Making Moxon's type-mould

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The following is a revised account of my attempt to construct the type-mould described in the second volume of Joseph Moxon's *Mechanick exercises: or, the doctrine of handy-works. Applied to the art of printing.*[1] It was first published in the Printing Historical Society's *Bulletin* in 1996.[2] Since that time I have made a number of further moulds, including two new attempts at interpreting Moxon's account, and these have caused me to revise some of my original conclusions. The main motivation for the original project was to check Moxon's description and illustrations and gain some insight into the practical problems and difficulties of mould-making in the period before the advent of accurate metal-machining equipment. Whenever possible, Moxon's account was followed but, on the two occasions where it was found wanting, the reconstruction was based on the under-half of a type-mould belonging to Oxford University Press and believed to date from the late-seventeenth century. Due to a miscommunication between myself and the then archivist at OUP, I described this half-mould incorrectly as being of great primer size. It is in fact the under-half of a long primer mould, and is quite similar to the pica mould shown in Davis and Carter's figure 11, which they describe as 'probably of Moxon's time'.[3] I have indicated in the text wherever I have had to rely on the long primer OUP mould.[4]

Moxon's description of the mould-making process runs to about 5000 words and is contained within the section of his text which deals also with the sinking of matrices and the dressing of 'letters' (type).[5] He starts with a general description of the type-mould and then provides a list of its constituent parts. This account is accompanied by two full-page intaglio plates depicting full-scale views of both halves of the mould fully assembled, together with

1. London: Printed for Joseph Moxon ...,1683–[1684]. Published as the second volume of *Mechanick exercises* (the first covers other trades and crafts). A new edition, edited and annotated by Herbert Davis and Harry Carter, was published by Oxford University Press in 1958 (second edition 1962). The original edition is referred to here as 'Moxon', and the 1962 edition as 'Davis-Carter'. It should be noted that the pagination of the two is different, and page-references apply to one edition or the other, not to both.

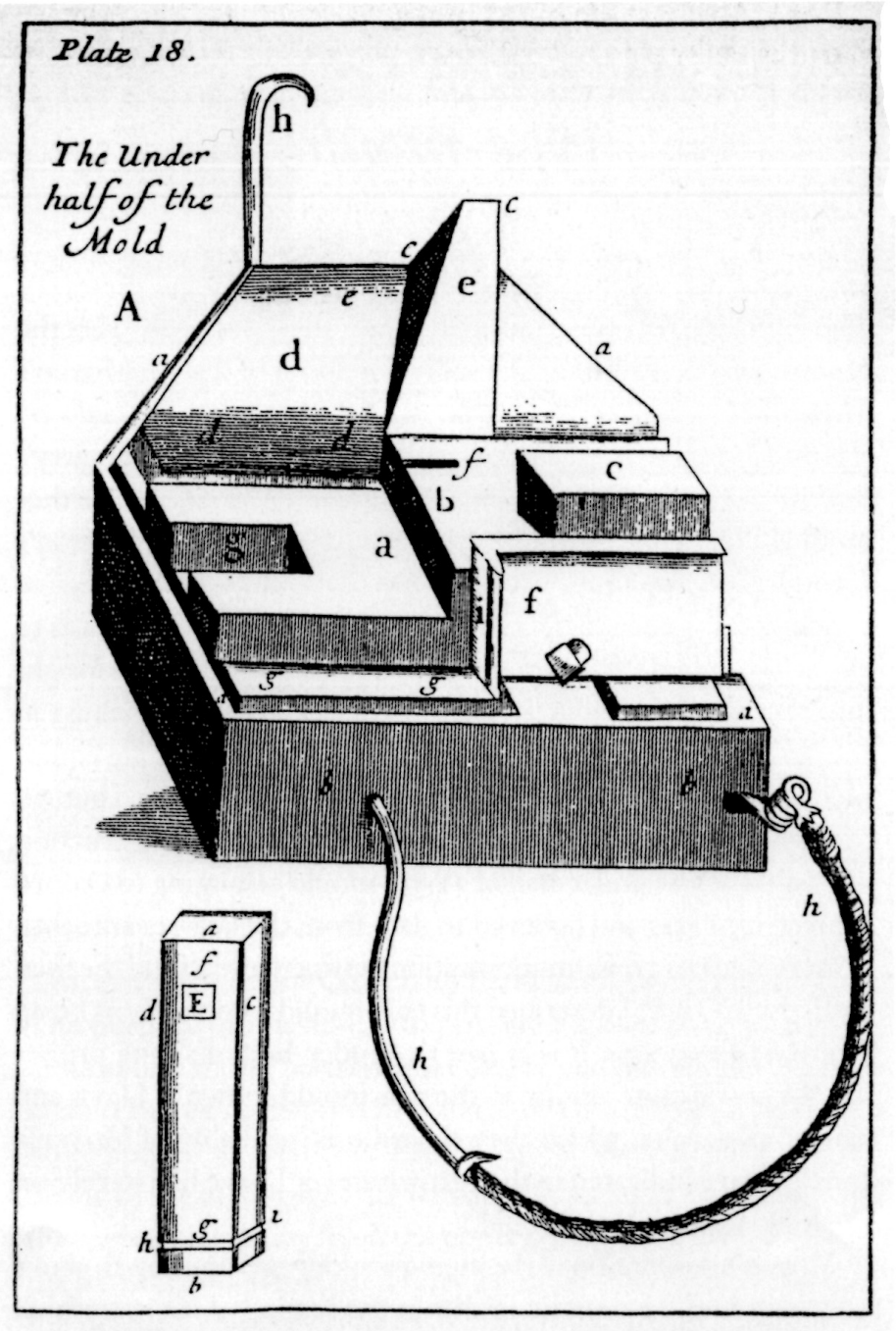
2. Number 40 (Winter 1995/96), 15–23.

3. Davis-Carter p. 405. The pica half-mould is also at the OUP.

4. Some of the historical type-founding material surviving at the Oxford University Press, including the hand-moulds, is listed in Stanley Morison's *John Fell, the University Press and the 'Fell' types* (Oxford: Clarendon Press, 1967).

