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The Codex Atlanticus in glass: new visual documentary evidence*

Juliana Barone

THERE has recently emerged scholarly interest in the glass plate negatives of Leonardo's manuscripts as they offer precious records on how his works on paper appeared over a century ago. A large quantity of glass plate negatives can be found in Italian collections and relates in various ways to early publication projects of his manuscripts. Less expected is the fact that a significant number of glass plate negatives of Leonardo's Codex Atlanticus is in the Warburg Institute in London. Long overlooked, their existence and historical importance were first acknowledged in my preliminary study[1] which offered a comparative analysis between key Warburg glass plates and related illustrations in the Hoepli *editio princeps* (1894-1904)[2]. One of the main conclusions reached is that the Warburg plates provide testimony to both the state of conservation and structure of the Codex Atlanticus sheets prior to the first printed edition. As a follow-up to this study, and with the support of the Warburg Institute, these glass plates have recently been photographed and fully catalogued. The purpose of this article is to consider some of the results, as well as questions that have arisen from my first-hand and on-going examination of this important historical material, while providing some new visual documentary evidence that is no longer availa-

Codice Atlantico
f. 918r [336r]

[1] Barone, Juliana, "The *Lastre di Vetro* of the Codex Atlanticus in the Warburg Institute and the Hoepli Edition". In *De-Coding Leonardo's Codices. Compilation, Dispersal, and Reproduction Technologies*, Paolo Galluzzi and Alessandro Nova (eds.), Kunsthistorisches Institut in Florenz. Max-Plank-Institut. Studi e Ricerche 15, Venice: Marsilio, 2022, pp. 233-243.

[2] Leonardo da Vinci, *Il Codice Atlantico di Leonardo da Vinci nella Biblioteca Ambrosiana di Milano. Riprodotto e pubblicato dalla Reggia Accademia dei Lincei*, transc. by Giovanni Piumati, intr. by Francesco Brioschi, Milan: Hoepli, 1894-1904.

* I am deeply grateful to Paul Taylor of the Warburg Institute for having drawn my attention to the existence of this important historical material and for his invaluable support. I would also like to thank Claudia Wedepohl and Eckart Marchand for their expert knowledge of Aby Warburg's work and collection, and Rembrandt Duits for kindly facilitating my contact with Vai van den Heiligenberg of the Deutsches Dokumentationszentrum für Kunstgeschichte – Bildarchiv Foto Marburg at the Philipps-Universität Marburg; Monica Taddei of the Biblioteca Leonardiana has kindly helped with illustrations.

ble otherwise. Key physical characteristics of the Warburg glass plates and of their original boxes, together with comparisons with illustrations from the Hoepli edition and glass plates in the *Archivio Fotografico delle Civiche Raccolta d'Arte Applicata e Incisione* in Milan are offered below as new tools for reassessing the early legacy of the Codex Atlanticus[3]. A comprehensive Table of Concordance is additionally provided as part of this study and to support further research developments.

Physical characteristics

There are 216 glass plates of Leonardo's Codex Atlanticus in the photographic collection of the Warburg Institute[4]. These glass plates are all negatives and most of them are well preserved. They do not reproduce all the sheets of the Codex Atlanticus, a point which will be addressed throughout this article. The majority show individual Leonardo sheets surrounded by small sections of adjacent sheets, a highly significant feature for a historical reconstruction of the page layouts dating back to the assemblage by Pompeo Leoni (1533-1608) of Leonardo's works in order to form the Codex Atlanticus. There are also some glass plates that show a portion of a Leonardo sheet, and others that reproduce the same sheet two or three times although with small differences in lighting or framing of the photographed image, so are not exact duplicates but may have been considered as such at some point in their history[5]. With respect to dimensions, the glass plates can be arranged in three basic groups even if there are slight variations within each group: 24x30 cm, 21x27 cm, 18x24 cm[6]. Comparatively, they are smaller than the Fabriano sheets of 50x38 cm of the Hoepli edition, and much smaller than the support sheets of 67x45 cm that Pompeo Leoni used when composing the Codex Atlanticus. Also, some Warburg glass plates weigh slightly more than others; the thickness of glass varies from around 1.5 mm to 2.5 mm but is not necessarily related to differences in the plates' sizes[7].

The Warburg glass plates are now preserved in new boxes marked alphabetically from A to T[8]. This lettering follows that given to them when previously stored in twenty yellow Kodak boxes. The sequence in which these glass plates were found in each of the Kodak boxes has been retained in the new boxes, but is unrelated to any of the two foliation systems of the Codex Atlanticus as used in the Hoepli and in the Giunti editions respectively, and does not seem to result from any kind of thematic arrangement either[9].

[3] For the Milan glass plates, I have been kindly granted electronic access to the 'Leonardoteca' (last consulted on 12/12/2021), which is in preparation by the Museo Galileo and for which I should like to thank Andrea Bernardoni and Paolo Galluzzi.

[4] An initial estimate of 220 included the lids of the boxes in which the glass plates were originally stored.

[5] For instance, the word "Doppia" (Duplicate) appears on glass plates J9 and J10.

[6] Glass plates of 24x30 cm can be found in boxes A, B, C, D, E, F, H, and some can also be found in box G; glass plates of 21x27 cm can be found in boxes O, P, Q, R, and some can also be found in boxes G, S and T; and glass plates of 18x24 cm can be found in boxes K and L, and some can also be found in boxes G, S and T.

[7] For instance, glass plates H1 and H11 are of the same size but the latter is significantly heavier and thicker.

[8] The new boxes comprise fifteen grey and two red; the latter contain damaged glass plates.

[9] For the Giunti edition, see Leonardo da Vinci, *Il Codice Atlantico della Biblioteca Ambrosiana di Milano*, transc. by Augusto Marinoni, Florence: Giunti, 1975-1980. For the Warburg glass plates and related illustrations in the Hoepli and Giunti editions, see the Table of Concordance below.

At times, however, there emerge signs of an attempt to gather together those plates that seemed to be duplicates or of comparable dimensions. More remarkable is that inside four of the Kodak boxes (M, O, R, S) fragments of the original boxes were found. The surviving fragments consist of four old lids, all of which contain the same information with respect to the maker, technique, dimensions and date (Fig. 1). We learn from them that a certain "M. Cappelli" had established a business at 31 Via Stella in Milan and had won a first-class silver medal in a Photographic Exhibition in Florence in 1887. "M. Cappelli" can be positively identified as the highly successful Michele Cappelli who would later expand his business and go on to win prizes including an International Grand Prix in Milan in 1906 and another in Turin in 1911. The Warburg Institute owns a variety of Cappelli glass plate negatives, some of which stored in their original boxes publicising such past awards. More specifically, with respect to the date on which Cappelli produced the glass plates used to photograph the Codex Atlanticus, the prize he was awarded following his first-class silver medal of 1887 was a Diploma of Honour in 1894[10], which, in turn, is not recorded on their old lids as it is likely to have post-dated them. So the Warburg glass plates must have been produced between 1887 and 1894. Perhaps not coincidentally, it was around these years that the project for the first printed edition of the Codex Atlanticus was officially announced and started to bear fruit. Among the documentation that has come down to us, we know that the publication project was presented on 3 May 1885 at the Reale Accademia dei Lincei in Rome, that special Fabriano paper displaying a watermark dating to 1887 was acquired, and that the first fascicle was printed and presented in the Accademia dei Lincei in 1891 even if first commercialised some three years later[11].

