

SOME ANCIENT NEAR EASTERN POT BELLOWS

by C. J. Davey

Although the smith was commonly referred to in Semitic language as the "user of bellows", it could recently still be said that "the history of forced draught is obscure".¹ Efficient and controlled smelting and casting required the application of a forced draught to the furnace, but little evidence has been forthcoming of the bellows which supplied this draught. Instead, the nozzles (or tuyeres) through which the air blast was fed to the furnace have been found in considerable numbers from as early as the fourth millennium B.C. and often they alone testify to the use of bellows.

One type of bellows known to have been used from an early period is the pot bellows (or bowl bellows). They are still used in many parts of Africa and Asia for smelting and forging iron,² and were found in the Sudan on iron working sites of the Roman period.³ Pairs of bellows operated by the feet are portrayed in the famous wall painting in the Tomb of Rekhmirē⁴ (Fig. 1), testifying to the use of these implements in Egypt at about 1450 B.C. Only at Tell edh-Dhiba'i, now in modern Baghdad, have pot bellows been uncovered and published as such (see No. 2 below). Elsewhere, vessels of similar shape have been excavated and published with a variety of identifications making it necessary to draw attention to them.

The operation of pot bellows has been described by many writers⁵ and only needs a brief account here. There are two basic systems (Fig. 2). The first is to have a diaphragm in the skin covering which will open as the skin is raised allowing air to enter the bellows. The diaphragm is closed when the skin is depressed and the air is forced directly into the furnace. This system requires a very well designed diaphragm if the bellows are to function efficiently and so a second method which is depicted in the tomb of Rekhmirē was probably more common. In this case the air enters the bellows through a gap between the tuyere and the bellows pipe as the skin covering is raised. When the skin is depressed air is forced into the furnace. To prevent air being drawn from the furnace, it has been thought that the system adopted by some African smiths in which two bellows operating reciprocally are used in conjunction with one tuyere,⁶ may have been employed by ancient smiths. This arrangement provides a constant draught to the furnace but was not used in the casting furnaces of Rekhmirē where two alternating bellows each have their own tuyeres. While a certain quantity of hot gas and ash was drawn into the bellows by this system, an induced draught effect into the furnace through the tuyere minimized it so that the bellows did not overheat. The bellows themselves can be manipulated by hand or operated with the feet.

The shape of the vessel used as bellows is distinctive. The opening at the top must be wide so that the hide covering it will move a maximum amount of air when it is oscillated. The covering is attached to the bowl with a cord which is fastened under an out-turned rim or in a groove made in the side of the pot, just below the rim. A one to four centimetre hole is positioned in the side of the vessel near the base into which a pipe can be inserted to transfer the air blast to the furnace. The base is normally flat although one possible example from Alalakh has a rounded base. Like much

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1. R. J. Forbes, in C. Singer, E. J. Holmyard and A. R. Hall, *A History of Technology*, Vol. I (Oxford, 1954), 577
 2. R. J. Forbes, *Metallurgy in Antiquity*, (Leiden, 1950), 116 f, and for example, T. C. Crawhall, *Man* 33 (1933), 41-3.
 3. R. F. Tylecote, *A History of Metallurgy* (London, 1976), 32.
 4. N. de G. Davies, *The Tomb of Rekh-mi-re at Thebes* (New York, 1943), Pl. 17.
 5. R. J. Forbes, *Metallurgy in Antiquity*, 116; H. Hodges, *Artifacts*, (London, 1964), 67 f.
 6. R. J. Forbes, in C. Singer, E. J. Holmyard and A. R. Hall, *A History of Technology*, Vol. I (Oxford, 1954), Fig. 382.

