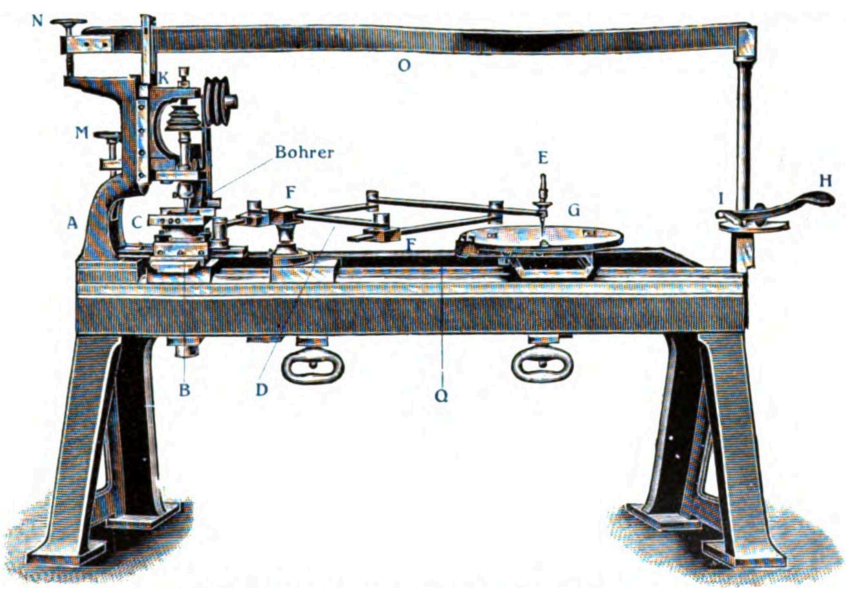
The Typographical Pantograph to 1900

Correcting the Received Narrative

DRAFT

This is a preliminary draft intended for limited circulation and review. It contains only public content, so there is no problem if you pass it on to someone who wishes to see it. It just isn't ready for publication yet.

Dr. David M. MacMillan



CircuitousRoot

2026

Dedication

To the late Gregory Jackson Walters, for Benton Engraving Machine #53 and much more.

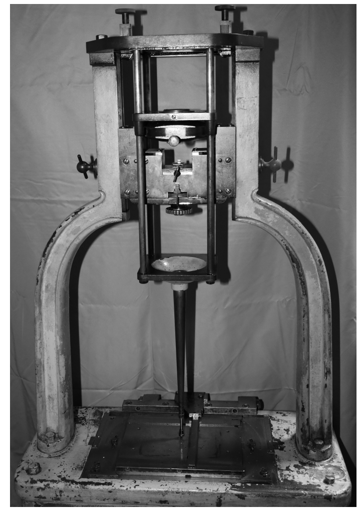


Figure 1: BEM 53.[1]

Title Page Image

The image on the title page is from Julius Wernicke's article "Neus aus der Schriftgiesserei" in *Klimsch's Jahrbuch,* Vol. 9 (1909): 35. It is a "matrizenbohrmaschine" manufactured by the firm of H. Bernert (Charlottenburg-Berlin), who took over this machine from its originator, H. Hofer (Berlin). This illustration may be as late as 1909, but is the earliest presently known image of the style of direct matrix engraving pantograph which Herrmann Hofer introduced by 1874 for seal engraving and other work and with which (as Dr. Dan Reynolds has pointed out) Jean Noé Carl Jakob Ludwig (founder of the typefoundry which became Ludwig & Mayer) and Hofer were successfully engraving typographical matrices by 1877. This was five years before Schraubstadter (Central Type Foundry, St. Louis, 1882), who may have used a similar machine. It was seven years before Benton began engraving punches and patrices (1884) and two decades before Benton began direct matrix engraving (circa 1899).

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Distribution

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`https://www.CircuitousRoot.com/artifice/letters/pantocut/index.html`

[1] Benton Engraving Machine, Type 2a, Machine No. 53, at CircuitousRoot in 2023. Photograph by DMM. License: CC BY 4.0 International.

Acknowledgments

I could not have done any of this without the extensive help of my many friends in the American Typecasting Fellowship over the years.

`https://www.AmericanTypecastingFellowship.org`

I hesitate to list names for fear that I might overlook someone, but must at least acknowledge the late Paul Aken, Jason Dewinetz, Jurie Florijn, Patrick Goossens, Richard L. (Rich) Hopkins, Mark Knudsen, Val Lucas, Raymond Stanley (Stan) Nelson, Edward Rayher, the late Theo Rehak, the late Stephen O. Saxe, Schuyler R. (Sky) Shipley, Fritz Swanson and the Printing Stewards, Inc., Victor Thibout, the late Gregory Jackson Walters, and Kylian and Sara Wrzesinski. I also owe a great deal to two people I never knew: Jim Rimmer and Paul Hayden Duensing.

Given the topic of this work, I am obviously deeply indebted to Dr. Dan Reynolds for discovering the first known successful application of a pantograph engraving machine to cast-metal typemaking, by Ludwig and Hofer in 1877.

Preface

The importance of the mechanically reproduced word cannot be overstated. In its many forms, this has been a foundational technology of our world today. Within its history, the transition in the 19^{th} century from what had been essentially a hand-crafted process into a fully industrial process was no less important. This transformation had many aspects, including the introduction of power to the press in the early 19^{th} century, the development of flong-based stereotyping and true rotary presses much later in that century, machine typecasting following the success of the "pivotal" type casting machine of David Bruce, Jr., and the creation of the two great "hot metal" composition systems which dominated the 20^{th} century: Ottmar Mergenthaler's Linotype and Tolbert Lanston's Monotype.

Behind these, however, is the creation of type itself. This, too, experienced a transition from handicraft to industrial technology in the 19^{th} century. The methods used in the 1830s were little changed from those of the 15^{th} century. The methods in use 70 years later were the industrial methods of the era which produced the railway and the telephone.

Along with the process of electroforming, the machine central to this change was the pantograph. Yet our received narrative concerning the use of this machine is demonstrably false and this error has, in turn, led to further errors in even very carefully researched scholarly literature. This alone is sufficient reason to take a closer look.

The present state of our knowledge traces the origin of machine-cutting in the process of making type matrices to Germany in the 1870s, but this knowledge is insufficient. There may have been earlier work, either in Germany or in other countries. There was also a significant use of this direct matrix engraving technology in German typefoundries between 1877 and 1900 (as an arbitrary cut-off date) and of Benton-inspired punchcutting from at least 1894.[2] Almost nothing is known of this in the English-language literature.

This reseach needs to be undertaken by someone who has a technical knowledge of machine typefounding, access to archival sources not yet digitized, and a good reading knowledge of German (often in Fraktur) and French.[3] I look forward to seeing what others will discover.

[2]There is, so far, no trace of machine cutting for cast metal type in the United States prior to 1880, when the Cincinnati Type Foundry imported a German pantograph. Similarly, there is at present no known instance from England prior to Barr's work for Linotype at the turn of the century.

[3]Developments in France are noticeably absent here. But during this period the first true "complete" foundry typecasting machine was developed in France. It would be surprising if there were not also important developments in matrix making there as well.

Notes on Style

Scope

Oversimplifying, there are two extremes in academic and technical writing. On the one hand, there is writing intended to convey a point or argument and which is comprehensible (or possibly even interesting) to some relatively wide audience. On the other hand, there is writing which is the low-level march through all of the data, because you need accuracy before you can aspire to readability. The present work is the latter. It has many flaws, no doubt, but the complaint that "it is too detailed and too boring" is not a bug, it's a feature.

Person

Older academic writing rigorously excluded the first person. Newer academic writing does not, but this can be jarring to those trained in an older tradition. Here I use a mix. The reason for this is intellectual honesty.

The history of typemaking is a field where much is unknown and much will never be known, but (fortunately) where new-to-us information is being rediscovered all of the time. When it is asserted here that "X is not known," sometimes that is not true. What is meant (what I mean) is that I do not know X. Hiding behind the third person just serves to make my own ignorance sound more authoritative — and if there has been one overarching problem with the history of typemaking it has been authoritatively expressed ignorance. I'll use a mix of first and third person here, inconsistently. Generally I'll use the first person to emphasize that the point in question is my own belief rather than a generally recognized conclusion.

Citations

The style of bibliographic citation used here is nonstandard because the styles available in current style guides in the humanities are at best unsatisfactory. I will use the CircuitousRoot house style.[4]

The method described there for the citation of works themselves is used consistently here. I haven't settled on the best method to add page/figure references to this, however. So at times I'll run the citation directly into the text, at times I'll isolate it parenthetically, and at times I'll isolte it in its own sentence-level unit. This inconsistency should settle down in the future.

[4] See *CR Bibliographic Style: A Justification and Explanation of The CircuitousRoot House Style for Bibliography and Citation* at `https://www.CircuitousRoot.com/PUTURLHERE`

Why this Document Is Incomplete

This work in its present form is very obviously incomplete. There are several important sections (and many more smaller sections) which just say "TO DO" and which have, at most, a sketch of what should be done. This is of course frustrating to any reader, and I apologize to you.

The reason for this is that something is better than nothing. The history of scholarship in typemaking is littered with memories and scattered remains of projects which were never finished and which went with their authors to the grave. We are all poorer for this.

I am under no illusions that this present work is of the same caliber as the lost works that I have in mind here. Still, what is actually here has been developed at least to a point where it may be reasonably criticized and may play a part in the conversation of scholarship.

I hope that it is useful to you. I'll finish the rest as / when / if I can.

Contents

1• The Current Narrative and Its Problems

1.1• TL;DR

What We Believe Today

All statements about this subject in the later 20th and all 21st century literature on the history of type say something much like the following. It is both simple and wrong.

> "It was not until the invention of the Benton pantograph punch-cutting machine in 1885 that any other method was known. All type made before 1885 was therefore dependent on hand punch cutting." {Rollins 1947}

What Actually Happened

The late 19th century was a period of tremendous technological innovation. During this time the pantograph, as an early analog information processing machine, was applied in many different fields — from coinmaking to calico printing. In typefounding, it was applied to all three of the major ways in which typecasting matrices were made: traditional punchcutting in steel (done since the 15th century), patrix or original type cutting in softer metal for matrix electroforming (done by hand since the 1840s), and direct matrix engraving (only done by pantograph). This was first accomplished in Germany in 1877 by the typefounder Carl Jakob Ludwig (in Frankfurt) with the machinist Herrmann Hofer (in Berlin), using a horizontal four-bar pantograph designed and built by Hofer. Their work began a continuous tradition of direct matrix engraving in Germany which endured until the end of the metal type era.

In 1882, a pantograph imported from Germany was used by William Schraubstadter and Gustav Schroeder at the Central Type Foundry in St. Louis, Missouri, to engrave the first matrices in the United States. This led to the first independent commercial matrix engraving service business (by Schroeder with Nicholas Werner) in 1888. Robert Wiebking followed in 1894 with a horizontal pantograph of his own design. Independently, soon after Schraubstadter's work, Linn Boyd Benton introduced in 1884 a vertical single-arm pantograph at his type foundry in Milwaukee, Wisconsin. This machine was adopted later for the two major "hot metal" composition systems, the Linotype and the Monotype, and contributed in no small part to their success. By 1899 Benton, too, had begun direct matrix engraving.

Pantographs were cutting edge high technology in the 1870s and '80s. The work of Hofer, Ludwig, Schraubstadter, Benton, and many others triggered rapid and varied developments which led to both vertical single-arm and horizontal four-bar pantograph engraving machines from a wide variety of makers being used in the 20th century to produce a vast quantity of matrices for both single type casting and hot metal composing machines.

1.2• Problems In the Current Narrative

TO DO

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NOTES:

 Things to correct (major):
 - The erasure (in the USA) of patrix cutting from the history of typemaking
 - The claim that Benton was the first to use a pantograph in
   cutting for making matrices.
   He was third, after Ludwig and Hofer in Germany in the late 1870s
   and Schraubstadter at the Central Type Foundry in St. Louis in 1882.
 Things to correct (lesser):
 - The idea that Benton developed three punch/matrix cutting pantographs
 - The fiction of Bullen's story of Dodge and Benton
 Things to correct (ancillary):
 - The idea that a "typeface" is a basic concept in type.  It is not;
   it is a regularizing and profoundly limiting idea - a Procrustean idea -
   which fits type through its sizes into a single mold.

 Point is not to dethrone Benton.  His work was brilliant and of
 great and lasting importance.
 The need for bragging rights as to "who invented this first" is long gone.
 The purpose is:
 - To understand in detail what we can of what really happened;
   a true story is always the best.
 - To see this not as a narrative of a Great Man
 - Instead to see these developments in the context of their
   contemporary technology and as a part of a complex, widespread
   movement both to mechanize the production of type and to
   regularize type as a product.
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Our present understanding of the development of the technology of typemaking in the 19th and early 20th centuries is largely the result of several eloquent and prolific writers of the time. Foremost among these is Henry Lewis Bullen, to whom we owe our picture of Linn Boyd Benton. Bullen's work, sadly, is marred by repeated outright fabrication (in many areas, only some of which are relevant here).[1] Other writers were more trustworthy, but few of them were practical typefounders. They wrote for particular sponsors or with particular goals, but without a full hands-on knowledge of type.

Beatrice Warde - Linotype

Paul Koch - romanticism

Carl Purington Rollins - as a printer

Even the great Mac McGrew, who wrote the book on American metal type,[2] made mistakes because he did not really know how the types he was using were made.

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[1]See Appendix I, "<u>Other Problems with Bullen as a Source</u>," on page 249 for a survey of other reasons which call Bullen's work into question.

[2]*American Metal Typefaces of the Twentieth Century,* {McGrew 1993}.

1.3• Problems Caused By the Current Narrative

TO DO

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NOTES:

Mythologizing the Benton Engraving Machine distorts our view
and gets in the way of practical application.
There's nothing magic about the Benton; you do not need one to make type.
Historically, there were multiple independent inventions:
Ludwig \& Hofer
Schraubstadter's application of a German machine
   (which might have links to Hofer)
Benton
Wiebking
Several minor machines (Ballou, Dedrick, Beeler 1899?)

Following close on this were important 20th century developments by
Pierpont and Barr,
by Gursch and various other German makers.

Standard industrial machines have also been (and continue to be) used:
Gorton 1-G, 3-G, and 3-K Precision Matrix Machine,
Goudy's application of the E&PM machine,
Jim Rimmer's Ogata,
Paul Hayden Duensing's Pries
(later used by Jim Walzcak and now used by Val Lucas).

maybe cite the range of machines used by the dozen+ makers in Ed's book.

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There are many aspects of this narrative,
but two of them are relevant here.

1. punchcutting in steel directly to punch or matrix engraving.  Rollins.

   problem:  erases one of the major methods of typemaking;
             arguably the dominant method of typemaking.

             leads to confusion - Mac McGrew and Wedding Text

2. Linn Boyd Benton and the pantograph
   problem:  not true
   problem:  leads to confusion,
             especially in conjunction with the erasure of patrix cutting.
             Bullen, Cost and the three pantographs.

- The issue is not priority; the marketing need for that is long past.
- The issue is that these omissions distort our understanding
- The erasure of patrix cutting hollows out our knowledge of the
  making of type
- The emphasis on the lone genius of Linn Boyd Benton
  oversimplifies a vibrant era into the myth of the Great Man.
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The pantograph was the high-tech information processing technology of its day, just as the computer is in our own time. In the late 19^{th} century, it was adopted enthusiastically by a wide range of innovators across all of the ways of making type.

The important task is not to dethrone Benton but to gain a broader, and deeper, knowledge of this chapter in the development of this core technology of civilization.

2• Context

2.1• Patrix Cutting for Matrix Electroforming

In the USA at least, this is the great forgotten chapter of typemaking.

2.1.1• A Very Quick Summary of Typemaking Methods

For making original cast metal printing types for ordinary text sizes, there are three primary methods: punchcutting, patrix cutting, and direct matrix engraving.[1]

Punchcutting by hand in steel, a skill known to precision metalworkers such as jewelers, locksmiths, and armorers since antiquity, was introduced with Gutenberg. Punchcutting by machine (by pantograph) in steel was introduced by Benton around 1883/1884. These punches were then driven (by hammer or by press) into matrix blanks and the "strikes" so produced were "justified" to become finished matrices. The matrices produced by this method were traditionally of copper.

Electroformed matrices were introduced in 1840; at first and continuing to the present day they were used to duplicate existing types. (This has of course given this process a bad name as the tool of the typographical pirate.) An electroformed matrix typically has an "eye" which is the actual electrolytic deposit, but the bulk of the matrix is typically of brass.[2] Soon after the introduction of electroformed matrices, however, cutting patrices by hand for new designs became an important technique (particularly in the larger sizes). Stephen O. Saxe has argued persuasively that this in turn enabled the complete transformation of the visual style of 19th century ornamented types.[3] Patrix cutting by pantograph was done by Benton around 1883/1884.

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[1]Other methods have been used, but with limitations. Sand casting for all sizes was used in a separate tradition in Korea before Gutenberg. Sand casting was used for larger sizes in the West; the former Type Archive had on display an example of this. Sand casting in any form requires extensive hand finishing, however. Brass punches with lead matrices were sometimes used in Germany for larger sizes (see {Mosley 2015}: 48). An elaborate sequence of making brass strikes (unfinished matrices) from punches (presumably of steel), then using these strikes as models to be duplicated in cast brass, then cleaning up these brass matrices by restriking them with the original punches, was used by several European foundries (including l'Imprimerie nationale in Paris). This has been described by James Mosley and the process has been duplicated by Stan Nelson (see {Mosley 2015}). The late 18th century "sanspareil" matrices were cut from sheet and assembled in two layers. All of these Western methods were, however, intended for the special case of large types. As a one-off experiment, the Michigan-based machinist and matrix maker Andrew W. Dunker created electroformed matrices for his typeface "Homespun" around assemblages of small metal rods (the face resembles embroidered letters). See {Duensing [n.d.]}.

[2]The extraordinary matrices made by Andrew W. Dunker were grown entirely in copper electrolytically. They were then justified using a metalworking (not woodworking) shaper. They are extraordinary items to see, handle and cast from. My thanks to Sky Shipley for allowing me to do so.

[3]Ssee {Saxe 2013}, {Saxe 2016}, and {Nelson et al. 2020}.

Direct matrix engraving was never done by hand.[4] It was first done by machine (by pantograph) by Ludwig and Hofer in 1877. It was first done in the United States by William A. Schraubstadter in 1882 at the Central Type Foundry.

2.1.2• Forgetting

The most extraordinary part of the story of patrix cutting for matrix electroforming is how it was completely forgotten in the second half of the 20th century, by both commercial typographers and historians of type, while it was still actively being done in type foundries. There is a level of disconnection here which is hard to imagine.

2.1.2.1• Obscurity and Romanticism

Typemaking As a Backroom Business

Today, type designers are the rockstars of the graphic arts world. It was not always so. In 1898, when William E. Loy introduced his lengthy series of articles on "Designers and Engravers of Type" in *The Inland Printer* he wrote that:

> The active development of the type founding industry has produced a large number of ingenious designers and engravers of type, about whom the public knows very little.

and he continues a short while later in an almost apologetic tone:

> Believing that the readers of *The Inland Printer* would be interested in an account of designers and engravers of type, … it is proposed to furnish a series of sketches, embodying such data as have been procurable. It is hoped that the publication from month to month may awaken an interest in the subject…{Loy 1898-02 No. 1}.

Publicizing Modern Typemaking

There were publications in the early 20th century which described modern typemaking for a popular audience. Linn Boyd Benton's chapter "The Making of Type," in Hitchcock's *The Building of a Book* {[Benton] 1906} and Beatrice Warde's "Cutting Types for the Machines: A Layman's Account" in *The Dolphin* {Warde 1935}. stand out among these. But such accounts tended to be tied to manufacturers. Benton described only his own process. Warde described only that of the Mergenthaler Linotype Company. The major companies themselves issued materials. Three films in particular are notable:[5]

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[4]If anyone knows of any verifiable example of hand matrix engraving, I would love to hear about it.

[5]Two of these, *Type Speaks!* and *The Eighth Wonder* have been well known for some time and must have had a reasonable circulation when they were made. Monotype's *Type Faces in the Making* was for a long time highly inaccessible; I cannot assess its influence at the time it was released.

- ATF's *Type Speaks!* {ATF 1948}
- The Monotype Corporation's *Type Faces in the Making* {Monotype 1956}
- Mergenthaler Linotype's *The Eighth Wonder* {Mergenthaler 1961}

Again, and naturally, their focus was on the methods used by the firms themselves.

Publicizing Traditional Typemaking

When it came to recounting the methods of hand typemaking, however, a completely different tradition emerged in the first half of the 20th century. It was deliberately romantic and, whether through lack of concern, through lack of knowledge, or through distaste it obscured patrix cutting completely. This may have had roots in England with William Morris, and it developed in an important way in Germany from the 1920s, but it took root most firmly in the United States.

Two articles by the great German type designer and hand punchcutter Rudolf Koch and his son Paul Koch, are perhaps the best remembered of these (at very least, they have the best illustrations[6]): "On Punch-Cutting" {Koch, Kredel 1932}[7] and "The Making of Printing Types" {Koch 1933}. The latter has the distinction of being the second article in the first issue of *The Dolphin,* coming right after Goudy's *On Designing a Type Face.* In the world of books and design in the middle years of the 20th century, that's about as exalted a position as you can have. Every well-educated Anglophone book person knew of these articles in the 1930s, and they have remained influential ever since.

They never mention patrix cutting, even by hand.[8]

The reason for this (purely in my own opinion, of course) is that Koch, like William Morris in an earlier generation, was a romantic who deliberately sought out preindustrial practices. Modern, dirty, industrial processs such as electroforming had no place in his world. Although he worked with an established large foundry (Klingspor), his workshop was independent of it; he did not work within Klingspor's 20th century industrial typefounding plant.

[6]By Fritz Kredel.

[7]A version of this article appeared earlier, but with fewer illustrations, as *Vom Stempelschneiden* in *Gutenberg-Jahrbuch* {Koch 1931}.

[8]At the time, the process was nearly a century old and, as Harry Carter observed just two years earlier in 1930, widely employed: "the present practice is to cut letters larger than 14-point in soft metal".[9]

Despite his devotion to traditional methods, Koch stood apart from them. There were professional punchcutters in the early 20th century still working in largely traditional ways. (Edward Philip Prince (1846–1923) might be cited here.) Moreover, while I greatly admire Koch's work and respect the sincerity and devotion with which he approached it, it seems to me that he also stood outside of the world of traditional mechanics. I am probably going out on a limb here, and may draw the ire of enthusiasts for his work, but the illustration reprinted at right, from the *Colophon* version of his punchcutting article, shows a method of holding an object for striking which no real mechanic would ever use.[11]

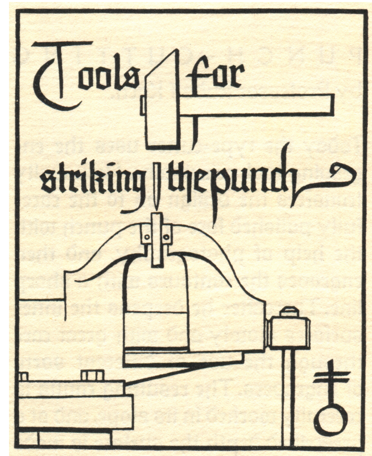

Fig. 2.1: Koch's[10]

Koch's methods may have changed with time (or this might simply have been Fritz Kredel's interpretation of the use of the lovely vise which figures prominently in photographs of Koch's workbench). His article in *The Dolphin,* for example, shows a completely ordinary punchcutter's fixture for striking (p. 36). Still, this illustration shows what happens when you try to return to the past without fully understanding its methods. As Koch himself put it:

> Wenn wir als Wissende tätig sind, ist uns immer unsere eigene Schwäche im Weg. Wenn wir aber unbewußt, als Unwissende wirken, wenn wir an entscheidenden Stellen ein gütiges Geschick anrufen müssen, dann fließen unbekannte und höhere Kräfte in unsere Arbeit und lenken unsere Hände. {Koch 1931}: 292.)

The translation in *The Colophon* renders this somewhat more simply as:

> If we rely only on previous experience, we are handicapped. However, if we approach the work with naivete, a high and unknown strength flows into our work and guides our hands. {Koch, Kredel 1932}

Koch's tradition was continued in the United States by Warren Chappel (who had studied with him). See *Let's Make a B for Bennett* {Chappell 1953} and chapter 3 of *A Short History of the Printed Word* {Chappell 1970}. The latter was published in association with *The New York Times.*

[10] From {Koch, Kredel 1932}. Scanned from my own copy. Public domain.

[11] To keep the punch blank from slipping, you would have to overtighten the vise. This is an abuse of your tools.

2.1.2.2• Middleton (1938)

R. Hunter Middleton, listed by McGrew as the second most prolific metal type designer in the United States,[12] represents an interesting intermediate position. In his 1938 book *Making Printers' Typefaces* he indicates that knows about patrix cutting, but he goes to some length to assert that it is only, and could only be, used in Europe:

> In Europe there is a compromise method in vogue for making matrices related to the punch cutting technique. This method involves the sculpturing of the letter in soft material similar to type metal in the manner of traditional punch cutters. A wax impression is made from the finished character followed by an electroplate shell. The electro shell is then backed up and inserted in a matrix blank, justified in the regular manner, and the matrix is complete. This method requires, first of all, skilled craftsmen, trained similarly to the traditional punch cutters. It may be justifiable if but one size of a typeface is required, or if deliberate variation in design is desired from one size to the other. In America, it is doubtful that even one such craftsman exists, hence the method would be physically impossible as well as impracticable economically, in this country. {Middleton 1938}: 18.

He then goes on to a passage which asserts that the matrices produced by "the typesetting machine companies" are all produced exclusively by machine punchcutting and press-driven stamped matrices. This was at a time when every matrix 14 point and larger made by the Lanston Monotype Machine Company was an electro matrix.[13]

There was, to be sure, a certain insularity among the major firms. Middleton was affiliated with the Ludlow Typograph Company and the Ludlow was commonly found (inter alia) in Linotype/Intertype shops rather than Monotype shops. Still, it is remarkable to think that a

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[12]See {McGrew 1993}: 154. McGrew cites Morris Fuller Benton as the most prolific (221 faces) and Frederick W. Goudy in third place (90 faces). Middleton designed 99.

[13]Technical Documentation preserved by Project Letter-kunde shows that Lanston electro display matrices were electroformed from pattern types which, in turn, were cast from a master matrix. The method by which this master matrix was produced is not yet known. None have survived. We know the external dimensions of the master matrix blank, but do not know its material or the method by which it was turned from a blank to a matrix. All three methods (punch, patrix, direct engraving) are possible. It is, in my opinion, unlikely that they were punched. The master matrix blanks were 0.092–0.097″thick. Driving a 36 to 48 point punch into such a thin blank would have been exceedingly difficult. It is unlikely (again, in my opinion) that they were directly engraved simply because when they were introduced in 1907 there was no tradition of direct matrix engraving at Lanston. My suspicion is that they were electroformed from patrices. There was a long tradition at Lanston of punchcutting, which would have translated directly to patrix cutting. Lanston was set up for mass production of electro matrices and the thickness of this master matrix blank is similar to that of a Lanston display mat. Finally, Lanston "borrowed" much of its electro making technology from the earlier work of John E. Hanrahan and the National Compositype Company. Hanrahan, an engraver who started at the Ryan Type Foundry in 1872, worked entirely as a patrix cutter in soft metal. My thanks to Patrick Goossens for preserving this documentation and for making it available to me.

typographer as well-informed as Middleton had never seen a Lanston Monotype display matrix.

2.1.2.3• Rollins (1947)

It is impossible to pin down with certainty when anything is forgotten,[14] but I would argue that a major inflection point in the disappearance of patrix cutting from the historical record of Anglophone typemaking came in 1947. In that year, R. R. Donnelley & Sons Company (founded in 1864 and still a major printing company today) held an exibition on the subject of "American Type Designers and Their Work" at the offices of their prestige imprint, The Lakeside Press, in Chicago. Carl Purington Rollins, printer to Yale University and a figure of great authority, wrote the material to accompany this exhibition. This was later reprinted (1948) in the influential journal *Print*.[15]

In this work Rollins established both the modern canon of type "designers" and some of our view of what constitutes the history of type. In doing so, he erased the knowledge of patrix cutting completely, skipping directly from hand punchcutting in steel to machine matrix engraving.

In this presentation, "American Type Designers and Their Work" (1947), Rollins begins with hand punchcutting in steel by Abel Buell (1759). He then immediately says:

> It was not until the invention of the Benton pantograph punch-cutting machine in 1885 that any other method was known. All type made before 1885 was therefore dependent on hand punchcutting …

This is false, but every English-language history of type since then has included some statement based on it.

2.1.2.4• McGrew (1986, 1993)

Few people in the late 20th century knew type better than Mac McGrew. He is remembered today for having, very literally, written the book on it: *American Metal Typefaces of the Twentieth Century*. This remains the standard desk reference for all typecasters, printers, and typographers working with metal type.[16]

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[14]Perhaps that is the whole point of forgetting?

[15]For online reprints of Rollins' 1947 exhibition materials {Rollins 1947} and 1948 article {Rollins 1948} see the CircuitousRoot Notebooks "Carl Purington Rollins" `https://circuitousroot.com/artifice/letters/press/history-of-printing/heroic-age/rollins/index.html`

[16]It was printed first as a "Preliminary Edition" by the author and privately circulated in order to solicit additional information and contributions {McGrew 1986}. The first widely circulated edition (and still the only edition) was published by Oak Knoll a few years later {McGrew 1993}. Sadly, it is out of print and secondhand copies routinely list for several hundred dollars. It is no longer realistically available to the generally impoverished young letterpress printers who need it most.

When describing ATF's face "Wedding Text," McGrew writes:

> … It is recorded that the 12 point size was cut in type metal in that year [1901], instead of cutting punches or engraving matrices directly. Electrotype matrices were then made from these cuttings. It is uncertain whether this *new method of cutting* delicate faces resulted in unusual problems or delays, but the face was hailed as "new" in 1907 and again in 1909 {McGrew 1986}: 359 [italics mine].[17]

Patrix cutting had been practiced for over 50 years when it was used to cut Wedding Text in 1901 and for over 140 years when McGrew wrote this. Many of the faces shown in his book had been cut in this way. Yet so thoroughly had this method been erased from the consciousness even of professional typographers in America that he thought it was new in 1901 and might, through its novelty, have caused a six year delay.

[17]The passage reads the same in the 1993 edition (p. 333). Note that the 1993 edition contains a typographical error: Wedding Text is ATF 414 (not 141). The 1986 edition has the correct series number.

2.1.2.5• Not Forgotten in Germany

It is interesting to note that patrix cutting was never forgotten in Germany. It is described as just one of the three methods both in specialist texts and in popular booklets.

Harwerth [Klingspor] (1924)

In 1923, the the type foundry of Gebr. Klingspor published a calendar for 1924. Each month has a woodcut by Willi Harweth associated with it illustrating some aspect of typefounding. There is also a section with texts explaining each. Here is the woodcut for January, showing Der Stempelschneider:

Fig. 2.2: Der Stempelschneider (Klingspor, 1923/4)[18]

However, while this is a stempelschneider in German terminology (where, I believe, the term covers both punchcutting in steel and patrix cutting in soft metal), this is not a punchcutter as an Anglophone typemaker would use the term. This is a patrix cutter working in soft metal. The telltale sign of this is the presence of the Lötwerkzeug (lead-work tool; soldering iron) — a tool for which the punchcutter in steel has no use — and its gas burner. The blocks on the bench near the gravers also look much more like patrix blanks than steel punch blanks.

[18]From {Klingspor 1924}. Scanned from my own copy. Public domain.

The text explains:

> Der Stempelschneider schafft mit Stichel und Feile nach der gezeichneten Vorlage das plastische Modell des Buchstaben. Für die kleinen Schriftgrade schneider en einen Stahlstempel, der zur Erzielung der Gießform in Kupfer oder Eisen eingeprägt wird. Die Größeren Grade werden in Schriftmetall geschnitten, von ihnen wird die Matrize im galvanischen Bad des Galvanoplastikers hergestellt, der nebenbei auch Vervielfältigungen von allen Arten von Druckstöcken vornimmt.

Google translates this as:

> Using a graver and file, the punch cutter creates a three-dimensional model of the letter based on a drawn template. For smaller type sizes, a steel punch is cut, which is then struck into copper or iron to produce the casting mold. Larger sizes are cut directly into type metal; from these, the matrix is produced in the electrolytic bath of an electrotyper — who, incidentally, also creates reproductions of all manner of printing blocks.

This is a fine explanation of the process. It also makes it quite clear that the term "stempelschneider" was being used for both punch and patrix cutting.

Karl Mahr (1928)

TO DO. Der Stempelschneider refers in Mahr's text explicitly to punch and to patrix cutters. The woodcut shows a patrix cutter at work, with many of his tools (including the gas flame and soldering iron)

Konrad F. Bauer (1930s, 1950s)

TO DO

Bohadti (1954)

Gustav Bohadti describes the process of patrix cutting by hand and machine in some detail in *Die Buchdruck Letter.* {Bohadti 1954}: 133–135. His book is an authoritative study of all aspects of typemaking. When discussing punchcutting in steel he uses the term "stempelschneider" (punch cutter, the traditional term) and calls the process "der stahlschnitt und die geprägte Matrize" (steel engraving and the driven matrix) (p. 131). When discussing patrix cutting, he entitles the section "Der Zeugschnitt von Hand und mit Hilfe der Bohrmaschine" (Material cutting by hand and drilling machine). "Zeug" is being used here in much the same way as 19th century American typefounders used the term "metal." But he does, in the same section, refer to the soft metal patrix blank as "der punzen." (p. 133).

What is most interesting is that his photographic illustration of Der Stempelschneider (p. 161)" (p. 133) shows not a punch cutter in steel but a patrix cutter. He is very clearly engraving a patrix, not a punch. On his bench are more patrices and the gas burner of the lead worker.

As with the Harweth/Klingspor example from 1924 above, this as good evidence that the term "stempelschneider" was applied in German to both punch and patrix cutters during a period where both operations were well known.

2.1.3• The Origins of Matrix Electroforming

TO DO: Evaluate this section; it is getting out of hand, and it is about to get bigger. Should it remain here, become an appendix, or be moved to a separate work? Strictly speaking, all that is necessary here is a statement that we had matrix electroforming by 1845. But it is useful to understand what was being done in its earliest years in the context of the technology actually used. Failing to do this has led, for example, to misinterpretations of Starr's patent. Once again, it turns out that what really happened was much more complicated than the stories we are still telling ourselves.

TO DO: Tracking down volume 1 of *The Printer* (1858-1859) is important. It contains a series of articles on electrotyping by Filmer, with illustrations (one of which is his piece on James Conner, reprinted by Ringwalt).

The early history of the electroformed[19] typefounder's matrix was discovered by Rollo Silver and published by him in his paper "Trans-Atlantic Crossing: The Beginning of Electrotyping in America" {Silver 1974}. Given the great obscurity of some of the defunct 19th century journals in which he discovered his information and the fact that he accomplished this before the modern mass digitization of texts, his work is remarkable.

General Histories

References to the origins of electrolytic deposition, beginning with Galvani and Volta in the 18th century, may be found in most general histories of science and technology. Historical studies of the origins of electrodeposition from a technically informed perspective, though, are surprisingly difficult to find. Some good, if brief, surveys of early development occur in the introductory chapters of various older technical texts such as Walter G. McMillan's *A Treatise on Electro-Metallurgy* {McMillan 1890} or George Langbein's *A Complete Treatise on the Electro-deposition of Metals* {Langbein 1891}, both of which are available online.

TO DO: These are all basically 19th century sources. I have not yet found an academically rigorous and critically informed late 20th century or later study. Continue looking.

Michæl Faraday

The main thread starts with the great experimentalist Michael Faraday in England. For this we have original sources available. Beginning in 1831, he presented a long series of papers to

[19]"Electroforming" is the modern term in industry for items created through heavy electrodeposition (as opposed to items simply covered with a thin metallic film, for which the term "electroplating" is used). It is not a term that would have been heard during the era of metal type. At the time, the term "electrotype" typically was used both as a noun indicating a printing plate created through electrodeposition and as an adjective in the typefounder's "electrotype matrix." Often this was simplified, in both cases, to "electro." The opportunity for confusion here is great, so I will employ "electroforming," anachronistically, only when writing of type matrices and "electrotype" only when referring to printing plates.

the Royal Society on his "Experimental Researches in Electricity."[20] I is important to realize that we are at the dawn of our understanding of electricity in these papers. For example, in part of his "Third Series" (read 1833-01-10) he still has to argue such a basic point that the various kinds of electricity we observe are in fact the same thing {Faraday 1833a}. Also, in these papers he is investigating everything that he can discover, not trying to develop an industrial process. So in his "Fifth Series" {Faraday 1833b} and "Seventh Series" {Faraday 1834}, both "On Electro-chemical Decomposition" his primary focus is on breaking things apart with electricity (electrolysis) rather than putting them together (electrodeposition). Still, in the first of these he records the electrodeposition of silver (p. 703) and in the second that of tin (p. 104). From this humble origin came every chrome-plated automobile part and nearly every Lanston Monotype display face.