The four surviving Cappelli box lids also indicate that their boxes contained silver gelatine glass plates ("lastre a gelatina bromuro d'argento") that were to be opened only in the dark, and which were classified as extremely quick ("extra rapide" or "rapidissime"). These technical pieces of information do match the features of the Warburg glass plate negatives as they can be seen to have been coated on one side with a light-sensitive gelatine emulsion of silver bromide. A further piece of information the four old lids have in common lies in the dimensions of the glass plates: "Misura 21-27". They correspond with the measurements of several Warburg glass plates. The fact that the larger and smaller sizes, of 24x30 cm and 18x24 cm respectively, are not represented on these lids can be easily explained by losses over the years. By contrast, the preparation numbers ("N. Prep.") on these four old lids differ: "1170" (old lid found inside Kodak box O),

[10] Publicity of 1906 features references to "Diploma d'Onore – Milano 1894 – Torino 1898 / Firenze 1899", for which see Un mondo d'argento. Breve storia dei supporti per la fotografia in Italia (1839-1939), parte prima, 1.2.5 cappelli. bencinistory.altervista.org [13 nov 2022].

[11] Galluzzi, Paolo, "Introduzione. Il Codice Atlantico". In *Il Codice Atlantico di Leonardo da Vinci nell'edizione Hoepli 1894-1904 curata dall'Accademia dei Lincei* (Roma, Palazzo Corsini, 10 gennaio-28 febbraio 2005), Milan: Anthelios, 2004, pp. II-VI; and Galluzzi, Paolo, "La commissione per l'edizione nazionale dei manoscritti e dei disegni di Leonardo da Vinci. Un secolo di storia". In *Leonardo da Vinci: la vera immagine. Documenti e testimonianze sulla vita e sull'opera* (Firenze, Archivio di Stato, 19 ottobre 2005-28 gennaio 2006), Vanna Arrighi, Anna Bellinazi, Edoardo Villata (eds.), Florence: Giunti, 2005, pp. 26-42.

Fig. 1 - Original box lid found inside Kodax box 'O'. Credit: Warburg Institute, London.

"1248" (old lids found inside Kodak boxes R and S) and "1265" (old lid found inside Kodak box M). The fact that there are two old lids showing the same number and that there is a long gap between the numbers on the other two may suggest that Cappelli's production of the glass plates did not occurred sequentially, which could explain the variation in the thickness of glass.

There is a further level of information that has emerged from sustained examination of these four surviving Cappelli lids, some aspects of which are considered below. Each of the lids received a rectangular label decorated with thin blue framing lines. On the labels there are carefully written annotations in black ink, in German, specifying the number of the box and the quantity of glass plates it contained. Accordingly, the old lid found inside Kodak box O shows that the Cappelli box was numbered "23" and contained "11 Platten", while the lid found inside Kodak box S was numbered "25" and contained "7 Platten". The highest box number appears on the old lid found inside Kodak box R and reads "28". It is possible that there were originally 28 Cappelli boxes in total, each containing some seven to eleven glass plates, though it seems more likely that losses happened over time and that the original number of boxes and plates was considerably larger. For example, the quantity of plates per box can be securely shown to have changed. Looking at digits and annotations by other hands on the same old lids, such as those on the lid that was found inside Kodak box O, there is a "14" in blue chalk that stands for the number of glass plates, which contrasts with the "11" on the German label; the disparity marks a change

in the number of plates inside. Moreover, box numbers were similarly changed. While the old lid found inside Kodak box M is numbered "20" on the German label, it was ascribed a different number in an inscription in Italian, "Cas[sa] 18". Even more telling is the fact that there are annotations in blue chalk referring to places and dates which, given their location in relation to the German labels, are highly likely to have preceded them. A case in point is the old lid found inside Kodak box O, which displays the word "Pisa", top right, in blue chalk, as well as the word "Duplicati" in graphite, the latter presumably indicating that the plates in this box were seen as duplicates. The reference to "Pisa" reappears, in the same blue chalk, on the old lid found inside Kodak box R. And at the top left of the old lid that was inside Kodak box S, also in blue chalk, the year "1902" had been written. When one combines these pieces of information, it is highly likely that the Cappelli boxes totalled at least twenty-eight, that they contained gelatine glass plates produced between 1887 and 1894, and that these plates were used for photographing Leonardo's Codex Atlanticus by 1902. Moreover, they probably were at some point stored in Pisa, perhaps in 1902, and during or after this year they passed to the hands of a German owner and were systematised with adjustments regarding the number of boxes and of plates per box. The collection history of these plates and their connection with Aby Warburg will be fully explored in a forthcoming essay.

Selected comparisons with illustrations in the Hoepli edition and with glass plates in Milan

When we turn to the actual glass plates housed in the Warburg Institute, one of the central questions that emerge is whether they ever formed a complete set of negatives of Leonardo's sheets in the Codex Atlanticus. A related question is the extent to which the visual documentary evidence they contain differs from that of the illustrations in the Hoepli edition and of the glass plates in the *Archivio Fotografico delle Civiche Raccolta d'Arte Applicata e Incisione* in Milan considered to be their direct negatives[12]. With respect to the first question, it is a fact that the Warburg glass plates that have reached us span the beginning to about the end of the Codex Atlanticus. Warburg glass plate J2 corresponds in the Hoepli edition to f. 1va, while B4 relates to f. 400vd[13]. However, when the Warburg glass plates are considered following the sequential foliation of the Hoepli edition, a number of small gaps can be identified, except for six instances where the gaps are considerably

[12] For the Milan glass plates, see Laurenza, Domenico, "Gli studi e le edizione vinciane tra XVIII e XX secolo: documenti e spunti per una ricostruzione storica". In *Leonardo da Vinci: la vera immagine. Documenti e testimonianze sulla vita e sull'opera* (Firenze, Archivio di Stato, 19 ottobre 2005-28 gennaio 2006), Vanna Arrighi, Anna Bellinazi, Edoardo Villata (eds.), Florence: Giunti, 2005, pp. 99-108, esp. p. 105; and Bernardoni, Andrea, "Fotografare Leonardo tra la fine del XIX e l'inizio del XX secolo. Studio preliminare sui negativi per la stampa dei facsimili di manoscritti vinciani". In *De-Coding Leonardo's Codices. Compilation, Dispersal, and Reproduction Technologies*, Paolo Galluzzi and Alessandro Nova (eds.), Kunsthistorisches Institut in Florenz. Max-Plank-Institut. Studi e Ricerche 15, Venice: Marsilio, 2022, pp. 181-197.

[13] For a full concordance between the Warburg glass plate negatives and the illustrations in the Hoepli and Giunti editions with their respective foliations, see the Table of Concordance below.

wide[14]. As a result, Leonardo's studies of the mechanics of balances, transformation geometry and the more decorative geometrical figures are now underrepresented. Although we do not know if such glass plates ever existed and entered the Warburg collection, their absence may reflect losses of plates and perhaps of entire boxes, rather than thematic choices. As we have already perceived, the number of both boxes and glass plates changed over the years. Moreover, losses are also reflected in some of the old systems of numeration adopted for the marking of the Warburg glass plates. While some are restricted to small groups of plates, others appear consistently. There is one particular system that indicates that at some point there were at least "401" plates, and in another system the maximum number is "355"[15]. Such a disparity suggests that severe losses occurred, a disparity which is even more apparent if we compare it to the 216 glass plates that have come down to us.