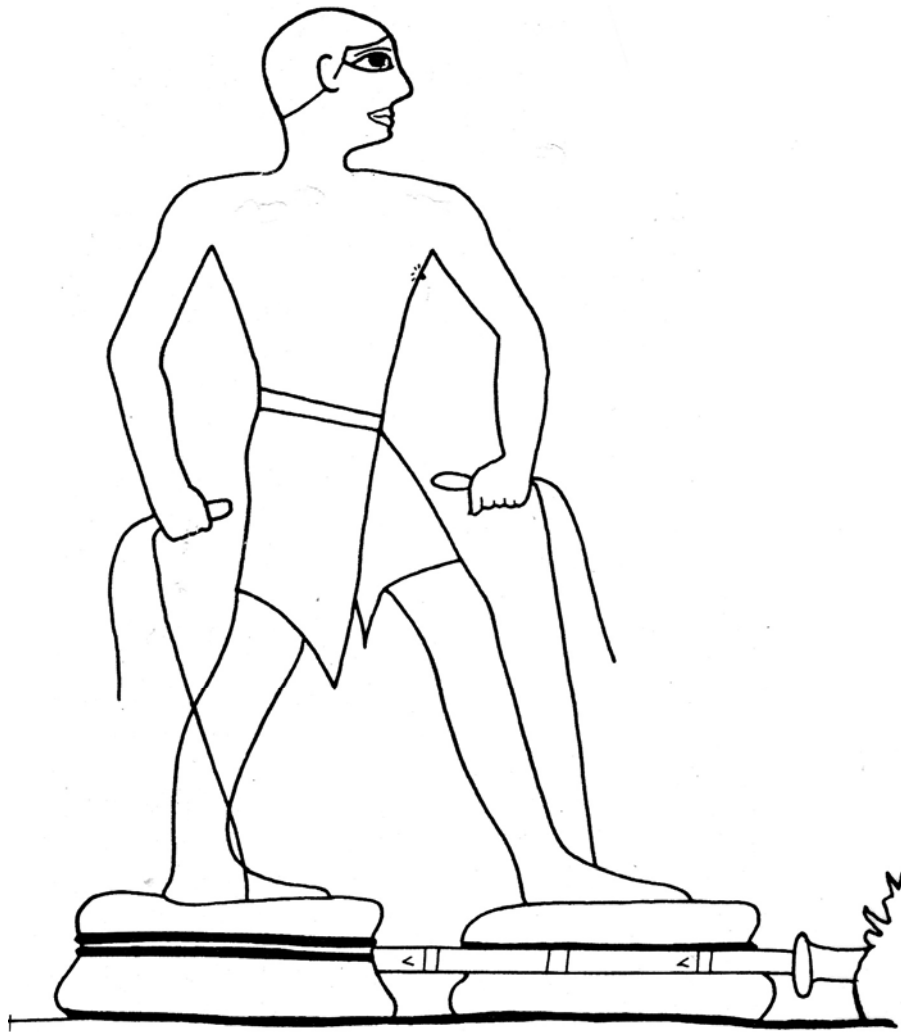


Fig. 1. A drawing of a bellows operator depicted in the wall-paintings of the Tomb of Rekmirē. Thebes c. 1450 B.C.

modern industrial equipment, pot bellows are roughly constructed and are stronger than necessary. While a couple of pairs mentioned below are made from limestone, most are formed from fired clay and size varies from 0.3 to 0.6 m. in diameter and between 0.13 and 0.23 m. in height.

Pot bellows can only be conclusively identified when they are found in a metallurgical context as vessels of this shape may have alternative functions. At Kultepe, Tell edh-Dhiba'i and Tell Beit Mirsim pot bellows were found associated with moulds indicating the presence of a casting foundry. The bellows found at Enkomi were uncovered in the vicinity of large slag deposits and were probably part of a smelting operation. While it is normal to find the internal surfaces of bellows blackened with ash, on occasions they are found to contain slag. Unless an accident occurred while smelting there is little reason for the bellows to be in this condition after the normal course of events and it may be that when the operating life of the bellows was concluded, it was used as a receptacle for unwanted material.

Various functions have been assigned to the vessels which are said here to be pot bellows. Two