Jacobi and Others

The consequence of Faraday's research that is of interest here isn't just electrodeposition in general but, specifically, the use of an electrodeposited plate to transfer an image which could be used for printing. Rollo Silver records a complex flurry of activity here in the 1836–1839 timeframe, with multiple competing claims of priority.[21] The upshot, in Silver's words, was that "by the beginning of 1840, the term *electrotype* denoted the new method of reproduction" {Silver 1974}: 84–85.

This process was international, centering intially around a dispute of priority between Jacobi in Russia[22] and Spencer (and Jordan, to a lesser extent) in England. This led to a rapid exchange of articles in the scientific magazines of the day. Many of these were quickly reprinted in the United States.

The Single Cell Apparatus

Before proceeding, it might be useful to clarify the kind of setup which was being used. It was not one which would be familiar either to 20th century electrotypers or to modern electroplaters in industry.

Today, we think of electroplating/electroforming as happening in a bath of some kind, with electrodes. One of these, the anode, is on the source side of the plating process. In many setups, it is eaten away as it supplies metal to replenish the metal plated out from the bath. The other

---

[20]The first of these was read on 1831-11-24 and published in the 1832 volume of the *Philosophical Transations of the Royal Society of London.* {Faraday 1831}. Faraday's papers on the subject were collected in a three-volume book, *Experimental Researches in Electricity* {Faraday 1839-1855}.

[21]See Appendix A, Sources for Early Typographical Electroforming, on page 213 for a survey of these.

[22]This is the German-Russian engineer, scientist, and inventor Moritz Hermann von Jacobi. He is commonly indexed as "Jacobi" (vs. "von Jacobi") and often was called Prof. Jacobi in the contemporary literature. His English-language Wikipedia page is at `https://en.wikipedia.org/wiki/Moritz_von_Jacobi` (version 2025-05-25 accessed on 2026-04-07).

electrode, the cathode, is the object which is to be plated (or the model of some kind onto which a thicker layer is to be electroformed). The electric current which drives this process is supplied from a source external to the bath. This could be a battery, a dynamo,[23] or an electronically regulated power supply connected to the public power grid.[24]

The photograph below shows the matrix electroforming apparatus used at the MacKellar, Smiths and Jordan Type Foundry in the 1890s.[25] The electrodeposition bath is on the right and the belt-driven dynamo providing power is on the left.[26]

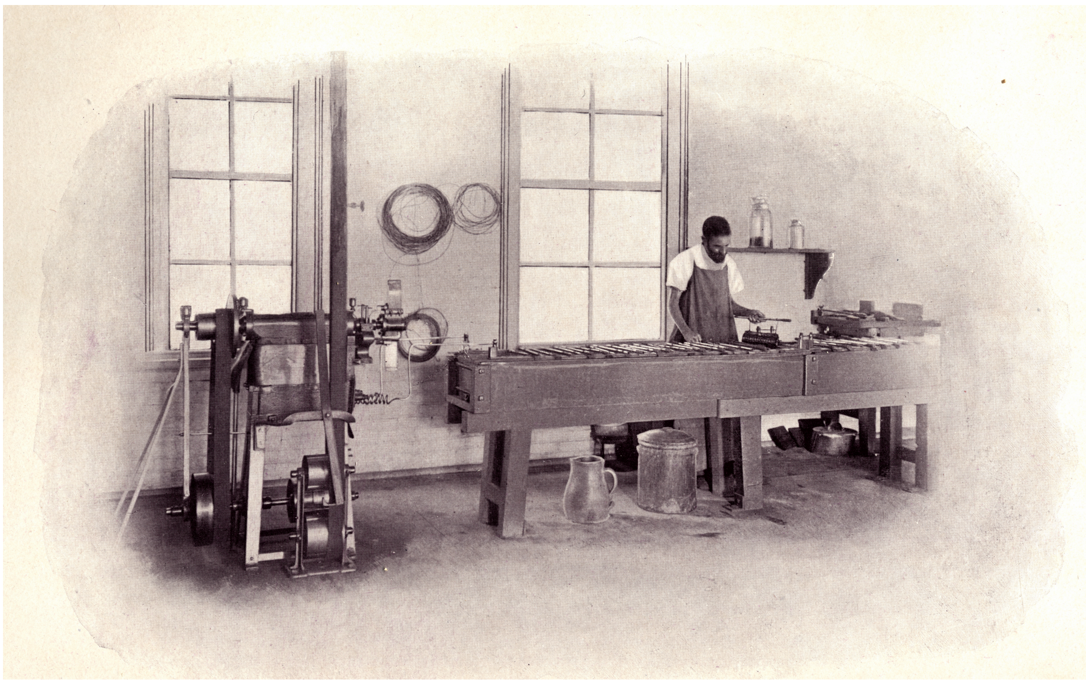


Fig. 2.3: Matrix Electroforming Apparatus, MSJ (By 1896)

Many of the early experimenters, by way of contrast, were using various versions of what later came to be called the "single cell depositing apparatus."[27] In these, there was no external power supply. The electrodeposition apparatus itself formed the electrochemical cell[28] which

[23]A dynamo is a direct current generator which uses a mechanical commutator. They were common in the late 19th century.

[24]These were uncommon in the 19th century.

[25]From {ATF 1896 100}. Public domain. At the time this photograph was published, MacKellar, Smiths and Jordan had not existed for four years. This was really just the Philadelphia branch of American Type Founders. But the book celebrating their centenary, *One Hundred Years,* was published very much as if they still existed.

[26]The electrotype department, shown elsewhere in the same book, is generally similar but with tanks of a slightly different shape and a dynamo of different manufacture.

[27]It is called this, for example, in Urquhart's *Elecro-Typing: A Practical Manual*. He says of it that "This was the apparatus first employed in the deposition of electrotypes, and it is even yet in use for small work, although greatly inferior to the separate current process." {Urquhart 1881}: 25–27. In the 1840s this term was unnecessary because there was no other kind of apparatus.

[28]In common language we tend to call the thing that you put into a device which powers it a "battery." This is often

provided the flow of current.

Both forms were known from a relatively early date. Jacobi, in *Die Galvanoplastik*, shows both. In his Figure 21 (see Fig. 2.4 below) he shows a box with a porous partition at e-f.[29] On the far side of this box as shown in the figure, there is a cathode[30] which is a zinc plate, Z. This far compartment is filled with a silute sulfuric acid.[31] On the near side, connected to Z by a wire, is a copper plate serving as the anode. Its compartment is filled with a copper sulfate solution. The perforated box at K contains a "stock of bruised sulpate of copper" to make up for the copper plated onto the cathode. In this apparatus, which has no external power source, copper from the solution on the anode's side will be plated onto the zinc cathode. (The cathode is shown in his figure as a simple plate, but of course it could be of any shape.)[32]

Jacobi also presented various external-battery configurations. These are shown schematically in his Figure 25 (see 2.5 below). The many lines in the box at A-B represent the individual cells of a battery. K and Z are the anode and cathode connections, respectively. There is only a single, undivided, container at C-D; it is filled with a copper sulfate solution. The copper anode, a, is reduced. The zinc cathode, c, "will be covered with a film of metallic copper." (p. 23).

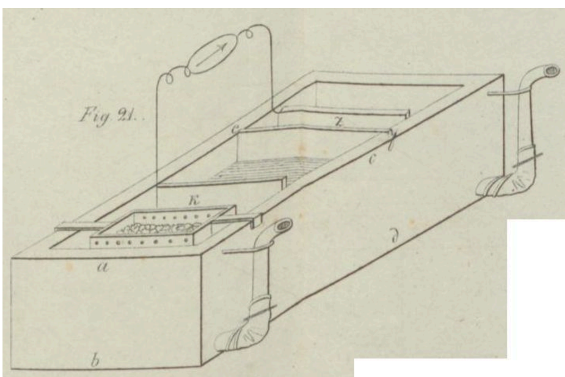


Fig. 2.4: Jacobi's Single Cell (1840)[33]

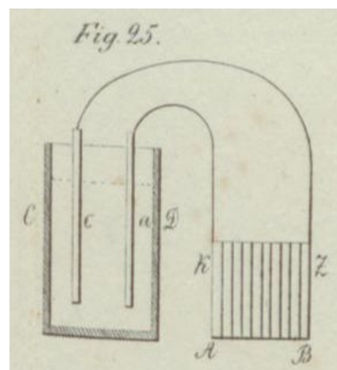


Fig. 2.5: Jacobi's External Battery Apparatus

TO DO: I've plated copper and tin, but only in external power source setups. Build and try a

not correct, though. To an electrical engineer, the simple unit which produces electricity from chemistry is called a "cell" (or an electrochemical cell). A group of cells together is a "battery." This is analogy to a military battery (or group) of cannons.

[29]He used porous clay. He says "this partition must be of such a nature that it will permit a free passage for the electricity, although it must allow but a slight connection between the two liquids" (p. 18).

[30]Jacobi does not use this term

[31]Jacobi also mentions several other possible electrolytes.

[32]The drawing was, to me, initially confusing. The box has only one partition, at e-f. Behind it, at Z, the thing which looks a bit like a partition is actually the zinc cathode plate. In front of it, near the perforated box K, is the copper anode plate. Note that the anode and the cathode are connected by a wire. The circled arrow in the wire indicates a compass needle to show current flow (it's not as if Jacobi had a digital multimeter). The two flexible tubes, shown held with their mouths above the level of the bath, are for draining the electrolytes to renew them.

[33]From {Jacobi 1840}. This image and the next are from the ETH Zurich digitization online at the e-rara platform (`https://www.e-rara.ch/?`), DOI: `https://doi.org/10.3931/e-rara-59157` Public domain.

single-cell setup. Show it here.

Jordans Electro Matrix (1839)

TO DO: I discovered this right before stopping work on Revision 2. Try to track down Jordan's original publications. It is possible that ultimate priority might actually be traced to these. Silver does not consider this source.

See Dircks 1952 (Jordantype), pp. 9–10

See Dircks 1863, pp. 5–6.

Spencer's Electro Matrix (1839?)

TO DO: I discovered this right before stopping work on Revision 2. Track down Spencer's original article. It is possible that ultimate priority might actually be traced to it. Silver does not consider this source.

> It is curious that among Mr. Spencer's earliest experiments was one of which type-founders have taken advantage, and, to this day, use it as a means of fraud upon each other. In one of his first articles announcing his discovery, he stated "that if he took a type used by the printer and attached it to one pole of a galvanic battery, the copper would be precipitated pon it, and when of sufficient thickness, it could be taken off and be used as a matrix with which to cast new type." This is practiced by all type-founders. Whatever expense an enterprising type-founder may incur to cut steel punches for new styles, as soon as his neighbor can get possession of a cast, he can, and does, by means of the elctrotype, reproduce the same at a fraction of the original cost. {Filmer 1872}: 524.

The "Trans-Atlantic Crossing"

The results of Jacobi and Spencer were duplicated in the United States and (at least in the minds of the participants) improved upon. This was documented in a rapid exchange of information which appeared in a journal edited by James J. Mapes, *The American Repertory of Arts, Sciences, and Manufactures.* In the April 1840 number, the editor reports[34] very briefly that

> Several scientific gentlemen in this city [New York City] have successfully repeated the experiments [of Jacobi and of Spencer], and specimens may be seen at the Mechanics' Institute, by those who wish to witness the results. ({Mapes 1840 April}: 202)

In the May number of *The American Repertory,* Mapes reprints a letter by Thomas Spencer to the *London Journal and Repertory of Arts* which contains a detailed discussion of his process.

[34] More experimental work in electrochemistry was happening simultaneously. In the same number of *The American Repertory* there is a reprint of a paragraph which appeared in *The Inventor's Advocate* on experiments by a Mr. Bottinger with coloring platinum electrodes placed in an "ammoniacal chloride of copper" solution. (p. 214). Mapes, as editor, takes care to distinguish this from the results obtained by Jacobi and Spencer.

To this Mapes appended a brief note claiming that "This process has been much simplified by Franklin Peale, Esq.,[35] first coiner [that is, Chief Coiner] of the mint at Philadelphia" ({Mapes 1840 May}: 281).[36]

The June number of *The American Repertory* contains an article by Mapes praising the steam engine in the Philadelphia Mint, designed by Franklin Peale. More significantly for the present discussion, it also contains a longer article discussing the work of several American experimentalists. These include Peale, James R. Chilton, M. D., and Joseph Saxton ({Mapes 1840 June}: 349–354).

Peale's work is of lesser interest here because he was duplicating medals rather than making printing plates or type matrices. His process did, however, involve first taking a cast of the medal in type-metal. The duplicate medal was then electroformed in copper using this as a mold/model. It also isn't entirely clear what Chilton was making, though we re told that his methods were successful.

The main point of interest is the report on the work of Joseph Saxton. He is said to have been "the first successful experimenter in this country" (p. 350). He exhibited at the Franklin Institue "a copy from a pentagraphic plate,[37] so perfect that it might readily be mistaken for the original" (p. 350). The next paragraph in Mapes' account makes it clear that this plate was a woodcut. (Mapes also asserts that a copy of a paper impression of a copper plate could be made.) This passage does not explain how Sexton was preparing these plates so as to be electrically conductive, though. Mapes does say that, in the case of electrotyping from a paper impression, the paper was "bronzed."

The article then reprints a long letter from Edward Solly, Jr. to the editor (Richard Taylor) of the *London and Edinburgh Philosophical Magazine* of April 1840. The major feature of this article is Solly's description of several methods he employed to coat nonconductive surfaces for electroplating (involving lead, silver, and copper). After this reprint, Mapes returns to observe that the "plan proposed by Mr. Solly, in using nitrate of silver for inducing precipitation on the surface of non-metallic bodies, has been anticipated by Dr. Chilton…" (p. 354).

So by June 1840, the *American Repertory* has reported the successful creation of electrotype

[35]Benjamin Franklin Peale (1795–1870). His tenure at the Philadelphia Mint was not without controversy. See the Wikipedia article on him at: `https://en.wikipedia.org/wiki/Franklin_Peale` Revision of 2025-01-24 accessed on 2026-04-08.

[36]Franklin Peale was also the son of Charles Willson Peale, in whose Museum a silhouette pantograph by Hawkins had earlier been in operation, and had assumed the management of that museum at his father's death in 1827. His half-sister Sophonisba Peale married Coleman Sellers, father of George Escol Sellers. The latter co-founded the Philadelphia machine shop which later built the first Lanston Monotype typecasting machines. 19^{th} century America could be a small world.

[37]This is of course relatively early evidence for the use of the pantograph in reproducing relief printing plates, but that's a different line of inquiry.

plates from both conductive and nonconductive originals. As yet, however, no sheet printed from such a plate has appeared.

Electrotype Plates and Typefounder's Matrices

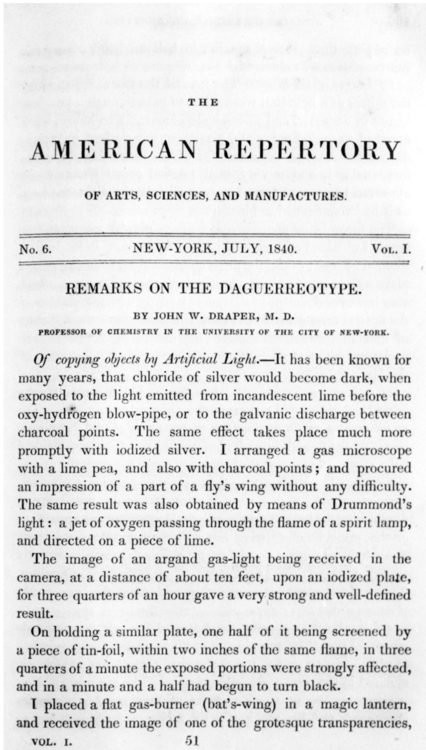
The July 1840 number of *The American Repertory* was accompanied by a sheet printed from an electrotyped plate.[38]

> We are happy in being able to present our readers with two impressions from copper-plates: the first is from the original engraved plate; the other, from an electrotype copy made by Dr. Chilton, …This is the first electrotype plate printed from in this country; and, so far as we can learn, is much larger than any made in Europe. ({Mapes 1840 July}: 434).

This pins down the date of the first printing electrotype in the United States, while also admitting that something earlier had appeared in Europe. Given the importance of this article for the history of both electrotyping and (as will be seen) matrix electroforming, it is reprinted in full on the following page (with the masthead of the issue).[39]

[38]Unfortunately, the only copy of this issue that I have seen, a digitization of an unidentified microfilm copy, lacks the plates. The illustration of the deposition cell which accompanies it is a woodcut, not one of the plates.

[39]In examining the page containing the masthead, readers unfamiliar with printed books should note that the number "51" at the bottom is the number of the gathering (often mistakenly called the "signature") of the printed sheets comprising the volume. It is not a page number.



THE

AMERICAN REPERTORY

OF ARTS, SCIENCES, AND MANUFACTURES.

No. 6. NEW-YORK, JULY, 1840. Vol. I.

REMARKS ON THE DAGUERREOTYPE.

BY JOHN W. DRAPER, M. D.

PROFESSOR OF CHEMISTRY IN THE UNIVERSITY OF THE CITY OF NEW-YORK.

Of copying objects by Artificial Light.—It has been known for many years, that chloride of silver would become dark, when exposed to the light emitted from incandescent lime before the oxy-hydrogen blow-pipe, or to the galvanic discharge between charcoal points. The same effect takes place much more promptly with iodized silver. I arranged a gas microscope with a lime pea, and also with charcoal points; and procured an impression of a part of a fly's wing without any difficulty. The same result was also obtained by means of Drummond's light: a jet of oxygen passing through the flame of a spirit lamp, and directed on a piece of lime.

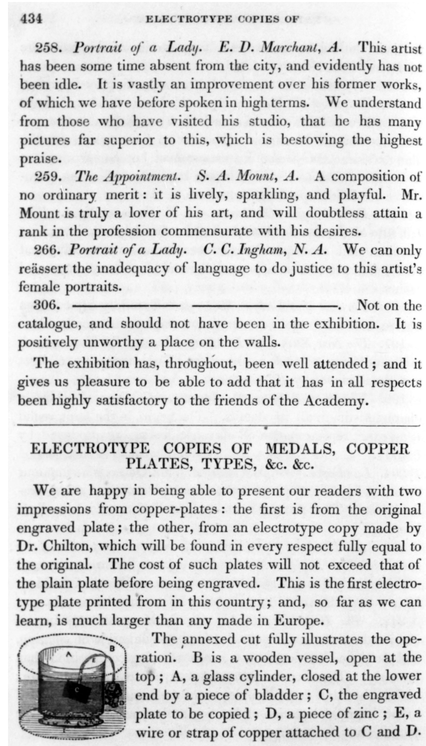
The image of an argand gas-light being received in the camera, at a distance of about ten feet, upon an iodized plate, for three quarters of an hour gave a very strong and well-defined result.

On holding a similar plate, one half of it being screened by a piece of tin-foil, within two inches of the same flame, in three quarters of a minute the exposed portions were strongly affected, and in a minute and a half had begun to turn black.

I placed a flat gas-burner (bat's-wing) in a magic lantern, and received the image of one of the grotesque transparencies,

VOL. I. 51

Fig. 2.6: *Amer. Rep.* (July 1840)[40]



434 ELECTROTYPE COPIES OF

258. *Portrait of a Lady.* *E. D. Marchant, A.* This artist has been some time absent from the city, and evidently has not been idle. It is vastly an improvement over his former works, of which we have before spoken in high terms. We understand from those who have visited his studio, that he has many pictures far superior to this, which is bestowing the highest praise.

259. *The Appointment.* *S. A. Mount, A.* A composition of no ordinary merit: it is lively, sparkling, and playful. Mr. Mount is truly a lover of his art, and will doubtless attain a rank in the profession commensurate with his desires.

266. *Portrait of a Lady.* *C. C. Ingham, N. A.* We can only reässert the inadequacy of language to do justice to this artist's female portraits.

306. ——— ——— ———. Not on the catalogue, and should not have been in the exhibition. It is positively unworthy a place on the walls.

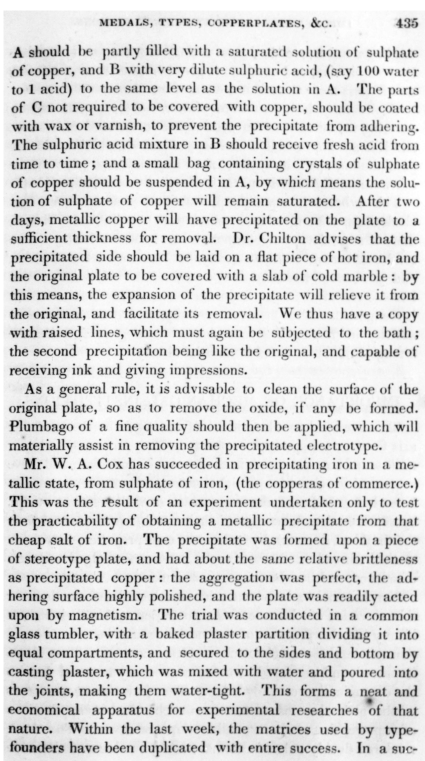
The exhibition has, throughout, been well attended; and it gives us pleasure to be able to add that it has in all respects been highly satisfactory to the friends of the Academy.

ELECTROTYPE COPIES OF MEDALS, COPPER PLATES, TYPES, &c. &c.

We are happy in being able to present our readers with two impressions from copper-plates: the first is from the original engraved plate; the other, from an electrotype copy made by Dr. Chilton, which will be found in every respect fully equal to the original. The cost of such plates will not exceed that of the plain plate before being engraved. This is the first electrotype plate printed from in this country; and, so far as we can learn, is much larger than any made in Europe.

The annexed cut fully illustrates the operation. B is a wooden vessel, open at the top; A, a glass cylinder, closed at the lower end by a piece of bladder; C, the engraved plate to be copied; D, a piece of zinc; E, a wire or strap of copper attached to C and D.

Fig. 2.7: Mapes, p. 434



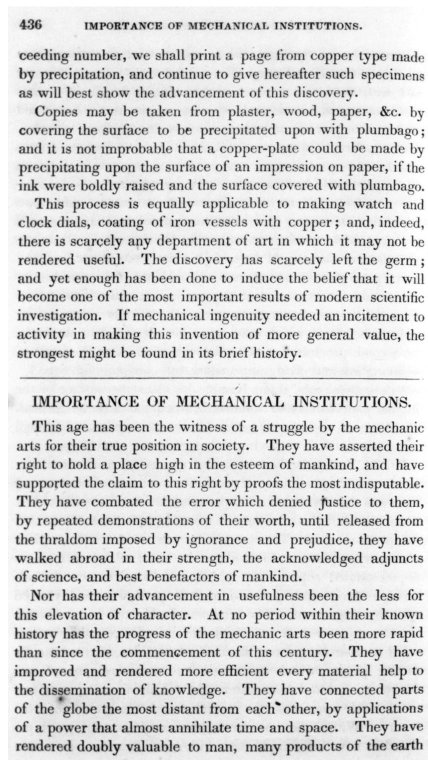
MEDALS, TYPES, COPPERPLATES, &c. 435

A should be partly filled with a saturated solution of sulphate of copper, and B with very dilute sulphuric acid, (say 100 water to 1 acid) to the same level as the solution in A. The parts of C not required to be covered with copper, should be coated with wax or varnish, to prevent the precipitate from adhering. The sulphuric acid mixture in B should receive fresh acid from time to time; and a small bag containing crystals of sulphate of copper should be suspended in A, by which means the solution of sulphate of copper will remain saturated. After two days, metallic copper will have precipitated on the plate to a sufficient thickness for removal. Dr. Chilton advises that the precipitated side should be laid on a flat piece of hot iron, and the original plate to be covered with a slab of cold marble: by this means, the expansion of the precipitate will relieve it from the original, and facilitate its removal. We thus have a copy with raised lines, which must again be subjected to the bath; the second precipitation being like the original, and capable of receiving ink and giving impressions.

As a general rule, it is advisable to clean the surface of the original plate, so as to remove the oxide, if any be formed. Plumbago of a fine quality should then be applied, which will materially assist in removing the precipitated electrotype.

Mr. W. A. Cox has succeeded in precipitating iron in a metallic state, from sulphate of iron, (the copperas of commerce.) This was the result of an experiment undertaken only to test the practicability of obtaining a metallic precipitate from that cheap salt of iron. The precipitate was formed upon a piece of stereotype plate, and had about the same relative brittleness as precipitated copper: the aggregation was perfect, the adhering surface highly polished, and the plate was readily acted upon by magnetism. The trial was conducted in a common glass tumbler, with a baked plaster partition dividing it into equal compartments, and secured to the sides and bottom by casting plaster, which was mixed with water and poured into the joints, making them water-tight. This forms a neat and economical apparatus for experimental researches of that nature. Within the last week, the matrices used by type-founders have been duplicated with entire success. In a suc-

Fig. 2.8: Mapes, p. 435



436 IMPORTANCE OF MECHANICAL INSTITUTIONS.

ceeding number, we shall print a page from copper type made by precipitation, and continue to give hereafter such specimens as will best show the advancement of this discovery.

Copies may be taken from plaster, wood, paper, &c. by covering the surface to be precipitated upon with plumbago; and it is not improbable that a copper-plate could be made by precipitating upon the surface of an impression on paper, if the ink were boldly raised and the surface covered with plumbago.

This process is equally applicable to making watch and clock dials, coating of iron vessels with copper; and, indeed, there is scarcely any department of art in which it may not be rendered useful. The discovery has scarcely left the germ; and yet enough has been done to induce the belief that it will become one of the most important results of modern scientific investigation. If mechanical ingenuity needed an incitement to activity in making this invention of more general value, the strongest might be found in its brief history.

IMPORTANCE OF MECHANICAL INSTITUTIONS.

This age has been the witness of a struggle by the mechanic arts for their true position in society. They have asserted their right to hold a place high in the esteem of mankind, and have supported the claim to this right by proofs the most indisputable. They have combated the error which denied justice to them, by repeated demonstrations of their worth, until released from the thraldom imposed by ignorance and prejudice, they have walked abroad in their strength, the acknowledged adjuncts of science, and best benefactors of mankind.

Nor has their advancement in usefulness been the less for this elevation of character. At no period within their known history has the progress of the mechanic arts been more rapid than since the commencement of this century. They have improved and rendered more efficient every material help to the dissemination of knowledge. They have connected parts of the globe the most distant from each other, by applications of a power that almost annihilate time and space. They have rendered doubly valuable to man, many products of the earth

Fig. 2.9: Mapes, p. 436

[40]These page images are from {Mapes 1840 July}: 434–436). From a digitization by The Internet Archive of an unidentified microfilm. Public domain.

Here is a closer view of the woodcut of the apparatus. It is clearly an experimental setup, not a device for commercial production. The description of the process in the text, though, is relatively straightfoward.

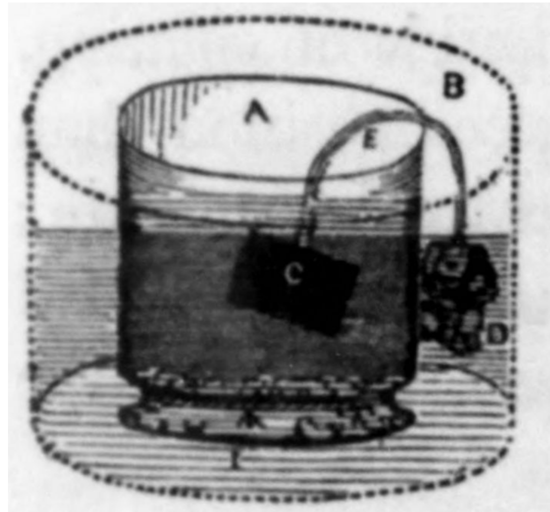
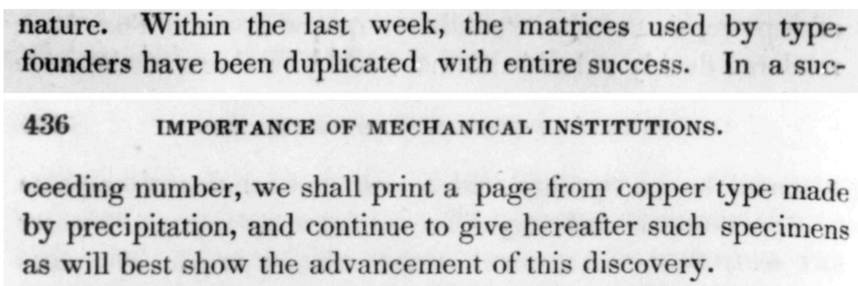


Fig. 2.10: Chilton's Electrotype Apparatus

Unfortunately, what follows this is not only a passage of great historical importance but also, perhaps fatally, one which is ambiguous. It certainly made sense to Mapes, who was involved with the participants at the time, but it is far from clear now.

Mapes continues after describing Chilton's apparatus with an account of the success of a W. A. Cox in electrodepositing iron from iron sulfate.[41]

Then Mapes writes:



nature. Within the last week, the matrices used by type-**founders** have been duplicated with entire success. In a suc-

436 IMPORTANCE OF MECHANICAL INSTITUTIONS.

ceeding number, we shall print a page from copper type made by precipitation, and continue to give hereafter such specimens as will best show the advancement of this discovery.

Fig. 2.11: First Electro Matrix (By July 1840)

The problem is that this in the same paragraph as his account of Cox's iron deposition. Mapes doesn't actually say *who* duplicated typefounders' matrices, and Cox is the most recent antecedent. But Cox was depositing iron, not copper, and I don't think that anyone has ever made an electroformed *iron* matrix. It is much more likely that Mapes simply ran his thoughts together here and that he meant Chilton, not Cox. This supposition is reinforced by the 1858 article on James Conner's first efforts (see below), which cites Chilton as the originator.

Since there is no reason to suspect that the correspondents reporting their work in the *American Repertory* were telling anything other than the truth, this is a firm identification of the date of the first electroformed typefounder's matrix to within a month.

Yet matrix electroforming did not progress *directly* from this without considerable additional work. The second part of the passage quoted above may shed some light on why this was so.

Firstly, it tacitly admits that the experimenters were not themselves typefounders. It does

[41]To a modern chemist, this is ferrous (II) sulfate. It was known traditionally as "copperas" or as "green vitriol."

not say something such as "Within the last week we duplicated matrices in our type foundry." Instead, it refers to "the matrices used by typefounders."

Secondly, it refers to "copper type made by precipitation" (that is, by electrodeposition). This is very strange, because type is not made of copper. It is made of typemetal (lead/antimony/tin alloy) cast against matrices. When metal type has been made of metals other than typemetal, such as brass or steel type, it is cut individually, not grown through electrodeposition. In a field as old and as varied as typemaking, it is unwise to say "never," but I am unaware of any other instance in the history of type involving copper type grown by electrodeposition.

The promised page printed "from copper type made by precipitation" never appeared.

It would seem, therefore, that as innovative as the making of this first electro matrix was, its makers did not have the background as typefounders to pursue it.

James Conner

The trail of sources at this point goes cold. Articles in later numbers of *The American Repertory* on this theme concern electrotype plates, not matrices. The next source that Silver could discover was an 1859 article by William Filmer[42] on Conner.[43] This appeared in a short-lived journal, *The Printer*[44] This is a very rare source. Its first volume, in which this article appears, has never been digitized.[45] Silver located a copy of the original and his quotations appear to be from that original. The article was, however, reprinted in the entry for John Conner in Luther Ringwalt's 1871 *American Encyclopædia of Printing*. {Ringwalt 1871}: 121–122.[46] Its importance is such that this 1871 reprint is presented in its entirety on the next two pages.

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[42]William Filmer was an early and well-known electrotyper. His obituary in *The Inland Printer* says that he began electrotyping in the 1847–1850 timeframe. He began in Boston, soon moved to New York, and worked at later periods in San Francisco. See {[Filmer] 1900}. William Filmer (1825–1900) should not be conflated with his son William P. Filmer (1866–1942), who was also an electrotyper. W. P. Filmer's obituary appeared in the *Oakland Tribune,* 1942-11-23, p. 5.

[43]This was a part of a series under the general title "Electro-Metallurgy." Filmer wrote in his 1872 *Overland Monthy* article that he had "furnished a series of articles for a publication called *The Printer,* issued in New York, in 1858–9, giving the minutest details of the process, illustrated with engravings of every machine and tool used. {Filmer 1872}: 527.

[44]This was unrelated, of course, to later journals bearing the same or similar names.

[45]I have not, myself, seen the original.

[46]Ringwalt's reprint was almost immediately reprinted in an obscure Boston periodical, *The Typographic*, in December of the same year. {*The Typographic* 1871}.

COMPOUND WORDS—CONNER, JAMES. 121

words only those which have their respective parts connected by a hyphen are compound in the printing-office sense. Unfortunately, the usage applicable to many words is conflicting, dictionary-makers and writers disagreeing, as to whether they should be printed distinctly, or be connected with a hyphen, or be printed as single words. Webster's and Worcester's Dictionaries designate, in each doubtful word, whether it is to be printed with or without a hyphen, but they do not explain on what principles their decisions are founded, and they do not always reach similar conclusions. Goold Brown, in his grammar, undertook to solve this problem by the doctrine that: Permanent compounds are consolidated; as bookseller, schoolmaster: others are formed by the hyphen; as, glass-house, negro-merchant. But Parker in his Aids to English Composition, in commenting on this doctrine, says that no better reason can be given for the use or omission of the hyphen than caprice. Wilson, in his Treatise on Punctuation, lays down some rules, yet he acknowledges that there are numerous exceptions to most of them, and he laments that the subject under consideration has been sadly neglected. Practically, the only safe course open now for proof-readers and compositors is to consult their favorite dictionary in all doubtful cases.

Condensed.—This general term is applied to various styles of job letter which are narrower than Roman letters of a corresponding size. Some of the English founders use in a similar sense the word compressed. (See JOB LETTER.)

Conner, James, born April 22, 1798, near Hyde Park, Duchess County, New York, died May 30, 1861, was the founder of the Conner Type Foundry of New York, which, since his death, has been conducted by his sons, under the firm name of James Conner's Sons. After serving an apprenticeship to the printing-business in a New York City newspaper-office, he worked for some years as a journeyman printer, chiefly in book stereotype offices, beginning his labors as a stereotyper in the office of Mr. Watts, who, in conjunction with Mr. Foy, was one of the first, if not the first, to stereotype successfully in the United States. Subsequently he started a stereotype establishment in New York, to which an extensive type-foundry was afterwards added, and he prepared plates of a number of valuable standard works, some of which he sold, while others he published on his own account. Later in life, after an adventurous career, his business attention was concentrated on his type-foundry, and he made strenuous exertions to increase his variety of faces as well as to improve the facilities for manufacturing type. A biographical notice of Mr. Conner, which appeared in The Printer of May, 1859, gives the following account of some of his experiments:

Among these, elaborated by the process of chemical precipitation, was the casting of letters from an electrotyped matrix. Previous to Mr. Conner's successful efforts in this direction, Messrs. Mapes and Chilton, chemists, had experimented to produce a fac-simile of a copper-plate which Mapes wished to use for his magazine. Ascertaining the perfect success of the experiment under other hands, he was anxious to have their battery tried on a copper-plate. It was, to his and Mr. Chilton's joint delight, successful, and a very favorable report was inserted in many of the European scientific periodicals. So gratifying, in fact, were the results of the experiments made in this direction, that improvements were suggested from time to time.

In the course of his experimenting, Conner took a Long Primer Italic capital T, and inserted it through a piece of stereotype plate. This was attached to a copper wire by soldering; some zinc was attached to the other end of the wire; a weak solution of sulphuric acid was made and placed in a vessel; a solution of common blue vitriol in another apartment; then the matrix and the zinc were placed in their respective apartments, and the process of extracting the copper from the sulphate, through galvanic action, commenced, and the copper obtained was thrown on the intended matrix.

Conner and his assistants then took a small cut of a beehive, and, setting this also in the same way, obtained a perfect matrix, which is now in use at Conner's foundry. These successes encouraged him to other experiments on a larger and more valuable scale. Mr. Conner, therefore, ordered a fancy font of type, which he originally had cut on steel, selecting therefrom a perfect alphabet, points, and figures, and then shaved a stereotype plate on both sides. This he lined off into sizes, equal to the matrices he desired to make. He then made the necessary openings through the plate, and inserted the types designed to be precipitated on, which he cut off and soldered on the back. This proved a highly successful experiment, as it gave him a perfect set of matrices at one precipitation. This plate is still to be seen at Mr. Conner's establishment, as originally made, and is regarded as a great curiosity—being supposed to be the first alphabet thus made, in this or any other country.