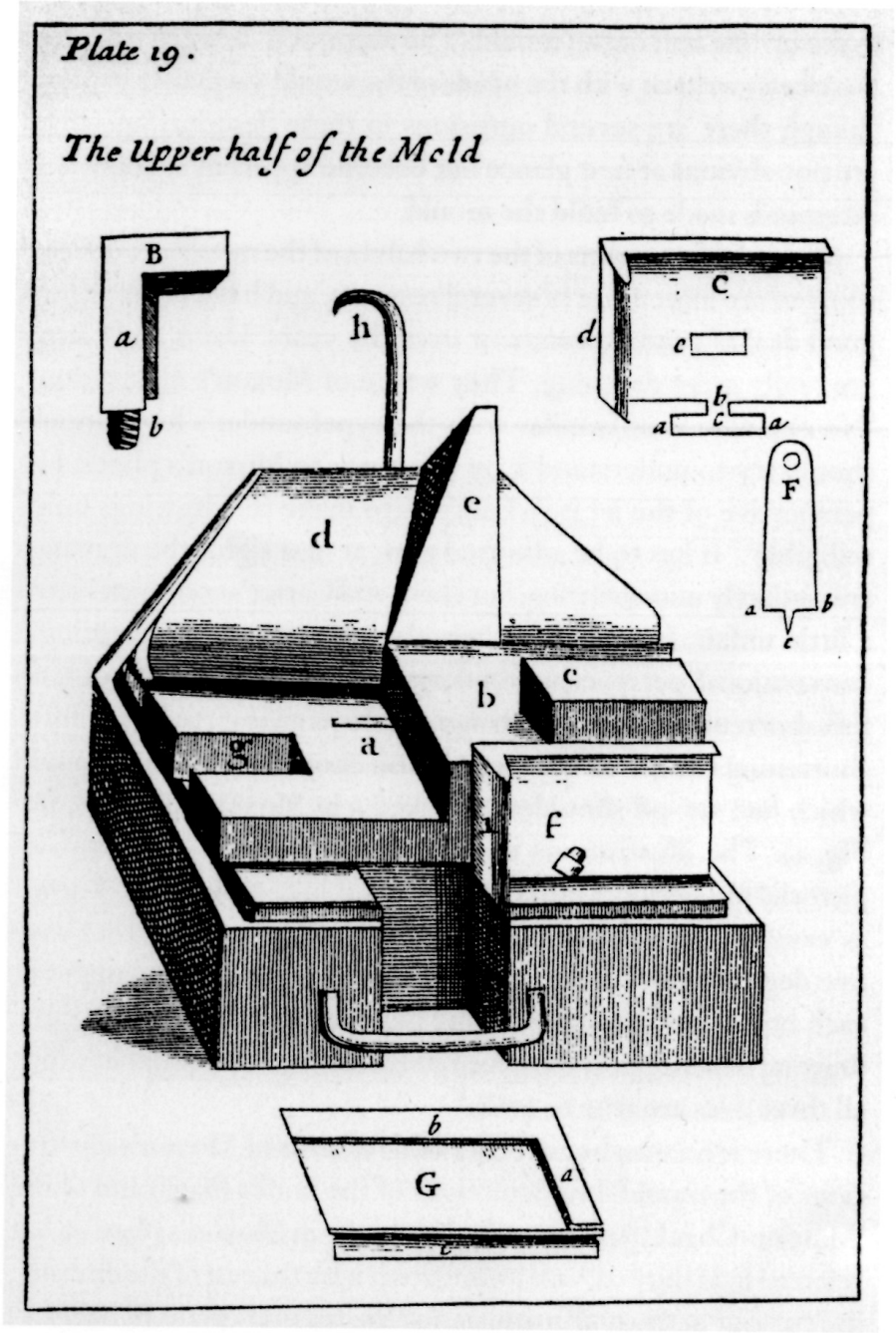
5. Moxon pp. 129–147. Davis-Carter pp. 134–150.

1. (Right and opposite) Moxon's plates 18 and 19, showing the two halves of the hand-mould (actual size).



certain details (see Fig. 1, Moxon's plates 18 and 19). Each separate part is identified by reference letters and Moxon lists the parts as follows:

a	The *Carriage.*
b	The *Body.*
c	The *Male-Gage.*
d e	The *Mouth-Piece.*
f i	The *Register.*
g	The *Female-Gage.*
h	The *Hag.*



aaaa	The *Bottom Plate.*
b b b	The *Wood* the *Bottom Plate* lies on.
c c e	The *Mouth.*
d d	The *Throat.*
e d d	The *Pallat.*
f	The *Nick.*
g g	The *Stool.*
h h g [sic]	The *Spring* or *Bow.*[6]

After this come separate descriptions, presented in the order in which they are needed to assemble each of the parts which go to

6. Moxon p. 131. Davis-Carter pp. 135, 138.

make up one half of the mould. The account is detailed and must have been written with the needs of the would-be maker in mind, though there are several omissions in these descriptions which are not obvious at first glance but become apparent as soon as an attempt is made to build the mould.

Moxon's illustrations of the two halves of the mould are detailed too, but are inaccurate in several respects, and have come in for a good deal of critical comment over the years. Davis and Carter are really quite damning. They wrote of Moxon's illustrations, 'No one who is unfamiliar with the typefounder's hand-mould should try to understand it by reference to Moxon's plates. His perspective of the jet is so faulty as to make the drawings unintelligible'.[7] It has to be admitted that, at first sight, the drawings are distinctly unconvincing; but Davis and Carter's comments seem a little unfair. It is doubtful whether Moxon was attempting a conventional perspective rendering, as there appears to be no foreshortening in these drawings. Perhaps an impression of foreshortening has arisen because Moxon chose to illustrate a mould which had cut-off shoulders (marked *a* in Moxon's plate 18, my Fig. 1). The illustrations are in fact much closer to a form of pictorial projection formerly used by cabinet-makers and known as 'cavalier'. In this projection, the x-axis is drawn upward at forty-five degrees from the y- and z-axes, which are at right-angles to each other and parallel with the picture plane. This produces a drawing which appears to have a distorted top surface but in which all three axes are true to scale.[8]

There are a number of other odd features of Moxon's illustrations of the mould. His depictions of the hooks (hags) and of the 'Matrice-Check' (not identified by letter in Moxon's plate 19 but referred to in the text)[9] are inconsistent with the rest of the drawing; the cut-out in the bottom-plate for the register (plate 18 below f) is positioned too far to the left on the under-half of the mould and is absent from the upper-half (plate 19 below f); no slots are shown for the register-retaining screws, nor for the holes for the mouthpiece-retaining screws (these should be near to d on plates 18 and 19). All of these anomalies only came to light through attempting this reconstruction. Finally, the drawing of the jet is much too wide. But having admitted all this, the quality of the drawings is probably well up to the standards of technical presentation of the time and they form an essential part of Moxon's description of the mould.

Moxon's illustrated account of mould-making differs fundamentally from modern methods of engineering specification in

7. Davis-Carter p. 134, footnote to plate 18.

8. See *British Standard construction drawing practice*. London: British Standards Institution, 1984. B.S. 1192, part 1.

9. Davis-Carter p. 146.

that nowhere does he rely on accurate measurement. Dimensions are frequently provided but they are almost always qualified by the word 'about', which leads to the conclusion that the precision necessary for mould-making was achieved principally by the careful fitting together of the individual parts by a combination of trial and error and the use of patterns, rather than by measurement. When something needs to be accurately square, flat or parallel, Moxon always indicates this in the text, but it seems clear that no effort was to be wasted on making non-critical components more accurate than was necessary. The Oxford University Press half-mould, shows this clearly: to eyes grown used to the products of modern precision engineering it has a hand-crafted look, but wherever it needs to be accurate its anonymous craftsman made it so. Apart from careful workmanship, the other means of achieving accuracy was by adjustment. Because moulds are made of a number of separate parts, held together by screws and not filed out of a solid chunk of metal, all the parts can be subtly adjusted in relation to one another. The procedure for achieving this adjustment is described by Moxon in his section '*Of justifying the* Mold'.[10] One is reminded of the engineer's adage – 'if you can't make it accurate, make it adjustable'.