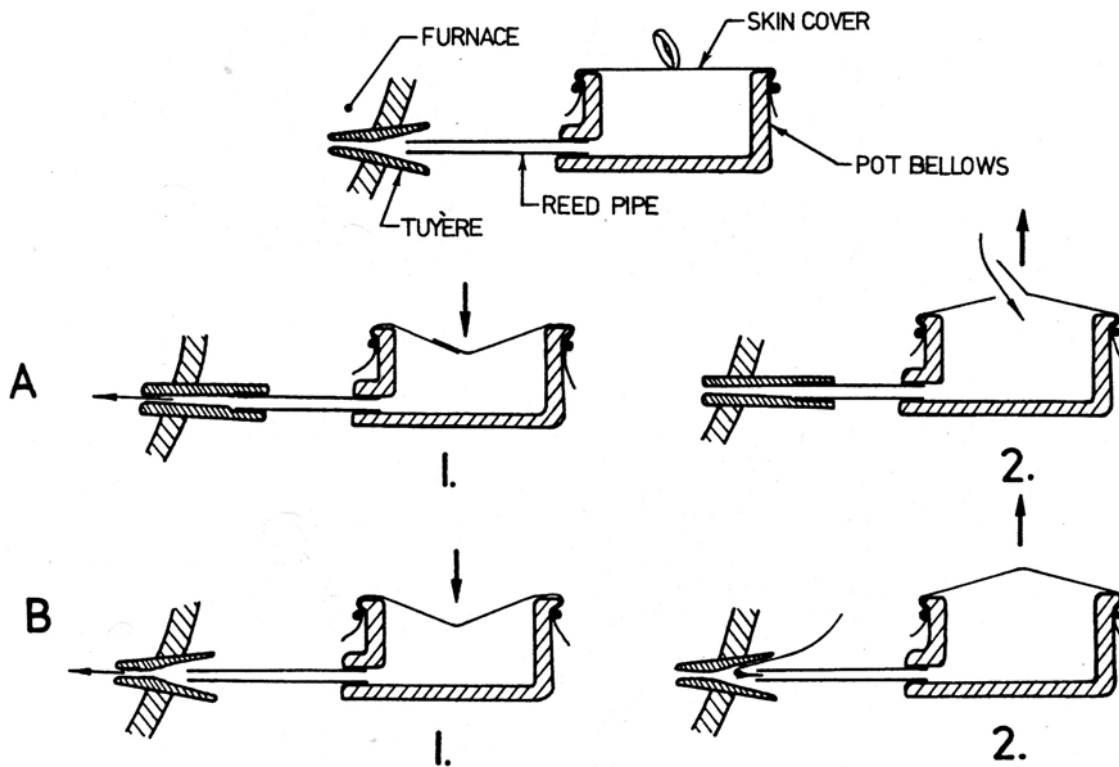
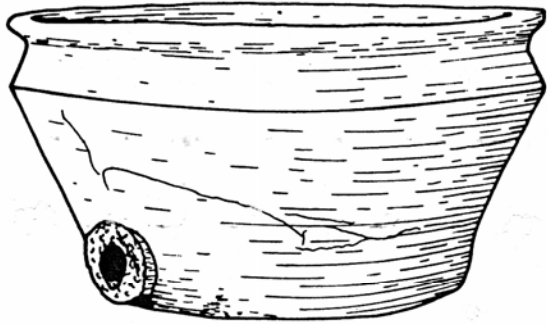


Fig.2. Diagrammatic sketch of pot bellows operation. A. The use of bellows with a diaphragm in the hide covering. B. Pot bellows operated without a diaphragm.

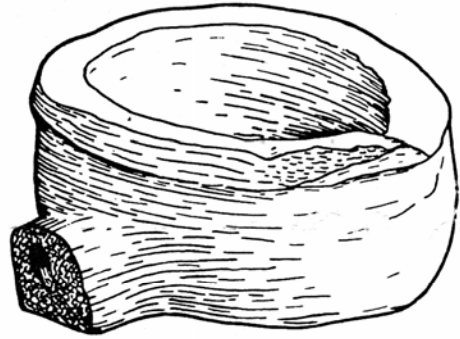
examples (No. 4) were thought to be ingot moulds but this identification does not explain either the hole at the base of the vessel, nor its height. Circular ingots of copper are not common in the Late Bronze Age and if they were required, they could have been obtained directly from the smelting furnace where circular bun-shaped ingots are formed.

In spite of their relatively large size, pot bellows have been commonly identified as crucibles (Nos. 3, 5 and 6). This determination was made because of the metallurgical context of the vessels which in one case at Enkomi contained slag, and because of the slight resemblance to the much smaller crucible shape. The context applies equally well for their identification as bellows. If these vessels were in fact crucibles, a crucible slag would coat the internal surface of all of them and not just the one which it has already been suggested indicates a secondary function. The smelting of large quantities of copper in a crucible does not seem to be technically feasible.⁷ A refining and casting process would also produce similar quantities of crucible slag and although a vessel with a hole at the base may seem a most convenient design for a crucible, most examples have small holes which would be easily choked with solidified metal during pouring. These large vessels charged with metal would be a considerable weight and very difficult to handle and to support in the furnace. The scene in the tomb of Rekhmirē where large bronze doors are being cast would indicate that when large quantities of metal were required, many small crucibles were used. The vessel from Tell Beit Mirsim is carved from limestone which decomposes at 900°C which is about 300°C below the

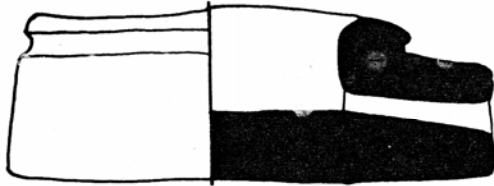
7. R. F. Tylecote, *Bulletin of the Historical Metallurgy Group*, 8 (1974), 54.