His next experiment was made on a more extended scale, and, to this end, the apparatus was enlarged so as to admit three fonts of fancy types, which were placed in communication with the precipitated copper at the same operation. Between each letter was inserted a piece of wood, made to the height necessary to separate each matrix from the other as it came out, it being impossible to connect the wood along with the precipitated metal. Thus divided, each matrix would fall apart without the labor of sawing. This experiment, however, was by no means successful. From the circumstance of wood being introduced as dividing lines, and becoming wet, it swelled—such swelling causing the type to spring from the bottom of the trough. In the process of precipitation, only a very thin shell was formed on the face of the type; about the same quantity having found its way to the bottom, in consequence

Fig. 2.12: Conner (1858) in Ringwalt (1871), p. 121[47]

[47] From {Ringwalt 1871}. Digitization by the Scientific and Technical Information Center (STIC) of the United States

122 CONNER, JAMES—COPPERPLATE PRESS.

of the springing of the dividing lines, and the throwing of the types off their feet. All these difficulties have been since overcome, and his establishment has several thousand precipitated matrices that can scarcely be told from those made from a steel punch.

Consecutive Numbering-Machines.—Several machines are made by which tickets, checks, or cards can be numbered consecutively with great facility. They are extensively used in printing railroad tickets and tickets for secured seats in places of public entertainment.

Consonant.—An articulate sound which in utterance is usually combined and sounded with an open sound called a vowel; a member of the spoken alphabet other than a vowel; hence, also, a letter or character representing such a sound. Consonants are divided into various classes, as mutes, spirants, sibilants, nasals, semi-vowels, etc.

Contents.—A summary of the matter treated in a book, which usually follows the preface or introduction, but sometimes precedes it. When a work is divided into chapters, and the contents of each chapter are summarized at its head, these summaries are frequently printed at or near the beginning of the work, as contents; while in works not thus divided, and in which the summary assumes the shape of a minute alphabetical index, such an index is usually printed at the end of the book.

Context.—The parts of a composition which precede or follow a sentence quoted.

Co-operative Associations.—A number of co-operative associations of journeymen printers, formed for the purpose of enabling them to acquire an interest in printing-establishments, without abandoning their situations as journeymen, have been organized in various portions of the United States. The organization is usually effected under a general act authorizing the formation of corporations for manufacturing purposes. In one company, whose articles of association furnish, in some respects, a type of others, the capital stock is fixed at $5000; the term of the existence of the company is twenty-five years; the number of shares is twenty-five; the business is intrusted to the management of five directors or trustees; a small portion of the sum represented by the par value of each share of stock is paid at the time of the original subscription, and the balance in weekly instalments; members are prohibited from selling stock except to the association; and the members mutually agree that in case of difficulty or dispute they will rely for a settlement upon the honor of the board of directors, and the members of the association generally, instead of appealing to the courts.

Copper.—The immense number of impressions which electrotypes are known to bear without serious injury to their surface, has attracted increased attention to the value of copper as an ingredient of type-metal, and while a process of copper-facing type has been employed to a comparatively limited extent, many type-founders announce that copper forms an important portion of their alloy.

Copperplate Engraving.—This art is supposed to have been invented by Tommaso Finiguerra, a goldsmith of Florence, about or before 1460. It is said that he chanced to cast, or let fall, a piece of copper, engraved and filled with ink, into melted sulphur; and, observing that the exact impression of his work was left on the sulphur, he repeated the experiment on moistened paper, rolling it gently with a roller. His leading object is supposed to have been to obtain proofs or copies of the fine engravings he executed on gold and silver plates. In engraving copperplates they are cut with a steel instrument called a graver, the design being generally, either in part or entirely, etched upon the metal. This process is based on the chemical action of nitric acid. An etching ground, composed of white wax, burgundy pitch, and asphaltum, is laid upon the surface of the plate. This compound is tied up in a silk bag or roll, and, the plate being warmed, the wax is applied by rubbing over the surface—the heat of the metal causing the etching ground to ooze through the silk, and uniformity of thickness being caused by the application of a dauber. A drawing is made with a needle through this composition, until along all the lines the metal is laid bare. An edging of wax being placed around the plate, a solution of nitric acid is poured over it; this must be sufficiently strong to act readily, but not very intensely, upon the copper; this is technically called biting. The chemical action which ensues is the formation of an oxide of copper, which is rapidly dissolved off in the form of a nitrate of copper, there being at the same time some nitrous acid generated, which is visible in red fumes. When the acid has penetrated to a sufficient depth, its operation is arrested by an application that neutralizes it, and the plate is touched up by the graver. For a long period nearly all the illustrations used in books were copperplate engravings, but in modern times they have been supplanted, to a very large extent, by wood-engravings, mezzotints, and steel-plate engravings.

Copperplate Paper is usually made from the best stock, is unsized, calendered on one side and rough on the other.

Copperplate Press.—Many improvements have been introduced into this machine during the last few years. The copperplate press is employed in taking off prints or impressions from copper or steel plates, engraved, etched, or scraped as in mezzotint. It is a description of rolling press, and consists of two rollers or cylinders supported on a strong frame. These rollers are movable on their axes, one being placed just above the other. The table on which the plate to be printed is laid runs between the two. The upper cylinder is turned round by means of a cross fixed on its axis; the lower one is turned by the action of the upper on its surface. These rollers are so arranged as to admit of a greater or less amount of

Fig. 2.13: Conner (1858) in Ringwalt (1871), p. 122

Patent and Trademark Office. Public domain.

There are no dates in this account other than the reference to Chilton and Mapes. Steve Saxe thought that Conner's work must have taken place soon after theirs, in 1840 or 1841. It must have taken place at least a couple of years before 1844, because in that year, in the second edition of his book *Typographia,* Thomas F. Adams complained that

> the great competition for low prices among some of the smaller foundries, (which have sprung into existence[48] through the facilities afforded them, of multiplying *matrices* by the Electrotype process,) has induced them to use an inferior metal, and to turn out their letters without due regard to that nicety of finish so necessary for proper justification. {Adams 1845}: 45)

Adams' suggestion that the process was common by 1844 both suggests an earlier date (Saxe's 1840–1841 is very likely) and the rapid adoption of the process.

Conner's Early Methods

TO DO: This is hard to visualize with just words. It would be good to create some sketches of my reconstructions from Filmer of Conner's early methods.

Filmer's article does not describe the methods that Conner used going forward to the successful point where, in Filmer's words "his establishment has several thousand precipitated matrices that can scarcely be told from those made from a steel punch." (Ringwalt version, p. 122). Instead, Filmer tells us about Conner's earlier and only partially successful work. It will be useful when examining Starr's patent later to lay out what we know from Filmer about this very early work.

First, Filmer presents Chilton's work (which used a single cell apparatus). He then describes Conner's first work, electroforming a matrix of an italic capital 'T', using a single cell setup. (Curiously, Filmer never actually says that Conner was successful at this. At very least, this experiment induced him to continue. Filmer says nothing about Conner using a battery, though certainly at some point he must have begun doing so.

Filmer then tells us that Conner, presumably with the same apparatus, Conner created a matrix of an ornament depicting a beehive (see below). This was successful and the matrix saw service, but we have no further details about it.

In particular, for these first two reported experiments, we do not know how the overall shape of the matrix was created. The next experiment (in which Conner tried to grow an entire matrix font all at once) might shed some light on this. In that experiment, Conner took a stereotype

[48] I'm not sure about the degree to which Adams is correct in his claim that electro matrices produced many small type foundries. I have been able to identify only three (perhaps four) *new* type foundries in the United States which began in the period 1840–1844: The St. Louis Type Foundry (1840–1892), Pelouze & Co. (The Philadelphia Type Foundry, 1841–1892), E. Starr & Son (1840?) and, depending on how you count your foundries, a branch of E. Starr & Son in Baltimore (1841?) The son in E. Starr & Son was Thomas W. Starr, who received a patent for matrix electroforming in 1845.

metal[49] plate (shaved or smoothed off appropriately; basically just a plate of stereotype metal) and, for each matrix, cut an opening "and inserte the types designed to be precipitated on, which he cut off and soldered on the back" (121). In my interpretation of this, and thinking first of its use for a single matrix, Conner took a stereotype metal plate and, through a hole in it, placed a type so that the type stood proud of the plate. He soldered the type in place. This plate was then a mold, of a kind, for the casting face of the entire matrix. On it, he deposited enough copper to form a matrix (and then would have finished it to size, of course). We know that the matrix was created on the plate (and that the plate was not itself any kind of a matrix blank) because the plate for the whole-font experiment was said still to survive.

In the whole-font version of this, Conner would have had ended up with a solid plate of copper which he would then have had to cut into individual matrices.[50]

In the final experiment described by Filmer, Conner tried to avoid the step of cutting the matrices apart by setting up wooden dividers between them. This, he hoped, would cause each to be grown separately on the stereotype metal plate. That this failed is not surprising, but I do not understand Filmer's descriptions of the type springing "from the bottom of the trough" (the "trough" is, I take it, the single cell apparatus) and this "throwing … the types off their feet." (If Conner had cut them off when he soldered them to the plate, the no longer would have had feed.)

While this interpretation may not be correct, and while it is certainly incomplete, what becomes very clear is that Conner's initial methods, while successful, were quite unlike conventional electro matrix making as it came to be practiced widely in the second half of the 19th century.

Unfortunately, afte describing these early successes and failures, Filmer simply says of the failures that "all these difficulties have been since overcome," without giving any details.

[49]Stereotype metal is one of the many typemetal alloys. Typically, it is of a softer composition than typemetal used for casting type itself.

[50]This was very different from electro matrix making after Starr's 1845 patent. To the best of my knowledge, the only other person who ever grew entire matrices from solid copper was Andrew W. Dunker, a Michigan-based machinist and amateur typecaster in the late 20th century.

Conner's Beehive

The second matrix that Conner made was of a cut of a beehive; this matrix saw service in his foundry. We do not have a positive identification of which cut it was,[51] Steve Saxe identified two of the earliest beehive ornaments from Conner's specimen books. It is possible that it was one of these.

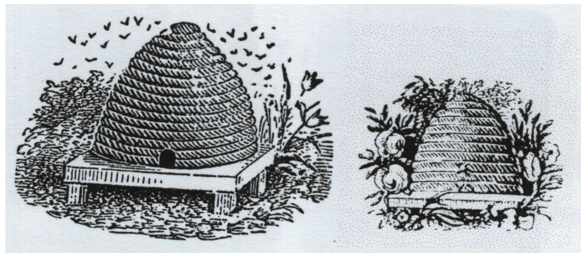

Fig. 2.14: Conner Beehive Ornaments (1852 & 1855)[52]

Thomas W. Starr Patent (1845)

The Starr family had a long and diverse history in early typefounding in the United States. Some of their members were highly skilled typefounders and their expertise was widely sought after. It is possible that, collectively, they provided the mechanical skill behind more failed type foundries than any other family in the history of the art.[53] Thomas W. Starr was the son of Edwin Starr and the co-founder, with his father, of E. Starr & Son around 1840.

In 1845, this member of the Starr family was awarded a US patent for "Improvement in Preparing Matrices for Type by the Electrodeposition Process." As the process of electroforming matrices was already well known and widely practiced at this time, Starr's patent has raised questions. How can you get a patent on a process when the prior art is this clear? Silver, for example, calls this "perplexing" (p. 101). Thinking of Starr's patent as an attempt to control electro matrix making, Silver says "Starr's patent was a mere formality. He could not control the process…" and likens the patent to an attempt to hold a tiger by the tail (p. 102).

No doubt a part of the answer to this may be seen in the way in which patents were issued at this time. Generally, there was far less probing into prior art on the part of patent examiners. They simply left such matters to be worked out in litigation.

There may, though, be a different answer which better illuminates the technical development

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[51]Annenberg records a Conner specimen book from 1841 in the Columbia University libraries; it has not been digitized. The next recorded specimen book dates to 1850 and, while more widely held, is not digitized either. {Annenberg 1994}: 119.

[52]These are scans by the late Stephen O. Saxe from the 1852 (left) and 1855 (right) specimen books of James Conner's United States Type Foundry (both from his own collection). These appeared posthumously in the book that he co-wrote with Stan Nelson, Rich Hopkins, and myself {Nelson et al. 2020}: 73. The images are in the public domain and I'm sure that Steve wouldn't have minded my reprinting them here.

[53]See the CircuitousRoot Notebook "The Starr Family": `https://www.circuitousroot.com/artifice/letters/press/noncomptype/typography/starr-family/index.html`

of the process. This comes when we take the title of Starr's patent at face value and read its details carefully.

Starr never claims the process of electroforming matrices itself. As his patent's title says, he is only claiming improvements in this process. Far from identifying this patent as an attempt to claim the process, its title is a claim that the process already exists.

What Starr does claim is using this process with:

> a metallic plate with an opening with slanted sides, the two arranged and prepared in the manner herein described

which is then used with a galvanic battery (vs. as a single cell) "in the same manner usually practiced in electrotyping."

What Starr is saying is that the precise details of his method differ from those employed before. This is entirely plausible. That his method is largely the same as the method we might use today is more the result of our having read Starr's patent (and of the merits of his method) than any lack of novelty.

Starr's 1845 patent appears in full on the next page.

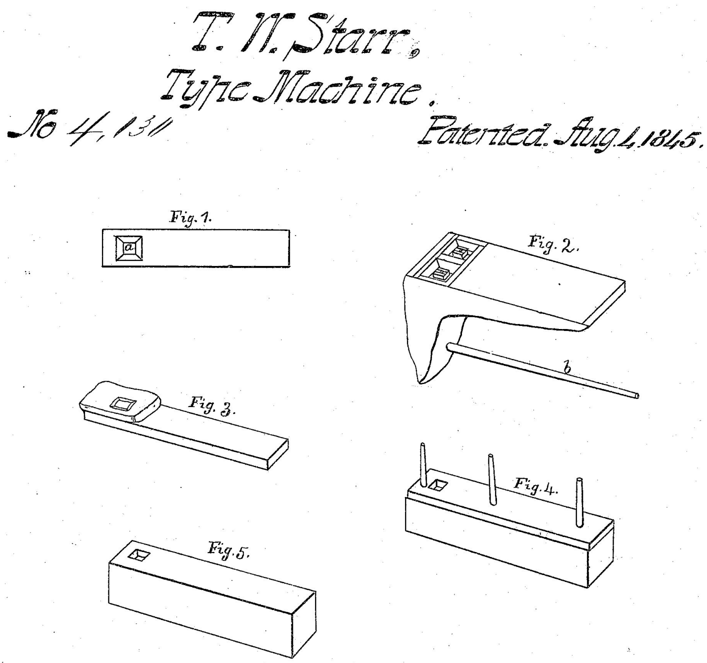

Fig. 2.15: US 4,130 (Starr, 1845), Drawings[54]

UNITED STATES PATENT OFFICE.

THOMAS W. STARR, OF PHILADELPHIA, PENNSYLVANIA.

IMPROVEMENT IN PREPARING MATRICES FOR TYPE BY THE ELECTROTYPING PROCESS.

Specification forming part of Letters Patent No. **4,130**, dated August 4, 1845.

To all whom it may concern:

Be it known that I, THOMAS W. STARR, of the city and county of Philadelphia, and State of Pennsylvania, have invented a new and improved manner of constructing matrices of copper or other metal for casting the face of types, borders, and other ornamental cuts used in printing; and I do hereby declare the following to be a full and exact description of my method, reference being had to the accompanying drawings, forming a part of this specification.

I in the first place take a plate of copper of a little greater thickness than the depth of the matrix is required to be (see Figure 1) and make a hole, *a*, in one end of the same, the sides of the opening to slant outward at an angle of forty-five degrees, (more or less.) I then insert the face of a type or cut from which I desire to form a matrix through the smallest end of the opening *a* and a little greater distance into the opening than the depth of the matrix is required to be, so as to allow for smoothing and polishing its surface after the matrix is formed. I then firmly secure them in that position and after connecting a copper conducting-wire, *b*, to them cover the whole with a coating of wax, save the face of the type, the opening in the plate surrounding the same, and a narrow margin around the edge of the opening, as represented in Fig. 2, two matrix-plates being represented connected together. The type-plate and conducting-wire as thus prepared is placed in a solution of sulphate of copper, (the usual preparation for electrotyping.) The conducting-wire *b* is then connected with the pole of a galvanic battery, the opposite pole being connected to a piece of copper in the usual manner practiced in electrotyping. As soon as a sufficient quantity of copper is deposited upon the face of the type and the cavity surrounding it is entirely filled the whole is withdrawn from the solution, the wax is removed, and the type is separated from the matrix-plate, the back of the matrix-plate then presenting the appearance represented in Fig. 3. The surplus copper is next removed from the back of the plate and both the face and back are smoothed off and polished. The matrix-plate is next riveted to a block of copper, as represented in Fig. 4, and after securing the rivets and removing the surplus portions of the same the whole is fitted up to a proper size for use, as shown in Fig. 5.

Any number of matrix-plates may be placed side by side and secured to each other and all be acted upon at the same time.

Having thus fully described my method of forming the matrices for casting the face of printers' type and other articles therein, what I claim as new, and desire to secure by Letters Patent, is—

The manner of forming the same by means of a common type or cut and a metallic plate with an opening with slanting sides, the two arranged and prepared in the manner herein described and placed in a solution of sulphate of copper and connected with the pole of a galvanic battery in the same manner usually practiced in electrotyping, and after receiving a sufficient deposit of copper to be fitted up for use in the manner herein set forth.

THOMAS W. STARR.

Witnesses:
Z. C. ROBBINS,
WM. COOPER.

Fig. 2.16: US 4,130 (Starr, 1845), Text

[54]From {US 4,130 Starr 1845}. Public domain.

We don't know many of the details of the ways in which matrices were electroformed before Starr's patent, but most of what we do know suggests that the details of the methods used were different (and were probably abandoned for good reason). Chilton used a single cell apparatus, for example. Filmer's description of Conner's early attempts (discussed earlier) make it clear that they were very much unlike Starr's.

Several features of Starr's process are notable because they differ from everything we know of Chilton's and Conner's methods and because they are strikingly modern.[55]

Unlike Chilton and Conner, Starr uses an external battery rather than the single cell apparatus.

Starr uses a pre-made matrix blank, where it is possible (if the interpretations presented earlier are correct) that Chilton and Conner were growing their matrices in their entirety.

Starr bevels the sides of the hole in the matrix blank into which the copper deposit will be made. This means that when the matrix is finally assembled this deposit is effectively dovetailed into it in two dimensions. One issue found with electroformed matrices is that this "eye" of copper can stick to a type in casting and pull out, ruining the matrix. The eye of Starr's matrix is secured in an extremely effective manner. You couldn't do better today.

Starr's method of assembling a two-part matrix with rivets became very common — perhaps more common even than some who have handled "foundry" mats might think. When a riveted matrix is well-finished, it may be impossible to see either the join between the two parts or the rivets themselves.

Other aspects of his method accord well with later practice, including the extensive waxing and the ganging of multiple "matrix-plates" together in a waxed assembly to form the same cathodic unit. This is different than the methods Filmer ascribes to Conner to grow an entire matrix font at once. Conner either grew a single slab and cut it apart or, unsuccessfully, tried to use wooden dividers. Starr uses individual matrix blanks and simply multiplies them for convenience.

Starr's patent is not, I think, a false first claim of priority in an attempt to control a new industry. Rather, it is the presentation of a newly mature method which was then generally adopted. No doubt Starr failed to profit from his patent (few patentees do), but this was not necessarily due to any lack of novelty in it.

[55]"Modern" here means that these procedures would have been recognizable and considered reasonable by any electro matrix maker through the end of the metal type era, even if the exact details of their own methods differed.

The Reception of the Process

Silver p. 102; international adoption

George Bruce's 1850 report to the commissioner of patents.

Conner's sons. Irony (noted by Annenberg, e.g.)

2.1.4• Nineteenth Century References to Patrix Cutting

The previous section established the origins of matrix electroforming in the period 1840–1844 and its rapid adoption. It did not, however, address the origin of the typographical objects from which these matrices were electroformed. Were they pre-existing types produced by conventional punchcutting (or produced by your competitors to aid in your career as a type pirate)? Or were they original creations, cut much as punches were cut, but by preference in soft metal that was easier to work?

The answer is both, of course. Typefounding piracy became a serious problem very quickly. Naturally, this is what has remained in the public memory (insofar as electro matrices are remembered at all). But very soon it became clear that patrix cutting by hand was more than just a cheaper solution. Because an electro matrix wasn't driven like a punch, it allowed the creation not only of larger types than would have been possible with traditional driven matrices but also more elaborately ornamental types.

TO DO: refer to Saxe's argument (2013, 2016, 2020) that patrix cutting and matrix electroforming was one of two technologies (the other being the pivotal type caster) which enabled the development of complex ornamented types, especially in the larger sizes, in the 19th century.

TO DO: Link to the CircuitousRoot page which has cataloged these for some years.

TO DO. Note that David Bruce, Jr.'s 1833 reference is probably a mistake on his part. George Bruce's 1850 Report doesn't cover patrix cutting.

TO DO: Use scans of these as well as transcriptions.

Waldow (1884)

Pye (1885)

Carl Schraubstadter (1887, 1888)

MSJ (1896)

Skopeo, of No. Six (1896)

Loy (1898–1900)

DeVinne (1900)

See Appendix B, Later Patrix Cutting References, on page 217 for further references to patrix cutting by hand and by machine.

2.2• The Regularization of Type

Practical typefounders tend to see the history of the pantograph in typemaking in terms of the technology itself. It is a matter of mechanics and engineering. This way of thinking is valid, and indeed the voice of the practical typefounder has been too little heard in the history of type. Nevertheless, the pantograph in typemaking exists in other, nontechnical, contexts.

One of these is the context of economic and social history. As it was introduced, the pantograph was seen quite consciously as a way to de-skill production.[56] This allowed the use of lower-paid workers. Typefounding has a long history of child labor, and (for example) the prevalence of female pantograph operators in the English Monotype operation was probably less a matter of empowering women and more a matter of paying them less. This de-skilling also removed a potential choke-point in the production system. Before the pantograph, the entire production process flowed through the hands (quite literally) of a relatively few skilled punchcutters. With the pantograph, their power was removed.

This economic and social context is, however, far beyond the scope of the present, more technological, study.

Another nontechnical (or at least only semi-technical) context is the process, over a period of centuries, of the regularization of type. This is the study of paradigm shifts and changing opinions about how we should think of type. Ways of thinking which seem "obvious" to one generation (to us now, for example) were often seen as the death of art itself to earlier ways of thinking. We need only call to mind Van Krimpen attempting to "prevent arbitrary encroachments from the side of the drawing office on the designer's work and intentions and otherwise inevitable disappointments at the designers end."[57] When type began in the West in the 15th century, each individual type was entirely a product of the minds of the punchcutter, matrix justifier, and typefounder — constrained only by the skill of their hands, the sharpness of their tools, and the properties of metals. Today, typemaking begins inside a grid determined by external standards. The pantograph was an important step along the path that brought us here, so it may be illuminating to review that path.

TO DO: Much of this derives from the long-form slides backing up my presentation at ATF 2018.

TO DO: compare and integrate this and the Appendix on Benton's self-spacing type.

Regularization and Its Discontents.

1911 Smalin article.

---

[56]Theo Rehak made this point about Benton's pantograph. The process perhaps reached its most complete form in the detailed, rigorous production system of the English Monotype firm.

[57]{Van Krimpen 1950s, 1991}. The quotation here is the subtitle of Van Krimpen's essay.

Possibly 20th c. designers railing against the machine (Van Krimpen).

2.2.1• Bodies and Points

TO DO

point system

standard bodies

2.2.2• Unit Set

TO DO: Maybe pull the Appendix on Benton's self-spacing types in here.

2.2.3• Standard Lines

TO DO

Werner

lining. Note importance of Schaubstadter.

reproduce This Is Not Pi. Inland

2.2.4• The Concept of a Typeface

TO DO

emergence of the concept of a typeface. See 1937 Carter article; Caslon; DMM 2018

2.3• Pantograph Origins TO DO

brief note on new discoveries of the pantograph in antiquity

2.3.1• Four-Bar Drawing Instruments

TO DO

2.3.2• The First Single-Arm Machines

The principle of the single-arm pantograph can be seen quite clearly in a very minor 20th century example presented as a children's toy (figure 2.17). It is just a "class 1" type of lever (a lever with the fulcrum in the middle) with a gimbal or other spherical pivot for the fulcrum. One end traces the pattern (a human head in silhouette, in this case). The other end traces a drawing, commonly at a reduced scale.

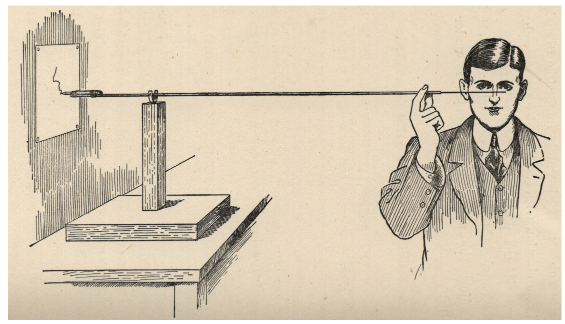

Fig. 2.17: Williams' Silhouettograph (1913?)[58]

Whether this can be called a "pantograph" is a matter of opinion. Its mechanism is completely different from the four-bar mechanism by Scheiner in the 17th century which introduced the pantograph to the modern world. It does, however, perform the same function: reproducing an original at some scale. It has often been called a pantograph (and in some situations, such as Benton's vertical engraving machines, is always called a pantograph), but then some things are called pantographs which have nothing to do with reproduction at scale. Here, I will call it a pantograph without further question.

For all its simplicity, it is a subtle device which admits of much variation. The earliest single-arm pantographs didn't look much like the one shown above and were not even drawing instruments.

TO DO: medallion lathes and reducing engines. Hulot. See my unfinished pantochron document.

2.3.3• Technical Differences Between the Two Styles

TO DO: The two styles are 4-bar and single-arm. Question: Is this necessary here, or will it be covered when I finish the "geometry" sections?

[58]From {Williams 1913}. Scanned by DMM. Public domain.

2.3.4• Pantographs Without Levers

TO DO: Just a quick taste of / observation of the existence of "pantographs" (functionally considered) which do not employ 4-bar or single-arm mechanisms. Nartov, etc.

2.3.5• Levers without Pantographs

Some things are commonly (and even officially) called "pantographs" which really have nothing to do with pantographs either in their mechanism or their function. It seems that any visually complex arrangement of levers runs the risk of being called a "pantograph," regardless of what it really is.[59]

2.3.5.1• Double Parallelogram Mechanisms

The device commonly called a "drafting machine" in 20th century drafting equipment catalogs is frequently referred to today as having a "pantograph" mechanism, but it is not in fact a pantograph either in its mechanism or its function. It is, instead, two linked parallelograms, with one bar of the first parallelogram fixed. It is not intended to reproduce an image, but rather to hold the angle of one (short) side of the second parallelogram constant in relation to the fixed side of the first parallelogram. In this way, it functions as a parallel ruler.

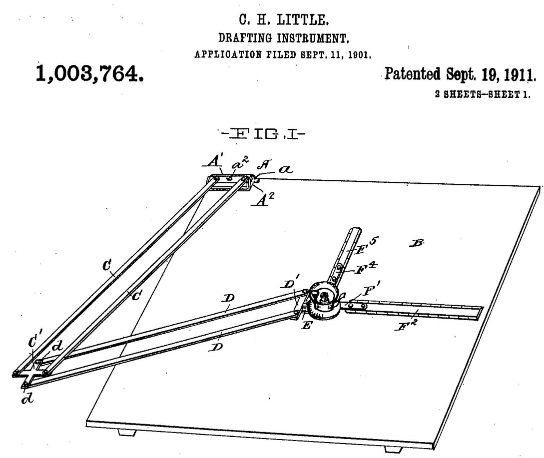

Fig. 2.18: Little, Drafting Machine (1901)[60]

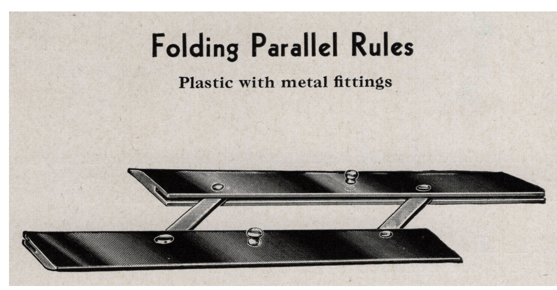

Fig. 2.19: Parallel Rule(r)[61]

It seems to have been invented by Charles H. Little by 1901-09-11 (the filing date of his first patent for it, {US 1,003,764 Little 1911}. In this patent, he refers to it as a form of "parallel ruler" rather than calling it a "pantograph."

A parallel rule[62] is simply a parallelogram hinged at its vertices. Geometry dictates that each pair of opposite sides are always parallel. It is easy to see that if you fix one side of such a parallelogram horizontally to the top of a drafting board the opposite side must always remain horizontal. Opposite sides of a second

---

[59]There is also a newspaper in Bloomington-Normal, Illinois, founded in the 19th century and called *The Pantagraph*. This is a perfectly legitimate use of a Greek-derived word (the "all-writer," basically) the existence of which now makes digital research into old machinery just a bit more complicated.

[60]From {US 1,003,764 Little 1911}: Fig. 1. USPTO scan. Public domain. Little's patent was filed in 1901 but not granted until 1911.

[61]From {Bruning 1948}: 96. Scanned by DMM. Public domain.

[62]Or parallel ruler; both terms are attested, though the perceived misuse of the term "rule" can be a flashpoint for older machinists.

parallelogram fixed at 90 degrees to the lower side of the first must, necessarily, always remain vertical.

By way of contrast, a four-bar pantograph consists of a single parallelogram with two sides extended. All of its sides are mobile. It is fixed at one point, traces at another, and draws (or cuts) at a third.

The same double-parallelogram mechanism was seen in the 18th century in Chrétien's "Physionotrace" (see the appendix D, Chrétien, Saint-Mémin, and Hawkins, on page 221). The same confusion over what a pantograph is also may be found in the literature.

2.3.5.2• Railway "Pantographs"

TO DO. These are just springs, really.

2.4• Pantographs for Silhouettes

Modern attempts to introduce both geometrical principles and actual machines into the making of art date back at least to the start of the Renaissance. Scheiner's pantograph was a part of this, and various perspective setups and devices precede it. This subject has been studied extensively in the history of art; see for example Martin Kemp's *The Science of Art* {Kemp 1990}, and especially its chapter "Machines and Marvels."[63]

Cautionary Notes:

Two things became apparent in writing this section:

Firstly, many authors don't really pay much attention to technology even when they are discussing machines. So it is not unusual for an author, even an academic author well-informed in the visual arts, to conflate single-arm and four-bar pantographs. A number of otherwise well-informed writers assume that "physionotrace" and "physiognotrace" are just different words for the same thing, when in fact they are two completely different machines. Even now, most people seem to think that the double-paralellogram mechanism is a pantograph. Engineering, by way of contrast, requires the accuracy of the details.

Secondly, and as is often the case, the more you look the more you find. There was a lot more going on than is covered here. Anyone interested in the history and technology of silhouette machines specifically, or in mechanical analog image processing, should treat this present section as just a tantalizing introduction. It is not even close to being a comprehensive reference.

[63]Kemp illustrates Chrétien's physionotrace on p. 186.

2.4.1• Portrait Silhouettes without Machines

The making of portrait silhouettes was popular from the middle of the 18th century to the middle of the 19th. Enthusiasm for it declined with the rise of photography, but the art has never entirely disappeared. There have been several excellent histories of the silhouette,[64] but most of them deal with the resulting objects as pieces of art and say little about the mechanics of production. One exception to this is the book *Mastering Silhouettes* by the contemporary silhouette artist Charles Burns {Burns 2012}. In addition to being a practical book of instruction, Burns' work briefly explores the history of silhouette making and the devices and machines sometimes used.[65]

A number of different methods have been used for making portrait silhouettes, ranging from tracing shadows on screens to freehand cutting with scissors. (Remarkably, to a nonpractitioner, this is the method that turns out to be the fastest and is the one employed by Burns as a professional silhouette artist today.) In the late 18th and early 19th centuries, however, various mechanical devices were invented for this purpose. Some of these were four-bar pantographs. Notably, though, at least one was a single-arm pantograph. This latter machine had a direct and documented influence on the first known use of any pantograph in the typemaking process.

The most straightforward method of producing a silhouette is to trace a shadow projected onto a translucent screen. This is shown, for example, in J. C. Lavater's *Physiognomische Fragmente zur Beförderung der Menschenkenntnisze und Menschenlie* ("physiognomic fragments for the advancement of knowledge and love of human nature"), published between 1775 and 1778 (see Figure 2.20).

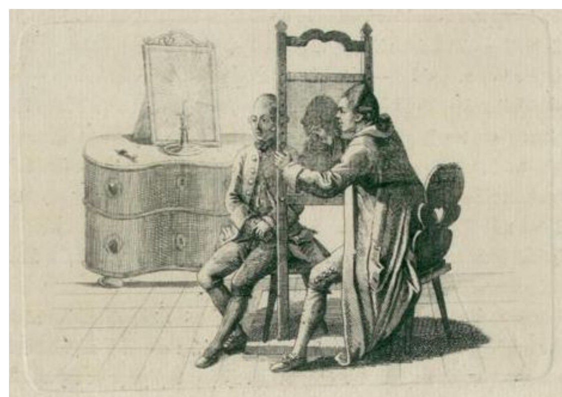

Fig. 2.20: Silhouette by Tracing[66]

[64]See, for example: *Silhouette: The Art of Shadow* {Rutherford 2009}, *A History of American Silhouettes* {Carrick 1968}, *Shades of Our Ancestors* {Carrick 1928} (which does illustrate a silhouette machine, albeit a non-pantographic one), *The History of Silhouettes* {Jackson 1911} (which covers more technology than most) or *A Treatise on Silhouette Likenesses* {Edouart 1835} (which speaks unkindly of "patent machines").

[65]See also Burns' film *Silhouette Secrets* (directed by Andi Reiss). This appears to be available (at present, in the USA) only in a streaming version via Amazon Prime Video: `https://www.amazon.com/Silhouette-Secrets-Andi-Reiss/dp/B0G4HYJGKH` This film may have aired on British television in 2014, but IMDB.com dates it to 2015 and it is dated to 2016 in its Amazon release.

[66]From Volume 2 of Johann Caspar Lavater's *Physiognomische Fragmente zur Beförderung der Menschenkenntnisze und Menschenlie* (in the text volume not the associated volume of plates) {Lavater 1776}: 93. Digitized by the ETH, Zürich, from their copy. Public domain.

2.4.2• Pantographs for Scaling Silhouettes

The method of tracing on a screen, while straightforward, has the disadvantage of producing only life-sized images. By at least the late 18th century the traditional four-bar pantograph was being used to scale these silhouettes to other sizes. This is shown quite clearly in a book by Jacob von Döhren describing methods for altering silhouette drawings. These methods include the use of the conventional four-bar pantograph (called by its older German name "storchschnabel") {Döhren 1780}: Tab. I. See Figure 2.21.

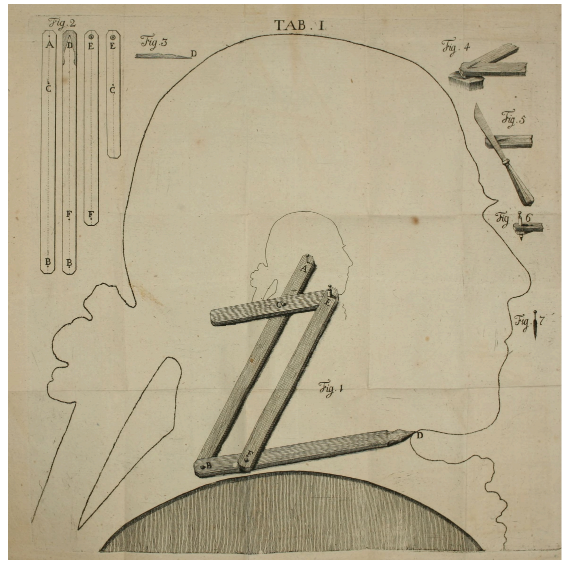

Fig. 2.21: Storchschnabel (1780)[67]

2.4.3• Chrétien

Possibly the best known portrait machine of the late 18th and early 19th centuries was the "physionotrace" invented no later than 1784 by the French musician Gilles-Louis Chrétien. It remained in use up to the introduction of photography. For all of its popularity, though, the details of its construction and operation were lost until a single drawing of it was discovered in the early 20th century.