Where measurements do occur in Moxon's text, they are in inches and fractions of an inch, down to about ¼ of an inch. For dimensions smaller than this, Moxon uses type-sizes, providing a list of these sizes and an indication of how they relate to the foot described in an earlier passage in which he deals with type.[11] As well as fractions of the inch and type-sizes, Moxon also occasionally refers to the 'Scabbord', which he says was half of a 'Nomparel'. Since he numbers 150 nomparels to the foot, this scabbord must have been roughly 1/25 of an inch.[12] In the section on mould-making, the type-sizes he uses for measurement range between 'Brevier' and 'Two-lin'd English'. Using Moxon's scale of sizes, these approximate to a useful series of common fractions of the inch. This rough correspondence is intriguing. It would be interesting to know whether a similar range of thicknesses of iron and brass stock were offered by metal-suppliers in and before Moxon's time.[13] The availability of metal in a standard range of thicknesses would have been enormously helpful. The table on the following page shows how Moxon's type-sizes relate to common fractions of the inch.

10. Moxon p. 142. Davis-Carter p. 146.

11. Moxon p. 14. Davis-Carter p. 21.

12. Moxon pp. 14, 60. Davis-Carter pp. 21, 68.

13. In the first volume of Moxon's *Mechanick exercises* ... (1677–1680), in the section on smithing, he refers to iron from Germany being supplied, via the Netherlands, 'wrought into square Bars three quarters of an inch square' (p. 14). This appears to be the only reference he makes to metals being supplied in standard sizes.

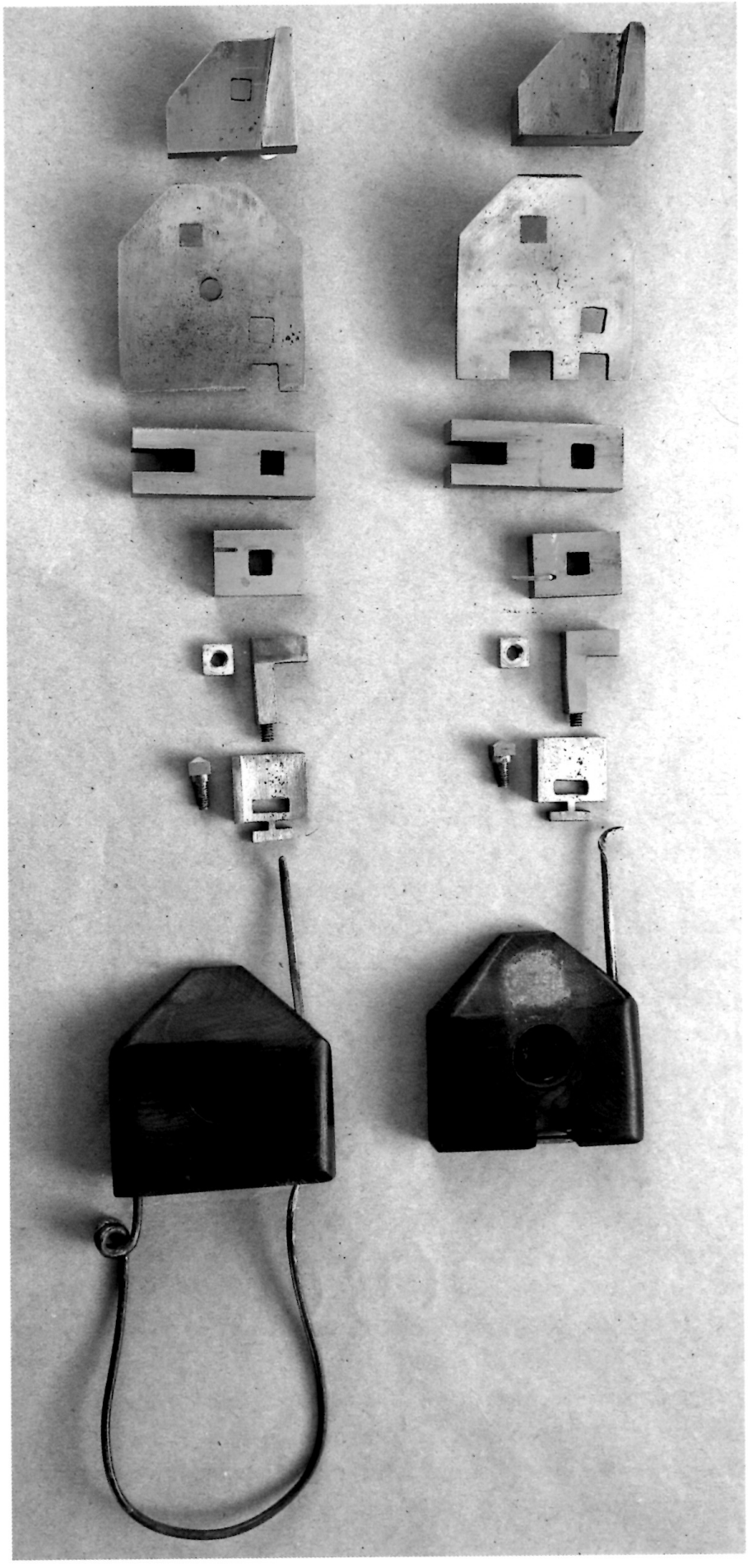
Moxon's type-sizes and their decimal equivalents (in inches)		Common fractions (of the inch)	Decimal equivalent of common fractions (of the inch)
Two-line English	0.3636	3/8	0.375
		11/32	
Double pica	0.3158	5/16	0.3125
		9/32	
Great primer	0.24	1/4	0.25
		7/32	
English	0.1818	3/16	0.1875
Pica	0.16	5/32	0.1562
Long primer	0.1302	1/8	0.125
Brevier	0.1071	3/32	0.0938

Note that, although given in inches, these figures are expressed as fractions so that the units are immaterial.

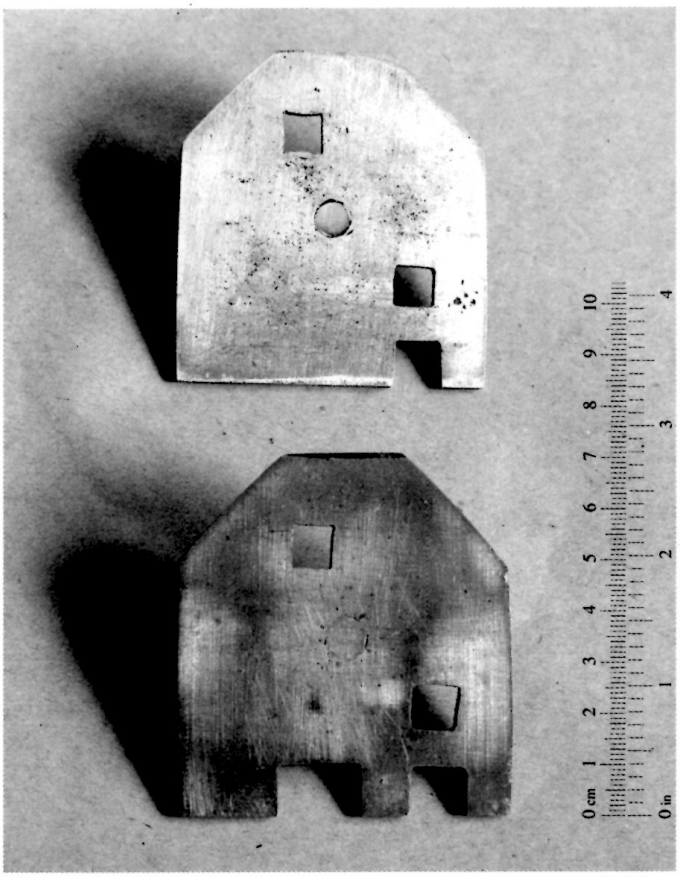
A detailed commentary upon Moxon's blow-by-blow account of the making of each of the separate parts of the mould follows, using Moxon's own headings and sequence. Moxon's headings refer to one half of the mould only. A complete mould has both an upper- and a under-half. Figure 2 shows all the parts of my reconstruction for both halves disassembled. (Figs. 3–5, 7–9 and 11 show the parts in various stages of assembly, with scales added to Figs. 3–5 and 9). Note that the only parts which are not exactly duplicated are the bottom plates, the woods and the spring. The bodies are identical, except for their grooves which are handed. The groove in the upper-half body is on its underside and holds a small semi-circular-sectioned piece of wire between it and the upper surface of the carriage. This wire projects out from the body onto the surface of the carriage and causes the 'nick' to appear on the front[14] of type cast in the mould. The groove on the under-half body is on its upper surface and is provided to accommodate this wire (see Fig. 5).