In spite of the existing gaps in the Warburg glass plate collection, it is important to bear in mind that those which have reached us are not restricted to negatives corresponding to either of the two commissions for the Hoepli edition that occurred under the aegis of the Reale Accademia dei Lincei. As is known from written documentation and from evidence in the printed edition itself, there were two different commissions: one resulted in Rome's Filippo and Augusto Martelli providing illustrations for ff. 1ra-94ra, and the other in Milan's Giovanni Beltrami supplying all the remaining illustrations[16]. When we consider a sample of the Warburg glass plates that correspond to the Martelli illustrations, such as from f. 1va to f. 9vb, we find significant variations in the size and thickness of the Warburg glass plates, as well as evidence of the use in the photographic process of a range of glass plate holders[17]. Interestingly, the same features are likewise visible in those Warburg glass plates that correspond to the Beltrami illustrations. In other words, although there are differences among the Warburg glass plates themselves, such dif-

[14] The gaps have been identified between glass plate T9 (corresponding to Hoepli f. 87va) and glass plate S10 (corresponding to Hoepli f. 107vb); glass plate K9 (corresponding to Hoepli f. 180vb) and glass plate P4 (corresponding to Hoepli f. 205va); glass plate B2 and O3 (both corresponding to Hoepli f. 217vb) and glass plate P2 (corresponding to Hoepli f. 231rb); glass plate S11 (corresponding to Hoepli f. 120vd) and glass plate T11 (corresponding to Hoepli f. 130rb); glass plate D19 and D10 (both corresponding to Hoepli f. 148vb) and glass plate K10 (corresponding to Hoepli f. 158ra); and glass plate K1 (corresponding to Hoepli f. 164ra) and glass plate E4 (corresponding to Hoepli f. 177vb). When the Warburg glass plate shows more than one Leonardo sheet, the correspondence was established with respect to the main sheet visible in the plate.

[15] The number "401" is written on the back of glass plate I12, whereas "355" is written on a small label at the back of glass plate E6.

[16] The first time the reference to "G. Beltrami-Milano-ripr." appears is on Hoepli f. 94rb. All the previous references are to "Eliotiopia Martelli, Roma".

[17] Hoepli f. 1va relates to the main Leonardo sheet in glass plate J2; and Hoepli f. 9vb, to that in P7. Overall, the glass plates relating to those in the Hoepli edition from f. 1va to f. 9vb are currently spread across boxes C, F, G, I, J, K, L, P and S, for which see the Table of Concordance below. As for the types of glass plate holders, their marks include four small frames of an 'L' shape the arms of which are of the same length; four medium-sized frames of an 'L' shape the arms of which are of the same length; four long frames of an 'L' shape the arms of which are of the same length; small diagonal lines at the corners; and small 'triangles'. There is also a type of glass plate holder that seems to have left no apparent marks on the plate, as well as wooden bars which form part of the photographic apparatus. I owe this information to Vai van den Heiligenberg, photograph conservator at the Deutsches Dokumentationszentrum für Kunstgeschichte – Bildarchiv Foto Marburg at the Philipps-Universität Marburg.

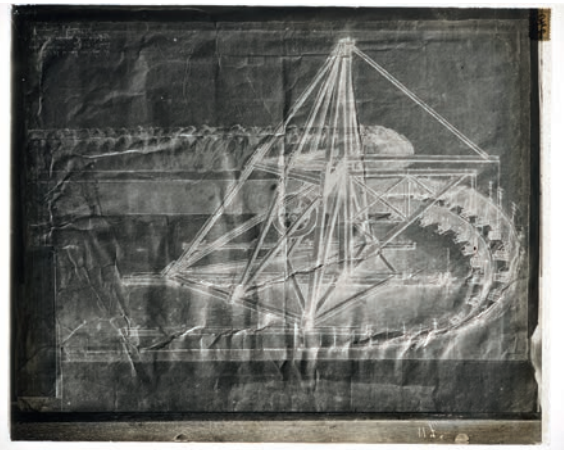

Fig. 2a - Glass plate negative J10. Credit: Warburg Institute, London.

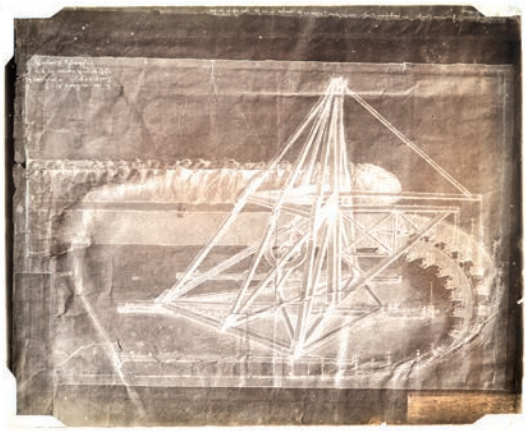

Fig. 2b - Glass plate negative J8. Credit: Warburg Institute, London.

ferences are not exclusive to the glass plates corresponding to either the Martelli or the Beltrami illustrations, but present in both. That means that either the glass plates pertaining to these two different commissions were comparable, or the Warburg glass plates are not directly connected to the making of the printed edition.

Other interesting elements that have emerged in the study of the Warburg glass plates is that some of them are negatives of the same Leonardo sheet even if not exact duplicates. They are of two main types: negatives that record the same sheet with no variation in layout but with changes in lighting[18]; and negatives that show the same sheet but feature variations both in lighting and in layout due to differences in the framing of the sheet when photographed[19]. In addition, there are two instances in which a pair displaying the same layout is linked to a third negative showing variations in layout[20]. A telling case is the pair G6 and J10 (Fig. 2a), and glass plate negative J8 (Fig. 2b). G6 and J10 show a highly finished drawing of a machine for excavating soil and despite one of them being darker than the other, both display comparable layouts and physical characteristics. The images are well-centred, they do not reveal any portion of an adjacent Leonardo sheet, and their plates do not have marks of holders though in one of their margins there appears a wooden bar that has been identified as belonging to the photographic apparatus[21]. By contrast, in J8 the image is slightly tilted and shows one sentence of a Leonardo upper sheet that had been arranged by Pompeo Leoni on the same support. What is more, there is no wooden bar in J8 and the edges of this plate indicate that it was held in the photographic apparatus by four small frames of an 'L' shape the arms of which are of the same length. Clearly, the image in J8 resulted from a photographic set-up different from that of G6 and J10, though such differences alone are not enough to determine if these plates

[18] See C8 and F4; G6 and J10; I4 and I12.

[19] See B1 and B14; B2 and O3; B12 and E7; D7 and D8; D9 and D10; E5 and E6; P1 and R7; O1 and O7.

[20] See C8, F4 and J9; G6, J10 and J8.

[21] There are other Warburg glass plates that similarly show a wooden bar, such as C8, F4, I4, I12, J5.