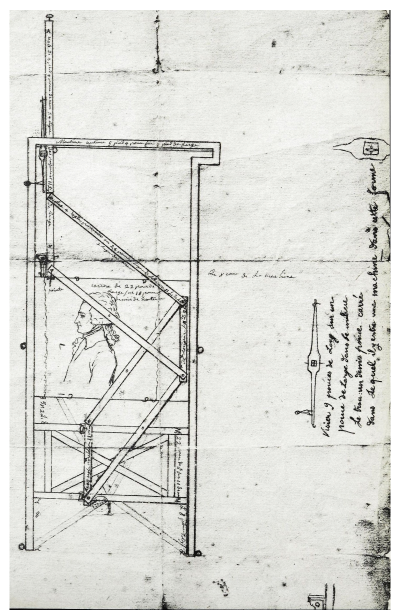

Fig. 2.22: The Physionotrace[68]

Chrétien's physionotrace has often been called a pantograph (even after a full explanation of its operation was published in the 1920s) but it was not. Rather, it was an optical drawing aid by which an artist could view points on the subject (someone sitting for a portrait, for example) and transfer these to a sheet of paper. This was in effect a parallel projection, at full size, of the subject to the paper. It was not limited to (or primarily used for) just silhouettes; points anywhere on

[67]From Jacob von Döhren's *Beschreibung eines sehr einfachen zur Verjüngung der Schattenrisse dienenden Storchschnabels, den sich jeder Liebhaber selbst verfertigen kann* (Description of a very simple pantograph [storchschnabel] used to remake silhouettes, which any enthusiast can make themselves) {Döhren 1780}: Tab. I. Digitized by the Getty Research Institute. Public domain.

[68]This is a drawing made by Edme Quenedey des Riceys, an early associate of Chrétien's (with whom he later had a falling out). The history of digital versions of this drawing is complex. This instance is from {Courboin 1908}: [Plate following p. 40], cropped slightly. From the University of Heidelberg Library's digitization. Public domain.

the subject could be transferred.

The full-size image thus recorded was then reduced to a smaller scale by a conventional drawing pantograph. It was completed by hand and engraved into a printing plate. Generally, the sitter received both the plate and a number of copies printed from it.

As it was neither a pantograph nor a silhouette machine, Chrétien's physionotrace is not important here as a direct technological precursor of pantographic typemaking. There are, however, three reasons to cite it here.

Firstly, it is a leading example of the popularity of mechanized methods in art during this period.

Secondly, because it has often been described as a pantograph, it is important to note here that it was not.

Finally, a device which was almost certainly a copy of Chrétien's was employed by the expatriate French artist Charles Balthazar Julien Févret de Saint-Mémin in the United States during the end of the 18th and beginning of the 19th centuries. He called it a "phisiognotrace." Saint-Mémin was successful and, while a creator not of silhouettes but rather of fully engraved portraits, was a part of the popularity of itinerant silhouette artists in the US in the early 19th century. This fad for silhouettes, in turn, led directly to the first use of the pantograph in typemaking (by Hallock in 1836).

See Appendix D, Chrétien, Saint-Mémin, and Hawkins, on page 221 for a more detailed discussion of this machine.

2.4.4• Hawkins

Art historians have conflated Chretien's physionotrace (or Saint-Mémin's phisionotrace) with the slightly later "physiognotrace" of John Isaac Hawkins. This can be seen as late as 2017, in a major study published by the Philadelphia Museum of Art and Yale University Press concerning the influences of the Peale family on art in the early United States. First it establishes the importance of Chrétien's and Saint-Mémin's physionotrace (mistakenly calling it a physiognotrace). Then it calls Hawkin's device (as installed in Peale's Museum) "a simplified, efficient new version of the physiognotrace" {Soltis 2017}: 122, 126.

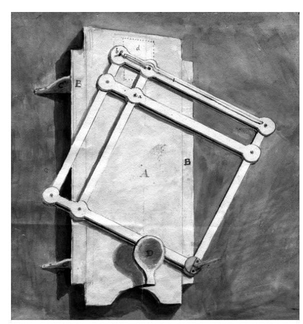

Fig. 2.23: Hawkins' Physiognotrace[69]

In fact, Hawkins' physiognotrace was a completely different device. Unlike Chrétien's machine, it was a true pantograph. It captured images directly at a reduced scale. Unlike Chrétien's optical machine, it was fully mechanical, relying upon physical contact with the sitter. It

[69]From {Peale 1803}. Public domain.

was also purely a silhouette machine. This was in fact an important advantage. While Chrétien's physionotrace was part of a process of producing full portraits, it required hand engraving to complete the portrait. Its products were impressive, but they were also expensive. Brigham cites a figure of eight to thirty-five dollars. $35 in 1803 is equivalent to about $1,000 today based on cost-of-living estimations or $29,000 today based on the cost of skilled labor.

The silhouettes produced by Hawkins physiognotrace were just silhouettes, not full portraits, but they were fast and cheap. Peale priced them at one cent and, in the first full year of operation (1803) sold 8,880 of them.[70]

Hawkins' physiognotrace commends itself to our attention for several reasons.

Perhaps most commonly, but least importantly, because a view of this device was drawn by Charles Willson Peale in a letter sent to Thomas Jefferson, it has become a part of Jeffersonian hagiography. More importantly, it was a four-bar pantograph and a mechanical device for the arts which achieved exceptional commercial success. It was also a central part of the fad for silhouettes in the United States during the early 19th century. While some of these silhouettists were using different machines (such as Cephas Thompson's; see below), Shaw estimates that "collectively they produced tends of thousands of these small images" {Shaw 2003}: 35. This fad for silhouettes led directly, albeit with a different style of silhouette machine, to the first use of a pantograph in typemaking.

Looking at a different aspect of its importance, at Peale's museum Hawkins' machine was operated by Moses Williams, an African-American and former slave of the Peales. His work and success there is a complex instance in the history of race relations in the United States.[71]

See Appendix D, Chrétien, Saint-Mémin, and Hawkins, on page 221 for a more detailed discussion of this machine.

2.4.5• Thompson's Single-Arm Pantograph

From the point of view of very early typemaking, though, a very different style of silhouette pantograph is more important. This was not a four-bar machine but rather a single-arm pantograph. Two versions of this were patented in the same year, one by the itinerant artist Cephas Thompson, in the United States, and one by the German mathematical instrument maker Charles Schmalcalder, in Great Britain.

TO DO: Finish this; the reconstructed patent drawing is beautiful.

---

[70] {Brigham 1995}: 70. The current values are as calculated on the Measuring Worth website at `https://www.measuringworth.com/calculators/uscompare/relativevalue.php`

[71] For this see in particular Gwendolyn DuBois Shaw's "'Moses Williams, Cutter of Profiles': Silhouettes and African American Identity in the Early Republic" {Shaw 2003}.

2.4.6• Schmalcalder's Single-Arm Pantograph

TO DO: Finish this.

patented by Charles Schmalcalder[72] in London in (GB Patent No. 3,000 of 1806-12-22) {Schmalcalder 1806 (1807)}.

Schmalcalder's machine consists of a long rod ("from two to twelve feet, or still longer") which slides through a ball (a kind of spherical pivot) On one end a "fine steel tracer" follows the shape of the subject. On the other end a point or pencil creates the image. The scale of the resulting image is dictated by the relative lengths of each side of the rod. In his arrangement, the distance between the pivot (ball) and the paper or other material for the image may be varied.

Two technical points may be noted (these will be of interest in later typographical pantographs by Hallock and by Benton) First, this style of pantograph creates an inverted and reversed image. Second, as implemented by Schmalcalder this single-arm pantograph does distort the image. Both the tracer and the marking point are fixed while in use. (They may be adjusted in and out, but are then fixed by screws.) At the tracer end, the spherical motion described by the tip of the tracer is accomodated by the theoretically flat profile of the subject because it is in fact just tracing that profile through the air. At the image end, the board holding the paper is hinged so that it can pivot in and out to accomodate the spherical motion of the marking point.

Schmalcalder claims many uses for his "delineator," but the first that he cites is "for taking profiles."

[72] A website for the Schmalcalder family gives his dates as 1781-03-29 to 1843-12-25 and attributes to him a patent for a "prismatic compass" (GB Patent No. 3,545 of 1812-03-05). `https://smallcalder.me.uk/110.htm`, accessed 2019-02-20.

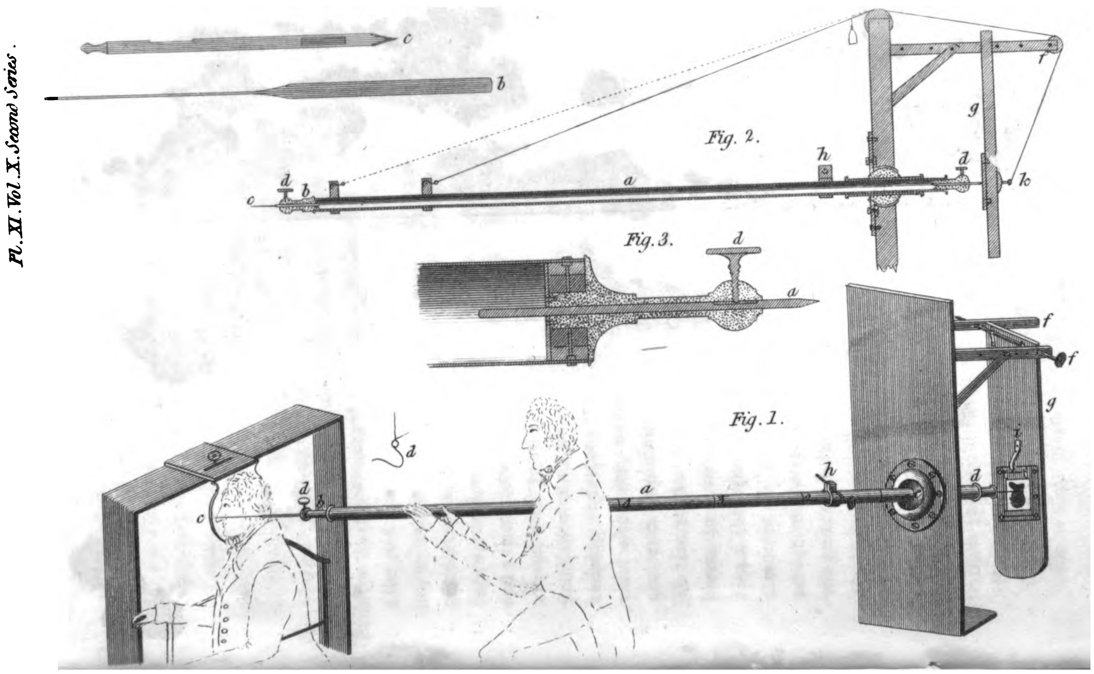

Fig. 2.24: Schmalcalder's Delineator (1806)

Schmalcalder's patent was objected to immediately by Hawkins {Hawkins 1807}. There seems little point in getting involved in two century old patent disputes, but it is interesting in the study of Hawkins' patent that his primary objection to Schmalcalder's has to do with his (Hawkins') "perspective parallel ruler." This is a complex device which (and this is what it interesting) seems almost entirely unrelated to the rest of Hawkins' generally 4-bar pantograph mechanisms.

Schmalcalder's single-arm machine was easy to understand, easy to make, and, as far as I can tell, not patented in the United States. Burns says that it was "much copied" {Burns 2012}: 20. Burns also shows a surviving "physiognotrace" built on Schmalcalder's principles which was used by (and possibly made by) the gunsmith and silversmith John Vogler circa 1810. (This machine is in the collection of the Museum of Early Southern Decorative Arts / Old Salem Museum and Gardens, Winston-Salem, North Carolina. See: `https://www.oldsalem.org/item/collections/physiognotrace-or-silhouette-machine/1105/` {[Vogler 1810]}.)

What is important here, though, is not the popularity of Thompson or Schmalcalder single-arm pantographs so much as the fact that a young Homan Hallock saw one in operation and, a quarter century later, applied its principle to the first use of a machine[73] in typemaking.

[73]By this I mean something with coordinated moving parts, however crude, as opposed to the hand tools and fixtures of the punchcutter, however sophisticated.

2.5• Pantographs for Cutting

2.5.1• Medallion and Reducing Engines

TO DO.

17th century. Nartov. In use until early 21st century in mints.

2.5.2• Leschot's Watch Plate Drilling Machine

TO DO. Is this the first rotary-spindle pantograph? Or does wood type come first? The first rotary spindle in metal?

2.5.3• The Pantograph in Wood Type

TO DO:

the curious thing is that no link can be traced from this well-established and well-known technology to the uses of the pantograph in making cast metal type

original sources not often cited. See Hallock 1837, p. 134, which happens to have a reference to wooden types "cut by machinery" by George F. Nesbitt.

2.6• The Pantograph as Established High-Tech

just a very quick assertion of fact. For further examples, see

Appendix L, The Range of 19th Century Industrial Pantographs, on page 261

2.7• Punch/Patrix vs. Matrix Cutting

Unless you have cut a punch or patrix (by hand or machine) and have engraved a matrix (always done by machine), the technical issues associated with each process may seem unclear, or unimportant, or both. The similarities and differences between these processes may seem exceedingly detailed for the simple reason that they *are*. Successful typemaking is all about the details.

This is not the place for a course in matrix making, so a few points must suffice.

2.7.1• Machines for Punches and Patrices

TO DO

Are patrix cutting machines somehow different than punchcutting machines? No, they are the same.

the only differences may be in speeds, feeds, and cutter geometry

2.7.2• Why is Direct Matrix Engraving Harder?

2.7.2.1• Surface Finish

In cutting punches or patrices, whether by hand or by machine, the surface which will produce the casting surface in the matrix (and therefore, in the end, the printing surface of the type) is prepared as a smooth surface independently of the cutting process. In punchcutting, for example, it is polished flat and smooth against a bench stone.

However, in the direct engraving of matrices (which was only ever done by pantograph or, today, CNC milling) this surface is produced by the cutting process itself. Moreover, the cutting tools involved typically are very fine-tipped (in some cases measuring as little as 0.002″). This finish is very difficult to achieve. There is no magic to it — it just requires good, careful technique — but it is something that you don't have to deal with in punch or patrix cutting.

2.7.2.2• Accuracy in Depth of Cut

Accuracy in depth of cut is more important in direct matrix engraving because the casting cavity of the matrix is created by the engraving process itself. The depth to which you cut is the final depth-of-drive of the matrix. By way of contrast, in punch and patrix cutting the depth to which you cut can vary considerably. The depth-of-drive (depth of the casting cavity) of the resulting matrix is determined by driving the punch into the matrix and then justifying it (or the equivalent processes in electroforming from a patrix).

2.7.2.3• Precision/Repeatability in Depth of Cut

Precision isn't the same thing as accuracy. Accuracy is a measure of hitting a known value. Precision is the ability to hit the same target repeatedly, without necessarily knowing the actual value of that target. While important, this isn't quite as important here as accuracy. It matters primarily when a cutter breaks and must be replaced or resharpened, and even then primarily only on the final cut(s).

If you break a cutter and either replace it or resharpen it, you want the resulting cutter to be at the same depth as the old one. This is good machining practice anyway, of course. It matters particularly for the final cuts.

This can matter in punch and patrix cutting as well as matrix cutting A new cutter which is longer than the old one will cut both deeper and wider (and of course the opposite is true of a shorter cutter). If the difference is so great that it appears in the final punch, patrix, or matrix then of course this is a problem.

In matrix cutting this is also true, but additionally the different depth can affect the creation of the casting surface itself.

The precision in depth of cut necessary for typographical engraving is difficult to achieve. See the next section (2.8, A Note About Removable Spindles, on page 51) for a discussion of the advantage of a Benton-style removable spindle (called a "quill" in Benton's terminology).

2.8• A Note About Removable Spindles

In a milling machine (and a rotary-spindle typographical engraving machine is just a very specialized milling machine) a spindle holds a cutting tool in some way. Determining the location in space of the tip of the cutting tool is obviously important; this is as true in a modern CNC milling center as it was in the 19th century.

Just trying to establish the cutter's depth by "touching off" against the workpiece can be done, but has its disadvantages. Typically it is not as accurate as it might be desirable and it relies upon operator skill.[74] This problem only becomes worse with the often very fine tips present in typographical engraving. It is hard to know when your 0.002″ cutter tip has actually contacted the work's surface.

There is a good solution to this which is well known from Benton's machines (and which may have been present earlier on Hofer's), but before describing it, it is important to point out that Benton's solution is not required. Matrices were, and still are, engraved on machines which have completely standard spindles. The Ogata pantograph used by Jim Rimmer was one such.

[74] There are many techniques to be found in traditional machining, ranging from estimating the drag upon a piece of cigarette paper between the cutter and workpiece to rolling gauge pins under the cutter tip.

The Preis pantograph used first by Paul Hayden Duensing, then Jim Walzcak, and presently by Val Lucas is another.[75]

The problem is that "touching off" on a fine cutter tip is difficult. If, instead, the entire spindle is constructed so as to be removable, a relatively broad surface on the spindle can be used for reliable, repeatable positioning. If, further, the cutter grinder used is equipped to receive this spindle and to use the same surface on it for cutter forming, then repeatability is possible.

Here is the spindle (called a "quill" in Benton's terminology) of a Benton engraving machine. In understanding this, Monotype terminology is useful even if this is not a Monotype device. In Monotype terminology, an object which comes to a full locating stop against another object is said to "bank" against it. In a Benton quill, the ring-shaped front surface of the main quill casing banks against a stop in either the engraving machine or the cutter grinder.

Fig. 2.25: ATF Quill #53, General View (with cutter)[76]

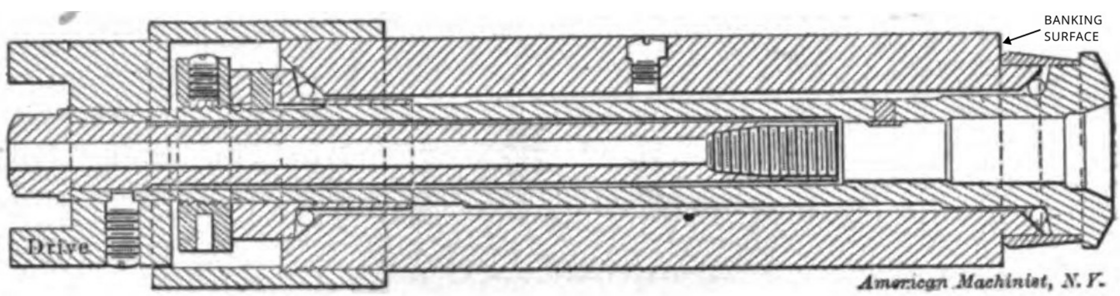

Fig. 2.26: ATF Quill, Longitudinal Section, Annotated[77]

[75]The Wiebking pantograph also lacks a removable spindle in the Benton style, but there is some question remaining as to whether Wiebking used it for direct matrix engraving.

[76]This is the quill for Benton Engraving Machine number 53, at CircuitousRoot. It is shown here with an original cutter installed, as ground at ATF.

[77]From {Kaup 1909}. There are some differences between this drawing and ATF Benton quills actually observed. However, the depiction of the banking surface formed by the main body of the quill, which is what is important here, is correct.

3• Non-Cutting Typographical Pantographs To 1882

It is of course possible that the pantograph, as a drawing instrument, was employed in type design before its uses noted here. At present, however, I am unaware of any evidence of this.

An argument against the likelihood of the use of the pantograph in type design in early periods is contained within the observation that the scaling of type across sizes is very much a phenomenon of the machine age. Harry Carter discusses this in his essay "Optical Scale in Typefounding" {Carter 1937}. Daniel Berkeley Updike, writing in opposition to machinery in type design, put it more succinctly in his monumental work on *Printing Types*, saying that "each size is a law unto itself." {Updike 1922}: Vol. 1, p. 11. See also "The Regularization of Type," section 2.2 on page 35, above.

Publication note: An abbreviated version of the material on Hallock, MSJ, and Beeler may (or may not) appear in the next number of the *American Typecasting Fellowship Newsletter*.

3.1• Hallock (1836–1660s)

The first documented application of a pantograph to the making of metal type went beyond just the potential use of a pantograph as a drawing instrument in type design. Beginning in 1836, Homan Hallock (1803–1894), an American missionary printer then in Smyrna,[2] used pantographs to trace the designs of Arabic and "Nestorian" (that is, Syriac) letters onto steel punch blanks. He then cut these by hand in the traditional manner.

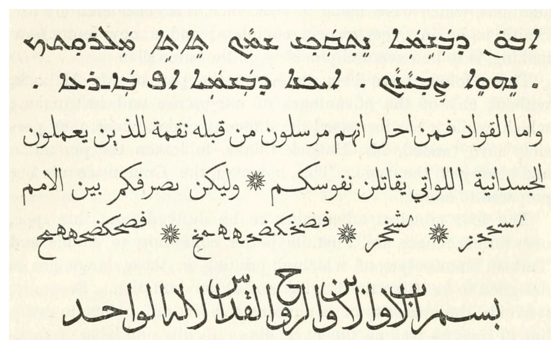

Fig. 3.1: Specimen of Hallock's Types [1]

The definitive source for information about Hallock and this work is J. F. Coakley's article "Homan Hallock, Punchcutter" {Coakley 2003}. Coakley's work is based on extensive research in the unpublished Archives of the American Board of Commissioners for Foreign Missions, held by the Houghton Library of Harvard University. The information here is derived primarily from Coakley's account.

How Hallock learned to cut punches is unknown. Around 1822, he apprenticed to printers, Flagg and Gould in Amherst, MA, who had "the capability … of dealing with oriental languages"

[1] {Hallock 1837}: 134. Public domain. The first two lines are in "Nestorian, or Modern Syriac" at Great Primer size. The third and fourth lines are Arabic, at Two Lines Pica. The fifth line is also Arabic, "showing the manner of combining the letters". The sixth line is Arabic, "condensed and interlocked," at Canon size.

[2] The city of Smyrna was then a part of the Ottoman Empire. It is today the city of Izmir in Turkey.

{Coakley 2003}, p. 19. In 1826 he moved to Malta and began work there as a missionary printer; in 1833 he moved again, to Smyrna. Citing Hallock's letters, Coakley says that in 1834 he began both casting his own type and cutting his own punches, but that these projects came to little (p. 21).

Hallock returned briefly to the United States in 1835 and there met with Richard Starr.[3] From Starr he purchased foundry equipment and contracted for the cutting of punches. He did not, however, remain long enough in the USA to have completed any significant training in punchcutting at this time. It seems that to a great extent he must have been self-taught. His immediate superior in Malta, the Rev. Daniel Temple, wrote of him that "his genius is … extremely fertile."[4]

In 1836, the director of the missionary printing office in Smyrna, Eli Smith, acquired a set of "pattern sheets" of Arabic letters used by Turkish writing masters {Hallock 1865}, p. 178, note. At the same time, Hallock had hit upon the idea of adapting a single-arm pantograph of the type that, as a child, he had seen employed in drawing silhouettes. With this he could trace the Arabic forms from these large pattern sheets at a reduced scale onto the surfaces of his punch blanks.[5] In light of Benton's later work, it is interesting that the very first known application of a pantograph to typemaking was a single-arm machine (which is in general a less common form of pantograph than the traditional four-bar machine). Hallock called this a "scratching machine" {Coakley 2003}, p. 24.

However, in 1837 Hallock replaced this single-arm pantograph with a commercially manufactured four-bar machine that he already owned.[6] After adopting this machine, he abandoned some of his earlier work and proceeded to cut punches at the rate of two (at first enthusiasm) or (later) one per day. By late 1838 he had completed 240 punches for Arabic type {Coakley 2003}, pp. 24–25.

A question might arise as to why Hallock didn't use this four-bar pantograph first, when he already owned it. We cannot know his thought processes, of course, but the nature of typographical punches suggests an answer. Punches are wrong-reading[7] A single-arm pantograph with its pivot *between* the pattern and the work,[8] as was found on the silhouette pantographs,

[3]The Starr brothers, particularly Edwin and Richard, had a hand in many of the early 19th century American type foundries. See the CircuitousRoot Notebook "The Starr Family": `https://www.circuitousroot.com/artifice/letters/press/noncomptype/typography/starr-family/index.html`

[4]{Coakley 2003}, p. 21, citing correspondence by Temple from 1834.

[5]Coakley cites for this an autobiographical account written by Hallock in 1883 and published, posthumously, in 1929 as *The New Arabic Type.* I have not yet been able to examine this work.

[6]The date of 1837 is that deduced by Coakley. Hallock's letter, which he cites, is not entirely clear.

[7]Print is right-reading, of course. Type, which produces print, must be wrong-reading. Matrices, which produce type, must be right-reading. Punches, which produce matrices, must be wrong-reading.

[8]By way of contrast, Benton's single-arm pantographs have both the pattern and the work on the same side of the pivot point.

automatically produces a wrong-reading image from a right-reading pattern. A four-bar pantograph, however, produces a right-reading image from a right-reading pattern. In order to use his four-bar pantograph to trace designs on punch blank faces, Hallock had to invert its scribe so that it faced upward and scribed "downside-up" on a punch blank held above it.

Hallock returned to the United States in 1841 and continued punchcutting through the late 1860s. He produced faces for Arabic, "Nestorian" (Syriac), Armenian, and even Tamil. Presumably he continued to employ the four-bar pantograph, because in a studio photograph of him from 1865 he chose to have this pantograph displayed on the table next to him.

There is more to Hallock's typemaking than just the use of a pantograph. At an early point he was experimenting with composite types for which accents were cast separately {Hallock 1844}, pp 132-133. In 1847 he listed a number of typefounding supplies that he was prepared to supply, including several inventions. These included a machine for leveling the faces of punches (something which would be well appreciated by anyone who has cut a punch), an "instrument for filing kerned type," and a machine for driving punches. Of some historical significance in terms of priority, this 1847 list also includes what must be a choker valve for a typecasting machine — two years before Sturgis' 1849 patent on the choker valve.[9] This list by no means exhausts his inventiveness.

He seems to have stopped work in the late 1860s. He died in 1894, having lived long enough to see the pantograph integrated completely into typemaking (although whether he kept up with these developments is unknown). There seems to be no evidence, however, that his own use of it ever went beyond tracing for hand punchcutting in steel. His later life and work are covered in some detail in {Coakley 2003}, pp. 28–41.

Knowledge of Hallock's work had some circulation in the United States. In 1844 six pages of printing in his types were exhibited at an exhibition of the Massachusetts Charitable Mechanic Association in Boston. The description of this exhibit emphasizes the use of the pantograph in the production of these types, and a sample of them was reproduced in the published report of the exhibition {Hallock 1844}: 131–134.[10] In 1866, perhaps more obscurely, reports of his production of an Arabic Bible in Syria received notice by the American Bible Society. {Hallock 1866a}. Despite this, there seems to be no direct connection between Hallock's work an any later application of the pantograph to typemaking. Coakley concludes his 2003 article by observing a sad irony. Despite Hallock's long career making Arabic types both abroad and in the United States, in the year of his death the entry on "Arabic" in the *The American Dictionary of Printing and bookmaking* asserted that types for Arabic had to be purchased from European foundries

[9] He called it "a stop, which admits of the lead being taken from lower than the surface of the metal." See {Coakley 2003}, pp. 37–38.

[10] Interestingly, the next item in the report was a case of wood type by George F. Nesbitt "cut by machinery."

"as American foundries do not make them"[11] {Coakley 2003}, p. 41, and {Pasko 1894}, p. 25.

Visual Sources

Coakley notes that a drawing of Hallock's pantograph appears in his autobiographical account published in 1929 as *The New Arabic Type* {Coakley 2003}, pp. 25n33. I have not yet been able to locate a copy of this work. This drawing is reproduced in Coakley's article. It has also been reproduced in an account of Hallock's work by Brian Johnson, "American Arabic", {Johnson 2014}: 19. This is online at: `http://www.dlir.org/archive/archive/files/56c4983f83800ee60d93afdd30d24335.pdf`

Coakley's 2003 article also reproduces an 1865 photograph of Hallock with this pantograph at his side, as well as further examples of Hallock's types in print.

3.2• MSJ by 1872

While Hallock worked outside of the industry, the next (currently known) development occurred at the heart of American typefounding: the great Philadelphia firm known at this point in its history as MacKellar, Smiths, and Jordan ("MSJ"), which prided itself on being America's oldest type foundry.[13]

Fig. 3.2: Card Printed at MSJ [12]

Important as this is, the source for our information about it is remarkably obscure. It is also a good illustration of the kind of research that has been enabled by the digital age. The book in which this information appears is for the most part completely unrelated to type or the history of type. It is unlikely that such a source would have been discovered by a typographical researcher before the mass digitization of texts.

The evidence of this use comes from a book published in 1872 in Philadelphia which documents, in detail, the course of a visit to Philadelphia by an early Meiji-era Japanese diplomatic delegation.[14] One of the purposes of this delegation was to study American industry and, no doubt because Thomas MacKellar was a member of the "Committee on Arrangements" for this visit, they stopped at the MacKellar, Smiths & Jordan Type Foundry on Saturday, March 23, 1872. Since this source is one previously unknown to the typograhical literature, two extracts

[11] Taking a more international view, Johnson argues for the importance of Hallock's "American Arabic" on the development of Arabic typeface and publishing in the 19th century. {Johnson 2014}: 20.

[12] {Japanese Visit}: 40. Public domain.

[13] It traced its origins to Binny & Ronaldson in 1796.

[14] For a better understanding of the context of this delegation in the history of Meiji Japan, see {Nimura 2016}.

from it which bear on the present topic are worth quoting:

> Ascending by the steam elevator to the upper stories of the building, they were shown the processes of making type-punches and matrices, and the exact and delicate gauges and beautiful machinery employed in manufacturing moulds and type-casting machines.
>
> In the designing and punch-cutting room, they saw the operations of the Pantograph, or machine used to graduate the sizes of ornamented type, and when its mode of working had been thoroughly explained, Nagano[15] requested to have the name of the instrument written out for him, which he stowed away with care. {Japanese Visit 1872}: pp. 37–38.

At present this is all of the information we have. The source itself is unimpeachable. There is no question that a pantograph was in use at this very important type foundry. It is also clear that the foundry was proud of this machine and desired to show it off.

[15]NAGANO Keijiro.

3.3• Beeler and MSJ

This section is an attempt to fit otherwise isolated data points into the present narrative. I should emphasize that while the information here is solid, its interpretation is at present purely speculative.

Fig. 3.3: Charles H. Beeler, Jr.[16]

First, a point of confusion must be addressed. There were two persons named Charles Henry Beeler, father and son, who worked for the Philadelphia type foundry which became MacKellar, Smiths and Jordan.[17] Clouse gives the dates of the father as 1826–1899 and attributes to him ("and, possibly, his son") eleven typefaces for MSJ.[18] However, William Loy's 1899 biographical sketch of C. H. Beeler, Jr. implies that the father was a wood engraver. Loy says that the son "began regularly to work at wood-engraving with his father" in 1869 and only turned to type engraving in 1872. Loy attributes over 40 faces to Beeler, Jr.

To confuse matters further, Loy notes that Beeler, Jr. was assisted in turn by his son. See {Loy 1899-12 No. 23}. C. H. Beeler, Jr. lived from 1855 to 1934.[19] The dates of the grandson are not yet known. This close association of father and son in engraving (of various kinds) at the same foundry inevitably will lead to some confusion. It also, however, can explain Beeler's presence at MSJ from a very young age. Loy says of him that "he literally grew up in a type-foundry."

It is also relevant to note that Beeler certainly worked in patrix engraving in soft metal. Loy says of him that he "was able to take the place of Mr. Jackson." Jackson, in turn, had been the star apprentice of Edwin C. Ruthven, an enthusiastic proponent of patrix cutting for matrix electroforming.[20]

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[16]From {Loy 1899-12 No. 23}. Scanned by DMM from my copy. Public domain.

[17]Prior to this, it was the Johnson Type Foundry. For the long history of this foundry, see: (1) Annenberg's *Type Foundries of America and their Catalogs* (entries for Binny Binny & Ronaldson (65–67), James Ronaldson and Richard Ronaldson (220–221), Johnson & Smith (162–163) L. Johnson & Co. (163–165), and MacKellar, Smiths & Jordan (179–187)) {Annenberg 1994}, (2) the foundry's own account of itself, *One Hundred Years* {MSJ 1896}, and (3) Clouse's *MacKellar, Smiths & Jordan: Typographic Tastemakers of the Late Nineteenth Century* {Clouse 2008}.

[18]Clouse's source is an unpublished manuscript, "C. H. Beeler, Artist & Engraver, examples of work and brief biography," held by the Rare Book and Manuscript Library of Columbia University (Cabinet J, Shelf 2, No. 43. Now, box 2") {Clouse 2008}: 79n155. I have not yet examined this source.

[19]He died on 1934-01-19 {Beeler 1934}.

[20]Loy says: "After he [Ruthven] began cutting type on soft metal he employed as many as twelve apprentices at one

The first data point is a statement recording an invention. At some time before 1899 (the date of Loy's biographical sketch of him), Charles Henry Beeler, Jr. invented

> a simple and accurate form of pantograph, which changes the porportions of the letters according to taste, instead of following the one fixed templet from six-point to seventy-two point, as is usually done. {Loy 1899-12 No. 23}.

At present, we know nothing more with certainty about this machine.

The second data point is an image. It has been a part of the typographical literature for well over a century, but I am unaware of any previous comments upon it. It is part of an illustration in an 1896 publication by MSJ entitled *One Hundred Years*[22]

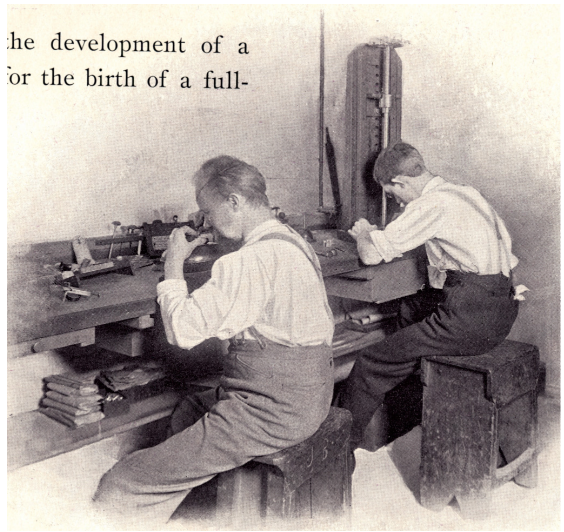

Fig. 3.4: Patrix Engraving at MSJ [21]

In this picture, the person at left is engaged in hand cutting a patrix (note that he uses an engraver's bag rather than a punchcutter's bench pin). The person at right is using a vertical-format single-arm pantograph. This is a machine for tracing, not rotary cutting. As it is being used at the bench alongside a hand patrix cutter, it is almost certain that it is tracing a type design onto a patrix blank. Like Hallock's first pantograph in 1836, it is a single-arm machine which has its pivot point in the middle, between the workpiece (which would be above) and the pattern (which would be on the bench). This pivot point is adjusted up and down, it would appear, by placing its bracket in a series of holes in the backplate of the machine.

This machine is not discussed in the text of *One Hundred Years,* and I have found no other reference to it in the literature. We do not know with certainty who made it or when. Neither do we know, beyond the suppositions above, the details of its operation.

However, it is not unreasonable to speculate that this pantograph was created by Beeler. In 1896 he was a senior engraver at MSJ (and Loy tells us that for *One Hundred Years* he cut the face Ronaldson at 15 point).

It is just barely possible to speculate that this might be the machine seen by the Japanese del-

time, but of all this number but two were considered skillful, the late W. W. Jackson reaching the highest degree." {Loy 1899-04 No. 15}.

[21]{ATF 1896 100}: p. 45. Scanned by DMM from my own copy. Public domain.

[22]See {ATF 1896 100}. This publication was done by what was then simply the Philadelphia branch of American Type Founders ("ATF"). But MSJ had been a proud foundry and old traditions die hard. It is written in such a way that it appears to be by MSJ (which no longer existed at the time). It barely mentions ATF.

egation in 1872. But the dates work against this highly speculative hypothesis. Beeler started work at MSJ at about age 14 (in 1869) and would have just started to transition from wood engraving to type cutting in 1872.

Whether or not this pantograph was the MSJ pantograph of 1872, the combination of the report on the Japanese delegation, Loy's emphasis on the importance of Beeler's MSJ pantograph, and this photograph published in 1896 suggest that there was a continuous use of pantographs at MSJ from at least 1872 through 1896.

As an aside, this photograph also demonstrates that non-Benton pantographs continued to be used at MSJ for several years after the 1892 amalgamation of ATF. It is worth a closer look.