'*Of the* Bottom-Plate.' (*aaaa* in Moxon's plates; Moxon pp.132–133. Davis-Carter p. 138). This is the chassis on which the half-mould is built. As with all mould-parts, bottom-plates are made by sawing, filing and drilling them together as a pair. An exception to this is the cut-out for the matrix which occurs only on the bottom-plate of the upper-half of the mould. The large square hole in the top third of both plates is not mentioned by Moxon in his description of the bottom-plate, but he does mention the need for such a hole when describing the fitting of the mouthpiece. I

14. The essential six planes of a sort are referred to as if it were a soldier, standing to attention in such a way that when observed from above the 'face' (the uppermost plane bearing the letter-form) of the type is the right way up. Thus the plane with the nick is the 'front' (despite the fact that this side faces towards the bottom of the page in an imposed forme), the opposite plane is the 'back', the other two vertical planes are 'sides', and the horizontal plane at the bottom is the 'foot' or 'feet'.



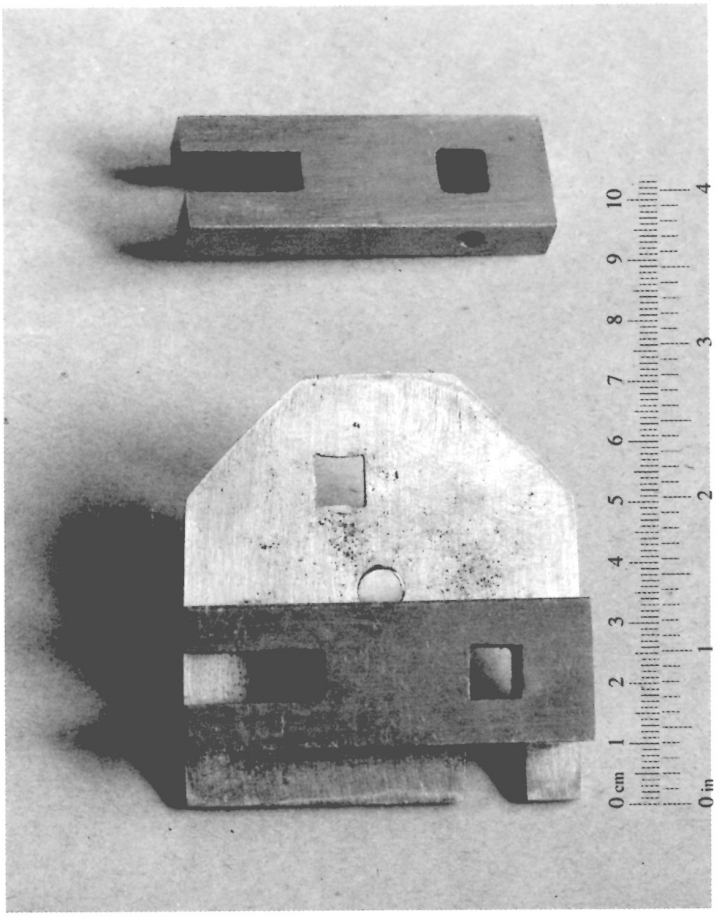
2. The parts of the reconstructed mould before assembly (shown at approximately thirty percent of actual size).



3. The bottom-plates. The top one belongs to the upper-half of the mould.

have used the Oxford University Press mould as a model for this. The purpose of this hole is to provide a means of attaching the mouthpiece to the bottom-plate and to provide for their adjustment relative to each other. Moxon also fails to mention the square holes needed in the lower-third of both plates to allow for the fitting of the male-gages. In Moxon's illustration, the cut-out for the register is missing from the upper part and is shown too far to the left on the under-part. The adjustment slots identified as c on the detailed illustration of the register on Moxon's plate 19 do not appear on either of his main illustrations.

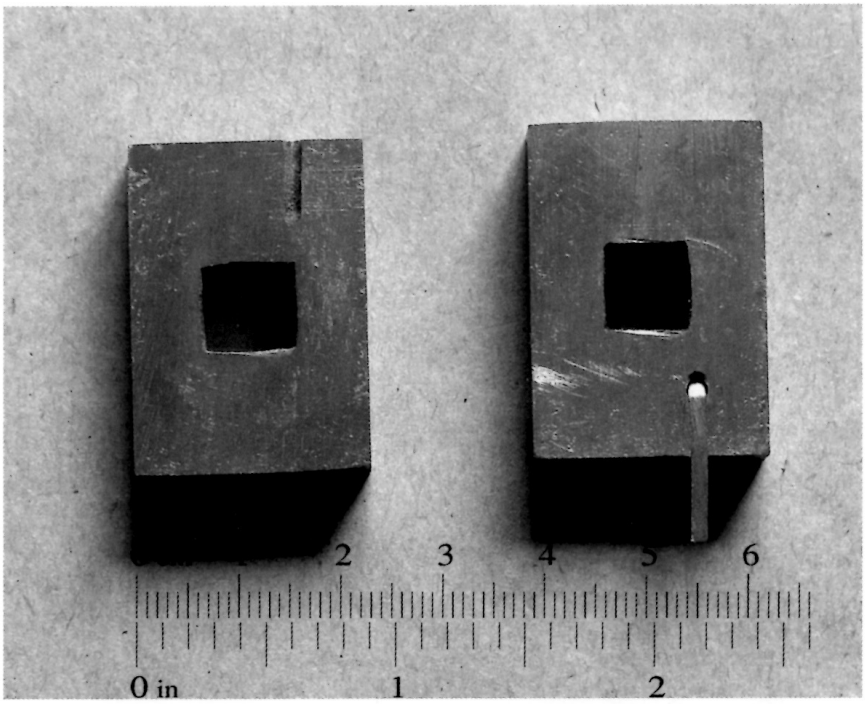
'*Of the* Carriage.' (Moxon p. 133. Davis-Carter p.139). The carriages act as the adjustable sides of the mould-box and work with the male-gage to maintain horizontal alignment of the two halves of the mould. Moxon states that the carriages should be of iron. They are brass in the OUP mould. Brass was used in my first reconstruction because it was readily available in a convenient thickness, but my recent reconstructions have all been in iron. Since the two halves of the mould slide on the carriages, both must be parallel-sided, flat and accurately square. Their height is also critical, as this determines the length of the type-body.