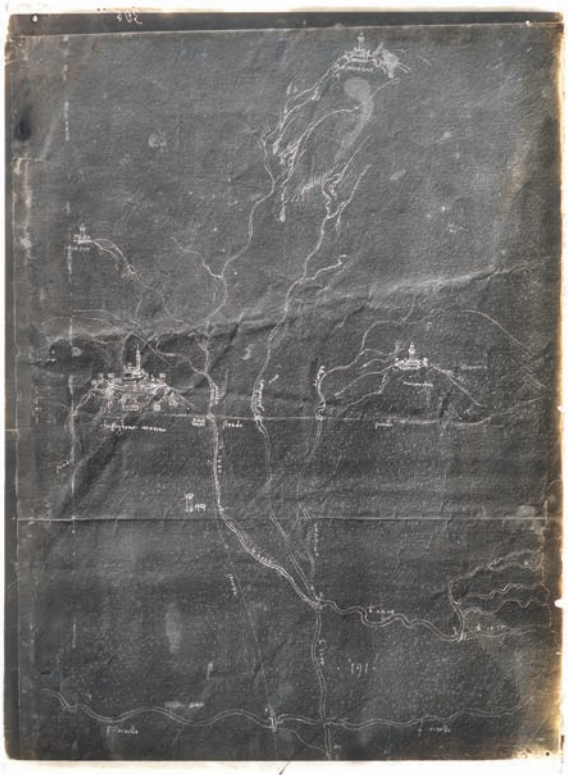

Fig. 3a - Glass plate negative G5. Credit: Warburg Institute, London.

Fig. 3b - Hoepli edition, f. 336r, 1894-1904.

were part of distinct photograph campaigns. When we turn to the Milan glass plates, we find neither corresponding negatives nor analogous traces of glass plate holders or wooden bars. Yet this Leonardo sheet was reproduced in the Hoepli edition, f. 1vb, and displaying a more finished layout than that of the Warburg glass plates. No subsidiary elements pertaining to either the photographic or printing processes appear in the Hoepli edition, which contrasts with the archaeological marks often seen on the Warburg glass plates. Perhaps less expected is that physical characteristics of Leonardo's sheets, such as laid lines, undulations, creases and scratches, as well as traces of his own working process, including folds, incised lines and holes made by compasses became relatively less visible in the Hoepli illustrations.

An additional feature that characterises the Warburg glass plates is that they do not record Leonardo's large bifolios in full. More specifically, some are negatives of a portion of a large bifolio or record half a large bifolio, while others show details of Leonardo's sheets. In the first case, an example is glass plate G5 (Fig. 3a), which measures 30x24 cm and exhibits about two-thirds of a large bifolio of 45.1x31.2 cm offering a topographical drawing of the Val di Chiana[22]. No corresponding negative is found in the Milan collection, but there must have been one of the entire bifolio which was used for Hoepli illustration, f. 336r, as it was printed in full as

[22] The Warburg glass plate was used in portrait format so that it accommodated a large portion of Leonardo's topographical drawing.

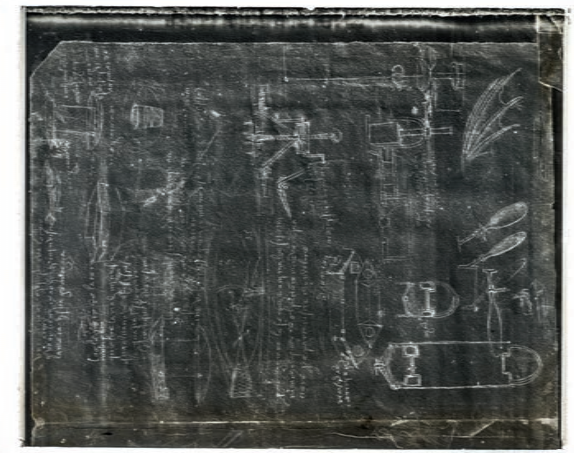

Fig. 4a - Glass plate negative F2. Credit: Warburg Institute, London.

a single illustration (Fig. 3b). As for the Warburg glass plates that show halves of large bifolios, E7 and F2 (Fig. 4a) are of special interest. Measuring 30x24 cm each, these glass plates reproduce the upper and lower halves of a large bifolio of 42.8x30 cm on mechanical devices. They additionally record the presence of strings, presumably used as aids for this large piece of paper to be as flat as possible when photographed. There are no corresponding negatives in the Milan collection, but this bifolio was reproduced in full and with no signs of strings in the Hoepli edition, f. 320vb (Fig. 4b). While it is true that such aids would not appear in the Hoepli illustrations, we know that the Codex Atlanticus was unstitched for the Hoepli photographic campaign[23], and so their use was most likely unnecessary. The presence of strings, visually documented in the Warburg glass plates[24], may well characterise a different photographic campaign. Another telling factor that distinguishes the Warburg glass plates is that there are instances in which de-

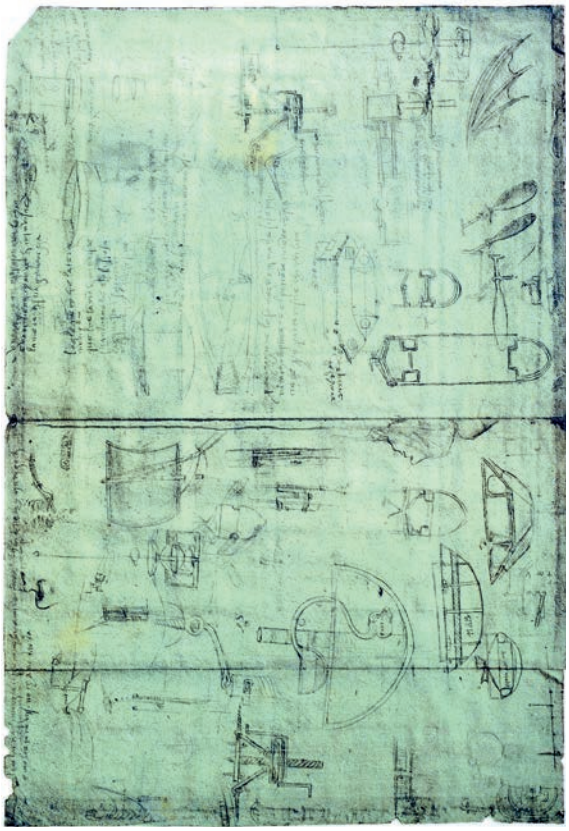

Fig. 4b - Hoepli edition, f. 320vb, 1894-1904.

tails seem to have been deliberately singled out for photography. Some plates recorded figures as opposed to texts, and others left out blank areas and displayed specific motifs from Leonardo's sheets[25]. A case in point is L8 (Fig. 5), which is a small plate of 18x24 cm and shows two little human figures from a Leonardo sheet on naval warfare measuring 29x38.7 cm. This sheet is seen in full in the Hoepli edition, f. 346va, but does not appear either in its entirety or in part among the Milan negatives, and in fact nowhere in this collection or in the Hoepli edition do we find any deliberate detail.

Such a range of differences strongly suggests

[23] Marinoni, Augusto, "Sul restauro del Codice Atlantico". *Raccolta Vinciana*, XXI (1982), pp. 9-20, esp. p. 10.

[24] Other glass plates showing strings include A7, B1, D7, E2, G4, H14, I6, K8, N1, N4, L8, P2, T1, T3.

[25] See, for instance, G1, K6, L2, L4, L7, N4.