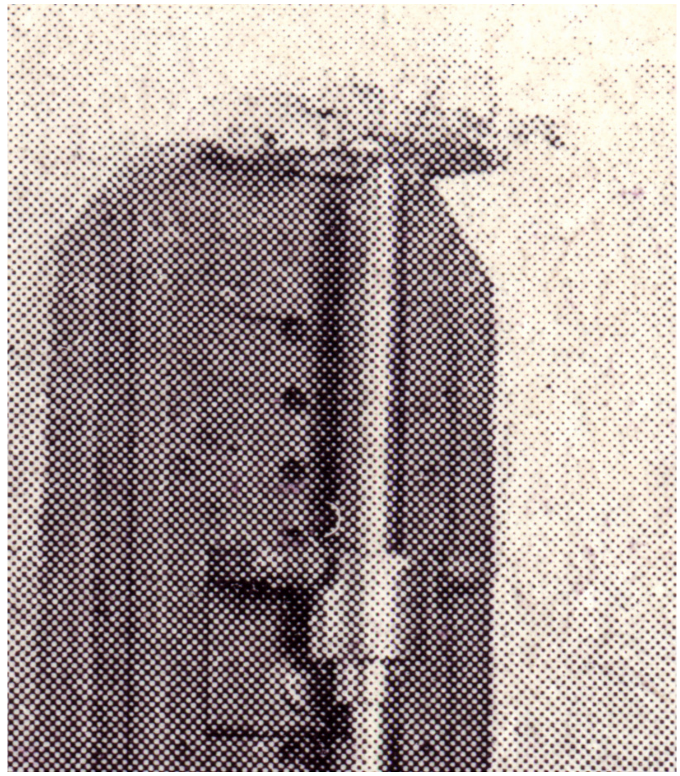

Fig. 3.5: MSJ Patrix Pantograph, Detail

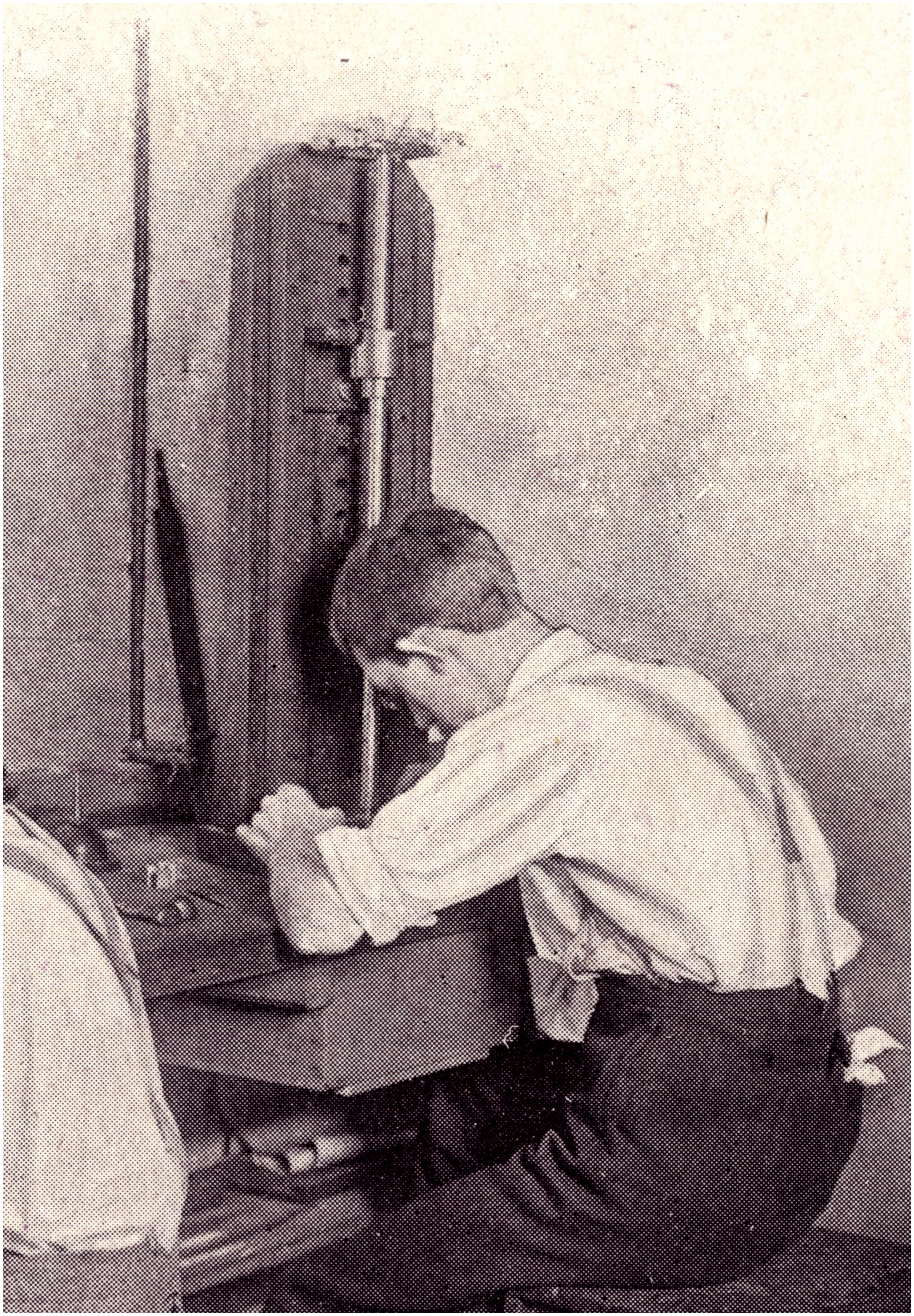

Fig. 3.6: MSJ Patrix Pantograph, Overall View

4• Early and Failed Attempts through the 1880s

The use of pantographs as drawing and/or tracing instruments in type-making, as discussed in the previous sections, is interesting in the context of the general study of the regularization of type. However, this use isn't really what has drawn people to this subject. The real question is this: when was the pantograph first used to guide a cutting tool to make a punch, or a patrix, or a matrix? It is very important to be clear about the answer to this question: *we do not know.*

Much of the rest of this paper will argue that the first use of the pantograph as a cutting tool in metal type-making was not by Benton in 1884. But if not, then when was it and who did it? We know with certainty that there were at least two very successful instances before Benton: Carl Jakob Ludwig with Herrmann Hofer in Germany from 1877 and William Schraubstadter with Gustav Schroeder at the Central Type Foundry in St. Louis (USA) in 1882. But were they the earliest?

There are suggestions that they were not. In particular, our earliest report about the Central hints that there were other not necessarily successful attempts going on at the same time. Pantograph technology was "in the air" at the time. It would be more remarkable if there weren't other efforts.

The evidence for these may well exist, but I have not found it in the Anglophone literature. If I were to hazard a guess — and it is no more than that: a guess, a hunch — I would suggest that the place to look would be in the German-speaking areas of Europe in the third quarter of the 19th century and, beyond that, to the Francophone portions of the Swiss watchmaking industry and Leschot's watch-plate drilling pantograph of the 1840s. I must emphasize, though, that I have no actual evidence for any of this. It is simply a suggested area for further research.

4.1• Herman Wiebking in 1878 and 1882

In Germany in 1878, Herman Wiebking[1] experimented with using a pantograph to engrave matrices. His machine was made in Berlin "possibly during 1870 or even before." His son Adolf Wiebking (reporting on this) did not view this work as successful. Herman Wiebking brought his pantograph with him when he emigrated to the US and "engraved a matrix, in 1882, from which type was cast by Marder, Luse & Company of Chicago."[2] There is no known evidence to

[1] Herman Wiebking was the father of the great Chicago-based matrix engraver Robert Wiebking, whose pantographic *matrix* engraving preceded Benton's and who set up the punchcutting department of the Ludlow Typograph Company.

[2] Herman Wiebking is mentioned three times in Nicholas Werner's posthumous biographical sketch of his son, Robert Wiebking {Werner 1932}: On p. 71, he mentions the 1882 matrix for Marder, Luse. On p. 72 he briefly notes that Wiebking was "said to have cut matrices and cast metal type in 1878 to 1880, just before he came to the United States." On p. 73 he relays information on this 1878–1880 matrix cutting from Adolf Wiebking.

suggest that the Marder, Luse foundry adopted this machine. Neither is there any evidence of a direct connection between Herman Wiebking's unsuccessful pantograph of the 1870s and his son Robert Wiebking's very successful pantographs constructed together with Henry Hutchins Hardinge from 1894 onward.

5• The First Known Success: Ludwig & Hofer (1877ff)

5.1• Dan Reynolds' Discovery

In 2021, Dr. Dan Reynolds[1] posted to his website an article describing an important discovery in the history of machine methods in typemaking.[2] Modestly, he described it only as the discovery of "the earliest German-made matrix-making machine." It is that, at least until we discover an earlier one. But it is also the earliest known machine used to cut a type design into either a matrix or a punch/patrix. He dates this to 1877, predating the second known successful instance (Schraubstadter in 1882) by five years and Benton (in 1884) by seven years. As important as this priority is, it is equally important that this first use wasn't an isolated exception. It was the beginning of a *continuous* tradition of pantographic matrix engraving in Germany which evolved independently of that in the United States.

There are also links here from Germany to the traditions of machine typemaking in the United States. The first pantograph used to cut matrices in the USA (by Schraubstadter, in 1882; see below) had been imported from Germany. This machine went on to more general commercial use. Schroeder and Werner used it to cut, among other typefaces, the very popular DeVinne.

Reynolds traces this matrix cutting back to the early years of the foundry which later became Ludwig & Mayer. It was founded late in 1875 by Jean Noé Carl Jakob Ludwig (see {Klingspor 2007}) and originally traded under the name "C. J. Ludwig." Ludwig's son Richard, in a book published in 1926 under the slightly unusual name *1875–1925*, recounted the origins of matrix engraving at the firm. I have not examined a copy of this book, but Reynolds translates the section having to do with matrix engraving.

Summarizing from Reynolds' translation, C. J. Ludwig observed an engraver using a machine to engrave seals.[3] The machine had been made by Hofer, in Berlin. (Advertisements by Hofer for his engraving and guilloché machines appeared in the *Illustrirte Zeitung* throughout this period.) Ludwig purchased a machine from Hofer and, after some initial failures and another visit to Hofer, began successfully engraving matrices.

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[1] Dr. Reynolds currently teaches at the book studies program at the Johannes Gutenberg University in Mainz, Germany (Johannes Gutenberg-Universität Mainz, Gutenberg-Institut für Weltliteratur und Schriftorientierte Medien, Abteilung Buchwissenschaft, `https://www.buchwissenschaft.uni-mainz.de/`). At the time of his 2021 article, he taught at the Hochschule Niederrhein University of Applied Sciences in Krefeld, Germany. His personal website is at: `https://www.typeoff.de/`

[2] "An independently-invented matrix-engraving machine: The 'Ludwig–Hofer pantograph,'" 10 September 2021 (accessed 2026-04-08), `https://www.typeoff.de/2021/09/ludwig-hofer-pantograph/`

[3] The modern German word for these is Petschaft. Some contemporary sources, such as Hofer's advertisements, used "Petschafte." See, for example, Fig. 5.15 on page 82.

Richard Ludwig's account concludes by mentioning a new (in 1925) machine by Michael Kämpf of Frankfurt am Main,[4] which was different from Hofer's but which the Ludwig & Mayer foundry had just put into service. The Kampf pantograph engraver of 1925 was described and illustrated in the 1925-11-15 issue of the *Deutsche Graveur-Zeitung und Stempel-Zeitung,* where it was said to be similar to the Hofer machine:

> Wem die sogenannte Hofer'sche Graviermaschine bekannt is, welche zur Herstellung von gebohrten Petschaften und Scriftgußmatrizen heute noch viel Verwendung findet, wird in der vorliegenden Bauart der Kämpf'schen Maschine Bekanntes herausfinden. {DGZ 1925-11-15}
>
> Anyone familiar with the so-called Hofer engraving machine, which is still widely used today for the production of engraved seals and typecasting matrices, will find something familiar in the present design of the Kämpf machine. [Translated by Google, with correction by DMM]

This account of the Kämpf machine is of particular significance here because it confirms that it was simply a well-known fact in German engraving circles in 1925 that the Hofer machine was a pantograph and was widely used for making typecasting matrices.

Despite the lack of specific dates in Richard Ludwig's account, Reynolds is able to date this original use, based on events mentioned, to 1877.

At the time of its use, this pantograph would simply have been called a "Hofer" machine, after is manufacturer (it is so called in the 1925 *DGZ* article, for example). Because of its importance to typemaking, and because of the critical role played by Ludwig in developing Hofer's machine for matrix engraving, Reynolds refers to it as the "Ludwig-Hofer" pantograph. This seems appropriate.

5.2• Possible Earlier Rediscoveries

When working from published sources, the question of "discovery" becomes not so much one of the date of first publication as the date of general recognition. For example, Richard Ludwig published the account of his father and the first use of pantographic methods in matrix making in 1925. Werner published his account of Schraubstadter at the Central (1882) in 1927. Earlier accounts were present in the trade literature (e.g., reports on Hofer's exhibition of his machine at a Berlin trade show in 1879, Kelly's account of Schraubstadter in 1883, and so forth). We have always known that Benton was not the first. Yet a quarter of the way through the 21st century virtually every academic and popular text still identifies Benton as the originator of these methods.

[4]The firm of Michael Kämpf went on to become very successful in high-end pantographic engraving machines.

With this in mind, Reynold's 2021 publication of his discovery of Ludwig and Hofer's success of 1877 is clearly the first source to bring this to the current typographical and academic communities. However, there might have been an earlier rediscovery.

[With deepest apologies, in the political situation of 2025/6 it is very difficult for an American to do academic research into German sources. I do not, therefore, have the complete reference here. If any reader in Europe who might have ready access to this source could confirm this, I would be most grateful.]

There is reason to believe, based on "snippet" results from Google Books searches, that an article in volume 6 (1996) of the *Leipziger Jahrbuch zur Buchgeschichte* might contain a reference to Ludwig and Hofer.[5] The following may be reconstructed from Google Books snippets:

> [p. 405] 1875 ist das Gründungsjarhr der Schriftgißerei Ludwig & Mayer, Franfurt. Von ihr wurde 1877 eiene Matrizenbohmaschine entwickelt und in die Praxis eingeführt.[5] … [Note] 5 Vlg. Richard Ludwig: Jubiläumsschrift 1875–1925. Frankfurt am Main 1925, S.8.

I would translate this as:

> 1875 is the founding year of the Ludwig & Mayer typefoundry, Frankfurt. In 1877 they developed a matrix engraving machine and introduced it into practice.

The source cited by this brief reference is, of course, the same 1925 publication by Richard Ludwig.

[5] I believe, from a citation in Dan Reynolds' article "The Norddeutsche Schriftgießerei and VEB Typoart", at `https://www.typeoff.de/2018/04/norddeutsche-schriftgieserei-veb-typoart/` (posted 2018-04-21, accessed 2025-10-20), that this 1996 article is: (Walter Bergner. "Entwurf und Herstellung von Schrifttypen in Ostdeutschland — Zur Geschichte des Betriebes Typoart in Dresden." In: Mark Lehmstedt and Lothar Poethe (ed.): *Leipziger Jahrbuch zur Buchgeschichte* 6. Wiesbaden: Verlag Harrassowitz (1996): pp. 405–36.)

5.3• Evidence through 1900

5.3.1• In Contemporary Technical Literature

5.3.1.1• *Der Welthandel* (1878)

The earliest reference to Hofer's typographical pantograph that I have discovered (so far) is in a monthly journal of business, industrial, and scientific reports: *Der Welthandel: Monatschefte für Handel & Industrie, Länder- & Völkerkunde* in early 1878. It doesn't say much, but it is quite clear that this is a pantograph for cutting typecasting matrices.

Der Ingenieur H. Hofer hat eine von
ihm eingeführte Gravirmaschine, welche
sich hauptsächlich zur Herstellung der zum
Schriftguß nöthigen Kupfermatrizen eignet,
in neuerer Zeit wesentlich verbessert. Es
wird dabei durch Vermittlung eines Panto-
graphen, die leicht in eine Platte gravirte
Vorzeichnung (Buchstabe oder Verzierung) in
jeder gewünschten Vergrößerung oder Ver-
kleinerung in Kupfer gravirt. Abgesehen
davon, daß die Herstellungskosten neuer Alpha-
bete für den Schriftguß vermittelst der Gravir-
maschine geringer sind, zeichnen sich auch die
so erzeugten Lettern durch eine Correktheit
und Feinheit aus, wie sie durch Handarbeit
schwerlich erreicht werden kann. Freilich setzt
die Maschine, welche auch zur Herstellung
von Stempeln zum Buntdruck, sowie zur An-
fertigung von Guillochirarbeiten benützt werden
kann, einen geübten Arbeiter bei ihrer Hand-
habung voraus.

Fig. 5.1: DW (1878), p. 91[6]

Der Ingenieur H. Hofer hat eine von
ihm eingeführte Gravirmaschine, welche
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die Maschine, welche auch zur Herstellung
von Stempeln zum Buntdruck, sowie zur Anfertigung
von Guillochirarbeiten benügt werden
kann, einen geübten Arbeiter bei ihrer Handhabung
voraus.

Fig. 5.2: DW (1878) Transcription

Google Translate renders this as:

> The engineer H. Hofer has recently significantly improved an engraving machine he introduced, which is primarily suitable for producing the copper matrices required for typecasting. Using a pantograph, the preliminary drawing (letter or decoration) easily engraved on a plate is engraved in copper at any desired magnification or reduction. Apart from the fact that the production costs of new alphabets for typecasting are lower using the engraving machine, the letters produced in this way are characterized by a precision and fineness that can hardly be achieved by hand. Of course, the machine, which can also be used to produce stamps for color printing and for guilloché work, requires a skilled worker to operate it.

[6] {From *Welthandel* 1878}. The transcriptions presented here and elsewhere will preserve original spellings and word forms.

5.3.1.2• At the Berliner Gewerbeausstellung (1879)

TO DO. Hofer exhibited his machine (but, as he was a scientific instrument maker, he exhibited it in that section). Cite catalog entry. Note that it is omitted in the Report for the scientific instrument section (because, no doubt, it was not really a scientific instrument).

5.3.1.3 • *Journal für Buchdruckerkunst* (1879-06-25)

In the “Correspondenz” section of the *Journal für Buchdruckerkunst, Schriftgiesserei und die Verwandten Fächer* of June 25, 1879, there appears a brief report on the “Matrizen - Bohrmaschine von H. Hofer” as then being exhibited in Berlin:

Ein anderer interessanter Ausstellungs-Gegenstand ist die *Matrizen-Bohrmaschine* von *H. Hofer*. Dieselbe lehnt sich an das Princip des Pantographen (sog. Storchschnabel) an und soll den Stahlstempel überflüssig machen. Der die Maschine Bedienende hat weiter nichts zu thun, als den Leitstift auf der Originalzeichnung des Buchstabens hin und her zu führen, während dessen der Bohrer am anderen Ende die erforderliche Gravirung macht. Die Mater kann nicht nur tief und conisch, sondern auch so gebohrt werden, dass das Justiren überflüssig wird, und da nach Aussage des Fabrikanten die Herstellung einer Mater nur 15 Minuten erfordert, so eröffnet sich der Schriftschneiderei in dieser Bohrmaschine eine schätzenswerthe Bundesgenossin. Inwieweit die Hofer'sche Maschine sich bewährt, muss indess erst eine grössere Praxis darthun. Zu Petschaften etc. ist sie allseitig mit dem günstigsten Erfolge von den Graveuren angewendet worden, und dürfte auch für die Giessereien nicht ausser Acht gelassen werden. Deshalb sei sie den Besuchern der Berliner Ausstellung bestens empfohlen. Sie befindet sich in der Gruppe XI. Wissenschaftliche Instrumente, unter Nr. 1247.

Fig. 5.3: JBSVF 1879-06-25 Col. 490[7]

Ein anderer interessanter Ausstellungs - Gegenstand is
die Matrizen-Bohrmaschine von H. Hofer. Dieselbe lehnt
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ausser Acht gelassen werden. Deshalb sei sie den Besuchern
der Berliner Ausstellung bestens empfohlen. Sie befindet
sich in der Gruppe XI. Wissenschaftliche Instrumente, unter
Nr. 1247.

Fig. 5.4: JBSVF Transcription

With the help of Google Translate, but correcting for technical vocabulary and restoring some of the original German word order, I make this out as shown below, left. But I have no doubt butchered both the German and English languages in my translation. Google renders this passage as shown below, right.

Another interesting exhibit-item is
the Matrix-Cutting Machine of H. Hofer. It is based
on the principle of the pantograph (also called the “crane's bill”)
and is intended to make the steel punch superfluous. The
machine operator has nothing further to do, than
the stylus/tracer [Leitstift] on the original drawing of the type there
and here [back and forth] to move, while the cutting tool at the other
end the required engraving makes. The matrix can
not only be deep and conical, but can also be cut [gebohrt, lit: drilled],
that justification becomes unnecessary, and since according to
the manufacturer [Hofer] the making of a matrix only 15 minutes
requires, this offers [eröffnet] the punchcutter in this
cutting machine a valuable ally. To what extent
Hofer's machine will prove itself, however
greater practical experience must demonstrate. For seals, etc., it
has generally with success by engravers
been applied, and should not for the [type]foundries
be ignored. Therefore, to the visitors of
the Berlin Exhibition it is highly recommended. It is located
in Group XI. Scientific Instruments, under
No. 1247.

Fig. 5.5: JBSVF Google+DMM Translation

Another interesting exhibit is H. Hofer's matrix drilling machine.
It is based on the principle of the pantograph (so-called stork's beak)
and is intended to eliminate the need for a steel die.
The operator of the machine has nothing more to do than move
the guide pin back and forth on the original drawing of the letter,
while the drill at the other end makes the required engraving.
The matrix can be drilled not only deeply and conically,
but also in such a way that adjustment is unnecessary.
And since, according to the manufacturer, the production of
a matrix takes only 15 minutes, this drilling machine offers
a valuable ally to the type cutter. However, more extensive
practical experience will have to demonstrate the extent
to which Hofer's machine will prove its worth.
It has been widely used by engravers for seals, etc.,
with excellent results, and should not be overlooked by
foundries either. Therefore, it is highly
recommended to visitors to the Berlin exhibition.
It is located in Group XI: Scientific Instruments, under No. 1247.

Fig. 5.6: JBSVF Google Translation

When the commentator refers to the cutting as “deep and conical” (tief und conisch). I think that the reference is both to the depth of drive of the matrix and to the beard angle (what would be called the draft angle in other kinds of casting. This is not the cone hole of a Monotype

[7] {From JBSVF 1879-06-25}.

composition matrix!

Fournier famously said that a matrix well-struck is half-justified. One advantage of direct matrix engraving is that a matrix well-cut is fully justified (“das Justiren überflüssig wird”).

Technical points aside, two business matters emerge from this account. First, Hofer was exhibiting his machine at a public exhibition in 1879, only two years after Ludwig began using it to cut matrices. Second, there was still some hesitation about the ultimate success of this new technology, despite the claims of its maker. Anyone who has brought a new product to a trade show, from the 19th century to the 21st, will empathize.

5.3.1.4• In *Wochenschrift des VDI* (1879-12-27)

In the *Wochenschrift des Vereines Deutscher Ingeniure* of 1879-12-27, A. Martens wrote of several items on display in the Scientific Instruments section[8] of the Berlin Trade Exposition (Berliner Gewerbeausstellung), including a matrix and seal cutting pantograph and a guilloche engraving machine, both by Hofer. Regrettably, there is no illustration. Here is his account of the first, in facsimile and transcribed:

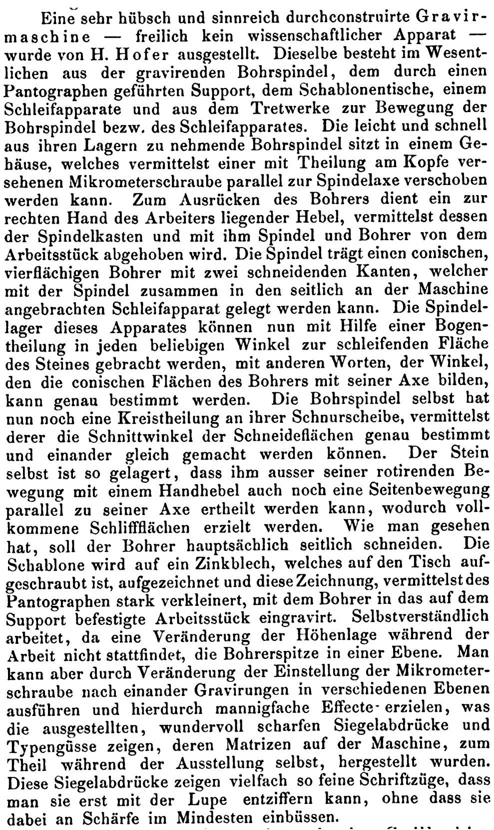
Eine sehr hübsch und sinnreich durchconstruirte Gravirmaschine — freilich kein wissenschaftlicher Apparat — wurde von H. Hofer ausgestellt. Dieselbe besteht im Wesentlichen aus der gravirenden Bohrspindel, dem durch einen Pantographen geführten Support, dem Schablonentische, einem Schleifapparate und aus dem Tretwerke zur Bewegung der Bohrspindel bezw. des Schleifapparates. Die leicht und schnell aus ihren Lagern zu nehmende Bohrspindel sitzt in einem Gehäuse, welches vermittelst einer mit Theilung am Kopfe versehenen Mikrometerschraube parallel zur Spindelaxe verschoben werden kann. Zum Ausrücken des Bohrers dient ein zur rechten Hand des Arbeiters liegender Hebel, vermittelst dessen der Spindelkasten und mit ihm Spindel und Bohrer von dem Arbeitsstück abgehoben wird. Die Spindel trägt einen conischen, vierflächigen Bohrer mit zwei schneidenden Kanten, welcher mit der Spindel zusammen in den seitlich an der Maschine angebrachten Schleifapparat gelegt werden kann. Die Spindellager dieses Apparates können nun mit Hilfe einer Bogentheilung in jeden beliebigen Winkel zur schleifenden Fläche des Steines gebracht werden, mit anderen Worten, der Winkel, den die conischen Flächen des Bohrers mit seiner Axe bilden, kann genau bestimmt werden. Die Bohrspindel selbst hat nun noch eine Kreistheilung an ihrer Schnurscheibe, vermittelst derer die Schnittwinkel der Schneideflächen genau bestimmt und einander gleich gemacht werden können. Der Stein selbst ist so gelagert, dass ihm ausser seiner rotirenden Bewegung mit einem Handhebel auch noch eine Seitenbewegung parallel zu seiner Axe ertheilt werden kann, wodurch vollkommene Schliffflächen erzielt werden. Wie man gesehen hat, soll der Bohrer hauptsächlich seitlich schneiden. Die Schablone wird auf ein Zinkblech, welches auf den Tisch aufgeschraubt ist, aufgezeichnet und diese Zeichnung, vermittelst des Pantographen stark verkleinert, mit dem Bohrer in das auf dem Support befestigte Arbeitsstück eingravirt. Selbstverständlich arbeitet, da eine Veränderung der Höhenlage während der Arbeit nicht stattfindet, die Bohrerspitze in einer Ebene. Man kann aber durch Veränderung der Einstellung der Mikrometerschraube nach einander Gravirungen in verschiedenen Ebenen ausführen und hierdurch mannigfache Effecte erzielen, was die ausgestellten, wundervoll scharfen Siegelabdrücke und Typengüsse zeigen, deren Matrizen auf der Maschine, zum Theil während der Ausstellung selbst, hergestellt wurden. Diese Siegelabdrücke zeigen vielfach so feine Schriftzüge, dass man sie erst mit der Lupe entziffern kann, ohne dass sie dabei an Schärfe im Mindesten einbüssen.

Fig. 5.7: WVDI 1897-12-27 (Part 1)[9]

Eine sehr hübsch und sinnreich durchconstruirte Gravirmaschine
— freilich kein wissenschaftlicher Apparat —
wurde von H Hofer ausgestellt. Dieselbe besteht im Wesentlichen
aus der gravirenden Bohrspindel, dem durch einen
Pantographen geführten Support, dem Schablonentische, einem
Schleifapparate und aus dem Tretwerke zur Bewegung der
Bohrspindel bezw des Schleifapparates. Die leicht und schnell
aus ihren Lagern zu nehmende Bohrspindel sitzt in einem Gehäuse,
welches vermittelst einer mit Theilung am Kopfe versehenen
Mikrometerschraube parallel zur Spindelaxe verschoben
werden kann. Zum Ausrücken des Bohrers dient ein zur
rechten Hand des Arbeiters liegender Hebel, vermittelst dessen
der Spindelkasten und mit ihm Spindel und Bohrer von dem
Arbeitsstück abgehoben wird. Die Spindel trägt einen conischen,
vierflächigen Bohrer mit zwei schneidenden Kanten, welcher
mit der Spindel zusammen in den seitlich an der Maschine
angebrachten Schleifapparat gelegt werden kann. Die Spindellager
dieses Apparates können nun mit Hilfe einer Bogentheilung
in jeden beliebigen Winkel zur schleifenden Fläche
des Steines gebracht werden, mit anderen Worten, der Winkel,
den die conischen Flächen des Bohrers mit seiner Axe bilden,
kann genau bestimmt werden. Die Bohrspindel selbst hat
nun noch eine Kreistheilung an ihrer Schnurscheibe, vermittelst
derer die Schnittwinkel der Schneideflächen genau bestimmt
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selbst ist so gelagert, dass ihm ausser seiner rotirenden Bewegung
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Typengüsse zeigen, deren Matrizen auf der Maschine, zum
Theil während der Ausstellung selbst, hergestellt wurden.
Diese Siegelabdrücke zeigen vielfach so feine Schriftzüge, dass
man sie erst mit der Lupe entziffern kann, ohne dass sie
dabei an Schärfe im Mindesten einbüssen.

Fig. 5.8: WVDI (part 1) Transcription

Google translates this as:

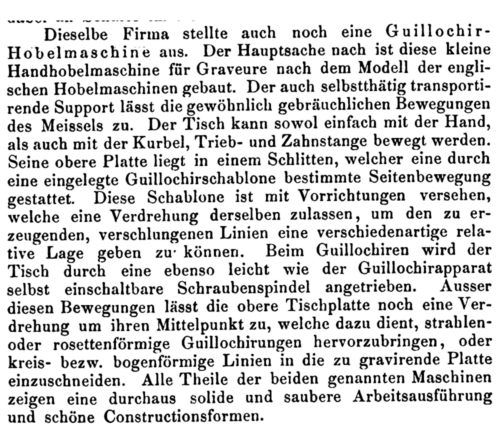
> A very attractive and ingeniously designed engraving machine — admittedly not a scientific device — was exhibited by H. Hofer. It essentially consists of the engraving spindle, the pantograph-guided support, the template table, a grinding device, and the treadle mechanism for moving the spindle and the grinding device. The spindle, which can be easily and quickly removed from its bearings, is located in a housing that can be moved parallel to the spindle axis using a micrometer screw with a graduated head. A lever located to the operator's right hand serves to disengage the drill; this lever lifts the spindle head, along with the spindle and drill, from

[8]He does note that they are not really scientific instruments.

[9]{From Hofer 1879-12-27}.

the workpiece. The spindle carries a conical, four-sided drill with two cutting edges, which can be placed together with the spindle in the grinding device mounted on the side of the machine. The spindle bearings of this device can now be brought into any desired angle to the grinding surface of the stone using an arc scale; in other words, the angle formed by the conical surfaces of the drill with its axis can be precisely determined. The drill spindle itself now has a circular scale on its cord disc, by means of which the cutting angles of the cutting surfaces can be precisely determined and made equal to one another. The stone itself is mounted in such a way that, in addition to its rotating movement, it can also be given a lateral movement parallel to its axis using a hand lever, thus achieving perfect grinding surfaces. As we have seen, the drill is intended to cut primarily laterally. The template is drawn on a zinc sheet screwed onto the table, and this drawing, greatly reduced in size using the pantograph, is engraved with the drill into the workpiece mounted on the support. Naturally, since there is no change in elevation during the work, the drill bit operates in one plane. However, by changing the setting of the micrometer screw, one can sequentially execute engravings in different planes, and thereby achieve a variety of effects, as demonstrated by the wonderfully sharp seal impressions and type castings on display, the matrices of which were produced on the machine, some of them during the exhibition itself. These seal impressions often display such fine lettering that they can only be deciphered with a magnifying glass, without losing any of their sharpness.

This is Martens' account of Hofer's guilloche machine (concluding with a favorable impression of the quality of construction of both machines):



Dieselbe Firma stellte auch noch eine **Guillochir-Hobelmaschine** aus. Der Hauptsache nach ist diese kleine Handhobelmaschine für Graveure nach dem Modell der englischen Hobelmaschinen gebaut. Der auch selbstthätig transportirende Support lässt die gewöhnlich gebräuchlichen Bewegungen des Meissels zu. Der Tisch kann sowol einfach mit der Hand, als auch mit der Kurbel, Trieb- und Zahnstange bewegt werden. Seine obere Platte liegt in einem Schlitten, welcher eine durch eine eingelegte Guillochirschablone bestimmte Seitenbewegung gestattet. Diese Schablone ist mit Vorrichtungen versehen, welche eine Verdrehung derselben zulassen, um den zu erzeugenden, verschlungenen Linien eine verschiedenartige relative Lage geben zu können. Beim Guillochiren wird der Tisch durch eine ebenso leicht wie der Guillochirapparat selbst einschaltbare Schraubenspindel angetrieben. Ausser diesen Bewegungen lässt die obere Tischplatte noch eine Verdrehung um ihren Mittelpunkt zu, welche dazu dient, strahlen- oder rosettenförmige Guillochirungen hervorzubringen, oder kreis- bezw. bogenförmige Linien in die zu gravirende Platte einzuschneiden. Alle Theile der beiden genannten Maschinen zeigen eine durchaus solide und saubere Arbeitsausführung und schöne Constructionsformen.

Fig. 5.9: WVDI 1897-12-27 (Part 2)

Dieselbe Firma stellte auch noch eine Guillochir-
Hobelmaschine aus. Der Hauptsache nach ist diese kleine
Handhobelmaschine für Graveure nach dem Modell der englischen
Hobelmaschinen gebaut. Der auch selbstthätig transportirende
Support lässt die gewöhnlich gebräuchlichen Bewegungen
des Meissels zu. Der Tisch kann sowol einfach mit der Hand,
als auch mit der Kurbel, Trieb- und Zahnstange bewegt werden.
Seine obere Platte liegt in einem Schlitten, welcher eine durch
eine eingelegte Guillochirschablone bestimmte Seitenbewegung
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verschlungenen Linien eine verschiedenartige relative
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Tisch durch eine ebenso leicht wie der Guillochirapparat
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kreis- bezw. bogenförmige Linien in die zu gravirende Platte
einzuschneiden. Alle Theile der beiden genannten Maschinen
zeigen eine durchaus solide und saubere Arbeitsausführung
und schöne Constructionsformen.

Fig. 5.10: WVDI (Part 2) Transcription

Google translates this as:

> The same company also exhibited a guilloche planer. This small hand-held planer for engravers is essentially modeled after English planers. The self-contained support allows for the usual movements of the chisel. The table can be moved simply by hand, or with a crank, pinion, and rack. Its upper plate rests in a carriage, which allows lateral movement determined by an inserted guilloche template. This template is equipped with devices that allow it to be rotated to give the intertwined lines to be created a variety of relative positions. For guilloche work, the table is driven by a screw spindle that can be switched on just as easily as the guilloche machine itself. In addition to these movements, the upper table plate also allows for rotation around its center, which serves to create radial or rosette-shaped guilloches, or to cut circular or arcuate lines into the plate to be engraved. All parts of both machines mentioned exhibit a thoroughly solid and clean workmanship and beautiful construction.

Martens' account contains considerabe technical detail, and several point will jump out at anyone who has hands-on experience in pantographic matrix engraving.

First, the machine is supplied with a grinding machine (einem Schleifapparate). This would have been critical to its success. An engraving machine is useless without a cutter grinder

Second, the cutters were "conical" and four-sided ("einen conischen, vierflächigen Bohrer"). Today these might more commonly be described as "pyramidal" in shape, very much like the cutters used on the Benton pantograph engraving machines; the form cut by a rotating pyramidal cutter is of course a cone. Unlike the Benton's four-sided cutters, however, which have four equal cutting edges, these are said to have only two cutting edges. I presume that they were therefore of diamond rather than square cross section.