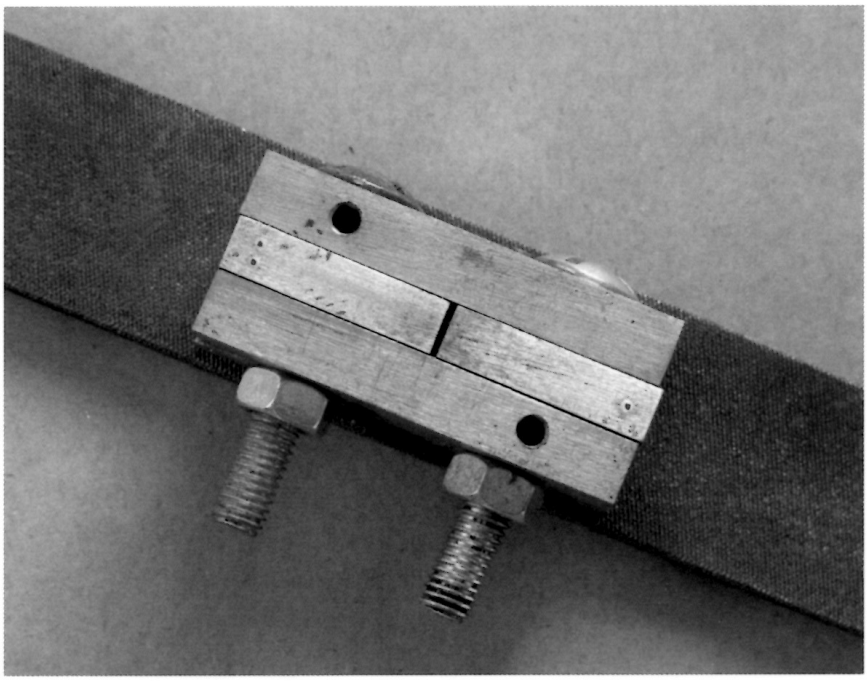
4. The carriage alone (top) and in position on the bottom-plate (bottom).

Moxon's method of achieving the necessary flatness and squareness was to rub the parts on a large flat file while holding them square to the surface by means of a 'Flat-Gage' (a carefully-squared-up piece of boxwood). Moxon calls the file he employs a 'Using-File'.[15] It is very large (about 40 square inches in area and ¾ of an inch thick); unfortunately nothing approaching this size of file seems to be available today and a smaller, less satisfactory alternative had to be used. Moxon does not at this point in the text mention the square holes in the right-hand end of the carriages needed to accommodate the male-gages but does refer to them later when describing 'the body'. According to Moxon's description, the carriage is clamped to the bottom-plate only by this male-gage. In all my reconstructions I have found this to be less than satisfactory. Even when the nut on the male-gage is tightened very severely there is still a tendency for it to move in use, because the carriage is attached to the bottom-plate at only one end. The pica mould at OUP is provided with additional bolts which fix the carriage to the bottom-plate at its other end. This is another feature that Moxon seems to have overlooked.

15. Moxon describes the use of the flat-gage and using-file on pp. 83–84.



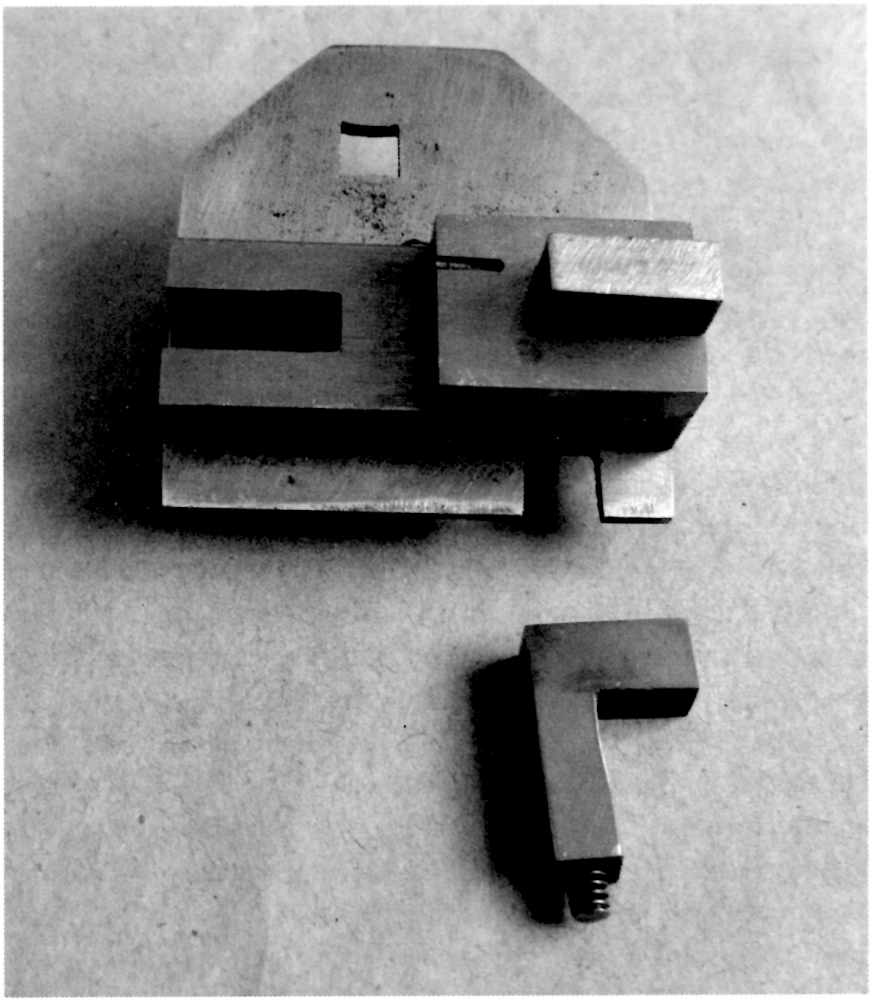
5. The two bodies. Note the wire and groove which form the nick in a sort during casting.



6. The bodies and carriages bolted together and being worked on the using-file.

'*Of the* Body.' (Moxon p. 133. Davis-Carter p. 139). The bodies act both as the sides of the mould-box and the means of controlling the type-size (the 'body' of the type itself) to be cast. Moxon is careful to point out that the bodies need to be the 'exact breadth' (height) of the carriage. A method of ensuring this, is to work both carriages and both bodies on the using-file at the same time, with all four parts clamped together. Figure 6 makes this clear.

Experience gained from my reconstructions suggests that the various parts in the pack can be rearranged and inverted in order to average out any inequalities caused by uneven pressure. What is more, the large base created by locking everything together helps enormously in keeping the parts square. Moxon does not suggest this procedure at this point, but does refer to a similar process later in the text when explaining how to justify the mould.[16]