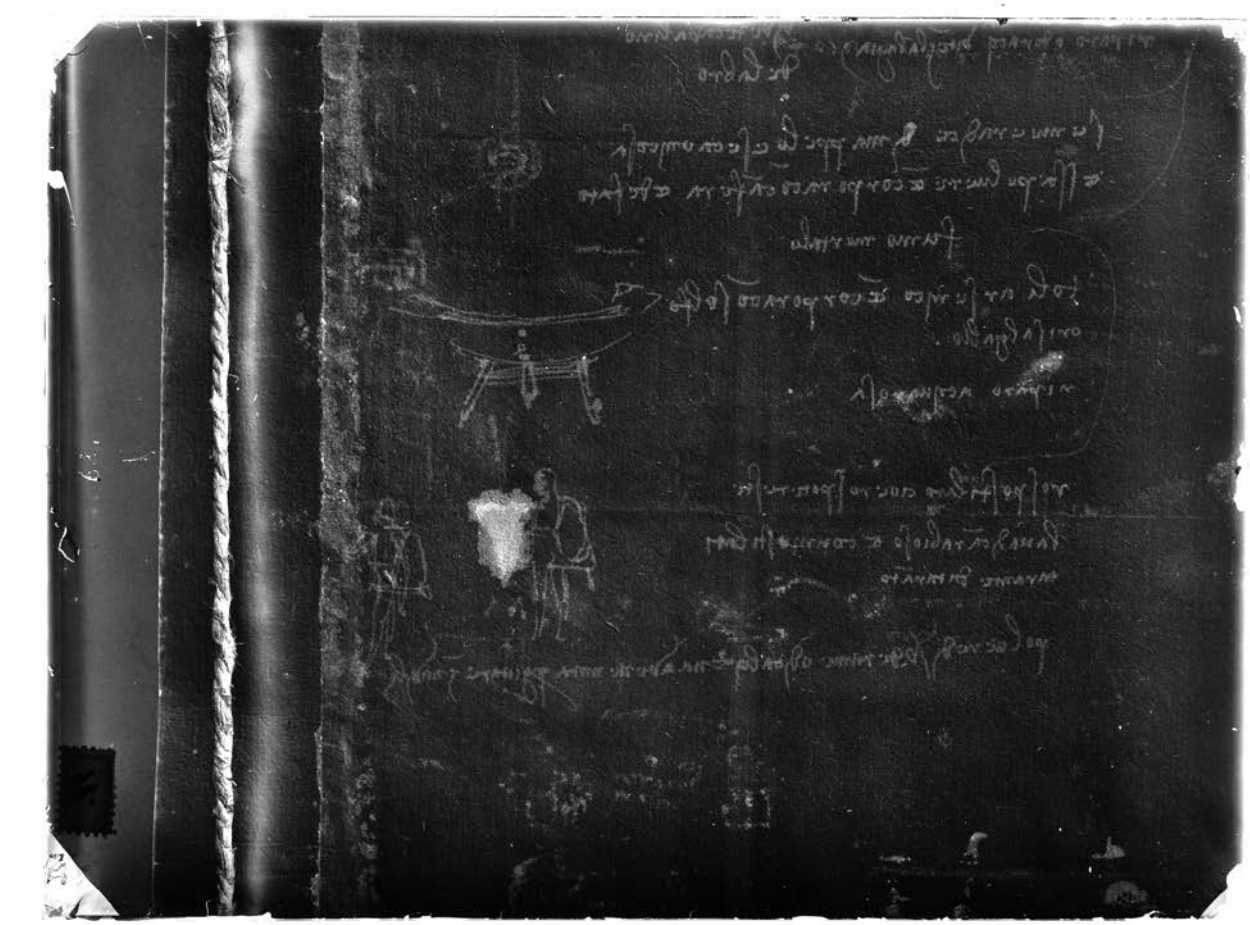

Fig. 5 - Glass plate negative L8. Credit: Warburg Institute, London.

that the Warburg glass plates, or at least some of them, did not provide the direct visual sources for the illustrations in the Hoepli edition. What is more, the singularities we have seen concerning the photographing of Leonardo's sheets—especially the lack of glass plates showing large bifolios in full—seem to reveal that adjustments in photographic set-up were necessary for them to 'fit' within the boundaries of a single glass plate. Those adjustments are unlikely to have taken place when the Warburg glass plates were used for photographing the Codex Atlanticus, but this did not impact the taking of detailed photographs, for which glass plates of smaller dimensions were usually used. By contrast, adjustments in set-up may well have been made for the Hoepli edition since large bifolios were duly illustrated in full. If that is true, it seems just possible that large bifolios were for the Hoepli edition photographed according to size, rather than simply following the original sequence of sheets from the Codex Atlanticus, as this practical expedient would have saved constant re-adjustments as well as time.

At this stage is worth recalling that there do exist instances of close correspondence between the Warburg glass plate negatives and the illustrations in the Hoepli edition, but it is mainly from their differences that we can gain vital insights into the former's his-

torical importance[26]. In that respect, there emerge particularly telling discrepancies in layout when we compare to the Hoepli illustrations those Warburg plates that exhibit small bifolios, folios or fragments. A case in point is Warburg glass plate B2 (Fig. 6a)[27]. It shows a main Leonardo folio that displays ground plans and notes relating to his Romorantin project. Pasted on it, top right, is a small fragment also linked to Romorantin which, in turn, slightly overlaps with an even smaller fragment, top far right, that contains notes also related to the French project, but with its upper part just out of shot due to the photographic framing of the image. On the same glass plate, top left, another Leonardo folio can be seen, but only its lower part due to the way it was visually framed when photographed. When we turn to the Hoepli edition (Fig. 6b), we find that the main Leonardo folio and its two related fragments were all printed in full in a single illustration and in the same arrangement as that of the Warburg negative, and so preserving this part of Pompeo Leoni's layout even if the main folio, f. 217vb, was lettered separately from the two fragments, which were ascribed a single reference, f. 217vc. However, the other Leonardo folio, top left, was reproduced individually and in its entirety in a different illustration, f. 217va (Fig. 6c). In this case, the option to separate this folio from the other three was most likely dictated by issues relating to dimension, but the creation of two separate illustrations deviated from Leoni's unified page layout. Curiously, there are two glass plates in the Milan collection that correspond to the Hoepli illustrations. But while the one related to f. 217va is most likely its direct negative[28], that for f. 217vb and f. 217vc turns out to be a negative from the Hoepli edition, rather than for it, because it shows the printed letters "b._" and "c._" as well as the printed reference "G. Beltrami-Milano-ripr"[29].

A related example concerning increasingly complex and disparate layouts is that of Warburg glass plate L6 (Fig. 7a). It shows a central piece consisting of a fragment in which there is a human face (drawn by a Leonardo student) next to autograph engineering studies; this piece is in turn surrounded by two other fragments and two folios seen only partially. Once again, the Warburg negative could not have been the direct source for the Hoepli edition because the latter reproduced the fragments and folios in their entirety. What is more, they were in the Hoepli edition newly displayed forming two separate illustrations. One contains the former central piece, f. 342rb, which appears together with the fragments above it and to its right seen in full, f. 342ra and f. 342rd (Fig. 7b), while the other shows the two remaining folios also in full and newly numbered as f. 342rc and f. 342re. These relatively less crowded Hoepli layouts facilitated the appreciation of Leonardo's studies but also disrupted the ways in which Leoni had compiled them. There are no corresponding glass plates in the Milan collection

[26] Barone, 2022.

[27] This glass plate may have been broken before it passed to a German collection because there is a stick on it with the Italian word "gasta".

[28] Milan glass plate, inv. d5201.

[29] Milan glass plate, inv. d2192. A comparable case of a Milan negative from the Hoepli edition is glass plate, inv. d2551.

