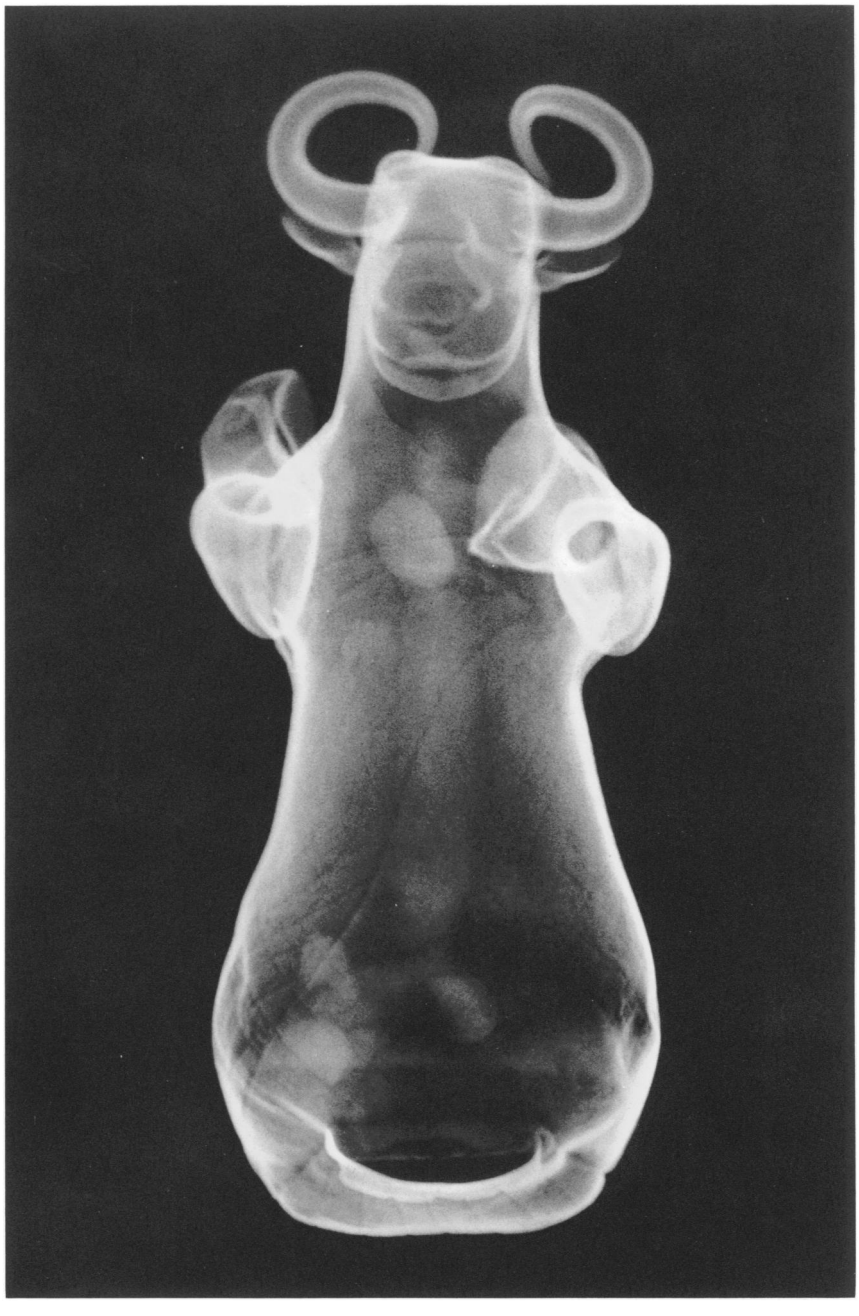

FIGURE 17
The Museum's figurine before treatment

FIGURE 18
Detail of the garment behind the proper right shoulder. In the middle of the top groove the craftsman's strike can be seen to be slightly out of line

FIGURE 19
Detail of the garment. In the top element the craftsman started at the right, as can be seen from the slightly overlapping grooves

visible on the outside surface (Figure 20). The rest of the body is in one piece except for a section approximately 3.5 cm. by 4 cm. wide that forms the top of the neck at the back. Though the joins are visible intermittently on the outside surface, the solder can only be seen in the radiograph and on the inside surface. A paillon that did not run is visible on the inside surface at the proper right of the neck where the separate piece butt joins the body (Figure 21). Because it did not run, the join at this point is not perfect and a groove 0.5 mm. in length can be detected on the outside. The join in the main body piece, lapped about 7 to 10 mm., runs vertically, but not completely straight, down the front slightly to the proper right of center. It can be seen on the radiograph and from the inside (Figure 16). There is a suggestion of a scarf join at the proper left knee on the inside, but it is difficult to be certain. It might have been necessary to cut and lap the metal at this point to round it sufficiently.