7. The male-gage shown alone (bottom) and in position, clamping together the body, carriage and back-plate (top).

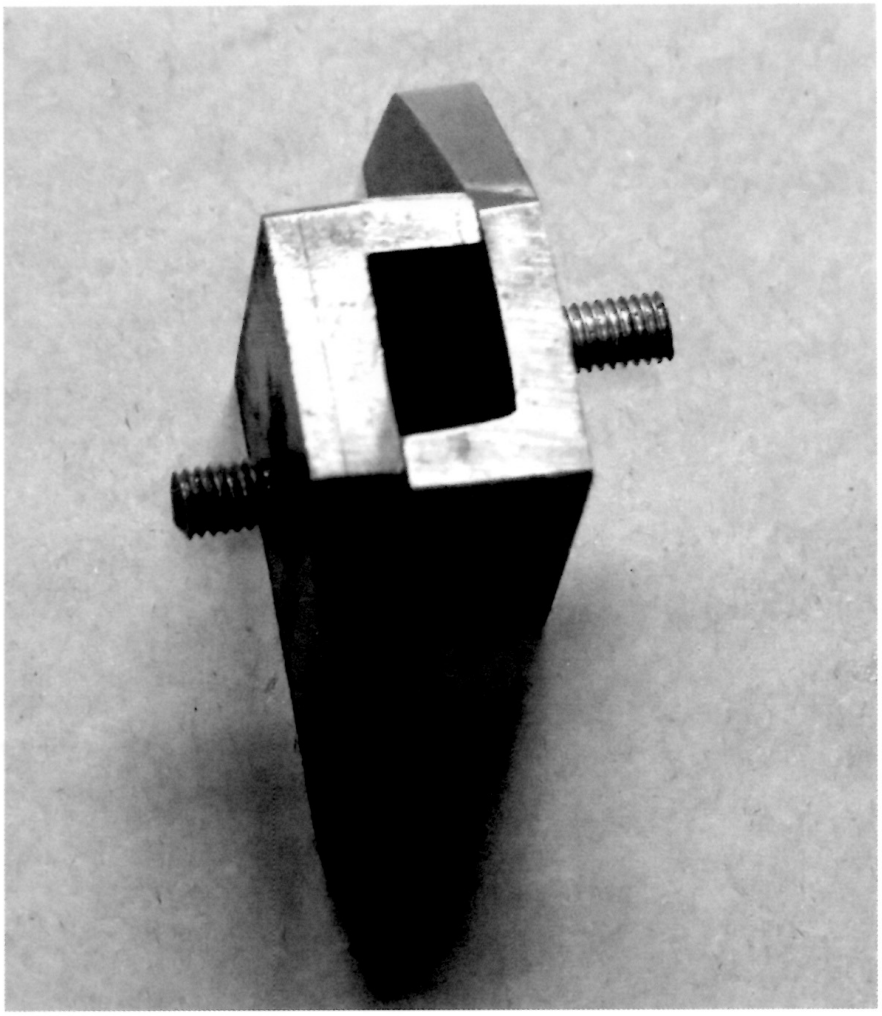
'*Of the* Male-Gage.' (Moxon p. 134. Davis-Carter p. 140). The purpose of these gages is to maintain the horizontal alignment of the two halves of the mould and provide the means of fixing together the body, carriage and bottom-plate. They stand proud of the bodies and engage in slots in the carriage of the opposite half, called by Moxon '*Female*' gages. Moxon's description of the male-gage is quite difficult to follow and would be very difficult indeed without his detailed illustration. The thread on the end of the example he shows is left-handed but this is probably the result of reversal in the engraving process. Moxon indicates that the

16 Moxon pp. 146–147. Davis-Carter p. 150.

length of the shank of the male-gage, excluding the thread, should be one scabbord (1/25 of an inch) shorter than the combined thickness of the bottom plate, carriage and body. This leaves just enough clearance for the nut to be tightened to hold the parts firmly in place. The same arrangement is seen in the OUP mould. Interestingly, the thread on this half-mould has been locked by having type-metal poured over it. Because of this, it is not possible to know what sort of thread was used, but from what can be seen it appears very similar to the other threads made for this mould; apart from the threads on the register-retaining screws, which are smaller, all the screws are just over ¼ of an inch in diameter and have a pitch of 18 threads per inch. The nuts for the male-gages are square and roughly made.

'*Of the* Mouth-Piece.' (Moxon pp. 134–137. Davis-Carter pp. 140–142). The purpose of the mouthpiece is to funnel the molten type metal into the interior of the mould and provide a reservoir, to ensure that each cast character was completely filled. The funnel-shape is formed from two identical pieces of either brass or iron, each of which is attached to its respective bottom-plate by means of a threaded bolt riveted to its underside. This bolt has a square shoulder on its underside which fits, with some tolerance to allow for adjustment of the mouthpiece, into the square hole in the upper-part of the bottom-plate and is held in place by a nut. The two closely-fitting halves of the funnel slide over each other and adjust with character width ('set'). Moxon used more words to describe the mouthpiece than he used for any other part of the mould. It was also more troublesome to reconstruct, because its geometry is more complicated than that of the other parts. Moxon fails to provide any indication of the angle of slope for the sides of the funnel, so I had to rely on an approximation based on his illustration. The resulting mouthpiece, based on such evidence, works. But it is undoubtedly too wide, and when in use the mould heats up very quickly because of the volume of hot type-metal retained in the mouthpiece (in just the way that Moxon warns against). The sides of the OUP mould mouthpiece, very different in form from Moxon's, slope about 10 degrees. The method of attachment of the mouthpiece-parts to the bottom-plates is identical to that described by Moxon.

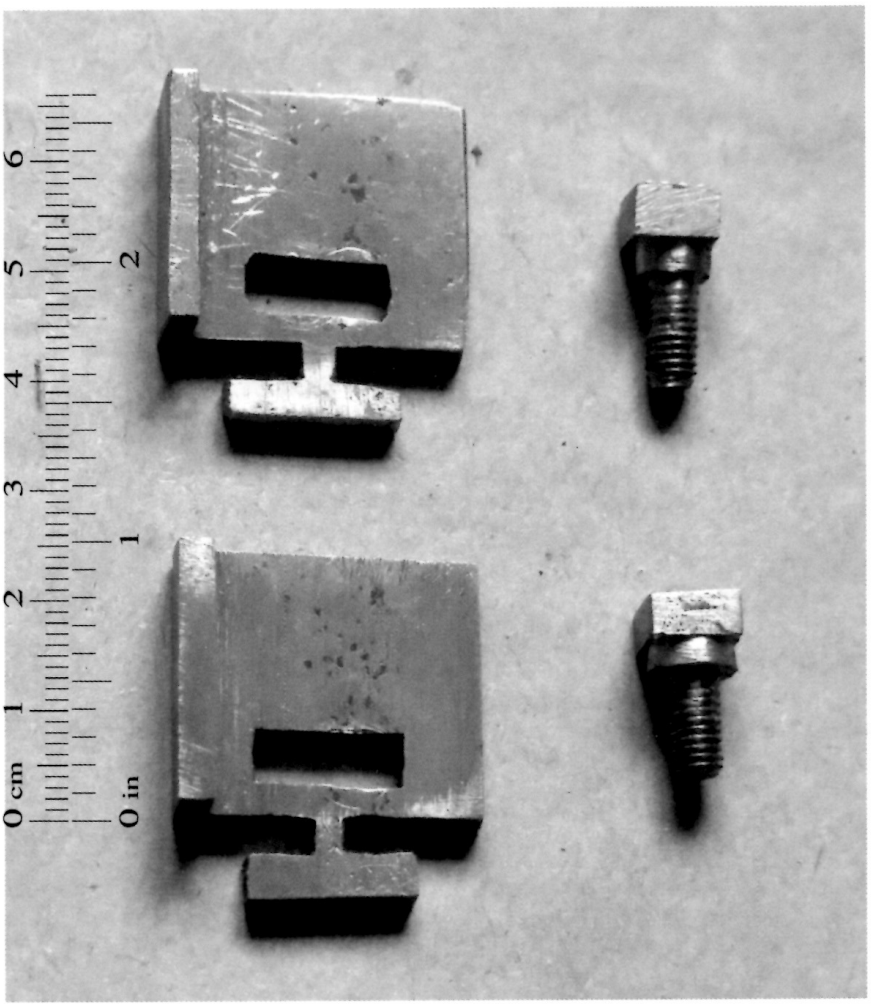
'*Of the* Register.' (Moxon pp. 137–139. Davis-Carter pp.143–144). The function of the registers was to provide a means of adjusting and accurately positioning the matrix under the mould. This task