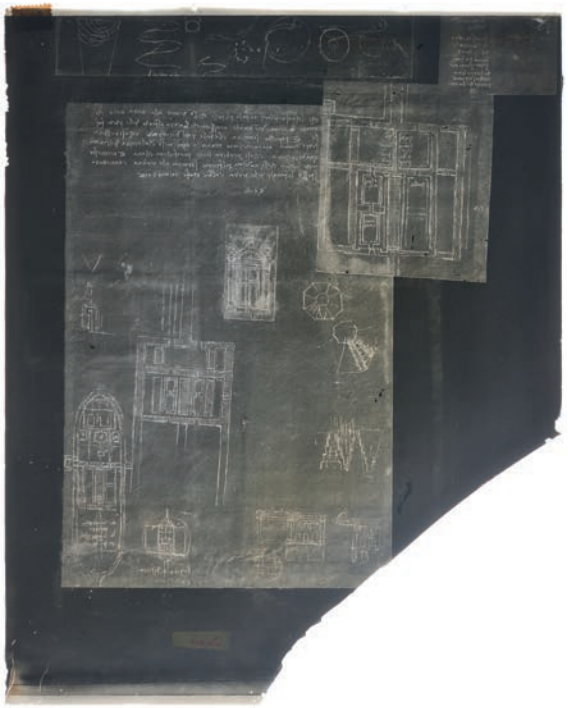

Fig. 6a - Glass plate negative B2. Credit: Warburg Institute, London.

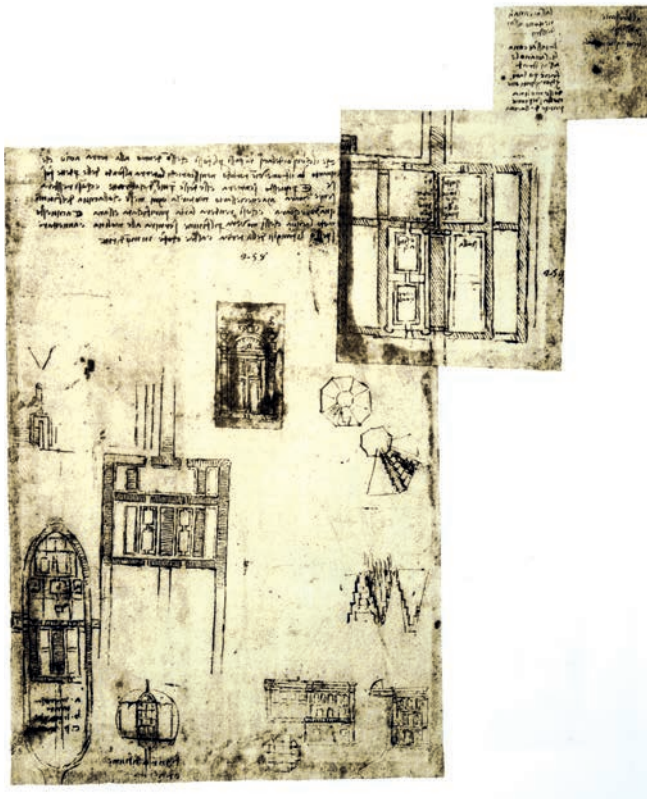

Fig. 6b - Hoepli edition, f. 217vb and f. 217vc, 1894-1904.

for comparison. Nevertheless, the Warburg plates clearly document an imagery of the Codex Atlanticus that preceded that offered by the Hoepli edition, and which provides conspicuous pieces of evidence for historical reconstruction.

Last but not least, in the process of identifying the images photographed in the Warburg glass plates and linking them to those in the Hoepli edition and in the Milan collection, there arose an unexpected situation; three Warburg glass plates proved not to have any correspondence whatsoever. Glass plate T7 shows two machines to lift water, a water fountain, devices to create water pressure, a ladder and explanatory texts. This Leonardo folio does not have a negative in the Milan collection, and it was not reproduced in the Hoepli edition either. Its existence was first acknowledged in 1929, by Gerolamo Calvi,

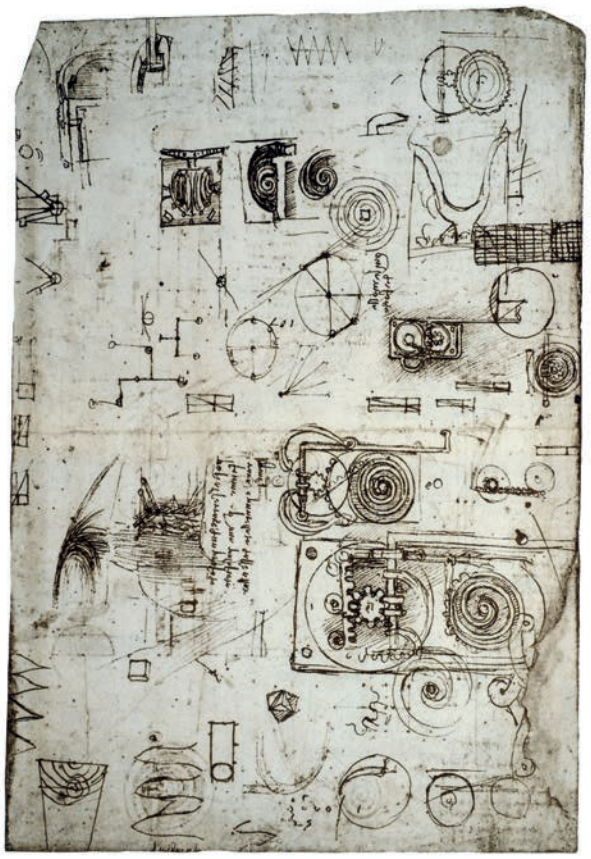

Fig. 6c - Hoepli edition, f. 217va, 1894-1904.

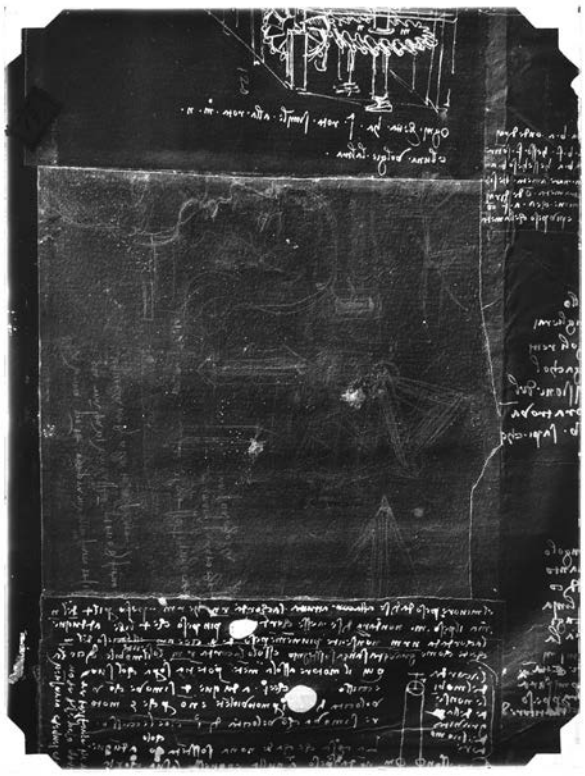

Fig. 7a - Glass plate negative L6. Credit: Warburg Institute, London.

who both published it and expressed surprise in finding it among the first sheets of the Codex Atlanticus but not as part of the Hoepli illustrations[30]. The other Warburg glass plate that has no correspondence is L2. It offers a detail of a Leonardo folio in which there is his now famous drawing of an artist looking through a pin-hole in order to draw an armillary sphere. Neither this detail nor the entire folio appears among the Milan glass plates or was printed in the Hoepli edition. The folio was first published by Giovanni Galbiati in 1939, who believed that it was left out of the Hoepli edition "for a strange forgetfulness" and reproduced it together with five others (one coincides with the image published by Calvi), all of which are absent from the Hoepli edition[31]. Thus Warburg glass plates L2 and T7 offer visual testimony to the fact that there were Leonardo folios in the Codex Atlanticus which somehow failed to enter the Hoepli edition. They also reveal that these two folios had been photographed prior to the Hoepli edition, even if not necessarily for it. Within this context, it is not entirely surprising to find that there is yet another Warburg glass plate, T6, which reproduces a Leonardo folio that has no correspondence in either the Milan negatives or the Hoepli illustrations. This glass plate will be published and fully discussed in a forthcoming article, but at this stage it should be anticipated that it contains physical characteristics analogous with those of other Warburg glass plates, which strongly suggest that they were part of the same photographic campaign.