The forelegs are separate hollow pieces soldered in place, as can be seen on the radiograph. The join lines at the shoulders are visible on the surface, as is the outline of an ancient rectangular patch, measuring about 2.5 cm. by 1 cm., behind the join of the proper left foreleg to the shoulder (Figure 20). Join lines are also visible around the small round pieces set in each forehoof. Some of these have ruptured (Figure 22); possibly the join was never strong because of reheating during the soldering of the vase. At the elbows of the forelegs there is an extra density in the radiograph that suggests a join across the leg at this point, but there is no indication of this on the surface. If each foreleg is made in two pieces, it would bring the total number of pieces to seventeen. The longitudinal join was not found, as the foreleg could not be studied from the inside.

The head is also made from a flat piece of silver cut at front and back, rolled into the general shape and soldered along the cuts. Join lines can be seen inside at the back of the neck from the edge upward for about 1.6 cm. and at the front of the neck from the edge to the lower jaw, 2 cm.; the front lap is faintly visible on the outside surface as well. The detailed modeling of

FIGURE 20
Profile view of the figurine showing the join line across the haunch and the patch behind the left shoulder

FIGURE 21
The right side of the butt join between the back of the neck and the body. The paillon of solder that did not run is visible in the center

FIGURE 22
Forehoof of the figurine

FIGURE 23
The head of the animal, looking into the interior. The metal at the sides of the head was roughly punched inward to make holes for the ears and horns, which extend into the head. The ends are soldered to the punctured metal, which surrounds them. The round convex shape below the ear is the reverse of the eye

the head was worked with a small blunt tool, the marks of which can be seen on the inside. Ears and horns are separate hollow pieces inserted into the head and soldered in place (Figure 23).

A vertical join line can be seen on the interior of the vase below the spout, which is also a separate piece soldered in place (Figure 24). The round bottom of the vase is a separate piece as well, as there are indications of solder on the outside. The surface of the vase inside and out is deeply scratched, and on the proper left side below the three incised lines at the top there are a series of parallel curved scratches.

The metal would have had to be firmly supported during the soldering operation in order not to collapse inward when heated and would also have had to be backed during the chasing of the design. Inside the animal we found 16.5 grams of a black, porous, sandy substance and five limestone pebbles (microscopic spot test, Mohs scale hardness 2½) from 1 to 1.5 cm. in diameter, weighing in all 6.3 grams. Four of the pebbles show on the radiograph. A thin layer of the black substance was also firmly attached to the inside surfaces. Most of the backing material, except where firmly attached to the surface, had presumably been withdrawn from the body before the head was soldered on; but where it was inaccessible, as in the forelegs, some had remained and eventually shaken loose from the crevices. An x-ray diffraction powder pattern analysis of the backing material was made by the National Spectrographic Laboratories. It showed that calcite ($CaCO_3$) and alpha quartz (SiO_2) are present as major components. Present in minor amounts are Al_2O_3, $Al_2O_3 \cdot H_2O$, and $Ca_2Al_2SiO_7$.

Micrometer readings of the thickness of the metal were taken where possible. The head at the back of the neck measures 0.9 mm. The upper edge of the vase varies from 0.65 to 0.75 mm., the spout from 0.6 to 0.95 mm. The body at the back of the neck is 1 to 1.15 mm., at the front and sides, 0.85 to 1 mm.

Though the present surface of the metal is generally pitted and eroded because of the thick crust of cerargyrite that formed by the action of chloride salts on the silver, the metal itself is strong and quite ductile. Thermal neutron activation analyses of the metal from uncorroded areas, specimens SB 1 and SB 2, were made by Dr. E. V. Sayre of Brookhaven National Labora-

tory and the New York University Institute of Fine Arts, Conservation Center, before removal of the horn silver; and by Dr. Pieter Meyers, formerly attached to Brookhaven and now at The Metropolitan Museum of Art, after treatment (see table).

The silver is surprisingly pure, but it is not very different in composition from some of the silver objects from Ur. In 1935 H. J. Plenderleith published an analysis of a silver rein-ring from Ur: silver 93.5%, copper 6.10%, gold 0.08%, zinc 0.15%.[1] From the text it appears that this specimen was assayed by Messrs. Johnson, Matthey and Co. Plenderleith also states that the objects he examined were generally of good quality silver.