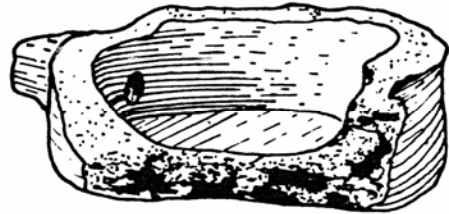
1. KULTEPE



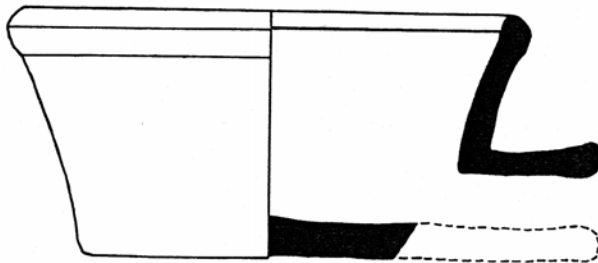
2. TELL EDH-DHIBAI



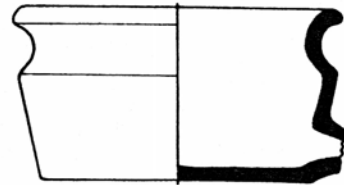
3. TELL BEIT MIRSIM



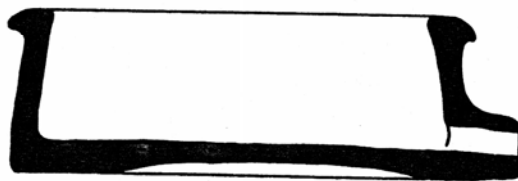
4. ENKOMI



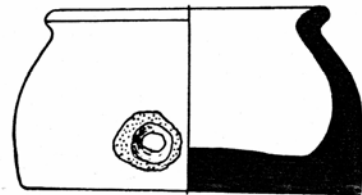
5. ENKOMI



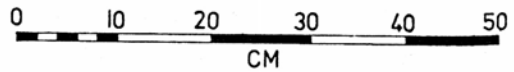
7. ALACA HUYUK

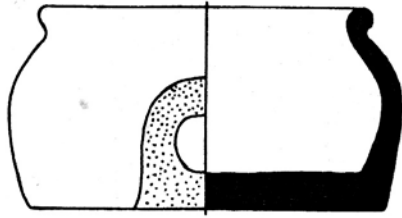


6. TELL ASMAR

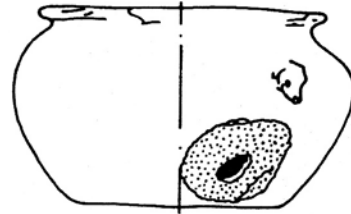


8. MEGIDDO

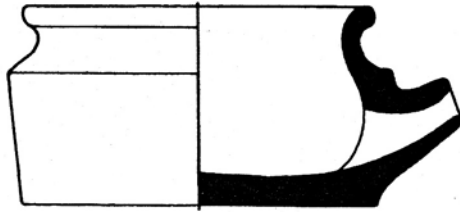




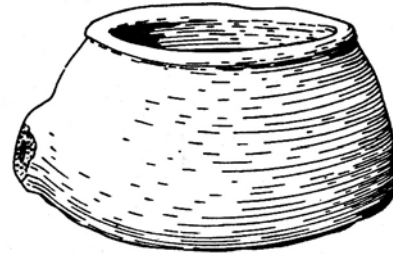
9. MEGIDDO



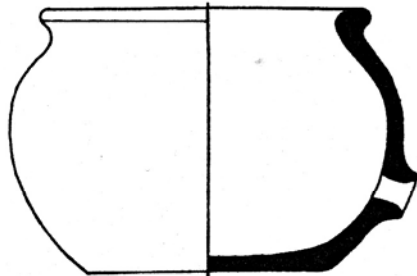
10. CHAGAR BAZAR



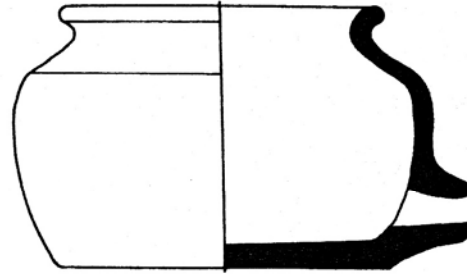
11. ALACA HUYUK



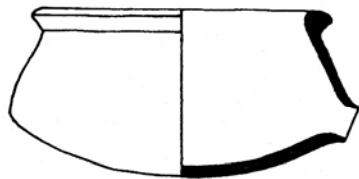
12. ALACA HUYUK



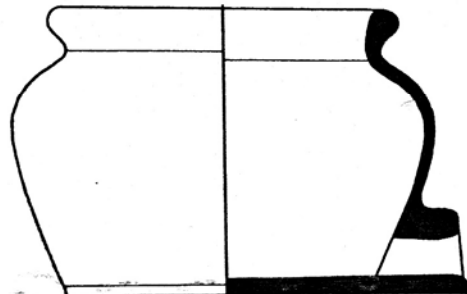
13. TELL JIDLE



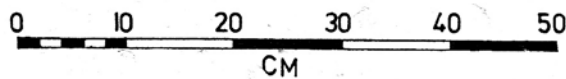
14. RAS SHAMRA



15. ALALAKH



16. SAREPTA



melting point of copper and therefore it could not be a crucible. Finally, there is the fact that at Kultepe and at Tell edh-Dhiba'i numerous conventionally shaped crucibles were found in addition to the much larger vessels which must be identified as pot bellows.