As it has become apparent, the Warburg Institute houses glass plates that currently form an incomplete group of negatives of the Leonardo sheets that were visible in the Codex Atlanticus between around 1887 and 1902, the time spanning the production of these glass plates and their actual use for photographing the Codex. Although incomplete, this group of glass plate negatives discloses a richly varied range of images and layouts, from large and small bifolios and folios seen in part or in full, to fragments and details. In addition, these plates provide new visual documentary evidence as to how Leonardo's works had

[30] Calvi, Gerolamo, *I manoscritti di Leonardo da Vinci dal punto di vista cronologico, storico e biografico*, Bologna: Zanichelli, 1925, esp. pp. 23, 28-29 (fig. 12). This folio appears in the Giunti edition, f. 7r.

[31] Galbiati, Giovanni, *Dizionario Leonardesco. Repertorio generale delle voci e cose contenute nel Codice Atlantico*, Milan: Hoepli, 1939, esp. pp. V-VIII, XII. This folio appears in the Giunti edition, f. 5r.

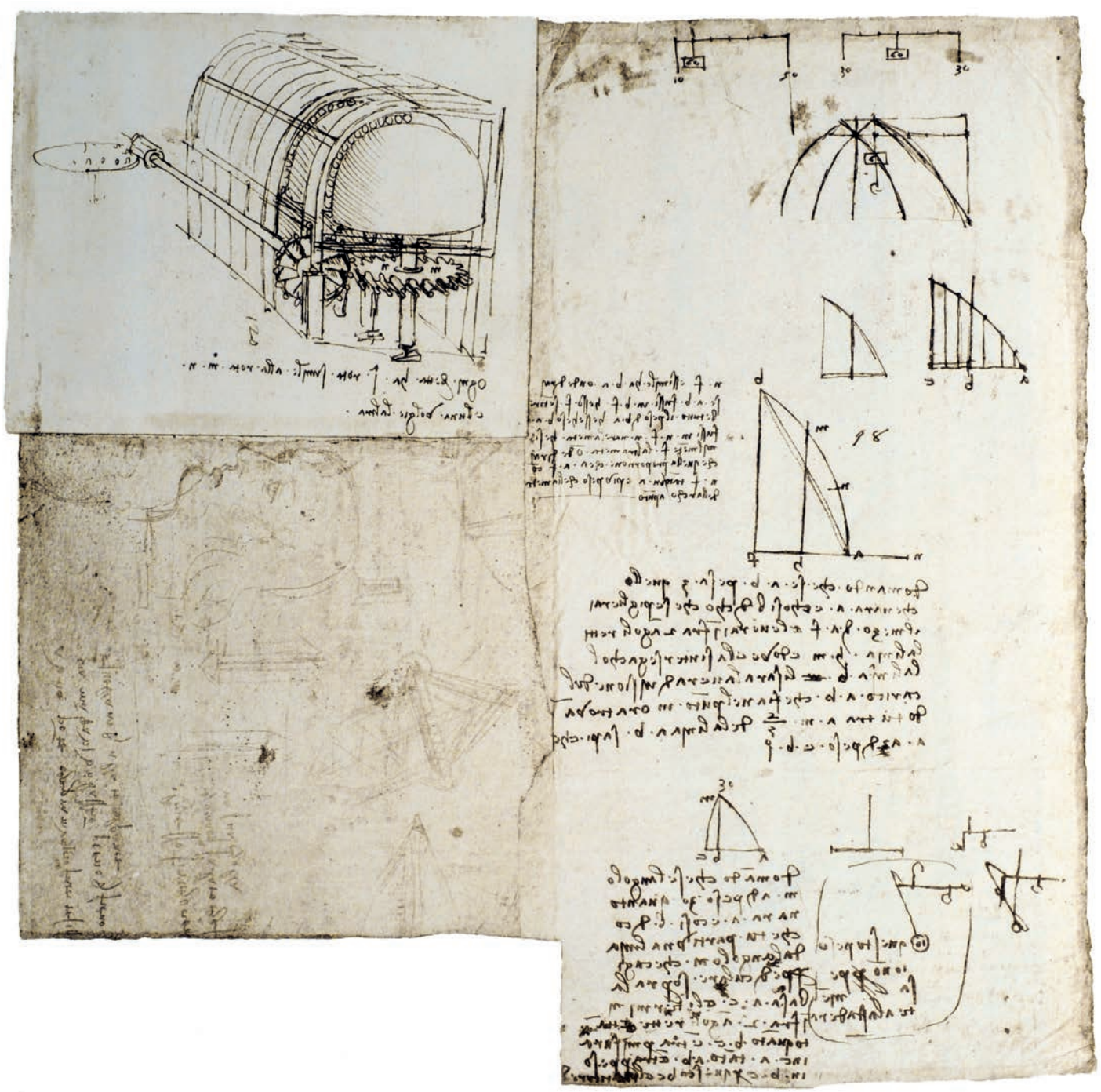

Fig. 7b – Hoepli edition, f. 342ra, f. 342rb and f. 342rd, 1894-1904.

been laid out by Pompeo Leoni on supports and viewed during the nearly three hundred years that preceded the advent of the Hoepli edition. They emerge as a key in the process of excavating and reconstructing the historical layers of Leonardo's Codex Atlanticus, as well as of bringing to light different aspects of his work and legacy.

Table of Concordance

The concordance is established between the Warburg glass plate negatives (according to the lettering of their boxes followed by their numerical sequence within each) and the foliation systems of the Giunti and Hoepli editions, respectively. References to the Warburg plates that show the same image(s) appear in square brackets [ ]. Correspondence with the Milan plates is provided in square brackets [ ], as well as with the Codex Atlanticus folios 'missing' from the Hoepli illustrations but later published by Gerolamo Calvi and Giovanni Galbiati.