Third, the spindle was removable. TO DO: Before addressing this, I need to do some further research on a later, similar, pantograph which will be available to me for inspection (a Gursch machine, in the Project Letter-kunde collection). Jurie Florijn, who has operated this machine, tells me that its removable spindle differs from that of the Benton. This, in turn, suggests that Hofer's machine's spindle also does not possess the same characteristics as Benton's removable quill. See sections 2.7.2.3, Precision/Repeatability in Depth of Cut, on page 51, and 2.8, A Note About Removable Spindles, on page 51, for discussions of why a removable spindle is significant.

Fourth, the depth adjustment of the machine is by micrometer dials. This was something done by most (all?) later machines, including those by Benton and by Wiebking and Hardinge.

From a technical point of view, Hofer's matrizen-bohrmaschine possesses all of the requisite features of a successful typographical engraving pantograph. It would work.

There is another feature of Hofer's machine which may be less obvious to a modern Benton operator but which is curiously parallel. Benton's Northwestern Type Foundry and, later, American Type Founders employed several methods of creating and using patterns. In the later practice most familiar to modern Benton operators, they used relief patterns electroformed from drag-engraved wax plates. However, the very first patterns used by Benton were zinc plates with the designs scribed on them. This is exactly Hofer's method ("Die Schablone wird auf ein Zinkblechi, welches auf den Tisch aufgeschraubt ist").

No zinc patterns from the Benton vertical pantographs survive[11] However, a collection of similar plates does survive for the Benton "Ad-Cut" pantograph.[12] Here is an example of such a zinc pattern. They are very difficult to use. (Also, as any printer who has worked with zinc plates can confirm, they are also highly susceptible to corrosion.)

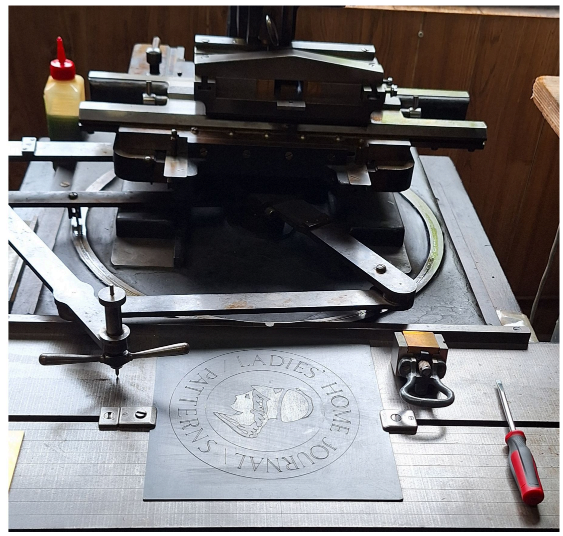

Fig. 5.11: ATF Zinc Pattern at the ATF Ad-Cut Pantograph (at Project Letter-kunde in 2024)[10]

[10]Photograph by the author. Thanks to Patrick Goossens and Project Letter-kunde for the opportunity to see this.

[11]One did survive until the late 20th century, in the possession of Benton's family in Wisconsin, and a photograph of the back of it with an inscription of its provenance and importance scratched in survives in the collection of Patrick Goossens' Project Letter-kunde, but the whereabouts of this plate are now unknown. See §7.2.1.

[12]This was a commercial engraving pantograph, the original manufacturer of which remains unknown, which Benton adapted to use his "quill" (removable spindle) mechanism. It is a horizontal four-bar machine. It survives at Project Letter-kunde.

5.3.1.5• Nordin (Sweden, 1881)

In any language other than German, the earliest reference of which I am aware is from a Swedish printers' manual from 1881. It says the following:

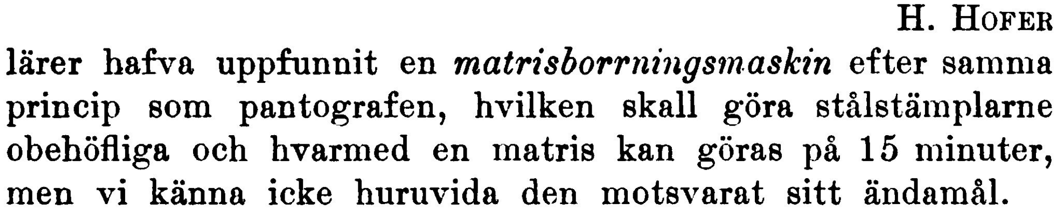
H. Hofer lärer hafva uppfunnit en *matrisborrningsmaskin* efter samma princip som pantografen, hvilken skall göra stålstämplarne obehöfliga och hvarmed en matris kan göras på 15 minuter, men vi känna icke huruvida den motsvarat sitt ändamål.

Fig. 5.12: Nordin on Hofer (1881)

Here is this passage transcribed:

> H. Hofer lärer hafva uppfunnit en *mastrisborrningmaskin*[13] efter samma princip som pantografen, hvilken skall göra stålstämplarne obehöfliga och hvarmed en matris kan göras på 15 minuter, men vi känna icke huruvida den motsvarat sitt ändamål. {Nordin 1881}: 57.

Google (with some corrections by Victor Thibout) renders this as:

> H. Hofer is said to have invented a *matrix drilling machine* after the same principle as the pantograph, which will make the steel punches unnecessary and with which a matrix can be made in 15 minutes, but we do not know whether it meets its purpose.[14]

This seems to fit well with the other accounts.

5.3.1.6• With Benton's Reception in Germany (1894)

The American Type Founders Company (ATF) exhibited Benton's 1884-patent pantograph at the World's Columbian Exposition in Chicago in 1893.[15] Its reception in Germany at the time is interesting, because of the claim that this was not new — matrices having been engraved using machines for two decades (that is, since the mid-1870s).

TO DO: But for now see the reprint of this in the coverage of Benton in section 7.2.11.3 on page 127. *Buchgewerbeblatt: Halb-Monatsschrift für alle Zweige des Buchgewerbes; Organ des Centralvereins für das Gesamte Buchgewerbe, Volume 2*

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[13]The term "matrizenbohrmaschine" (in German), which translates literally as "matrix drilling machine" became the standard term for a matrix engraving machine in Germany. So (by extension to Swedish) in the sense used here "matrisborrningmaskin" means a rotary spindle engraving machine, not a drill press.

[14]I am indebted to Victor Thibout for discovering this reference. He found it in 2017 and communicated it to me in an email on 2017-07-12, but at that time we were unable to confirm its accuracy and did not link it to Ludwig's work with Hofer.

[15]It was shown in what in the Benton Census I have called its "Type 1b" form, which is a mechannical rearrangement of patent with fundamentally the same kinematics.

See also Hermann Smalin's reference to Benton, as discussed in "Smalin (1911)," section 5.4.1.1 on page 80, below.

5.3.2• In Contemporary Nontechnical Literature

1877: Bohrmaschinen für Schriftgießerei

In the 1877 edition of the *Berliner Adreßbuch,* Hofer is listed as, among other things, a maker of "Bohrmaschinen für Schriftgießerei." See {[Hofer 1877 AB}. Although a "bohrmaschine" as employed in a typefoundry could refer to a two-dimensional pantograph for cutting wood illustrations, in light of the other evidence is is most likely that this is a pantograph for matrices. See the entry for this item in the "Hofer Data Points" appendix for a facsimile extract: "1877: Bohrmaschinen für Schriftgießerei".

5.4• Evidence and References After 1900

5.4.1• In Technical or Industry Literature

Pellehn, *Deutsche Mechaniker-Zeitung* (1903)

In 1903, G. Pellehn[16] wrote a long article surveying the theory and history of pantographs. This appeared in several issues of the *Deutsche Mechaniker-Zeitung*. This journal, in turn, was issued as a supplement to the *Zeitschrift für Instrumentenkunde*. See {Pellehn 1903} for the full bibliographic details and digital sources.

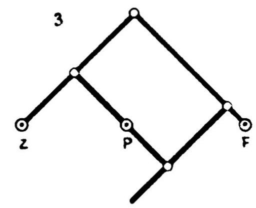
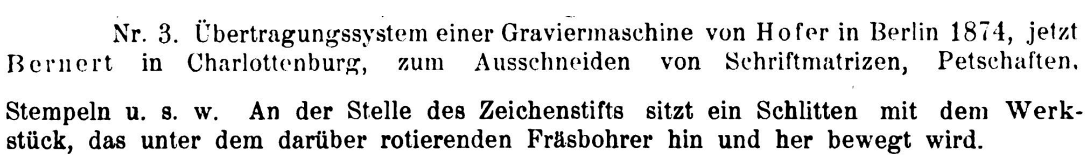


Fig. 5.13: Hofer 1874

In the first installment of this article, Pellehn shows, schematically, the geometrical arrangements of a number of different pantographs (including Benton's vertical machine, in his Figure 18 on p. 88). Figure 3, p. 87, shows Hofer's. Pellehn says this about it:



Nr. 3. Übertragungssystem einer Graviermaschine von Hofer in Berlin 1874, jetzt Bernert in Charlottenburg, zum Ausschneiden von Schriftmatrizen, Petschaften, Stempeln u. s. w. **An der Stelle des Zeichenstifts sitzt ein Schlitten mit dem Werkstück, das unter dem darüber rotierenden Fräsbohrer hin und her bewegt wird.**

Fig. 5.14: Pellehn on Hofer & Bernert[17]

Transcribed, this is:

> Nr. 3. Übertragungssystem einer Graviermaschine von Hofer in Berlin 1874, jetzt Bernert in Charlottenburg, zum Ausschneiden von Schriftmatrizen, Petschaften, Stempeln u. s. w. An der Stelle des Zeichenstifts sitzt ein Schlitten mit dem Werkstück das unter dem darüber rotierenden Fräsbohrer hin und her bewegt wird.

Translated by Google, this is:

> No. 3. Transmission system of an engraving machine by Hofer in Berlin in 1874, now Bernert in Charlottenburg, for cutting out lettering matrices, seals, stamps, etc. In place of the stylus sits a carriage with the workpiece, which is moved back and forth beneath the milling cutter rotating above it.

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[16]Pellehn is described as "in Charlottenburg[,] Kartograph im Reichsmarineamt." A cartographer of this period would of course be quite familiar with pantographs. His location in Charlottenburg, a district of central Berlin, is also interesting in the present context because it is also the location of the firm H. Bernant, which took over the manufacture of Hofer's matrizenbohrmaschine.

[17]From {Pellehn 1903}: 87–88. Extracted and composited by DMM. Public domain.

Unfortunately, Pellehn does not provide an image of the machine itself. Still, at least three historical and technical details may be gleaned from this account.

First, he dates Hofer's use of it to 1874. This is earlier than C. J. Ludwig's collaboration with Hofer, which confirms the claim by Ludwig's son that his father saw a machine in operation before beginning his collaboration. Pellehn cites several uses for this machine, including seal engraving. So his date, 1874, does not necessarily mean that this machine was used for engraving matrices in 1874 — only that the machine which became the Ludwig-Hofer matrix engraving pantograph was in operation in some way in 1874.

Second, Pellehn says specifically that it is used for, *inter alia,* cutting type matrices ("Ausschneiden von Schriftmatrizen").

Third, its general arrangement is given: a rotating cutter fixed in place above a moving workpiece. This matches later machines by Bernant (and fits with the tradition of German matrix engraving machines through those of the firm Emil Gurich, in Berlin).

See section 5.6, "To H. Bernert, Charlottenburg (Berlin)," on p. 83, below, for more on the transition of Hofer's machine to Bernant.

5.4.1.1• Smalin (1911)

In a chapter in a 1911 festscrhift published by a club of officers and workers of the Imperial Austrian printing office,[18] Hermann Smalin summarized modern developments in the typefoundry. His article is of interest for two reasons here.

First, he spends considerable time discussing the historical process of the regularization of type.

Second, while he credits Benton with the first punch cutting machine, he asserts that direct matrix engraving by Hofer's machine was known long before. This was, in general, the standard reaction in the German technical press to the publicity surrounding Benton's pantographs — something along the lines of "well, yes, but we've been doing direct matrix engraving for a long time." See also section 5.3.1.6, "With Benton's Reception in Germany (1894)," on page 76, above.

Smalin discusses Benton's pantograph, emphasizing its development in the context of type regularization and Benton's "self-spacing" (i.e., unit set) types. He implies that it started out as a punch cutting machine (which would imply the "Type 1" version of the 1884 patent). Then he says that "This machine has undergone many changes over the years" ("Diese Maschine erfuhr im Verlaufe der Zeit noch manche"), among which is the ability to engrave (bohr) matrices ("die daß damit Matern gebohrt werden können").

But then Smalin observes that this is nothing new, having been introduced by Hofer.

[18] See {Smalin 1911} for bibliographic details.

> Matern ohne Stempel zu schaffen, indem man die Buchstabenbilder mittels einer pantographisch arbeitenden Graviermaschine von Hofer direkt in geeignete Metallstücke bohrte, wurde teilweise schon längere Zeit ausgeführt. Erweitert hat sich diese Art der Materngewinnung durch die Einführung der oben erwähnten Stempelschneidemaschine. (p. 30)

Google renders this:

> Creating matrices without punches by cutting the letter images directly into suitable metal pieces using a pantographic engraving machine from Hofer has been carried out for some time. This type of matrix production has been expanded by the introduction of the above-mentioned punch cutting machine.

In general, the German-language literature from the late 19th and very early 20th centuries credits Hofer with the introduction of direct matrix engraving and suggests that punch (and by implication patrix) machine engraving followed on when knowledge of Benton's first pantograph spread after the 1893 World's Columbian Exposition in Chicago.

5.4.2• In Nontechnical Literature

TO DO: Cited by Reynolds: Dr. Franz Lerner, "Das tätige Frankfurt" (1955). But has very strong echoes of Richard Ludwig (1925) Text online at: `http://www.frankfurt-nordend.de/das_taetige_frankfurt.htm`

5.5• H. Hofer in Berlin

Fig. 5.15: H. Hofer in Berlin, Niederwallstr. 35 (1864)[19]

We know very little about Hofer. (See Appendix E, "Hofer Data Points," on page 229 for a compilation of the information that I have been able to gather.) During the period of greatest interest here, he always identified himself in his advertisements as "H. Hofer in Berlin [/] Niederwallst[raße] 35."[20] We know that the 'H' stood for Herrmann because an 1865 government report listed "Mechanikus Herrmann Hofer, Niderwallstraße Nr. 35" as the second deputy merchant appointed as an arbitrator to what I think was a local court in Berlin (I know neither the German language nor the municipal politics of 1860s Berlin). See {Hofer 1865 ARP} for the citation and the entry for this item in the "Hofer Data Points" appendix for a facsimile extract: "1865: Name Given as Herrmann Hofer".

TO DO: Trace to at least 1885 in the (*Illustrirte Zeitung*). Ref. to appendix on Hofer data points.

[19]From {[Hofer 1864 1118]} (*Illustrirte Zeitung,* Vol. 43, Whole No. 1118 (1864-12-03): p. 399).

[20]Little survives of prewar Berlin. Niederwallstraße 35 is now occupied by what appears to be a small residential building.

5.6• To H. Bernert, Charlottenburg (Berlin)

After its display in Berlin in 1879, the trail of Hofer's matrizenbohrmaschine seems to go cold. However, a clue is provided by a remark in Pellehn's 1903 general survey of pantographs. As already noted earlier, he remarks that a particular arrangement of linkages is that used by "einer Graviermacschine von Hofer in Berlin 1874." He then continues: "jetzt Bernert in Charlottenburg, zum Ausschneiden von Schriftmatrizen" ("now Bernert in Charlottenburg, for cutting type matrices.") See {Pellehn 1903}: 87–88.

5.6.1• H. Bernert, Charlottenburg

It makes sense that the firm of H. Bernert should take over the manufacture of this machine. Hofer was a one-man operation running out of his house, very much in the tradition of 18^{th} century scientific instrument makers. The firm of H. Bernert was an actual manufacturing business. Charlottenburg is a district in central Berlin. Other references put H. Bernert at Wielandstraße 42. According to Google Maps, this is between 6.4 and 7.1 kilometers from Hofer's address at Niederwallstraße 35 (depending on your route).

TO DO: Trace 19th century origins and locations. Makers of zinc and copper plates for engraving by the 1890s.

5.6.2• Bernert Matrizenbohrmaschine in Wernicke (1909)

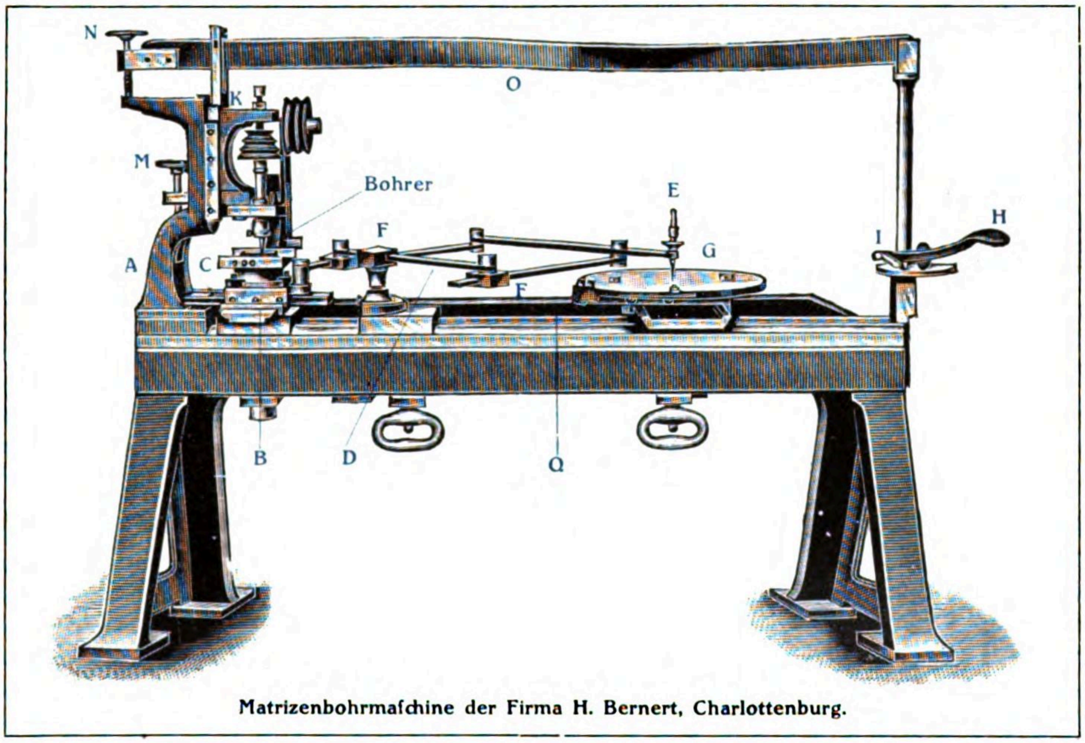

Fig. 5.16: Bernert Matrix Engraving Pantograph (1909)[21]

TO DO: Discuss Wernicke's article. Consult Patrick on the possibility of using extracts from his translation.

[21]From {Wernicke 1909}: 35.

6• The Second Known Success: Schraubstadter (1882)

6.1• Brief Summary: Germany to DeVinne

TO DO: Portraits of Wm. Schraubstadter, Schroeder, and Werner. Note on spelling of Gustav(e) from his patents, Loy, and Steve's notes in his edition of Loy.

TO DO: Bio sketch of William A. Schraubstadter.

TO DO: Bio sketch of Gustav Schroeder. From Loy. Check through Werner. From comment in Werner's letter to Gress (1932)

TO DO: Bio sketch (1910?) of Werner {[Werner 1912]}.

Partial: For context, from 1888 through 1891 Werner and Schroeder worked as partners using the original ex-Cincinnati, ex-Central pantograph and a copy of it that the St. Louis machine shop of Boyer made for them. Schroeder left this partnership in 1891, but Werner continued until at least 1893 as an independent engraver.[1] Around 1894 Werner joined the newly formed Inland Type Foundry as a machine engraver, presumably bringing his machines with him. He left in 1899, but returned somewhere around 1905/6 {[Werner 1912]}.

In 1880, the Cincinnati Type Foundry imported from Germany a typographical pantograph and attempted matrix engraving with it. They were not successful. It is unsurprising that they would have looked to Germany for this machine, as the foundry was run by Henry Barth — formerly Hans Barth, who had fled Germany after the failed revolutions of 1848. This is the Barth of Barth Typecasting Machine fame. We know nothing of the technical details of this pantograph save that it was a horizontal machine. In light of what we now know about Hofer and Ludwig's work from 1877 and the exhibition of their pantograph in Berlin in 1879, however, it is not unreasonable to suggest that this 1880 import might have been a Hofer machine.

In 1882 this machine was sold to the Central Type Foundry in St. Louis. In that year, William A. Schraubstadter (son of the foundry co-owner Carl Schraubstadter, Sr.) used it to cut the first matrices by machine in the United States. These were directly engraved in brass. The engraver Gustav Schroeder made the patterns. The first faces cut were Geometric[2], Geometric Italic, and Morning Glory. Later faces included the first typewriter face (unimaginatively but effectively named "Type-Writer.")[3]

[1] Note that this also demonstrates that he was doing *machine* engraving. Schroeder was a talented hand engraver who could work either by hand or by machine. Werner, while skilled in many fields, did not have the skills of a hand engraver.

[2] Patented by James A. St. John in a patent filed in 1880 {US D12,123 St. John 1881}.

[3] The choice of faces was very smart. These are all monoline faces without fine serifs and therefore easier to engrave. At the same time, though, monoline faces in 1882 were stylistic innovations.

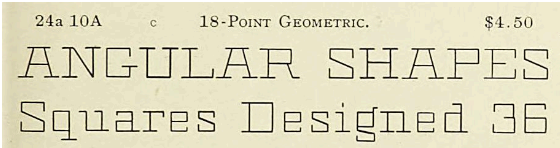

Fig. 6.1: Geometric, 18pt[4]

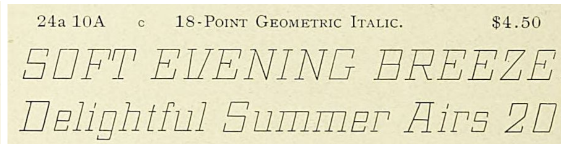

Fig. 6.2: Geometric Italic, 18pt

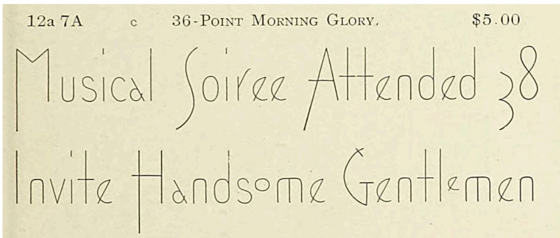

Fig. 6.3: Morning Glory, 36pt

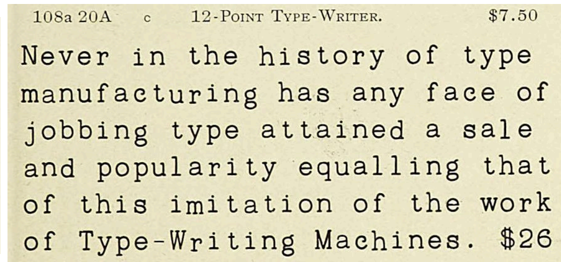

Fig. 6.4: Type Writer, 12pt

TO DO: Scribner?

In 1888, the printer Nicholas Werner (who had been at the Central when the first matrices were cut) formed a partnership with Schroeder. They purchased this machine from the Central, had a second machine made for them by the Boyer Machine Works in St. Louis,[5] and set up in business offering commercial matrix engraving services.

Werner and Schroeder engraved

TO DO: identify the faces; illustrate them — especially DeVinne

TO DO: identify which faces were cut directly as matrices and which were cut as patrices for electro mats

TO DO: Schroeder's departure for California; continued engraving by Werner. Identify and illustrate the faces.

The path of these machines (the one imported from Germany in 1880 and the copy made by Boyer in St. Louis in 1888) leads to the Inland Type Foundry. Werner was using them for commercial engraving services until at least 1893 (cutting DeVinne Condensed and DeVinne Italic, as seen below). At some point near the start of the Inland Type Foundry in 1894 he began working for them. The Inland sold at least one engraving machine, to the Genzsch & Heyse type foundry in Germany. It is not to be expected that the pantographs at the Inland survived the purchase of that firm in 1912 by ATF.

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[4]From the 1892 Central and Boston Type Foundry specimen book, *Popular Designs for Artistic Printers* {Central-Boston 1892}. Note that the use of these 1892 specimens to illustrate these faces is slightly anachronistic, since these have point-system bodies while the faces cut in 1882 were pre-point system. However, I have not been able to locate a Central (or Boston) specimen book from the period between 1882 and the adoption by the Central of the point system in 1885.

[5]Boyer has its own fascinating history and was closely involved with the formation of the Burroughs adding machine company.

The relationship between these machines and a 1906 pantograph made by Charles H. Schokmiller[6] for Stephenson, Blake (in England) is unknown.

[6]Of the Western Type Foundry, St. Louis and Chicago, 1901–1918).

6.2• Werner's Accounts

The notion that Benton in 1884 was the first to apply machine methods to the production of matrices should have ended in 1927 with Nicholas Werner's *Inland Printer* article. It did not.

But why trust Werner's accounts? Because he was there as an active participant. While he wrote and spoke about it long after these events took place, his accounts are firsthand. He knew Schraubstadter and Schroeder. He later purchased the pantograph, had another one made, and (in partnership with Shroeder) used them in commercial matrix production of at least one major typeface (DeVinne).

Against this must be placed the fabrications of Henry Lewis Bullen, which constitute what for a century has been accepted as the history of typemaking. For more on this, see chapter 11, "Interpreting Benton," p. 157, and "Other Problems with Bullen as a Source," Appendix I on page 249.

Werner never addressed the matter of the first pantographic typemaking[7] in a single, direct article. What we have from him are incidental references as he discusses or responds to other things: the design process of the typeface DeVinne, the history of typefounding in St. Louis, etc. This may seem surprising today, but isn't really. Linn Boyd Benton never published any account of his work as an inventor.[8] Neither did William Schraubstadter, Gustav Schroeder, C. J. Ludwig, or Herrmann Hofer. Werner himself wrote: "It seems to me that, in former days, type designers and engravers were very modest and kept their own personalities much in the background.[9]" Typemaking was just business and type makers weren't the celebrities they often are today. The emphasis on priority and proving that our Great Man was better than yours was a product of marketing departments later on.

[7]While we know now that it was not the first, it was the first in the United States and the first that he was aware of.

[8]He may have been the author of an anonymous 1893 article in *The Inland Printer* describing his pantograph, and his portrait appears in that article {[Benton 1893]}. He did write about typemaking by pantograph for a chapter in a popular book about books, *The Building of a Book* {Hitchcock 1906}. Patricia Cost also cites an instance in his correspondence of the 1930s where he wrote privately about his pantographs {Cost 2011}, 70. But he never published anything asserting his own priority of invention. He was, as Bullen and others have justly noted, a modest man.

[9]{Werner 1932}: 71.

6.2.1• *The American Printer* (1924)

The first instance of which I am presently aware where Werner mentions the events of 1882 is in *The American Printer* in the August 20, 1924 number {Werner 1924}. He is responding to an earlier article by Edmund Geiger Gress (E.G.G., editor of the magazine) from the May 20, 1924 number {Gress 1924}: 39–40. In that article, Gress recounted a conversation with R. W. Nelson (president of ATF) and said that the typeface "DeVinne" was "offered to one type foundry after another."

Werner's response to this claim about DeVinne[11] is not relevant here. What is important in the present context is what he says about how it was cut. These remarks have been extracted from his letter and are reprinted in Fig. 6.5 at right.

type foundry after another." I was intimately associated with Gustav Schroeder, one of the old Central Type Foundry's type designers and engravers; in fact, he and I worked together at the production of the DeVinne series. He cut some sample letters of the design for that foundry, which was then approved and the order given for a complete series.

Mr. Schroeder then worked out the designs for the complete font, from which patterns were made and the original type cut (for electrotype matrices)—the pattern making and the work at the engraving machine being performed by the writer, who later on designed, patterned and machine-cut the DeVinne Italic and DeVinne Condensed. (The DeVinne Extra Condensed and DeVinne Extended, which were not entirely in keeping with the design of the previous DeVinnes, were cut by a third party.)

Mr. Schroeder also made the designs and patterns for the first typewriter face, which was then cut by machine directly into the matrices (of brass), this, together with the Geometric, Geometric Italic and Morning Glory being no doubt the first faces ever cut directly into matrices (the process that is now in vogue). Here William A. Schraubstadter, later part owner of the Inland Type Foundry, was operator at the engraving machine, which was imported from Germany. This was anterior to 1890.

Fig. 6.5: Werner (1924)[10]

Fig. 6.6: DeVinne Italic, 42pt (1893)[12]

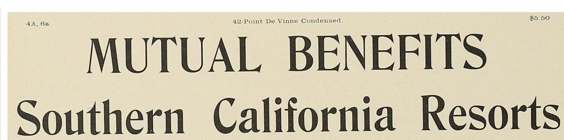

Fig. 6.7: DeVinne Condensed, 42pt (1893)

From Werner's remarks we learn that DeVinne Italic and DeVinne Condensed were cut as patrices ("for electrotype matrices") by Werner himself "at the engraving machine" after patterns by Gustav Schroeder. These two faces were shown (as new) by the Central in the October

[10]From {Werner 1924}: 45.

[11]DeVinne was patented by Gustave [sic] F. Schroeder in early 1893. Curiously, the patent was assigned to V[alentine] J. A. Rey of San Francisco, co-owner of the Palmer & Rey type foundry. See {US D22,263 Schroeder 1893}. This was after Schroeder had moved to California. This may have been a source of Nelson's remark to Gress that DeVinne was offered to multiple foundries.

[12]From {Central T. F. 1893}. DeVinne Condensed is shown on p. 68 and DeVinne italic on p. 69.

1893 number of *The Inland Printer* in 10 to 42pt bodies[13], which tells us that Werner was still doing commercial engraving (of patrices, this time) on these pantographs.

We also learn that William A. Schraubstadter operated the engraving machine to cut the first typewriter face (which was the Central Type Foundry's "Type-Writer") directly into brass matrices, along with Geometric, Geometric Italic, and Morning Glory[14] The date here is given in broad terms as "anterior to 1890," but more information on the date will emerge later.

Finally, we learn that the Central's pantograph was imported from Germany.

6.2.2• "St. Louis' Place on the Type Founders' Map" (1927)

Werner's next account came in a rather rambling article in *The Inland Printer* in 1927. This article concerns various aspects of typefounding in St. Louis, including point bodies, fine work in patrix cutting by hand, brass type, casting large bodies, the creation of ATF, eliminating kerns in the lowercase 'f', the origin of chalk plates (now largely forgotten), the typecasting machines of Schokmiller and of the Inland Type Foundry, the development of lining systems (one of his favorite topics), point-set type, and nickel matrices. His remarks on machine engraving form only a small part of this. See {Werner 1927}; the entire article is very much worth a look.

He begins (in the paragraph before the one reproduced to the right) by discussing both the negative and positive aspects of electroformed matrices: "piracy," on the one hand, compared with the fact that "the electrotyping process, however, proved itself to be highly valuable in the production of original faces."

> **In due order machines were invented for cutting both steel punches and metal master type, which made it possible to produce new faces with still greater speed and also, through the means of pantographic devices in the machines, to make the faces more accurate and conformative in design in all the sizes of a series. One of the earliest of such machines found its way to Saint Louis from Germany in 1882 and enabled the Central Type Foundry to push the making of original faces. Up to the time of the formation of the American Type Founders Company, only one other foundry (a small concern in Milwaukee) engraved new faces with the aid of machinery. So here we may again record pioneer work in Saint Louis.**

Fig. 6.8: Werner (1927), p. 765 ¶2[15]

He then goes on to note that pantographs were developed "for cutting both steel punches and metal master types". Importantly, these allowed faces to be made more "conformative in design in all the sizes of a series." The Central Type Foundry's machine was one of these: "One of the earliest of such machines found its way to Saint Louis from Germany in 1882 and enabled the Central Type Foundry to push the making of original faces." Note that while the way he phrased this doesn't mention the role of the Cincinnati Type Foundry in importing this machine neither does it exclude it.

The last sentence of this paragraph may need some unpacking, as it is the closest that Werner

[13]See {Central T. F. 1893}: 68–69.

[14]Werner's text isn't completelly explicit on the matter, but it is safe to presume that their matrices were brass as well.

[15]From the Internet Archive digitization from microfilm of {Werner 1927}. Public domain.

ever came to a snide remark. The “small concern in Milwaukee” is of course Benton and Waldo’s Northwestern Type Foundry. This is of course literally true; it was not a large foundry. But to separate Benton’s work at his own foundry (a small concern) with Benton’s work at ATF (a great concern) is not entirely fair. Note, also, that this says nothing of priority. Werner only says that prior to 1892 the only threads of machine engraving for type were the Central’s and this “small concern in Milwaukee.”

Werner continues with a discussion of direct matrix engraving. He identifies Gustav F. Schroeder as the patternmaker and William A. Schraubstädter as the pantograph operator. The first three faces were Geometric, Geometric Italic, and Morning Glory. He also notes Schroeder’s role in DeVinne.

A still more modern method of producing matrices now in vogue in type foundries is that of doing away with punches and master types. This consists in engraving the character into a matrix direct, a process rendered comparatively easy for the experts by the engraving machine. Here again Saint Louis was the scene for the pioneer work of this sort in the United States, the matrices for the Geometric, Geometric Italic, and Morning Glory, three quite popular faces at one time, having been the first that were produced in this manner. The first work on this machine was done by William A. Schraubstädter, who was then an apprentice in the Central Type Foundry. The patterns used as guides for the pantographic tracers were made by Gustav F. Schroeder, a type designer and engraver, from whose hands came a large number of the successful faces brought out by the Central Type Foundry, including that grand success, the De Vinne series, which enjoyed a world-wide popularity not only in this but in all other countries.

Fig. 6.9: Werner (1927), p. 765 ¶3

In what follows, we learn something new about this machine: that for the partnership of Werner and Schroeder a “new engraving machine” was built which had “several improvements.” The fact that these were “improvements” indicates, I think, that this was essentially the same design of machine rather than an entirely different one. This was made for them by the Boyer Machine Company. At some point in time, it was electrified (one assumes that the earlier Hofer or Hofer-style machines were mechanically driven via shafts and belts from a steam engine). The successor machine by Schokmiller (who also built typecasting machines) and Werner’s European foundry travels will receive more attention in his 1931 address (below).

Later on Mr. Schroeder, with whom I became associated in 1888 at type engraving, had several improvements incorporated in a new engraving machine, which was built for us by the Boyer Machine Company, of Saint Louis, whose head at the time, Joseph Boyer, is now one of the leading men of the Burroughs Adding Machine Company. Mr. Schroeder was also the first to apply electric power to such a machine. Further improvements were next made in engraving machines by the Inland Type Foundry and later on by Charles H. Schokmiller, whom I mentioned at the beginning of this article. Machines of later models were sold to European type foundries — Genzsch & Heyse, Hamburg, and Stevenson, Blake & Co., Sheffield. I myself had the commission to go overseas and instruct the engraving force of the latter foundry in its use.

Fig. 6.10: Werner (1927), p. 765 ¶4

He then mentions matrix making in passing, in the context of the Central’s face “Type-Writer” (which was a bestseller and the first of many typewriter-based faces): “The patterns for it were made by Mr. [Gustav] Schroeder, and William A. Schraubstadter

It may be news to many that the first font of typewriter type was cast in Saint Louis, being brought out by the Central Type Foundry and achieving so much popularity that it had to be cast by the ton. The patterns for it were made by Mr. Schroeder, and William A. Schraubstädter engraved the matrices on the machine. Your essayist had the pleasure of setting up the first matter and taking the first proof of typewriter type.

Fig. 6.11: Werner (1927), p. 765 ¶5

engraved the matrices on the machine" (766).

> The first matrices engraved here directly by the pantograph machine were cut in brass, but later they were done in steel and also a composition metal resembling German silver.

Fig. 6.12: Werner (1927), p. 766

Later, near the end of his article, he says something about the materials of matrices. Copper is the traditional material for hand-struck matrices, and copper is the material of the "eye" or casting cavity of electroformed matrices. Brass is the traditional material for engraved matrices. Typefounders have always been looking for more durable materials. The significant point here is that this is confirmation that the 1882 engraved matrices at the Central were engraved in brass.

6.2.3• "An Address" (St. Louis, 1931; 1941)

> This foundry was the first one to produce new display faces by the aid of engraving machinery, the Typewriter and the Geometrics being the first ones so engraved, by using the intaglio or routing method of making matrices. This method is now in world-wide use, being almost the exclusive one, superseding the old practice of cutting steel punches, which was indeed a laborious, painstaking art.