The following have been identified as pot bellows because of their shape and archaeological context:

1. KULTEPE

T. Ozguc, "Report on a workshop belonging to the late phase of the Colony Period (1b)", *Belleten*, 19 (1955). 79, Fig. 25.

This vessel was found in the Karum Level 1b in a well-equipped workshop, together with moulds, rough castings and crucibles. It was probably destroyed about 1800 B.C. The vessel is described as "a not very well finished bowl with thick walls" and its suggested function is that it was used for casting. Diameter 0.55 m.; height 0.22 m.

2. TELL EDH-DHIBA'I

L-al-Gailani. "Tell edh-Dhiba'i", *Sumer*. 21 (1965). 37, Pl. 7, Nos. 614/1 & 2.

A couple of examples were found in a copper-smith's workshop. Also present were tuyeres crucibles and moulds. Tablets, pottery and cylinder seals found at the site belonged to the Isin-Larsa and Old Babylonian periods indicating that the workshops ceased in about 1750 B.C.

3. TELL BEIT MIRSIM

W.F. Albright. "The Excavations of Tell Beit Mirsim. Vol. 2. The Bronze Age" *AASOR*. 17 (1938) 53 Pls. 40:7, 8; 31:7.

Two examples were found with an open stone mould and three quarters or a copper ingot. They belong to Stratum D which terminates in about 1550 B.C.. Albright thought them to be crucibles although they are carved from limestone

4. ENKOMI

P. Dikaios, *Enkomi Excavations 1945-1958* (Mainz, 1969). I, 241; IIIa, Pl. 127/48, Nos. 4543 and 4544

A badly damaged pair made from limestone were found belonging to Level IIA which Dikaios dates to the fourteenth century B.C. Their shape is similar to the pair from Tell edh-Dhiba'i and their interiors were blackened. They were found in an area of slag heaps and were thought to be ingot moulds. Diameter 0.42 m.; height 0.13 M.

5. ENKOMI

P. Dikaios, *op. cit.* 1. 259; IIIa, Pl. 120/5, No. 1691/1.

The vessel was found in Level IIIA which Dikaios attributes to the twelfth century B.C. It was handmade and has an unusually large hole at the base. Slag, soil and charcoal were found adhering to the inner surface and it was thought to be a crucible. Diameter 0.54 m.; height 0.24 m.

The following are possible examples of pot-bellows for which contextual information is often lacking:

6. TELL ASMAR

P. Delougaz, *Pottery from the Diyala Region*, (O.I.P. 63), (Chicago, 1952). 101, Pl. 190. No. D 301, 112.

The object was found in a Larsa Period Level below one attributed to the time of Ipiq-Adad II (c. 1860 B.C.). It is said that fragments of such vessels were found in Early Dynastic III Levels, but since all parallels quoted for the bellows are not bellows shapes but simply vessels with holes in the base, similar confusion may exist with regard to the identification of the earlier fragments. It was thought that the vessel could have served as a crucible. Diameter 0.55 m.; height 0.175 m.

7. ALACA HUYUK

H. Z. Kosay, *Alaca Huyuk Kasisi 1963-1967* (Ankara, 1973). 77, Pls. 33, 80. No. Al.t 3.

This vessel was taken from an Old Hittite Age Level (1700-1500 B.C.). It is of baked clay and is described as a "stew pot shaped vessel". Diameter 0.36 m.; height 0.17 m.

8. MEGIDDO

P.L.O. Guy, *Megiddo Tombs* (O.I.P. 33) (Chicago, 1938). 152, Pls. 49/22; 150/16. No. P4219.

Found in a Late Bronze Age I tomb (No. 1145 A). Its spout was broken away and it was no doubt used as a receptacle for burial offerings rather than being discarded. It is handmade.

9. MEGIDDO

P.L.O. Guy, *Megiddo Tombs* (O.I.P. 33) (Chicago, 1938). 152, Pls. 37/7; 135/8. No. X2845.

Similar to No. 8. Found in tomb No. 3 of the Late Bronze Age I.

10 CHAGAR BAZAR

M. E. L. Mallowan, "Excavations at Tall Chagar Bazar", *Iraq*, 4 (1937). 144, Fig. 20, No. 1.

Mallowan believes this to be the latest pot in Level 1 having a date in the late sixteenth century B.C. A spout at the base has been broken off. The sheep's-head decoration is uncharacteristic of industrial equipment which is normally devoid of artistic refinement. Diameter 0.33 m.; height 0.19 m.