Giunti edition (folios)	**Hoepli edition (folios)**	**Warburg plates (boxes)**
3r 4r	1va 1vb	J2 [see J13]
3r 4r	1va 1vb	J13 [see J2]
4r	1vb	G6 [see J8, J10]
4r	1vb	J10 [see G6, J8]
4r 3r	1vb 1va	J8 [see G6, J10]
5r	[Galbiati 1bis ra]	L2
7r	[Calvi, fig. 12] [Galbiati 1bis va]	T7
12r	2va [Milan d2551]	I2
13r	2vb	C8 [see F4, J9]
13r	2vb	F4 [see C8, J9]
13r	2vb	J9 [see F4, C8]
15r	3rb	S5
15v	3vb	J1
18r	4rb	S6
18v	4vb	C4

29v 30v	8va 8vb	K6
31r	9ra	I4 [see I12]
31r	9ra	I12 [see I4]
34r	9vb	P7
37r	10va	I3
41ra 41rc 41vb 41rd	11vb 11vc 11vd 11ve	J12
47v	14va	E1
48r	14rb	K2
54ra 54rb	16rb 16rc	J11
58ra 58vb 58vb	17rb 17rc 17rd	F5
59ra 59rb	18ra 18rb	E3
62r	19va	I13
63r	19vb	J7
67rb	21rb	J6
68r	21vb	S7
71r	23ra	C5
71v	23va	C6
72r	24ra	F1
72r 72v	24vc 24va	G8
75r	25ra	K12
77v	27va	F7
79v	28va	J5
80r	28rb	S8
82r	29rb	T8

83r	30ra	C11
84v	30vb	E10
87r	32ra	P5
88r	32rb	F6
88v	32vb	F8
89r	32va	J4
91r	33rb	S3
95r	34vb	T5
101r	36rb	S9
107r	38rb	P6
108r	38vb	K14
113r	40ra	N8
118ra 118rb	42ra 42rb	Q5
120v 121v	43va 43vb	J3 [see I10]
121r	43rb	K13
121v 120v	43vb 43va	I10 [see J3]
127r	46rb	G1
132r	48ra	D2
133r	48rb	F9
142r 141r 143r	51rb 51ra 51rc	D1
153r	54vb	D3
154ra	55va	T10
158r	56vb	H13
160ra 160rb	57va 57vb	C1
166r 167r	59rb 59rc	D4
179v	63va	N2
182ra	64va	N7
190v	68vb	G2
226v	83vb	C10

238r	87va	T9
298v	107vb	S10
310v 311v	112va 112vb	F3
311v	112vb	K11
331v	120vd [Milan d5370]	S11
359r	130rb	T11
359v	130vb	D5
366r	133ra	P3
370r	134vb	D6
388v 387v 386v	141vb 141vc 141va	E2
395rb 395ra	146rb 146ra	S12
395vb 395va	146va 146vb	N6
400r	148ra 148rb	B1 [see B14]
400r	148ra 148rb	B14 [see B1]
400r	148rb 148ra	D7 [see D8]
400r	148rb 148ra	D8 [see D7]
400v 401r	148vb 148va	D9 [see D10]
400v 401r	148vb 148va	D10 [see D9]
426r	158ra	K10
426v	158va	A6
444r	164ra	K1
484r 482v 482v	177vb 177va 177vc	E4

485v 488r	178va 178vb	H12
489r	179ra [Milan d5160]	B9
494v	180vb	K9
547v	205va	P4
554r	208ra [Milan d5194]	R9
554v	208va [Milan d5203]	R6
555v	208vb [Milan d5202]	Q3
561r	211ra	P1 [see R7]
561r	211ra	R7 [see P1]
564r	212ra	C7
577v	216va [Milan d5189]	Q1
581r	217rb [Milan d5192]	R1
583r 582r 580v	217vb [Milan d2192] 217vc [Milan d2192] 217va [Milan d5201]	B2 [see O3]
583r 582r 580v	217vb [Milan d2192] 217vc [Milan d2192] 217va [Milan d5201]	O3 [see B2]
629rb 629ra	231rb 231ra	P2

648r	237va [Milan d5233]	A4
651v	239va	B10 [see H11]
651v	239va	H11 [see B10]
661r	243ra	L4
661v	243va	H10
662r	243rb	L1
662v	243vb [Milan d5044]	R2
663r	244ra	Q6
674r	249rc	I5
675v	249vb	I1
678v	251va [Milan d5419]	R3
680v	252va	Q7
693r	257rc	R4
696r	259r	H9
698v	260vb	R5
713r	264rb [Milan d5033]	Q4
717r	265va	H15
724r	268rb	O6
727r	269va	A3
728r	270ra	A2
728v	270va	A1
733r	271rf	O5
733v 732rc	271vd [Milan d5252] 271vc	H8
748v	276va	O1 [see O7]
748v	276va	O7 [see O1]

757r	279ra	L7
760or 757v	279vb [Milan d5269] 279va	E9
762v	281va	N12
763r	281rb [Milan c2746]	L3
765r	282rb [Milan c2746]	S4
778r	285ra	H7
784vb 784va	289va 289vb	C9
809r	295va	L5
818r	298rb	B6
827v	303va	F10
828r	303rb	H6
850r 849r	310rb 310ra	H5
851r	310vb	A5
855v	312va	N9
856r	312rb [Milan d5143]	B13
865r	315rb [Milan d5259]	Q2
866r	315vb [Milan d5147, Milan d5262]	I11
867r	315va	E8
868v	316va [Milan d5255]	F11
871r	317ra	G3
873r	317va [Milan d5260]	S13
876r	319ra	N10
877r	319rb	S14
881r	320vb	B12 [see E7]

881r	320vb	E7 [see B12]
881r	320vb	F2
883v	321vb [Milan d5149]	H4
884v	322va [Milan d5030]	S15
887r	323rb [Milan d5035]	I9
893r	326rb [Milan d5038]	N11
902rb 902ra	329rb 329ra	N1
911r	335ra	C12
918r	336r	G5 [see H3]
918r	336r	H3 [see G5]
928v 931ra 931rb	340va [Milan d5322] 340vb 340vc	K5
937r 936r 938r 939r 940r	342rb 342ra 342rc 342rd 342re	L6
939v 937v 938v	342va 342vc 342vd	C2
942r 941r	343rb 343ra	H1
942v	343vb	H2

944r	344ra	N3
945r	344rb	R8
949v	345vb	K8
950r	346ra	T1
950v	346va	L8
950v	346va	S2
974v	352va	N4
977r	353ra [Milan d5055]	M5
982r	355ra	A10
983r 984r 982r	355rb 355rc 355ra	C3
994v	358va	B5
996v	358vb	M2
1007r 1006r	361rb 361ra	M1
1008r	361rc [Milan d5381]	N13
1010r	362rb [Milan d5383]	M4
1010v	362vb	S1
1014r	363rc	A9
1019r 1018r	365rb 365ra	A8
1020ra 1019v 1018v	365vb 365vc 365va	L9
1021v	366vab	T3
1028v 1029v	368vd 368vc	B11
1032r	369va	M3
1039r	372vb	T2
1050v	377va	B3
1052ra 1052rb	378ra 378rb	B7

1052rb	378rb	I8
1060rb 1060ra	382rb 382ra	T4
1060vb 1060va	382vb 382va	K7
1062r	384ra	I7
1063r	384rb [Milan d5052]	N5
1063v	384vb	B8
1066r	385va	E5 [see E6]
1066r	385va	E6 [see E5]
1077r	388va	H14
1081v	390vb	K3
1084r	391va	O2
1087r	392va	M8
1094r	394rb	M7
1095ra 1095rb	394vb 394va	K4
1098r	395rb	G4
1099r	395v	I6
1103v 1102v	396vf 396vg	M6
1106r	397rb	O4
1108r 1107r	398rb 398ra	G7
1112v 1114rb 1114ra 1113v	400va 400vc 400vb 400vd	A7
1113v 1114rb	400vd 400vc	B4
--	--	T6