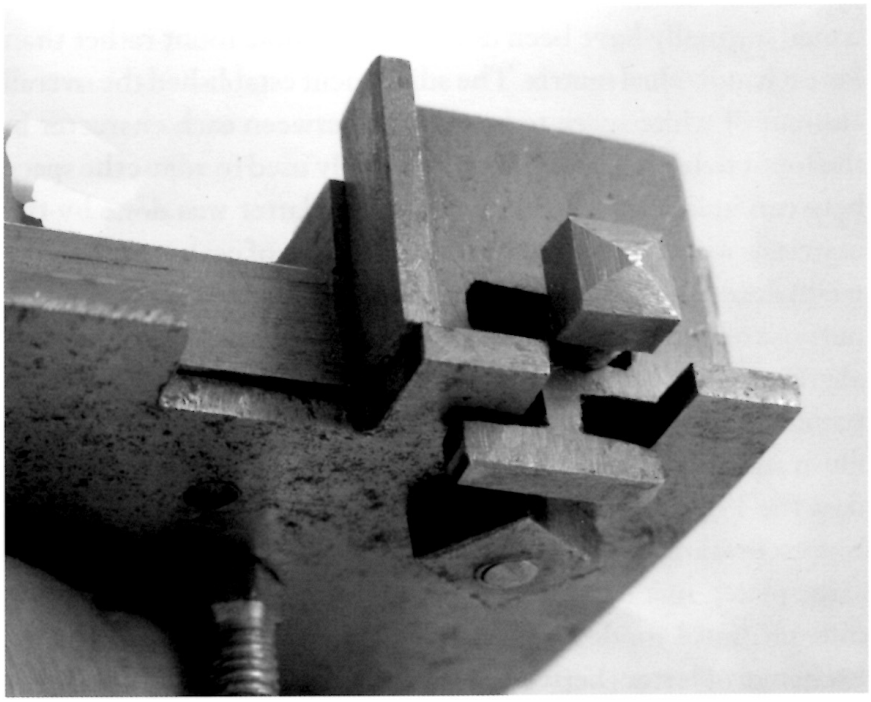
8. The two halves of the mouthpiece fitted together.

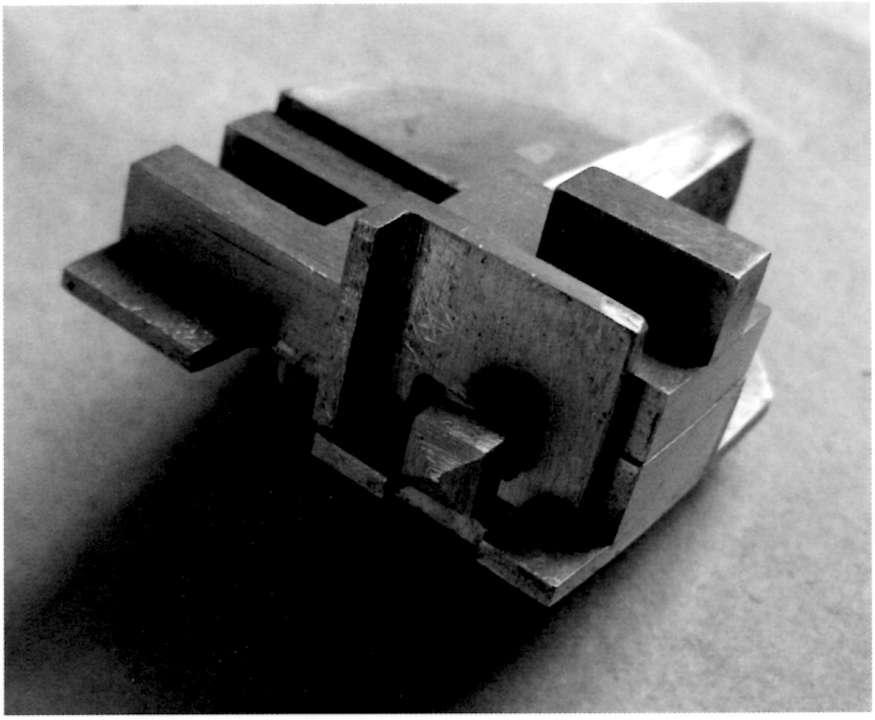
would normally have been done for the whole fount rather than for each individual matrix. The adjustment established the overall amount of white space to be allowed between each character in the fount to be cast, and was not normally used to adjust the space between individual character pairs. The latter was done by the matrix-justifier, who carefully filed the sides of each matrix to the width deemed appropriate. The registers also served the subsidiary purpose of assisting the male-gages in maintaining the horizontal alignment of the two halves of the mould by bearing on the underside of the carriages. The absence of a cut-out in Moxon's illustration of the upper-half bottom-plate (Plate 19) to accommodate the T-shaped protuberance which can be seen in his detailed representation of the register (shown on the upper-part of the same plate), made the interpretation of this part of his drawing difficult, until modelled physically, and was the subject of an exchange of letters between myself and James Mosley when this paper was first published. At that time no other moulds were known with registers of this sort, but in 1997 James visited the OUP

9. The two registers with their retaining screws.



10. The register in position, screwed to the upper-half of the mould.





11. The upper-half of the mould, complete apart from the wood. Note the cut-out in the bottom plate beneath the register-retaining screw (omitted from Moxon's illustration of the upper-half and somewhat displaced in the under-half). Its purpose is to accommodate the T-shaped part of the register (marked *aabc* in Moxon's plate 19, and visible also in Fig. 10).

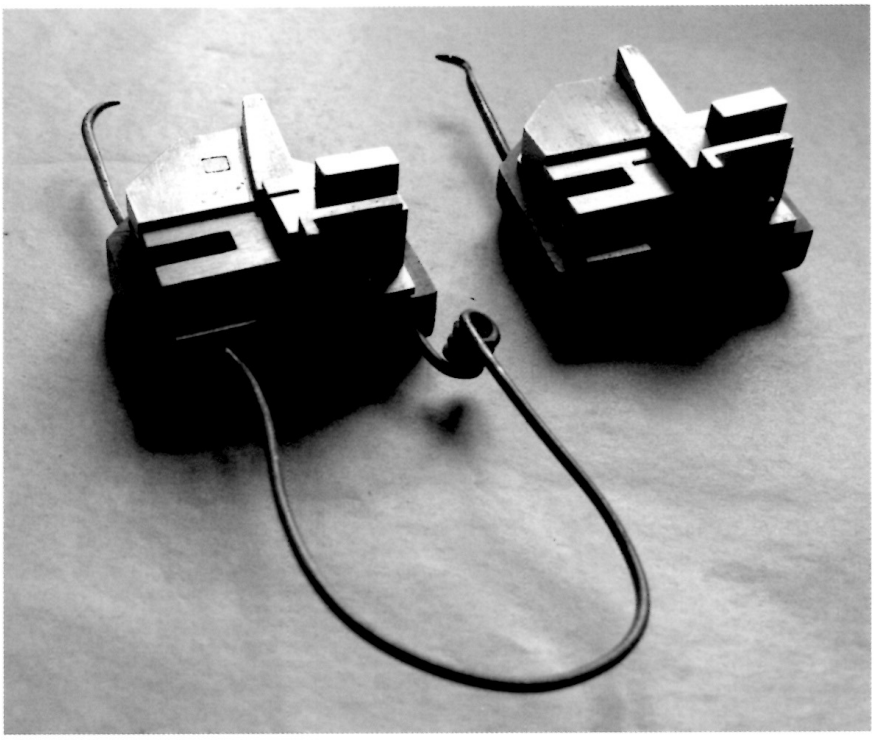
with the purpose of examining the moulds there and found to his surprise that the pica mould illustrated by Davis and Carter and described as 'probably of Moxon's time' has just such an arrangement.[17] It is curious that Davis and Carter chose a viewpoint for their photograph which fails to show this, given that it is this feature, more than any other, that matches Moxon's account. Moxon provides very little information about the register-retaining screws and his illustrations of these are difficult to interpret. They look quite unlike those used in the OUP long primer mould which, in the absence of any other information, I used as the model for my first reconstruction. Since then I have looked again at Moxon's drawings of these screws using a magnifying glass. The shading on their top surface leads me to suggest tentatively that they have the form seen in Figs. 9 and 10.