11. ALACA HUYUK

H. Z. Kosay, *op. cit.*, 78, Pls. 33, 78. No. Al.t 119.

This pot belongs to a Hittite Age Level (fifteenth century B.C.) Diameter 0.34 m.; height 0.175 m.

12. ALACA HUYUK

H. Z. Kosay, *op. cit.*, 77, Pl. 33. No. Al. p. 132.

The vessel was found upside down in the corner of a room of the New Hittite Age (c. 1400-1200 B.C.). It has a wider base than rim, which although reduces the likelihood of its being bellows does not suggest any other function for which it may be useful. Diameter of rim 0.245m.; diameter of base 0.4 m.; height 0.19 m.

13. TELL JIDLE

M. E. L. Mallowan, "Excavations in the Bilah Valley", *Iraq*, 8 (1946). 148, Fig. 10, No. 5.

This is a wheel-made vessel from Level 2 which is dated 1450-1350 B.C. It had been mended with bitumen and is said to have had a strap handle. The significance of the handle cannot be judged as there is no additional information given as to its possible position and design. The parallel suggested has a spout high on the shoulder and is clearly for a different function. Diameter 0.32 m.; height 0.15m.

14. RAS SHAM RA

C. F. A. Schaffer, *Ugaritica II* (Paris, 1949). Fig. 84, No. 15. RS 1931.

The vessel was found with three Canaanite lamps which probably date from the Ugarit Recent 3 Period (1365-1200 B.C.). Diameter 0.38 m.; height 0.235 m.

15. ALALAKH

L. Woolley, *Alalakh* (Oxford, 1955). 324, Pl. 111, Type 38.

A coarse greenish drab clay vessel found in Level I belonging to the thirteenth century B.C. Woolley found no other examples of this shape. Rim diameter 0.27 m.; Base diameter 0.3 m.; height 0.24 m.

16. SAREPTA

J. B. Pritchard, *Sarepta* (Philadelphia, 1975), Fig. 25:8. Published as an example of rim shape RR6.

The description and rough sketch of a vessel found in Court 148 of the palace at Mari⁸ appears to be a pot bellows of similar size and shape to those found at Tell edh-Dhiba'i. Diameter 0.47 m.; height 0.22 m.

A rimsherd from Idalion found in the copper smelting area may be part of a pot bellows used there in Phase 6.9⁹

Not all vessels with holes at their bases are pot bellows. One suitably shaped vessel from Zinjirli¹⁰ is too small to be more effective than a blow pipe and as the excavator suggests is probably a lamp. A pan shaped vessel from Telloh¹¹ belonging to the mid-third millennium B.C. is described as a fire

8. A. Parrot, *Mission Archeologique de Mari*, Vol. II, Le Palais, Architecture (Paris, 1958), 260-62, Fig. 315

9. L. E. Stager, A. Walker and G. E. Wright, *American Expedition to Idalion, Cyprus*, First Preliminary Report Seasons 1971 and 1972 (Cambridge, Mass., 1974), Pl. III/1, Reg. No. 14755.