Fig. 6.13: Werner (1931), p. 1[16]

Werner's next contribution comes in 1931, in the form of what was initially an address to a meeting of the St. Louis Club of Printing House Craftsmen {Werner 1931}.[17] It has no title, but its cover is hand-annotated with two potential titles: "St. Louis' Part in Typefounding" and "Some Thoughts about Typography." I am indebted to Robert A. Mullen, who wrote the book on St. Louis typefounding[18] for making me aware of this Address and for providing me with a scan of a photocopy of its transcript in the St. Louis Public Library some years ago. It is now available directly from the St. Louis Public Library Department of Special Collections' Werner Typography Collection.[19] It is marred by a sexism not uncommon in for its generation, but that does not detract from its evidence.

Again, Werner is discussing a variety of topics concerning typefounding and St. Louis. Insofar as machine engraving is concerned, he emphasizes the priority of the Central Type Foundry as "the first one to produce new display faces by the aid of engraving machinery, the Typewriter and the Geometrics being the first ones so engraved, by using the intaglio or routing method of making matrices." (see Fig. 6.13, above).

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[16]From the St. Louis Public Library Werner Typography Collection digitization of {Werner 1931}.

[17]It was reprinted a decade later under the title "St. Louis in Type-Founding History" in *Share Your Knowledge Review* {Werner 1941}.

[18]*Recasting a Craft: St. Louis Typefounders Respond to Industrialization*, {Mullen 2005}.

[19]`https://cdm17210.contentdm.oclc.org/digital/collection/werner/id/2026/rec/2`

Werner rambles, so the other points in his Address will be taken out of order. He credits Benton with cutting "the first Roman face engraved by machine" (p. 3, see Fig. 6.14, above). By this I believe that he means faces with serifs. The early faces at the Central had all been monoline faces intended for display. Benton began by cutting his "self spacing" (that is, point-set) types to his own design. These included both Roman and Italic types (though the exact dates of introduction of the various Benton types are uncertain).

> It is but fair to state that the first Roman face engraved by a machine was done on one invented by Mr. L. B. Benton, of Milwaukee, who was part owner of a small foundry in that city. His machine employed what is known technically as the upright pantograph, while the machines used in St. Louis had the flat pantograph. The two principles have about equal use. The upright pantograph, however, produces a certain small amount of distortion of the pattern used, due to swings from a central point, while the flat pantograph has no distortion. Were it not for machine

Fig. 6.14: Werner (1931), p. 3, col. 2

However, he makes an error with his claim that Benton's vertical pantograph "produces a certain small amount of distortion of the pattern used, due to the swings from a central point, while the flat pantograph has no distortion." This mistake is understandable, since other kinds of single-arm pantographs do produce distortion. Part of the brilliance of Benton's machine, however, is that it does not. See section H "Do Benton's Vertical Pantographs Distort?" on page 247 for an illustration of this.

He identifies by name the only woman of whom he is aware who worked as a pantograph engraving machine operator: Sarah Osborne. He does not give the date for this, but does note that it was during his time at the Inland Type Foundry. This must therefore have been at some point between 1894 (the startup of the Inland, with which he was involved) and 1899 (the year in which he left the Inland for the Keystone Type Foundry[20]).

> The fair sex is due some honor in the art of machine engraving. The Inland Type Foundry had the services of Miss Sarah Osborne as an operator of a machine, under my tuition, and she did most creditable work. I have never heard of any other woman being so employed.

Fig. 6.15: Werner (1931), p. 3, col. 1(b)

[20]See {[Werner 1912]} for these dates. Annenberg places the start of the Inland at 1895, but a closer examination of his account reveals that it must have been starting up in 1894 {Annenberg 1994}: 156.

Werner's other comments may shed some light on the history of these machines, but they are difficult to sort out.

He says that the Inland Type Foundry "sold an engraving machine to Genzsch & Heyse" and that members of that foundry visited St. Louis to learn it. This information may be confirmed by the biographical sketch of Werner in *Printing Trade News* (see {Werner 1912}, although it is unclear how much of that information may be traced back to Werner himself. Regrettably, he does not give a date for this.

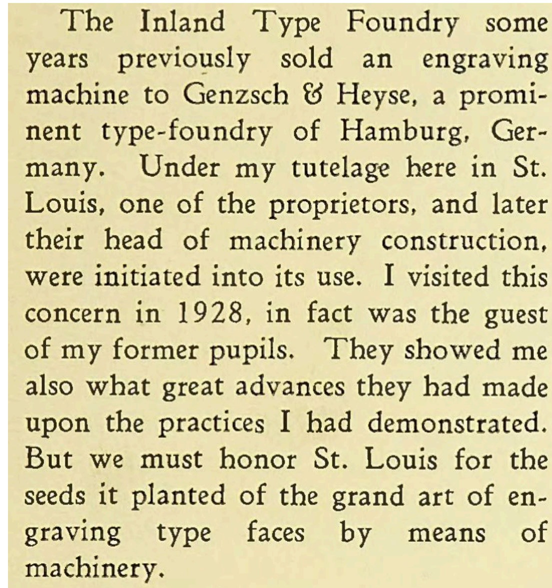
The Inland Type Foundry some years previously sold an engraving machine to Genzsch & Heyse, a prominent type-foundry of Hamburg, Germany. Under my tutelage here in St. Louis, one of the proprietors, and later their head of machinery construction, were initiated into its use. I visited this concern in 1928, in fact was the guest of my former pupils. They showed me also what great advances they had made upon the practices I had demonstrated. But we must honor St. Louis for the seeds it planted of the grand art of engraving type faces by means of machinery.

Fig. 6.16: Werner (1931), p. 3, col. 1(a)

While we know nothing with certainty about the details of this machine, it may well have been a variation on the Central/Werner machine. If this is the case, then there is a certain irony in a German type foundry purchasing an essentially German pantograph from an American foundry.

As a final note, Werner says that he cut "Flemish Condensed" for Stephenson, Blake (of England) at some point before 1906 (p. 3). 1906 in this case is simply the date at which he visited the Stephenson, Blake foundry in England to deliver to them a pantograph engraving machine made by Charles H. Schokmiller, of St. Louis. (This machine is not necessarily related to the Central/Werner/Inland machines.) However, Loy's article on Werner says only that he cut Flemish Expanded while working as an independent engraver after Schroeder's departure (thus between 1891 and 1893). {Loy 1899-08 No. 19}.

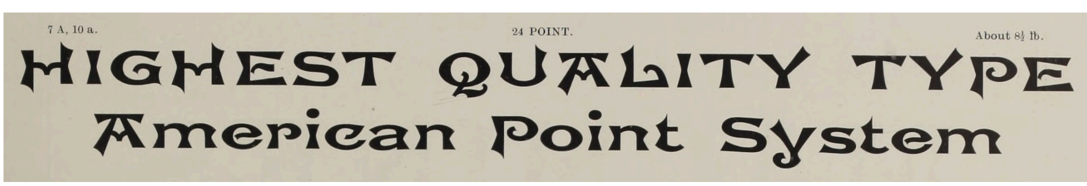

Fig. 6.17: Flemish Expanded[21]

[21]From {Stephenson, Blake 1908}. The only showing I have located for Flemish Condensed is in a 1984 Dover Pictorial Archive volume, Ludwig Petzendorfer's *Treasury of Authentic Art Nouveau Alphabets, Decorative Initials, Monograms, Frames, & Ornaments*. This is in copyright, but a preview showing Flemish Condensed may (or may not) be online on Google Books at `https://books.google.com/books?id=Yi43nSiaBJQC`

6.2.4• In a Letter to E. G. Gress (1932)

In a 1932 letter to Edmund G. Gress, Werner confirms again the matrix engraving of the Central. However, the greatest interest of this letter is in its lists of types cut and their circumstances. For this reason I will reprint it in its entirety here.

N. J. Werner and the Designers of Typefaces

I had occasion recently to write to Nicholas Joseph Werner, of St. Louis, for information about the designer of the DeVinne typeface that was so popular in the 1900 period, and received from him a letter so full of interest that I am quoting from it.

Fig. 6.18: Gress' Introduction (1932)[22]

With regard to machine engraving, he says two things directly. First:

> The DeVinne face was designed or drawn by Gustav Schroeder about 1888 and it was engraved by machine, I being the operator.

Second, he says of the original work at the Central:

> … Geometric … Geometric Italic, Morning Glory, and the very first typewriter face. These were engraved intaglio direct into matrices by William A. Schraubstadter, one of the partners of the Central Type Foundry. To the best of my knowledge, this was the first practice of the art of direct matrix engraving, which is now so general, instead of first making a master punch in steel or of engraving a master type from which to make electrotype matrices.

Here is Werner's letter, by paragraph.

"The DeVinne face was designed or drawn by Gustav Schroeder about 1888, and it was engraved by machine, I being the operator. At that time Mr. Schroeder and I were in partnership in the type-engraving business. Previously he was house engraver for the Central Type Foundry, while I was its house printer. While so employed, Mr. Schroeder designed and cut the Central's Hogarth, Geometric Antique, Geometric Gothic, Harper, Art Gothic, Art Initials, Erebus, Hades, Old Style Bold, French Old Style (lower case only), Old Style Script, Novelty Script, Victoria, Atlanta, Washington, Cushing, and others I do not now recall. During our partnership we produced the Jefferson, Lafayette, DeVinne, Victoria Italic and Era (the last for Barnhart Brothers and Spindler).

Fig. 6.19: Werner to Gress, ¶1

"While Mr. Schroeder was with the Inland, he made the patterns for the larger and smaller sizes of the Geometric (the middle ones coming from W. W. Jackson, a leading Philadelphia type designer and engraver), the Geometric Italic, Morning Glory, and the very first typewriter face. These were engraved intaglio direct into matrices by William A. Schraubstadter, one of the partners of the Central Type Foundry. To the best of my knowledge, this was the first practice of the art of direct matrix engraving, which is now so general, instead of first making a master punch in steel or of engraving a master type from which to make electrotype matrices.

Fig. 6.20: Werner to Gress, ¶2

[22]From {Gress 1932}: 52–53. Public domain.

"I noticed with some interest where you dropped off the serifs of some faces and made gothics of them. Your attempt is not the first. Geometric Gothic was made from Geometric Antique, the Studley from the Woodward.

Fig. 6.21: Werner to Gress, ¶3

"By the way, Mr. Schroeder soon tired of rustic life. He worked awhile for the Pacific States Type Foundry, then for the Keystone Type Foundry, for whom he produced the Encore, the Venezia, the John Hancock, and a number of other faces. He died in Florida. He originally came from Berlin, where Carl Schraubstadter, of the Central Type Foundry, became acquainted with him and then engaged him to come to St. Louis. I believe this was in 1881."

Fig. 6.22: Werner to Gress, ¶4

6.2.5• While Discussing Wiebking (1932)

The Chicago engraver and sometime typefounder Robert Wiebking died in 1927.[24] So Werner's 1932 article in *The Inland Printer* isn't quite an obituary. It is more of a tribute and, like all of Werner's writing, it rambles a bit {Werner 1932}.

Fortunately, it supplies the missing link in the history of the Central pantograph: the information that it was "imported from Germany for the Cincinnati Type Foundry during 1880" and that "it was sold in 1882 to the Central Type Foundry in St. Louis." He then repeats information covered previously: that with it were cut Geometric, Geometric Italic, Morning Glory and "the first typewriter face."

States. I know of an engraving machine being imported from Germany for the Cincinnati Type Foundry during 1880. However, this concern appeared to have had no one competent to operate it, and it was sold in 1882 to the Central Type Foundry, of St. Louis. With it were cut the famous Geometric and Geometric Italic, followed by the eccentric Morning Glory face. The first typewriter face was also cut with it.

Later on, Gustav Schroeder, who cut many faces for Central and many other foundries, bought the machine. At that time I went into partnership with him, and we produced a number of faces by its aid, including the popular De Vinne family. (To correct the general impression that Theodore L. De Vinne was the designer of the face named after him, I would state that it was the creation of my partner, Mr. Schroeder.)

Fig. 6.23: Werner (1932)[23]

[23]From {Werner 1932}. Public domain.

[24]See section 9.3, "Wiebking and Hardinge (1894–1927)," on page 151 for more on him.

6.3• Confirmation from 1883

Werner's accounts were written decades after the fact. They carry great weight because Werner was a witness to the events and because he later owned and operated the machine. However, contemporary independent confirmation is always a good thing. Fortunately, such an account exists.

The contemporary account is brief, and buried in an obscure source. At some point before April 1883, an article appeared in *The American Model Printer* concerning the Central Type Foundry. The article appears to have been written by W. J. Kelly, editor of the magazine. For the most part, it concerns the "copper alloy" type promoted by the Central Type Foundry. However, it also briefly discussed a visit to that foundry. This is a scarce journal which has not yet been digitized; I have not examined an original copy of this article. It was, however, reprinted at least twice in 1883.

One of these reprints was in the first number of a short-lived publication, *The Chicago Printer*, in April 1883 {Kelly 1883 CP}. It may have appeared there as advertising material. If so, then presumably this was paid for by the Central Type Foundry, as it is highly complementary to them. If in fact this was the case, then this would also imply that the foundry endorsed this account of their activity.

Another reprint appeared in the spring 1883 issue of *Hailing's Circular,* in England. {Kelly 1883 H}

While in St. Louis a few months ago, we visited the Central Type Foundry, with the view of examining the peculiarities of copper alloy, preparatory to purchasing an outfit for our new office, and were kindly received by the proprietors, and as courteously conducted through the foundry by Mr. Schraubstadter, the senior partner. Every process of manipulation was shown and technically explained to us, as were also a number of new machines, invented and improved by themselves, and in use only in this foundry. Suffice to say, we were astonished at the progress these gentlemen had made in the art of letter-founding and punch-cutting-- a very ingenious machine for doing the latter (perhaps the only one in actual use in this country) was under the full management of a very promising son of Mr. Schraubstadter.

Fig. 6.24: Kelly, from Chicago Printer

While in ST. LOUIS, a few months ago, we visited the Central Type Foundry, with the view of examining the peculiarities of copper alloy, preparatory to purchasing an outfit for our new office, and were kindly received by the proprietors, and as courteously conducted through the foundry by Mr. SCHRAUBSTADTER, the senior partner. Every process of manipulation was shewn and technically explained to us, as were also a number of new machines, invented and improved by themselves, and in use only in this foundry. Suffice it to say, we were astonished at the progress these gentlemen had made in the art of letter-founding and punch-cutting--a very ingenious machine for doing the latter (perhaps the only one in actual use in this country) was under the full management of a very promising son of Mr. SCHRAUBSTADTER.

Fig. 6.25: Kelly, from Hailings'

The first thing to consider about this account is its date. It was published by April 1883, which makes that a firm *terminus ante quem* for machine cutting. But this article as it appears here is a reprint from the *American Model Printer*, so it must have appeared slightly earlier. It also notes that this visit happened "a few months ago." If "a few" means three or more, these considerations place it firmly in the previous year, 1882. This matches Werner's recollections.

The second point to be made is that it refers to machine punch-cutting rather than patrix cutting or direct matrix engraving. By itself, this would not be surprising. But Nicholas Werner (see below) is quite clear that the first types produced were engraved directly as matrices. However, Werner himself used the same machine at a later point to engrave the face DeVinne by cutting patrices. Moreover, to an untrained observer, matrix cutting might easily be mistaken for punch cutting in steel. It is also possible that the observer, seeing matrices being made, simply applied the familiar term "punchcutting" to the process.

The third interesting feature of this account is its parenthetical remark that this machine was "perhaps the only one in actual use in this country." Such phrasing strongly suggests that there were other machines which were *not* in actual use (that is, machines for which some claim had been made but with which no results had been produced). Like so many aspects of this history, this detail suggests that what was really happening in the 1880s was much more complicated than we have believed it to be.

6.4• Confirmation in Loy on Schrœder and Werner

Both Gustav F. Schroeder and Nicholas J. Werner receive articles in William E. Loy's 1898–1900 series on "Designers and Engravers of Type" in *The Inland Printer.*

> and N. He also made for the Central the patterns for Geometric Italic, Morning Glory and Scribner, of which matrices were cut in brass by machine. He also cut the 6-point size of Law

Fig. 6.26: Loy on Schroeder 1 (1898)[25]

The remarks in Loy on Schroeder which are relevant here are brief. What makes them significant is that they are by a third party (Loy) who seems actually to have communicated with Schroeder.

> In 1889 Mr. Schroeder associated with himself N. J. Werner (now of the Inland Type Foundry), and some of the most successful designs made by the Central Type Foundry were made during the time of their coöperation. In 1891 he came to California, and he has since made his home in Mill Valley, a suburb of San Francisco. During the time he was working for various type founders he designed and cut for the Pacific States Type Foundry the series of Aldus Italic in four sizes, Sierra in eight sizes, an 18-point size of French Old Style No. 2, various borders and ornaments, and recently a lower case for the various sizes of Victoria Italic, from 6-point to 24-point.

Fig. 6.27: Loy on Schroeder 2 (1898)

Loy confirms the first faces, though he omits the non-italic Geometric and adds Scribner. He confirms that these were made by direct matrix engraving by machine in brass.

His remarks also confirm the partnership between Schroeder and Werner and give a date for move by Schroeder to California which terminated that partnership (1891).

When discussing Werner, he first establishes that Werner, while a printer, had learned at least a part of the craft of typefounding and that he later went into partnership as Schroeder & Werner.

> Finding that there was not enough work in the printing line to occupy him constantly, he between times learned the process of dressing and finishing type, at which occupation he spent a considerable portion of his time. Later he had the keeping of matrix and manufacturing records, and his opinions and judgment on new faces and the fitting of them began to be called for, and to a large extent were respected by his superiors. In this way he became more intimately acquainted with the business of type designing and engraving, as well as with the engravers employed in the house, especially with Gustav Schroeder, with whom he later on was associated under the title of Schroeder & Werner, both severing their direct connection with the foundry.

Fig. 6.28: Loy on Werner 1 (1899)[26]

[25] From {Loy 1898-12 No. 11}, from the Smithsonian Institution Library digitization. Public domain.

[26] From {Loy 1898-12 No. 11}, from the Smithsonian Institution Library digitization. Public domain.

Loy clearly doesn't understand the details of matrix engraving, but expresses the process in the terms which would have been most familiar to him. He says nothing in his sketch of Werner about pantographic work at the Central (which in fact Werner did not himself do), but does confirm that the partnership of Schroeder & Werner were engraving by machine. His list of their faces is valuable.

With the aid of routing machinery, and in a general way following the process of the manufacturers of wood type, during their partnership Messrs. Schroeder & Werner produced the first eight sizes of the popular De Vinne series, eight of the Victoria Italic, also the complete series of Hermes, Jefferson, Novelty Script, Multiform, and Johnston Gothic lower-case for the Central Type Foundry. For the Boston Type Foundry they produced the lower-case for the Façade Condensed, the caps having been previously cut by Julius Herriet, Jr. For Barnhart Brothers & Spindler they cut the Era series, one of the best and most popular faces produced by that foundry.

Fig. 6.29: Loy on Werner 2 (1899)

Loy continues by listing the faces cut by Werner on his own, after Schroeder left for California.

About this time Mr. Schroeder was desirous of taking up his residence in California, and the partnership was dissolved, Mr. Werner continuing on his own account. He then finished the full series of De Vinne and Victoria Italic, and designed and cut the De Vinne Condensed, De Vinne Italic, Midgothic, and Antique No. 6. A little later he cut the Quentell series, also for the Central, after designs by W. P. Quentell, of Kansas City, which has proven one of the popular faces of recent years. For Stevenson, Blake & Co., of Sheffield, England, he cut a series called by them Flemish Extended, and for Marder, Luse & Co., the four larger sizes of Caxton Bold.

Fig. 6.30: Loy on Werner 3 (1899)

Finally, Loy identifies some of Werner's work at the Inland Type Foundry.

When the Inland Type Foundry began business there was an opportunity to adopt correct standards of body, line, and set, and those suggested by Mr. Werner were generally used. Here was an opportunity for him to propagate his ideas at length, and he arranged to give all his time to that foundry. In its employ he has designed and in part engraved the Skinner, Extended Woodward, Condensed Woodward, and Gothic No. 8 series, as well as two new series shortly to be put upon the market.

Fig. 6.31: Loy on Werner 4 (1899)

The overall importance of Loy's two biographical sketches here isn't so much technical but historical. These biographical sketches confirm the scale of machine methods. The Central pantograph, and its copy by Boyer, were used not only to cut novelty faces (such as Morning Glory, as delightful as it is) but also some of the most important and bestselling typefaces of the period (DeVinne, Type-Writer). Loy's sketches also confirm the work of Schroeder & Werner as an *independent commercial matrix engraving business* operating from 1888 to 1894 with multiple type foundries (the Cental, the Boston, BB&S, and Stephenson, Blake) as customers.

6.5• Confirmation by Bullen in 1907

Surprisingly, even Bullen confirmed the priority of the Central, though he did so dismissively. Writing of Benton's "perfect" pantograph, he gets the date of invention in Germany wrong, the location of manufacture of the Central machine wrong, and the date of its use wrong. This does, though, confirm the existence and use of this machine — and from a most unsympathetic source, at that.

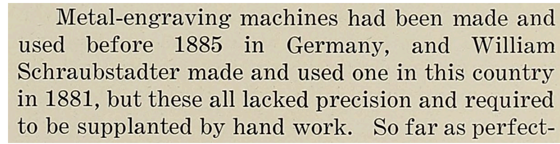
Metal-engraving machines had been made and used before 1885 in Germany, and William Schraubstadter made and used one in this country in 1881, but these all lacked precision and required to be supplanted by hand work. So far as perfect-

Fig. 6.32: Bullen on Schraubstadter[27]

There is no evidence at all for his statement that the German machines "all lacked precision." Contemporary accounts from Germany emphasized their precision. Moreover, to the practical engraver, the removable quill of these machines and the attention to cutter sharpening, all critical to Benton's later pantographs, argue otherwise.

6.6• Other References to the Central Machine

Writing for *The Inland Printer* in 1888, Carl Schraubstadter, Jr. (brother of William Schraubstadter) compares the form of the counters in types produced by traditional steel punchcutting with those produced by Benton's "punchcutting machine" and by "the drilling machine." He gives no dates for either; he is writing about the forms they produce, not their history. But his casual mentioning of both indicates that they were simply common knowledge for him at this time. It is also interesting that he calls the non-Benton machine "the drilling machine." This is a direct translation of the name that it would have had when it was built in Germany: bohrmaschine. See {Schraubstadter 1888} (*Inland Printer,* Vol. 5, No. 12 (September 1888): 906).

See section 7.2.6, "Knowledge of Benton by the Schraubstadters," on page 115, for a reproduction of Schraubstadter's original text.

[27]From {Bullen 1907}: p. 517.

6.7• Faces Known to Have Been Cut

TO DO (all of this; it is just sketched in now):

Revise visual presentation. Try to illustrate faces.

methods:

m for direct matrix engraving

p for patrix engraving and matrix electroforming

u for unknown method

sources:

LS - Loy on Schroeder

LW - Loy on Werner

W24 - Werner 1924

W27 - Werner 1927

W31 - Werner 1931, 1941

W32 - Werner 1932 WG32 - Werner to Gress 1932

Digital natives are reminded that in cast metal type each variation and each body size is cut separately as its own matrix font. Having, say, DeVinne at 18pt doesn't mean that you have it at 24pt or that you have DeVinne Condensed at all.

6.7.1• At the Central Type Foundry

Geometic (m) W24, W27, W31, W32, GW32 GW32 says that Schroeder made the larger and smaller sizes of the patterns but that the middle sizes came from W. W. Jackson.

see printers-circular-v15-1880-03-to-1881-02-google-TdgmAQAAIAAJ-uc-EXTRACT-v15-n8-1880-10-p189-central-type-foundry-announces-geometric-pica-longprimer-brevier.pdf* for 1889 announcement of Geometric in Pica, Long Primer, and Brevier

Geometric Italic (m) W24, W27, W31, W32, GW32

Morning Glory (m) W24, W27, W32, GW32

Type-Writer (m) W24, W27, W31, W32, GW32

Scribner (u) LW

TO DO: The faces by Schroeder by hand probably don't belong here; integrate with Loys list and move to Schroeder bio.

GW32 says that Schroeder "designed and cut" a number of faces at the Central other than those identified as machine cut; Schroeder was after all an engraver. These would have been cut either as steel punches or typemetal patrices: Hogarth, Geometric Antique, Geometric Gothic [GW32 notes that it is Geometric Antique minus serifs], Harper, Art Gothic, Art Initials Erebus, Hades, Old Style Bold, French Old Style (lower case only), Old Style Script, Novelty Script, Victoria, Atlanta, Washington, Cushing

LW also says that Schroeder cut Law at 6pt, but this may have been by hand.

GW32 also says that Schroeder left California and later produced Encore, Venezia, and John Hancock for the Keystone Type Foundry.

6.7.2• By Schrœder and Werner

DeVinne (first eight sizes), for the CTF (p) LW, WG32

DeVinne Condensed (probably p) W24. But in GW32 Werner says he cut DeVinne Italic after Schroeder left. DeVinne Italic (probably p) W24. But in GW32 Werner says he cut DeVinne Italic after Schroeder left.

Era, for BB&S (u) GW32

Victoria Italic (eight sizes), for the CTF (u) LW, GW32

Hermes, for the CTF (u) LW

Jefferson, for the CTF (u) LW, GW32

Lafayette, for CTF (u) GW32

Novelty Script, for the CTF (u) LW

Multiform, for the CTF (u) LW

Johnston Gothic, lowercase, for the CTF (u) LW

Façade Condensed, lowercase,[28] for the Boston Type Foundry, (u) LW

Era, for BB&S (u) LW

6.7.3• By Werner after Schrœder

Central Antique (u) GW32

DeVinne, finishing the series (presumably u), for CTF

Midgothic (u) GW32

Victoria Italic, finishing the series[29] (u)

Quentell, for CTF (u)[30] GW32

Flemish Condensed, for Stephenson, Blake (u) W31[31] (u)

---

[28]Caps cut previously by Julius Herriet, Jr.

[29]Loy on Schroeder says that Schroeder completed the lowercase from 6pt to 12pt in California for the Pacific States Type Foundry.

[30]"After designs by W. P. Quentell, of Kansas City."

[31]LW places Flemish Expanded (he says "Flemish Extended") with Werner after Schroeder; it is reasonable to assume that Flemish Condensed was produced at the same time.

Flemish Expanded, for Stephenson, Blake (u) LW (u)

Caxton Bold, four larger sizes, for Marder, Luse (u)

Schroeder continued work in California after dissolving his partnership with Werner, and cut several faces. It is likely that he cut these by hand rather than by machine, though. See LW. These were:

Aldus Italic, four sizes, for Pacific States Type Foundry

Sierra, eight sizes, for Pacific States Type Foundry

French Old Style No. 2, 18pt, for Pacific States Type Foundry

Victoria Italic, lowercase from 6 to 24pt, for Pacific States Type Foundry

"various borders and ornaments," for Pacific States Type Foundry

6.7.4• At the Inland Type Foundry

LW says that Werner "designed and in part engraved." Some of the engraving certainly was done by Sarah Osborne.

Becker (u) GW32

Bruce Title (u) GW32

Inland (u) GW32

Skinner, for ITF (u) LW, GW32

Extended Woodward, for ITF (u) LW, GW32 aka Woodward Extended

Condensed Woodward, for ITF (u) LW, GW32 aka Woodward Condensed

Gothic No. 8, for ITF (u) LW, GW32

"two new series shortly [1899] to be put upon the market" LW

6.8• A Note on Werner and Benton

TO DO: Decide if this sction is really necessary. It is useful, I think, to get a sense that these were real people with distinct personalities, not just data points for historians and targets for corporate marketers.

There is no sense that there was ever any fight for priority among the actual participants (Schraubstadter, Schroeder, Werner, and Benton).

Werner always shied away from the claim that the Central was the first in all aspects of pantographic type production. In {Werner 1927} he says no more than that before 1892 the Central and "only one other foundry (a small concern in Milwaukee) engraved new faces with the aid of machinery." In {Werner 1931} he claims only that the Central was first for display faces. In the same address, he credits Benton with having engraved the first Roman face. (The first faces cut by the Central were monoline display faces not suitable for use in text as a Roman face would be.) Engraving a Roman face, with serifs, is harder. It seems that Werner was being careful and trying to be fair, and that he did not know the exact date of Benton's first work. (This is not surprising, as we still do not know it.) Emphasizing the small size of Benton's foundry was perhaps unnecessary, but it was also true.

Werner's concern wasn't really to give the Central priority (though he did). He seemed far more concerned to ensure that the credit for DeVinne went to Schroeder.

Benton was similarly modest. Patricia Cost quotes from a letter from Benton to David Gustafson[32] in which he notes that his 1899 pantograph (the patent for which was issued in 1906) could engrave matrices, but that he "was not the originator of this idea." {Cost 2011}, 95.

Carl Schraubstadter, Jr. (brother of William Schraubstadter) went out of his way to praise the high finish of Benton's work in an important *Inland Printer* article on patrix engraving and matrix electroforming in 1887.[33]

To the best of my knowledge, neither William Schraubstadter nor Gustav Schroeder ever published anything about this matter (or, indeed, about anything else). Werner was the only one with any degree of flamboyance about him. The others were all modest technical people.

6.9• Development of the CTF Pantograph

TO DO: (or not; this may already have been covered above, with Inland and Genzsch & Heyse).

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[32]In correspondence for an entry on Benton in Gustafson's "Who's Who In Printing In the United States." No entry for Linn Boyd Benton actually appeared in {Gustafson 1933–1934}.

[33]See section 7.2.6, "Knowledge of Benton by the Schraubstadters," on page 115, for more on this. From {Schraubstadter 1887} (*Inland Printer,* Vol. 4, No. 6 (March 1887): 382.)

7• The Third Known Success: Benton (1884)

TO DO (somewhere in this chapter): Why the Benton myth? Better publicity. 1893 World's Columbian Exposition. Bullen. ATF specimen books. "Benton" became genericized; I have encountered several people who have simply used the term for any typographical pantograph. Possibly use examples of similar generic usages from DMM 2018 slides.

7.1• A Brief Summary: 1884–1899

A large part of the confusion surrounding Benton's pantographs is about what he actually made. You will find in our current literature phantom machines which never existed. Here is a brief summary.

There is no evidence one way or the other that Benton had any involvement in pantographs before 1883, though there is a suggestion on reasonable authority that this process might have started "about 1882" (see §7.2.1). Their first major use for Benton, Waldo and Company's foundry was to cut Benton's somewhat confusingly named "self-spacing" type (that is, his rather complicated variation of unit-set type). For a more detailed discussion of these types, see appendix G on page 239, What Was Benton's Self-Spacing Type? Here, it is sufficient to note that the first evidence that he was at work on these is his US patent 290,201, filed May 8, 1883.[1] These types were first announced in a trade notice in March of 1884.

A few days before this, on Feb. 29, 1884, he filed for a patent on a vertical single-arm pantograph engraving machine.[2] At least one instance of this machine was built in the distinctive form shown in the patent drawings, but this was not the form in which this machine was later

[1]Patents have at least two important dates associated with them: the date on which they were filed and the date on which they were granted. Most commonly, the latter is used when citing them and for most patents cited here that will be the convention used. However, in the case of Benton's patents the date of priority is very important (and also there was a long period between the filing of his 1899 pantograph patent and its issuance in 1906) so Benton's patents will be cited here by their filing dates.

[2]Note on terminology: The terminology employed here to designate Benton's vertical pantograph engraving machines is not standard or a part of the literature. It is the terminology that I adopted when writing *A Census of Benton and Related Pantographic Engraving Machines* {MacMillan 2023}. There has been considerable confusion in the literature about Benton's pantographs, including the claim that he created three (or four) distinct machines (which is not the case). Briefly, as used here and in the *Census*, a Type 1 Benton Engraving Machine (BEM) is one based on Benton's 1884 patent. It was built in two visually distinct but kinematically identical forms: Type 1a after the style shown in the patent drawings and Type 1b as a two-standard floor-standing model. A Type 2 Benton Engraving Machine (BEM) is one based on Benton's 1899/1906 patent. ATF built these in two slightly different forms, one smaller (Type 2a) and one larger (Type 2b). The Benton *Census* extends this terminology to direct copies of these Benton Engraving Machines by others (e.g., an ex-Monotype machine formerly at the Type Archive (Type 1c) or one of unknown provenance at Alberto Tallone Editore (Type 1d)), but these copies are not relevant here. Vertical pantographic engraving machines inspired by Benton's but not direct copies of it (such as the Pierpont machines) are not included in this terminology.

leased out. Figure 7.1 below shows the version of this first machine as shown in the patent. Figure 7.2 shows this same type of machine in its second form. These two machines may look very different at first glance, but they are identical in their functional arrangement and both would be equally covered by Benton's 1884 patent. (These images are not to scale. The Type 1a machine is intended to be mounted to a benchtop. The Type 1b machine is floor-standing.)

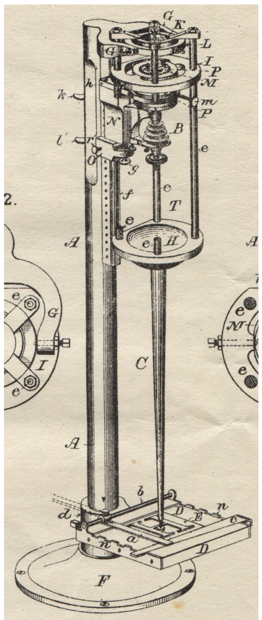
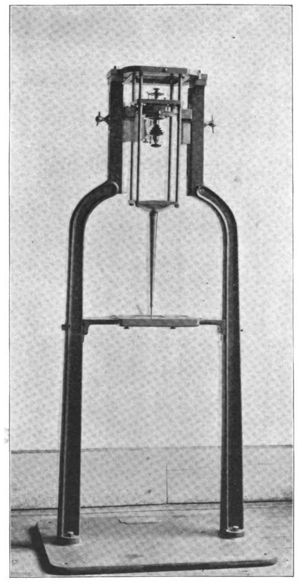


Fig. 7.1: Benton Type 1a by 1884[3]



BENTON PUNCH CUTTING MACHINE.
Height, 5 feet 4 inches. Floor space, 22 by 28 inches.

Fig. 7.2: Benton Type 1b by 1893

We know from primary evidence that Benton was cutting punches in steel by machine by July 1884. The Benton, Waldo foundry claimed this explicitly in a trade note which appeared in *The Inland Printer* in that month. We know from secondary evidence[4] and a knowledge of typefounding methods of the era that he was cutting patrices on it at the same time.

It is essential in understanding the development of these machines to realize that there is no fundamental difference between a machine for cutting punches in steel vs. one for cutting patrices in soft metal or even one for directly engraving matrices. You would certainly adapt your cutter geometries, your cutting speeds, and your operating protocols to match each situ-

[3]The image of a Type 1a Benton which is used here is from the filing of Benton's patent in Great Britain. {GB 11,894 of 1885 Benton}. It was scanned by me from an original printing of this British patent lent to me by Mark Knudsen; previously it had been owned by the late Monroe Postman. This image is of much higher quality than the low-resolution bi-level scans made by the USPTO before they destroyed all of the original patent documents. It is identical in every detail to the 1884 US patent filing. Public domain. The image of a Type 1b Benton which appears in the next figure is from an 1893 article on Linn Boyd Benton which appeared in *The Inland Printer* in conjuction with the display of this device at the World's Columbian Exposition in Chicago. This digitization is from the Hathi Trust presentation of the University of Michigan's copy. {[Benton 1893]}. Public domain.

[4]We know this from Patricia Cost's presentation of the deductions of William Charles Gregan as recorded by Theo Rehank. {Cost 2011}: pp. 60 & 73.

ation, but that's just ordinary machining practice. There is no technical reason why Benton needed to build a machine specific to any of these three processes. Indeed, we know that one particular Benton pantograph, machine number 55, a Type 2a machine formerly at the Dale Guild and now at Project Letter-kunde in Belgium, has cut all three.

Benton's 1884 pantograph had a cutting spindle which was below the workpiece, facing up.[5] It was fixed in its position during each cutting operation. This spindle was an adapted headstock from a Moseley No. 1 watchmaker's lathe (Benton's 1884 patent actually calls it a "lathe-head with additions"). The workpiece was above the spindle facing down and was moved by the pantograph mechanism. The operation was controlled by the lower end of the pantograph, tracing a pattern. The first patterns were incised lines on zinc sheets (a method attested in Europe as well).

This first machine (call it a "Type 1") existed in two visually distinctive but kinematically identical forms. The "Type 1a" machine, which looked like the patent drawings, is attested by a single photograph from the ATF Library from 1929.[6] It is not known if this machine survives. No later than 1891 (probably by 1887), this machine had become a visually distinct floor-standing model (call it "Type 1b"). This was the machine initially offered for lease.