1. C. L. Woolley, *The Royal Cemetery; Ur Excavations*, II (London, 1934) p. 293.

FIGURE 24
Interior of the vase

TABLE

Thermal Neutron Activation Analysis[1]

Specimen No.	*Description*	*Composition Weight Percent*[2]		
Composition of silver animal figurine		*Silver*	*Copper*	*Gold*
U1	solder, proper right side of neck, about middle, on overlap	95.3	4.6	0.1
U4	solder, on vase, near base on proper left side (with spout as front)	86.7	13.3	0.004
SB1	proper left hoof	99.4	0.6	0.008
SB2	proper left haunch	98.3	1.7	0.01
U2	back of head between horns	99.1	0.9	0.006
U6	proper left haunch below join	99.3	0.7	0.03
U8	across edge of sternum	98.6	1.4	0.04
U9	vase at 2.5 cm. down from rim, 1.5 cm. to proper left of spout (contains some black corrosion material)	96.8	3.2	0.01
Composition of silver pin with lapis head				
U3	drilling in silver, using 62 drill at 10.2 cm. from tip (black surface material discarded)	95.5	4.4	0.07

[1] Samples of approximately 100 μg. on a 1 cm^2 quartz plate were obtained by rubbing the quartz plate along the cleaned surface. A detailed description will be published shortly by E. V. Sayre.
[2] Approximate composition calculated upon the assumption that silver, copper, and gold are the only components in significant concentrations.

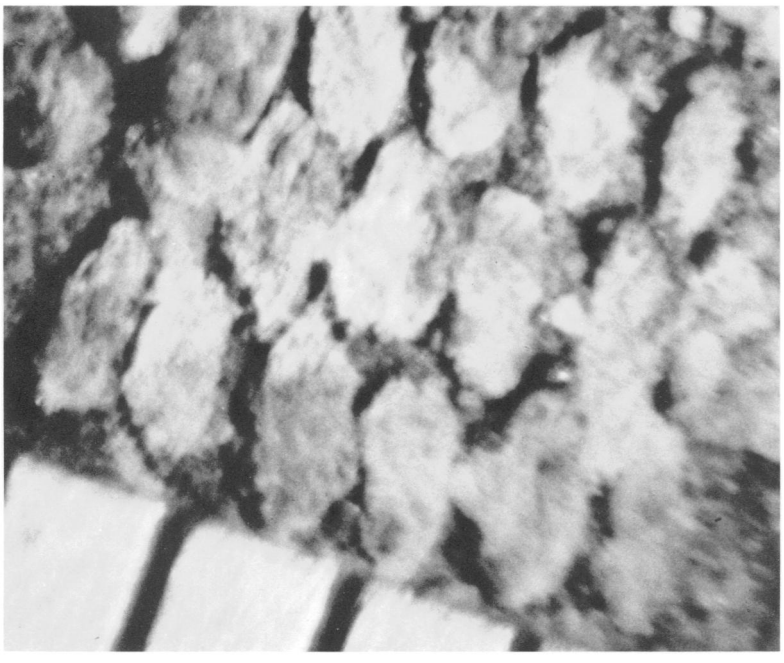

FIGURE 25
The textile pattern in the calcite layer (Photo: S. M. Alexander)

For the purpose of comparison with specimens from the silver animal figure, Dr. Meyers also analyzed a specimen of the Metropolitan Museum's silver pin with lapis head from Ur, acc. no. 33.35.44. The Ur analysis is quite consistent with those of the figurine (see table).

Spectrographic analysis was performed by Dr. Meyers on a sample of silver from the head of the figurine, cross section at the proper left side of neck below ear, part of overlap, weight 1.21 mg., and on a sample of solder from the small lump at the proper left side of the vase, weight 3.02 mg. The emission spectrum shows that the silver sample contains the following elements: Ag (XO.O), Cu (X.O), Pb (.X), Sn (.OX), and Au, Ni, Fe, Al, Mn, Sb, Ca, Cr, and Mg (trace amounts). Not detected: Zn, As, Co, Bi, Ti, V, and Ba. The analysis of the solder sample shows Ag (XO.O), Cu (10–20%), Pb (X.O–.X), Sn (.X–.OX), Mg (greater than trace), and Au, Ni, Fe, Al, Mn, Sb, As, Bi, Ca, Cr, V, Ba (trace amounts). Not detected: Zn, Co, and Ti.

Figure 17 shows the appearance of the corrosion products and the accretion described and analyzed by S. M. Alexander (see below), and Figure 25 is a detailed view of the fiber pattern in the calcite layer. Under microscopic examination it was possible for Nobuko Kajitani of the Metropolitan Museum Conservation Department and L. J. Majewski, Head of the Conversation Center at New York University Institute of Fine Arts, to determine that the fiber, because of the scaly pattern left in the calcite, had come from an animal. The yarn was 2 Z spun yarns plied into an S yarn. The fabric was plain weave, warp-faced or weft-faced, and the count 22 to 30 yarns per cm. in one direction and 10 yarns per cm. in the other direction.