10. W. Andrae, *Die Kleinfunde von Sendschirli* (Berlin, 1943), Abb. 69, No. S3046.

11. G. Cros, *Nouvelles Fouilles de Tello* (Paris, 1910), 151, Fig. D.

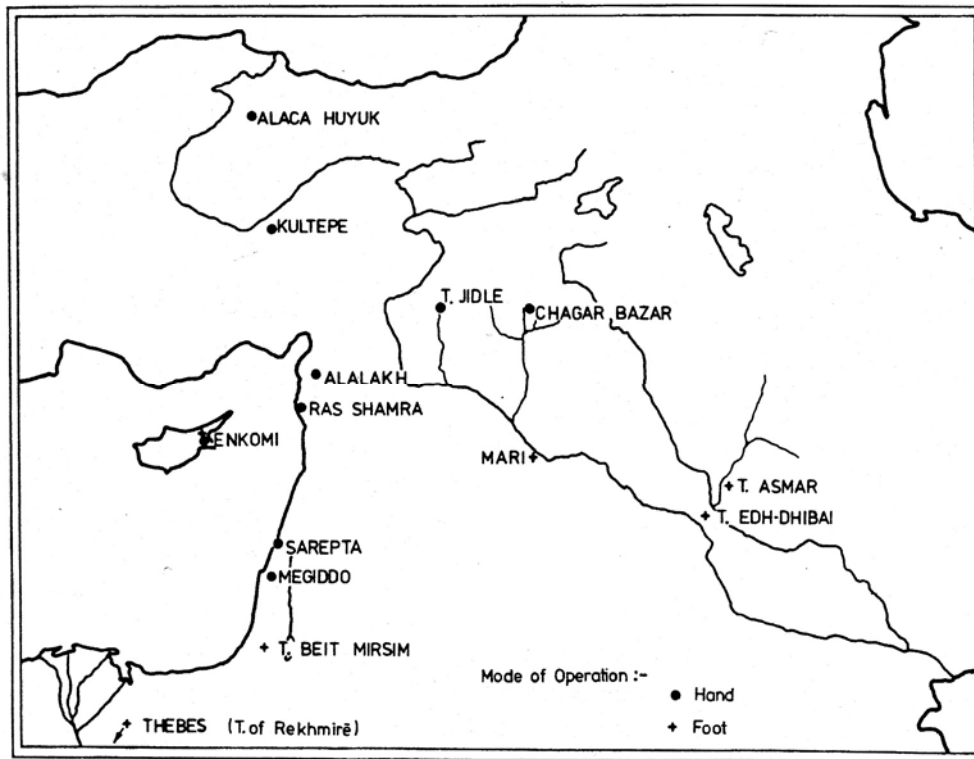


Fig. 5. A map of the distribution of pot bellows distinguishing those probably operated by the feet from those which were hand operated.

pan which is quite possible as the Sumerians had a term for such a vessel.¹² The absence of any protrusion at the rim under which a hide could be fastened excludes it from being pot bellows. A cylindrical vessel found at Enkomi¹³ had slag with copper incrustations coating its interior and could well have been used as a small refining furnace as illustrated by Coghlan.¹⁴ Again the absence of any device whereby a hide covering may have been secured precludes it from being a pot bellows.

Separation vessels have holes in their bases, but all the examples quoted by Levey¹⁵ are quite different in size and shape to the above examples of bellows. Grape and olive presses such as the one found at Vathypetro, Crete¹⁶ have a similar form to some of the bellows although this example has a large drain hole which makes it unsuitable to function as bellows.

All the examples of pot bellows listed above belong to the second millennium B.C. Their earliest occurrences are in Central Anatolia and Babylonia. By the mid-second millennium B.C. they are in use in northern Syria and southern Palestine and later still they are found in Egypt and Cyprus. A Neo-Babylonian text¹⁷ states that a copper-smith received from the temple administration, two he-goats "for skins of the bellows". The text is not completely unambiguous but it could plausibly be understood as referring to the skins of pot bellows. For the moment, however, the history of pot

12. M. Levey, *Chemistry and Chemical Technology in Ancient Mesopotamia* (Amsterdam, 1959), 17.

13. P. Dikaios, *Enkomi Excavations 1948-1958* (Mainz, 1969), 1, 253; IIIa, Pl. 159/20.

14. H. H. Coghlan, *Notes on the Prehistoric Metallurgy of Copper and Bronze in the Old World* (Oxford, 1951), Pl. 15.

15. M. Levey, *Chemistry and Chemical Technology in Ancient Mesopotamia* (Amsterdam, 1959), 17.

16. S. Marinatos and M. Hirmer, *Crete and Mycenae* (New York, 1960), Fig. 62.

17. *Y.O.S.* 7, 143

bellows between the end of the Bronze Age and the Roman Period when they are found in the Sudan remains unknown.

It may be significant that at Kultepe, Tell edh-Dhiba'i and Tell Beit Mirsim the bellows are found associated with stone, open moulds. These moulds first appear in north-west Anatolia¹⁸ and in north-east Syria¹⁹ during the last half of the third millennium. Very little can be said about bellows in northwest Anatolia. No examples of pot bellows have been found at Troy, although in the Aegean, tuyeres have been found at Poliochni²⁰ testifying to the use of bellows of one form or another.

Mesopotamia has the earliest examples of pot bellows at Tell Asmar and Tell edh-Dhiba'i and had trade connections with Central Anatolia where at Kultepe almost contemporary pot bellows have been found. The initial development of pot bellows could have been in either area or at an intermediate location such as north-eastern Syria or northern Iraq, where it has already been noted open stone moulds first appear.

While the evidence is not available to decide where pot bellows originate it is clear that more than one tradition of pot bellows developed at an early stage. If the idea of pot bellows passed between Kultepe and Tell Asmar, the actual shape of vessel did not. All the examples from Mesopotamia are straight sided and squat and could, as is indicated in some lexical texts,²¹ be operated with hands or feet. As foot operation is best performed with a pair of bellows oscillating reciprocally the fact that two were found at Tell edh-Dhiba'i increases the likelihood that they were worked with the feet. The pair from Tell Beit Mirsim certainly were. They were found *in situ* next to each other in a level which ended about a hundred years before Rekhmirē whose tomb paintings depict identical vessels being used (Fig. 1). The only other vessels suitably shaped for foot operation were found at Enkomi (No. 4) and there too a pair were found. It seems reasonable to conclude that the squat, straight-sided vessels found at Tell Asmar (6), Tell edh-Dhiba'i (2), Mari, Tell Beit Mirsim (3) and Enkomi (4) are all foot operated and that this system and design began in Mesopotamia.