'*Of the* Nick.' (Moxon p. 139. Davis-Carter p. 144). The nick identifies the front of any piece of type cast in the mould. Moxon's description is clear and easy to follow. See Fig. 5.

'*Of the* Bow *or Spring.*' (Moxon p. 140. Davis-Carter p. 145). The function of the spring is to keep the matrix pressed up against the mould while casting, and to provide a quick means of releasing it once the metal has set.

17 Davis-Carter p. 405, figure 11.

12. The completed type-mould.



'*Of the* Hooks, *or* Haggs.' (Moxon p. 141. Davis-Carter p. 145). These were provided to help release types that stuck in the mould after it had been opened. The type-caster used the hook from the empty half of the mould to remove the cast type from the other half. Surprisingly Moxon stated that they should be of iron (one would have expected brass in order to minimize the possibility of scratching the inside of the mould).

'*Of the* Woods *of the* Mold.' (Moxon pp. 141–142. Davis-Carter pp. 145–146). These serve to protect the hands of the type-caster from the heat of the mould. In English moulds they were normally rounded at the edges for comfort, but Moxon shows them square in his illustrations.[18] Each is attached to one of the mould's bottom-plates by means of a screw riveted to the plate's centre.

'*Of justifying the* Mold.' (Moxon pp. 142–147. Davis-Carter pp. 146–150). This is the subject of Moxon's final section on mould-making. It is quite long and describes a complicated and ingenious procedure for ensuring that the mould is properly adjusted and therefore capable of producing types which are square and true. Equally importantly, this process ensures that the mould has no fine crevices between its various parts into which metal could flow causing 'ragging'.[19] Ragging leads to the cast type sticking in the mould which dramatically slows down the rate of casting.

18. It may have been French practice to make the woods square. The mould shown in Denis Diderot and Jean le Rond d'Alembert (editors), *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers* (32 volumes, Paris: Chez Briasson etc., 1751–1771, plates vol. II, 1763, 'Fonderie en caractères d'imprimerie' plates II and 'Suitte de la pl. II') has square woods, while those depicted by Fournier have square woods with beveled edges (see Pierre-Simon Fournier, *Manuel typographique*. 2 volumes, Paris: Imprimé par l'auteur, 1764–1766 (vol. I, plates V–VII show the mould); reprinted in translation in Harry Carter (editor), *Fournier on typefounding* (London: Soncino Press, 1930)).

19. Moxon pp. 142, 388. Davis-Carter pp. 146, 350.

THE ABSENCE OF AN ADJUSTABLE STOOL

The stool is the part of the bottom-plate against which the head of the matrix rests. It can be made adjustable by cutting this part of the bottom-plate out and inserting a small metal panel, held in place by a screw or screws. Several variations on this basic pattern are to be found in existing moulds,[20] but in its simplest form adjustment is possible through the addition or removal of shims (thin pieces of metal used as spacers) under the retaining screw. The need for this adjustment arises when the typefounder wishes to cast from matrices which have been justified to a different mould. Moxon makes no reference to either the need for this or the means of achieving it, yet other moulds presumed to be from his period have just such an adjusting device. It seems most unlikely that Moxon would have left out the description of this on the grounds of simplification, as elsewhere he is not daunted by the explanation of rather more complex matters. Furthermore, if the absence of this description was simply an oversight one might expect to find some reference to an adjustable stool later in the text, when Moxon describes the sinking of punches.[21] This process involves marking off onto the matrix blank the distance between the stool and the point at which the punch had to be sunk, so the presence or absence of an adjustable stool would certainly have needed to be allowed for. But no reference to an adjustable stool is made here either.

It is quite possible that Moxon's account is giving us a 'snapshot' of the type-mould as he knew it, either because at this date in England stools were fixed or, perhaps more probably, because moulds were made both with and without adjustable stools and Moxon was simply more familiar with the latter type. In either case, one suspects that a mould without an adjustable stool might have been supplied by the punchcutter, to match a particular set of his matrices. The chronological change from fixed to adjustable stools is argued against by the presence of a fixed-stool mould at the Plantin-Moretus Museum, which is evidently later than others with adjustable stools.[22] It is likely that moulds were made in the seventeenth century, and probably earlier, without adjustable stools, so that some moulds said to be of this period may either have had this feature added at a later date, or are really of later manufacture. After all, it is far simpler to modify a mould by the addition of an adjustable stool than to re-justify a set of matrices. As thread-sizes were not standardised in the seventeenth century, a comparison of the threads of the stool-adjustment screw with the other screws in any particular mould, might throw some light on this.

20. See Stan Nelson, 'Mould making, matrix fitting, and hand casting', *Visible language*, 19:1 (1985), 107–120. Stan has made a number of hand-moulds, based on surviving exemplars and the accounts given by Moxon and Fournier (see note 18), and is currently writing a monograph on the history and materiality of the hand type-mould .

21. Moxon pp. 147–153. Davis-Carter pp. 153–156.

22. See Mike Parker, 'Early typefounders' moulds at the Plantin-Moretus Museum', *The library*, 5th series 29 (March 1974), [93]–102. On page 98 Parker describes mould GI 52, a large, all-steel Flemish mould with French bottom-plates, of which he says 'The mould has no stool; the bottom-plate is continuous across the head of the matrix and serves the purpose'.

CONCLUSION

Reconstructing a mould following Moxon's description turned out to be much more fascinating than could have been anticipated at the start, mainly because it provided the means of penetrating what is held to be a difficult passage of his text and because it shows that his diagrams are, in their own way, reliable guides. The reconstruction of the mould took about thirty hours, excluding the time needed to justify it. If Moxon were to see it, he would no doubt have some harsh words for some parts of it, but the fact that a workable mould can be made in this time, using only simple tools of the sort familiar to a workman of Moxon's era, both demystifies mould-making and increases one's respect for the hand-mould's design. The simplicity and duplication of its parts, the dual function of most of its components, its adjustability and above all its ease of operation, are all indications of a mechanism that was highly evolved. There were, after all, around ten generations of typefounders between Gutenberg and Moxon.

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