The other vessel from Enkomi (No. 5), which is one of the latest examples, and the one from Kultepe have similarities in form and would seem to testify to a second tradition of pot bellows during the second millennium B.C. existing in parallel to the first. The other vessels (Nos. 7-16) which may or may not be pot bellows have a variety of shapes but are similar in that they are all fairly tall. This renders them impractical for foot operation and if they were pot bellows, they must have been manipulated by hand. It may be significant that no two of these vessels have been found in close proximity to each other indicating that they were normally operated individually. This mode of operation would seem to have first developed in Central Anatolia where it is attested to by the discovery of tall pot bellows at Kultepe and Alaca Huyuk; it was then introduced into northern Syria from where it eventually passed to Cyprus.

G.A. Wainwright has documented the Egyptian records of the blowpipe and the first occurrences of pot bellows in Egypt.²² Although the first depiction of pot bellows is from the tomb of Rekhmirē of about 1450 B.C., the use of them in Palestine during the Middle Bronze II period at Tell Beit Mirsim would indicate that they were probably introduced to Egypt during the period of Hyksos rule about two hundred years earlier. The blowpipe continued to be used after the introduction of pot bellows for less demanding work and is in fact also represented in the paintings in the

18. For examples see H. Schmidt, *Heinrich Schliemann's Sammlung Trojanischer Altertümer* (Berlin, 1902), 265-9.

19. M. E. L. Mallowan, *Iraq* 4 (1947), 160, Pl. 18B; E. A. Speiser, *Excavations at Tepe Gawra* (Philadelphia, 1953), Vol. 1, 104, Pl. 47.

20. L. Bernabo-Brea, *Poliochni, Citta Preistorica Nell'Isola Di Lemnos* (Roma, 1964), Vol. 1, No. 2, Pls. 83/r,s,t; 167/1,2,7; 170/7,8

21. L. Oppenheim, R. H. Brill, D. Barag and A. von Saldern, *Glass and Glassmaking in Ancient Mesopotamia* (New York, 1970), 69, n. 73.

22. *Man* 44 (1944), 95-6.

Tomb of Rekhmirē. At Timna in southern Palestine numerous tuyeres have been found and there is evidence of large scale Egyptian mining and smelting during the New Kingdom, but no bellows have come to light.²³ Although Lupu and Rothenberg think that pot bellows are a distinct possibility, it is probably more likely that the bellows used at Timna were made of a perishable material. A group of Asiatics depicted in the Tomb of Khnum-hotpe III at Beni Hasan belonging to the early nineteenth century B.C.²⁴ are thought to have two pairs of skin bellows with them.²⁵ A first millennium B.C. Hebrew seal from Tell el-Kheleifeh has on it a similar object which Avigad²⁶ believes to be a pair of skin bellows although Muhly²⁷ considers it to be more the shape of an ingot. Skin bellows are obviously more portable than conventional pot bellows and would be convenient for conducting smelting operations in the various locations where copper was mined.

If skin bellows were also in use during the second millennium B.C. why were the cumbersome pot bellows developed and used? Open stone moulds have already been mentioned as part of the metallurgical tradition to which the pot bellows of the second millennium belong. Stone was used instead of clay and sand because of its durability. Stone moulds like pot bellows are cumbersome, but the high output of second millennium B.C. bronze workshops required the permanence of the stone mould.

Pot bellows were likewise required in these industrial centres where large scale casting necessitated continuous operation of sizable furnaces reliably and efficiently ventilated. The power and durability of pot bellows ensured their use in preference to skin bellows in situations where their weight and awkwardness were of little importance. Whether pot bellows were used by glass-makers to ventilate their Kuru-kilns which it seems were fired with the aid of forced draught,²⁸ cannot be decided. It is certainly logical that they should have been as glass-making developed during the period when pot bellows were a regular component of large second millennium B.C. bronze workshop equipment.

ACKNOWLEDGEMENTS

The author is grateful to Prof. and Mrs. U. B. Alkim and P. S. de Jesus who drew his attention to some examples of pot bellows. The latter, Prof. Oates and Mrs. Maxwell-Hyslop are also to be thanked for their comments and helpful advice.

23. A. Lupu and B. Rothenberg, *Archaeologia Austriaca* 41 (1970), 99.

24. P. E. Newberry, *Beni Hasan I* (London 1893), Pl. 31.

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