Although this machine could have directly engraved matrices, if equipped with appropriate workholding devices, we have no evidence that it was used for anything other than punches and patrices. The patent refers to it as a Punch-Cutting Machine.

In a second patent, US 809,548, filed on February 17, 1899, Benton described a kinematically inverted variation of this machine. In it, the workpiece was held fixed during the cutting operation, below the cutter and facing up. The cutting spindle was mounted to the pantograph mechanism at a position above the workpiece, facing down. This is the form of the machine (call it "Type 2") which was illustrated in ATF's 1912 and 1923 specimen books, for example. It can cut matrices, patrices, and punches (and one surviving machine, No. 55, is equipped to do so). This machine was built in two sizes (with the same general layout for each): a smaller size ("Type 2a") and a larger size ("Type 2b").

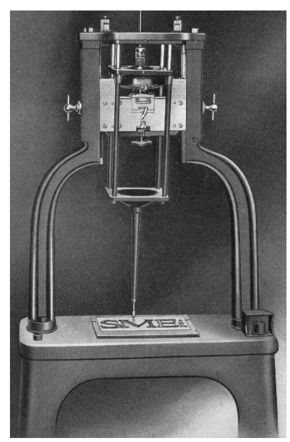


Fig. 7.3: Type 2a[7]

[5]Benton's 1884 patent reserves the right to invert these positions.

[6]This appears in Bullen's article "The Typographic Library and Museum at Jersey City" published in *The Pacific Printer and Publisher* {Bullen 1929}. The same photograph was reprinted in the ATF Library's "Catalogue and List Prices of Duplicates…" {ATF 1936}. (The machine is not listed in this sale catalogue; it simply appears in the general views illustrating the Library.)

[7]From the 1923 ATF *Specimen Book & Catalogue* {ATF 1923}. Scanned from my copy. Public domain. ATF was always ready to promote the primacy and superiority of Benton's machine. They printed 60,000 copies of this catalogue.

The arrangement of the Type 2 machine makes the design of a matrix holder easier than it would be in the more confined space available in a Type 1 machine. Further, it is easier to make this holder removable. The ability to remove a matrix holder during cutting (without disturbing the matrix in it), to measure the current depth of the engraving, and to return it to its place is of greater importance in matrix engraving than in punch or patrix cutting.

Both patrix cutting and direct matrix engraving continued at ATF during the 20th century.[8] Little information survives about the particular machines used. By the end of ATF in 1993, only Type 2 machines remained at ATF.[9]

[8] I own an ATF matrix font of Goudy Handtooled, at 60 point for my Barth type casting machine, which is electroformed from patrices. This face was introduced in 1922.

[9] No Type 1 machines are known to survive, although all avenues of inquiry have not yet been exhausted.

7.2• The Evidence of Benton's First Pantograph

What do we know with some degree of certainty about Benton's pantograph engraving machine(s) in the 1880s? The answer is that we know very little.

7.2.1• Benton Before 1883

Published Evidence

Let us start in 1882, the year in which Schraubsdtadter began engraving matrices by pantograph for the Central Type Foundry. For that year, I can discover no published evidence based on primary sources which indicates any activity on Benton's part in the area of either his self-spacing type or machine engraving.

Patents

In January of 1882 Benton filed a patent for a "Mold for Casting Printers' Leads."[10] It was a straightforward adaptation of an ordinary stereotype casting box. In the middle of the year, his partner at the North-Western Type Foundry, Frank M. Gove, died at a young age.[11] At some point soon after, Robert Van Valkenburgh Waldo became a partner in the firm.

A Zinc Plate

There is one piece of evidence which suggests that Benton was involved with pantograph engraving in 1882. A packet of photographs and photocopies was sent by the Milwaukee, Wisconsin type machinery collector Henry Weiland to the typefounder and matrix engraver Theo Rehak (The Dale Guild Type Foundry). The postmark is AUG 24 '87. This envelope and its contents passed on with the rest of the Dale Guild to Patrick Gossens' Project Letter-kunde.[12]

Some of Benton's younger relatives were living in Wisconsin and several of the photographs in this packet involve Benton family history. Two of these are sepia monochrome photographs which show the backs (never the front, alas) of two zinc or typemetal patterns.[13] These have

[10]US patent 254,792, filed Jan. 9, 1882 and issued March 14, 1882 to Linn Boyd Benton. Not assigned. This was Benton's third patent. It is basically a modified stereotype casting box. It has been called his first type-related patent, but an argument can be made that one of his earlier patents, from 1876, is a patent for a nontypographical object made in the way a typefounder would make it. See Appendix F.2, "Thinking Like An Electrotyper (1876)," on page 236, for a discussion of this earlier patent.

[11]Cost quotes from his June 14, 1882 obituary in the Milwaukee *Daily Republican-Sentinal*. {Cost 2011}, 40, 42n17.

[12]My thanks to Patrick for his heroic efforts in preserving this material and for giving me access to it.

[13]That they are zinc is a plausible guess. Benton was using zinc patterns originally (and ATF was still using them to the end on the Ad-Cut machine). These are self-identified as patterns. However, the texture of the metal in the possibly-1882 plate looks as though the plate was cast. This, however, would suggest that it was more likely cast from stereotype metal. Whether the use of the term "metal" in the first plate is an example of the 19th century patrix cutter's use of this word to mean typemetal or whether it is simply a layperson's use of "metal" to distinguish it from, say, wood, cannot be known.

been annoted at some point (with writing scratched into them) to identify them.

I do not yet have permission to reproduce these photographs, and the writing is difficult to read. However, as best I can make it out, one of these reads (with the '/' character, not present on the plates, indicating line breaks):

> Metal Pattern made for / L Boyd Benton in / Milwaukee / about 1882

The other reads:

> Pattern made by L Boyd Benton / for [illegible] — 1886 / First job face on Benton / Punch cutter – accents"

We do not know who annotated these plates. It wasn't Benton himself, as he is referred to in the third person. It was, most likely, a family member. Family memories for exact dates are notoriously unreliable, so this date of 1882 cannot be taken as evidence. It does, however, suggest that there was a Benton family tradition which held that he was at work on pantograph engraving in 1882.

If the date of 1882 is correct, it would seem to indicate preliminary work (as the patent filing and first public announcement weren't until 1884). In 1882, Schraubstadter at the Central Type Foundry was cutting faces for sale and Ludwig & Hofer had been engraving matrices by machine for five years.

I do not know if these plates survive.

7.2.2• Self-Spacing Type (1883 Onward)

The earliest published primary evidence we have for Benton's self-spacing type is the filing date of its patent, May 8, 1883.[14] See Appendix G, "What Was Benton's Self-Spacing Type?," on page 239, for more about this type.

The earliest reference in the trade that I have found for Benton's self-spacing type dates to February 1884. It references the patent, but does not suggest that the writer has actually seen the type. It is interesting that it calls the type by Benton's trade name for it, "self-spacing." That language is not in the patent itself and suggests that this may have been written from a press release by the foundry.

SELF-SPACING TYPE.

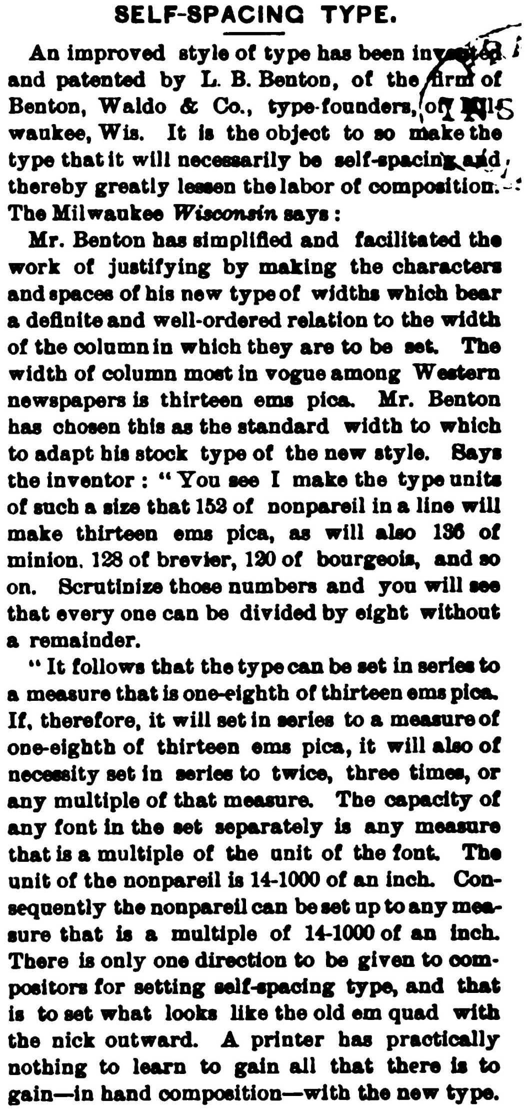
There has just been issued by the United States Patent Office at Washington, to Lynn B. Benton, of Milwaukee, a patent on a new style of type, called by the inventor self-spacing type. The inventor claims that it can be set up in one-third less time than the type in general use, the additional speed in composition to be gained by doing away with justifying. Mr. Benton makes his type in units of such a size that 152 of Nonpareil in a line make thirteen ems Pica, as will also 136 of Minion, 128 of Brevier, 120 of Bourgeois, and so on. Every one of these numbers can be divided by eight without a remainder. The inventor claims that his type will space itself and banish three em spaces--if it gets the chance.

Fig. 7.4: *Printers' Circular* (1884)[15]

[14]US Patent 290,201, "Printing-Type." Issued Dec. 18, 1883 to Linn Boyd Benton, of Milwaukee, Wisconsin. Not assigned. {US 290,201 Benton 1883}.

[15]From {*Printers' Circular* 1884}. (Vol. 18, No. 12 (February 1884): 243.)

In March of 1884 a longer trade notice appeared in *The American Stationer*.



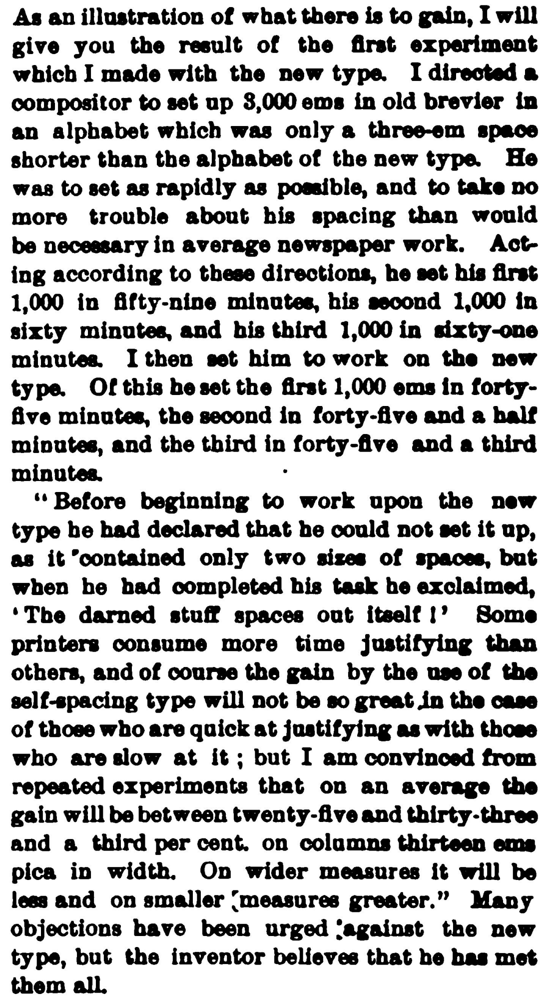
SELF-SPACING TYPE.

An improved style of type has been invented and patented by L. B. Benton, of the firm of Benton, Waldo & Co., type-founders, of Milwaukee, Wis. It is the object to so make the type that it will necessarily be self-spacing and thereby greatly lessen the labor of composition. The Milwaukee *Wisconsin* says:

Mr. Benton has simplified and facilitated the work of justifying by making the characters and spaces of his new type of widths which bear a definite and well-ordered relation to the width of the column in which they are to be set. The width of column most in vogue among Western newspapers is thirteen ems pica. Mr. Benton has chosen this as the standard width to which to adapt his stock type of the new style. Says the inventor: "You see I make the type units of such a size that 152 of nonpareil in a line will make thirteen ems pica, as will also 136 of minion, 128 of brevier, 120 of bourgeois, and so on. Scrutinize those numbers and you will see that every one can be divided by eight without a remainder.

"It follows that the type can be set in series to a measure that is one-eighth of thirteen ems pica. If, therefore, it will set in series to a measure of one-eighth of thirteen ems pica, it will also of necessity set in series to twice, three times, or any multiple of that measure. The capacity of any font in the set separately is any measure that is a multiple of the unit of the font. The unit of the nonpareil is 14-1000 of an inch. Consequently the nonpareil can be set up to any measure that is a multiple of 14-1000 of an inch. There is only one direction to be given to compositors for setting self-spacing type, and that is to set what looks like the old em quad with the nick outward. A printer has practically nothing to learn to gain all that there is to gain—in hand composition—with the new type.

Fig. 7.5: *American Stationer* (1884), Top[16]



As an illustration of what there is to gain, I will give you the result of the first experiment which I made with the new type. I directed a compositor to set up 3,000 ems in old brevier in an alphabet which was only a three-em space shorter than the alphabet of the new type. He was to set as rapidly as possible, and to take no more trouble about his spacing than would be necessary in average newspaper work. Acting according to these directions, he set his first 1,000 in fifty-nine minutes, his second 1,000 in sixty minutes, and his third 1,000 in sixty-one minutes. I then set him to work on the new type. Of this he set the first 1,000 ems in forty-five minutes, the second in forty-five and a half minutes, and the third in forty-five and a third minutes.

"Before beginning to work upon the new type he had declared that he could not set it up, as it contained only two sizes of spaces, but when he had completed his task he exclaimed, 'The darned stuff spaces out itself!' Some printers consume more time justifying than others, and of course the gain by the use of the self-spacing type will not be so great in the case of those who are quick at justifying as with those who are slow at it; but I am convinced from repeated experiments that on an average the gain will be between twenty-five and thirty-three and a third per cent. on columns thirteen ems pica in width. On wider measures it will be less and on smaller measures greater." Many objections have been urged against the new type, but the inventor believes that he has met them all.

Fig. 7.6: *American Stationer* (1884), Bottom

This information on the announcement of Benton's types is relevant, but insofar as the history of his pantograph is concerned it is insufficient. While he developed his pantograph in response to the need to cut these types, that does not imply that he used it to cut them at first.[17]

[16]From {*American Stationer* 1884}. (Vo. 15, No. 10, Whole No. 454 (March 1884): 307.) This source references "The Milwaukee *Wisconsin*". This may be an error. The Archive of Wisconsin Newspapers (Milwaukee Public Library: `https://mpl.org/databases/all/88`) lists no such newspaper.

[17]Here is a good instance where surviving materials could provide important information. A microscopic examination of the beards of surviving matrices or types for shape and tool marks would determine whether they had been cut by hand or machine. Evidence of machine cutting would reveal no new information, but evidence of hand cutting (if present) would indicate that he began cutting his self-spacing types before his pantograph engraving machine was available.

7.2.3• Benton's Pantograph Patent (Filed February 1884)

The earliest published primary evidence we have for Benton's pantograph punch cutting machine is the filing date for its patent, Feb. 29, 1884 as application Serial No. 122,534 ("Punch-cutting Machine") This patent was first issued as US patent no. 327,855 on Oct. 6, 1885, but a clerical error was discovered in it.[18] It was withdrawn and (re)issued as US Patent 332,990, on Dec. 22, 1885 to Linn Boyd Benton, of Milwaukee, Wisconsin. Assigned to Benton, Waldo & Co. {US 332,990 Benton 1884}. For the English version of this patent, see {GB 11,894 of 1885 Benton}.

Note that this was filed before the July 1884 announcement in *The Inland Printer* (see below).

It is interesting to observe that the patent for the cutter grinder corresponding to the 1884 pantograph's "lathe-head"[19] was four years after that for the pantograph, even though such a cutter grinder is, in practice, essential for the use of the pantograph. However, the precision of cutter depth control furnished by such a cutter grinder matters much more in direct matrix engraving than it does in punch or patrix cutting.

The "lathe-head" (cutting spindle) of his 1884-patent machines, however, was removable. The patent clearly states this and indicates an appreciation for the way in which this could preserve cutter depth:

> I employ both a blunt and a sharp tool … but instead of changing tools in the same lathe-head, which would disturb the adjustment for cutting any particular punch after the work was begun, I use two interchangeable lathe-heads, one provided with the blunt tool, the other with the sharp tool. (US 332,990, p. 4, lines 10-18)

Benton's patent also claims that:

> Heretofore type-punches have been successfully produced only by slow, laborious hand processes by persons possessing a rare degree of skill. (p. 1, lines 29–32)

This means that Benton was unaware of the work of Schraubstadter at the Central Type Foundry and of Ludwig and Hofer in Germany. It is possible, of course, that because his machine was a punch cutting machine and the others did direct matrix engraving that he was engaged in a delicate subterfuge here, but this does not fit Benton's personality. Neither does the possibility that he was concealing what he knew. Most importantly, had he known of this other work he certainly would have defended the novel aspects of his machine against it in his patent. Benton's pantograph wasn't the first, but it was a completely original achievement.

[18] See {Cost 2011}, pp. 94–95. I am unaware of any surviving copy of the erroneous version, 327,855.

[19] {US 442,874 Benton 1888}, "Tool-Grinder", filed 1888-01-17 and issued 1890-03-04.

7.2.4• Cutting Punches in Steel by Machine (July 1884)

> BENTON, WALDO & Co., of Milwaukee, claim to have perfected a machine for cutting punches for original characters for type foundries in steel,—an invention which will much cheapen the ordinary process of cutting by hand. It will cut from the largest to the smallest punch—even to half-diamond; while as a time-saver, we may state that a piece of work now requiring four hours to perfect by the hand process can, under its operation, be turned out in *half an hour*.

Fig. 7.7: *Inland Printer* (July 1884)[20]

Then in 1884 we have the first evidence of the actual construction of this machine and of its capabilities. This is a trade note in the July 1884 number of *The Inland Printer* announcing Benton, Waldo & Co.'s claim to "have perfected a machine for cutting punches … in steel." {*Inland Printer* 1884}.[21] Though brief, this is one of the more important press releases in the history of printing.

It should be noted briefly that this announcement appeared two years before the introduction of the "Blower" Linotype in 1886,[22] and that when it was introduced in 1886 the Linotype used electroformed matrices at first and then, soon after, matrices made using hand-cut steel punches. Bullen's story that the P. T. Dodge of the Mergenthaler firm convinced Benton to attempt punchcutting in steel is simply false. (This is discussed in greater detail within section 11.1.4, "Closer Looks at Bullen's Misinformation," starting on page 179.)

[20]From {*Inland Printer* 1884} (Vol. 1, No. 10 (July 1884): 21.) Scanned by DMM from the University of Wisconsin copy. Public domain.

[21]This note claims that "half-diamond" punches might be cut. Theodore Low DeVinne gives the point-system equivalent of the "Diamond" body size as 4 ½. "Half-diamond" (which would be something around 2 ¼ point) is not a generally recognized size. DeVinne does cite two historical types in that general range, a 2 ½ point equivalent "microscopique" by Henri Didot in 1827 and a 2 point equivalent face (but cast on a 4 point equivalent body) "non-plus-ultra" by Enschedé. The only purpose of such faces is to show of a foundry's capabilities. See {DeVinne 1900}: 67–68.

[22]In 1884, Mergenthaler was still working on one of the prototypes for the Linotype, the "Second Band Machine."

7.2.5• More About Self-Spacing Type (1886)

SELF-SPACING TYPE.

For five years past, a well known gentleman and printer of this city has been at work studying a problem. He has solved it and has patented an invention styled self-spacing type. The merits of this system of self-spacing type, patented by H. Bledsoe, the gentleman mentioned, are briefly stated as follows:

It will enable the compositor to accomplish 25 to 30 per cent more in the same time, and it will be impossible for type to get off its feet on account of defective spacing, as one line cannot be spaced too tight and another too loose.

But three spaces are used, the thickest of which is the regular 3-to-em space.

The regular " n " quad and " m " quad are retained.

" Fat," " medium " or " lean " faces can be used, as may be desired.

The type of all sizes, from brilliant (one-half brevier) to great primer (double bourgeois), will justify perfectly in any given pica em measure, and all sizes below long primer will justify in any given pica en measure.

Job faces, as well as book and newspaper faces, can be cast on this system of self-spacing bodies.

The inventor fully believes that from the interest manifested by type-founders and others, with whom he has correspondence, that it will shortly be adopted, and that much wonder will be felt that its simplicity has heretofore escaped the ingenuity of inventors in this field.

Here is an invention which will add to the earnings of the printer and reduce the danger of accident to a minimum, and therefore benefit the proprietor.—*Fort Worth Gazette.*

Fig. 7.8: Bledsoe's "Self-Spacing" Type[23]

Very little else appears for the next few years. In 1886, Benton and "self-spacing" types make the pages of *The Inland Printer* three times. In May, there is a reprint of material from the *Fort Worth [Texas] Gazette* claiming that an "H. Bledsoe" has invented and patented "Self-Spacing Type."

While Benton was not, in hindsight, the first to think of unit-set type, so far no evidence has surfaced that Bledsoe's invention was independent. In particular, his use of the name "self-spacing" is suspect. I have been unable to discover any patent for this.

In the August number, the editors report on a response by Benton in the foundry house organ.

THE self-spacing type, manufactured by Benton, Waldo & Co., of Milwaukee and St. Paul, has been, it is claimed, received with general favor. The *Northwestern*, a trade journal issued by the firm, kicks vigorously against the claim of H. Bledsoe, of Fort Worth, Texas, as the inventor and patentee of the system. It states that letters patent for the discovery and application of self-spacing type were granted to Mr. Benton, December 18, 1883, two years prior to Mr. Bledsoe's claim.

Fig. 7.9: Benton Responds[24]

A September 1886 entry in the "Of Interest to the Craft" column of *The Inland Printer* discusses a visit to Benton, Waldo & Co. and the self-spacing types, but makes no mention at all of the pantograph or other machinery. This visit remains significant because it is the first known report in print by someone who has actually seen Benton's workshop and his self-spacing types.

WE recently had the pleasure of spending a couple of hours in the workroom of Mr. Benton, of the firm of Benton, Waldo & Company, Milwaukee, discussing and learning the special advantages of his self-spacing type. He is an intelligent, entertaining, unostentatious gentleman, a mechanical genius of whom that city has every reason to feel proud; and, it is needless to add, a thorough, enthusiastic believer in the success and merits of his "system." One such man is of more value to the community than all the brainless dudes to be found throughout the length and breadth of the country.

Fig. 7.10: Visiting the Northwestern[25]

[23]From {*Inland Printer* 1886} (Vol. 3, No. 8 (May 1886): 473.) Smithsonian digitization. Public domain.

[24]From {*Inland Printer* 1886} (Vol. 3, No. 11 (August 1886): 716–717.) Smithsonian digitization. Public domain.

[25]From {*Inland Printer* 1886} (Vol. 3, No. 12 (September 1886): 789.) Smithsonian digitization. Public domain.

7.2.6• Knowledge of Benton by the Schraubstadters

Some knowledge of Benton's pantograph circulated within the members of the type-founding trade. In March of 1887, Carl Schraubstadter, Jr. of the Central Type Foundry (brother of William Schraubstadter) wrote about Benton's use of his pantograph to cut Roman types as patrices. After discussing the skill of Edward Ruthven in hand-cutting patrices, Schraubstadter says:

In perfection of finish, such faces as the Raphael, Ruskin, Steelplate Gothic, etc., silence all attempts to bring the process into disrepute, and lately Mr. Benton has cut Roman type on metal with his engraving machine, having such a high finish that it is safe to say that even in this field, until this time wholly given up to the punch cutter, the electrotype matrix will also drive out its copper rival.

Fig. 7.11: Carl Schraubstadter, Jr. on Benton[26]

> lately Mr. Benton has cut Roman type on metal [meaning patrices in soft metal] with his engraving machine, having such a high finish that it is safe to say that … the electrotype matrix will also drive out its copper rival. {Schraubstadter 1887}

A little over a year later, the same author discussed the geometry of the shoulders and counters of type as cut by Benton's "punch-cutting machine" and "the drilling machine" (by which he must mean the Central Type Foundry's pantograph; the term echoes its original German name: bohrmaschine). The point that he is asserting in the context of his article is that while type cast from matrices made by punches cut in steel has flat-bottomed counters.[28] He finds the flat-bottomed form superior than the machine-cut form.

though the former was an exceptionally high lead. The outside of the type generally slopes to the shoulder at a very small angle to the perpendicular, just sufficient to allow the face to be withdrawn from the matrix without tearing up the edges. The counters seldom come to a sharp point at the bottom, being in the shape of a "U," a "V" or of a semicircle, with all gradations between these shapes. The type cut on Mr. Benton's punch-cutting machine, and that cast from matrices produced by the drilling machine, has the nearest approach to a V-shaped form. In both of these cases the head of the type slopes equally from the inside and outside of the counter, but it is doubtful if such sharp lines are advantageous. When letters are cut on steel, the outside angle is made quite sharp, and the inside counter, being produced by a steel punch, is also comparatively straight for a great distance, but near the face it is usually finished by cutting, and there is a slight additional bevel at that point. The bottom of the counter is also usually flat or slightly curved, and for that reason the counters do not reach the shoulder.

Fig. 7.12: Counters by Machine Cutting[27]

> The type cut on Mr. Benton's punch-cutting machine, and that cast from matrices produced by the drilling machine, has the nearest approach to a V-shaped form. In both of these cases the head of the type slopes equally from the inside and outside of

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[26] From {Schraubstadter 1887} (*Inland Printer,* Vol. 4, No. 6 (March 1887): 382.) Internet Archive digitization from microfilm. Public domain.

[27] From {Schraubstadter 1888} (*Inland Printer,* Vol. 5, No. 12 (September 1888): 906.) Internet Archive digitization from microfilm. Public domain.

[28] It is interesting for the hand punchcutter to note that he says of counters made by steel punches "but near the face it is usually finished by cutting, and there is a slight additional bevel at that point." This "additional bevel" is formed by a corresponding small bevel near the face of the punch. It is what is referred to in punchcutting at l'Imprimerie nationale in France as the "talus" and it is a critical part of what makes a punch a specifically *typographical* punch (as opposed, say, to a machinist's letter marking punch). Clearly, Carl Schraubstadter knew his typemaking. My thanks to Raymond Stanley (Stan) Nelson for teaching me this in his 2016 punchcutting class at Wells College.

> the counter, but it is doubtful if such sharp lines are advantageous. {Schraubstadter 1888}

For the purposes of the present study, though, the relative merits of hand and machine methods are less important than the simple fact that Schraubstadter refers to both machines in familiar terms. He does not give dates for either, but his comments show that he is intimately familiar with the products of both.

7.2.7• Knowledge of Benton by the Linotype Firm (1888)

On January 10, 1888, we have the first indication (that is, first known and published so far) of any knowledge of Benton's engraver by the Mergenthaler firm. On that date, Whitelaw Reid of the Mergenthaler company wrote to order "100 steel blanks of the proper size for cutting a long primer or small pica face" to be sent to Benton, Waldo and Co. (See {Kahan 2000}, p. 48., who cites from the original letter.) This was a year before the Mergenthaler[29] firm acquired their first Benton pantograph.

7.2.8• Leasing the Machines (1889–1890)

From 1889 and 1890 we have an unusually good piece of evidence. In *Practical Typecasting,*[30] Theo Rehak photographically reproduces a page from the "Day Book" of Benton, Waldo & Co. {Rehak 1993}, p. 109. It itemizes the leases of six "Punch Engraving Machines." While it is not absolutely certain that the numbers associated with these machines are serial numbers or lease numbers, it is likely that they are the former.[31] This in turn strongly suggests (but does not yet prove) that machine serial no. 3 was both the first machine to be leased and the first machine acquired by the Mergenthaler company.

- No. 3, Feb. 13, 1889, to the Mergenthaler Printing Co., Brooklyn, NY.
- No. 4, May 1, 1889, to the Minneapolis Electro Matrix Co., Minneapolis, MN[32]
- No. 6, June 2, 1889, to the Minneapolis Electro Matrix Co., but sent to the Ames Manufacturing Co., Chicopee, MA.

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[29] The firm bore Mergenthaler's name, but by this point in time the firm and the inventor had parted ways. I know of no indication that Ottmar Mergenthaler himself ever became aware of Benton's pantograph.

[30] Through the gracious permission of Theo, this is now online at: `https://circuitousroot.com/artifice/letters/press/typemaking/literature/general/index.html#rehak`

[31] While I am wary of trusting Bullen, the date that Bullen cited for the lease of the first Benton machine acquired by the Mergenthaler company, Feb. 13, 1889, matches this list. {Bullen 1924}, p. 937. The list also skips numbers (Nos. 5 and 7), which one might expect of serial numbers but not of lease numbers.

[32] This is the firm then associated with the Goodson Graphotype composing machine. See: {[Goodson 1900]}, {US 414,399 Goodson 1889}, {US 414,400 Goodson 1889}. See also {Huss 1973}: p. 160. The company was involved in some litigation and had several patents. Curiously, in 1900 it was building a plant in Jersey City, NJ, just as ATF was building its Central Plant in the same city.

- Nos. 8 & 9, Feb. 15, 1890, to the Linotype Company Ltd., Manchester, England.
- No. 10, May 19, 1890, to the Rogers Typographic [sic] Co., Cleveland, OH.

To put the prices of these leases into perspective, a look at an online calculator of historic dollar values[33] suggests that $5,000 in 1889 would be somewhere between $176,000 (based on the consumer price index) and $1,370,000 (based on the value of the labor to make it) in 2024. These figures may seem high, but they are not out of line when compared to industrial-grade CNC machine tools today.

7.2.9• In the ca. 1891 Benton-Waldo Sales Booklet

Patricia Cost has published extremely valuable extracts from a booklet by the "Benton-Waldo Type Foundry"[34] promoting the leasing of "Benton's Punch-Engraving Machine." See {Cost 2011}, pp. 67–69. These extracts identify two additional customers (the Electro Matrix Company, but in New York, and the Lanston Type-Machine Company) and the receipt of a second machine by the Linotype Company of England. The brochure contained letters of endorsement from customers. Cost reprints extracts from letters from the Mergenthaler firm from 1889, from the English Linotype company dated Sept. 18, 1890, and from Tolbert Lanston himself on November 3, 1890. Most importantly, this brochure contains the first published illustration of this machine. It shows a floor-standing machine supported by two standards[35] (not the single-standard machine illustrated in Benton's patent). Cost dates this book to around 1891. It is probably reasonable to assume that the Machine No. 3 leased to the Mergenthaler Printing Company in 1889 looked like the one shown on its cover (if only because all subsequent machines copied from leased Type 1 Benton pantographs look like Type 1b machines, not Type 1a).

7.2.10• In *The Inland Printer* (1893)

The "World's Columbian Exposition," a world fair intended to commemorate the 400th anniversary of the 1492 voyage of Columbus, actually ran from May 1, 1893 through October 30, 1893. An anonymous article on Linn Boyd Benton and his engraving machine was written for *The Inland Printer* just before this (it speaks of the fair as being in the future) but was published in the May 1893 number {[Benton 1893]}, pp. 237-238. It contains what may be the first published portrait of Benton,[36] the first published photograph of the engraving machine (out-

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[33]"MeasuringWorth" `https://www.measuringworth.com/calculators/uscompare/relativevalue.php`

[34]In theory, it was the Northwestern Type Foundry of Benton, Waldo & Co.

[35]In traditional machine-building, a "standard" is a generally vertical support member of a machine.

[36]Cost reproduces an unpublished photograph of him taken by Morris Fuller Benton circa 1889 {Cost 2011}, p. 68.

side of the sales booklet privately published by the foundry,[37] and a brief set of claims for the machine. This article was the first illustration that the general public in the United States (at least within the profession of printing) had ever seen of a typographical engraving machine.

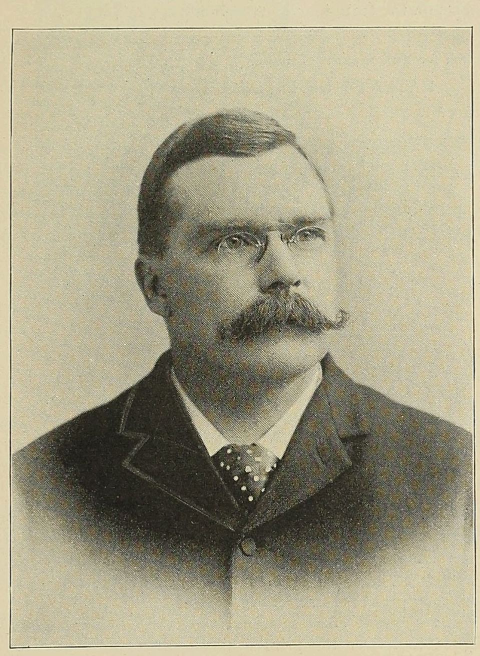
The entire article is reprinted in facsimile (from the Smithsonian Institution digitization) on the next two pages. An enlarged view of the top of the engraving machine follows that.

[37] It is the same photograph used in the circa 1891 Benton-Waldo booklet. See the reproduction of the cover of that booklet in {Cost 2011}, p. 68.

THE INLAND PRINTER. 237

L. B. BENTON.

APART from the natural gratification which arises from an opportunity such as the present affords to testify to the high estimation in which Mr. Benton is held by those who know him, there is to us an added pleasure in that this is the first time that his portrait and biographical sketch with a description of his chief invention — the Benton punch cutter has been published.



L. B. BENTON.

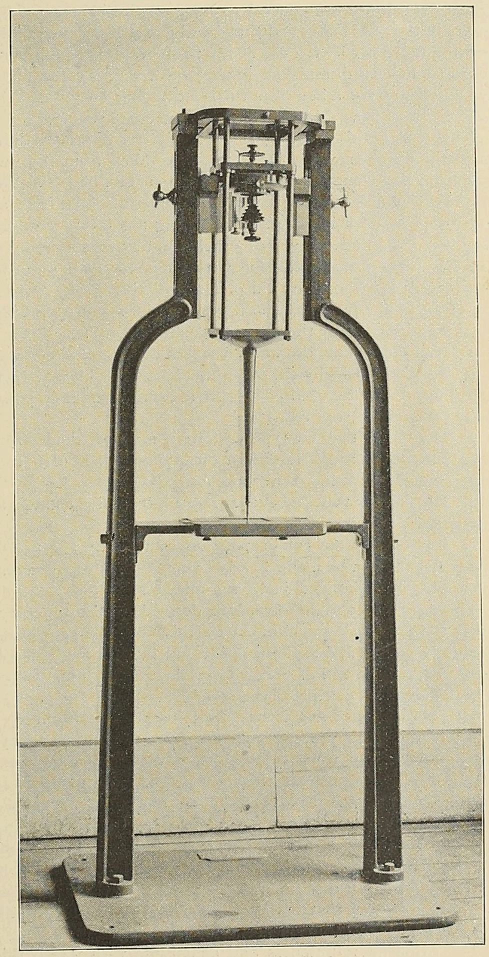
As the senior member of the typefounding firm of Benton, Waldo & Co., of Milwaukee, Wisconsin, Mr. Benton has sought to make his works speak for him. They have spoken so loudly that it was fitting — so many of our readers said, and we agreed with them — that Mr. Benton's native modesty should be prevailed upon to permit the appearance of his picture in these pages.

Linn Boyd Benton was born in Little Falls, New York, in 1844. In 1854 his father went to Milwaukee, and about two years later the family moved to the same city, but shortly after left Milwaukee for La Crosse, where for ten years young Benton remained, at first attending school and pursuing his studies with characteristic perseverance. His strong taste for the higher mechanics diverted his mind from the professional career mapped out for him by his father and the result was an agreement for the division of each day — the morning hours to be given to study and the post meridian to a gratification of his tastes in mechanics, and to these latter studies Mr. Benton traces much of the results that have been reached by him.

The printing business then threw its fascination over him and he entered the office of the La Crosse *Republican*, Charley Seymour's paper, and as a "devil" rolled the forms in the well-known style of the offices of those days. His inventiveness, ever alert, caused him to adopt a method of handling the sheets which assisted the pressman to a degree which appreciably shortened the time at press, young Benton's award being his freedom at an earlier hour. His advance through all the departments of printing was rapid, and as foreman of the office his success was pronounced.

Leaving La Crosse Mr. Benton went to Milwaukee as bookkeeper for Mr. J. A. Noonan, who conducted a typefoundry and paper house. Mr. Benton soon left the business office and took a position in the paper stock store, where he remained eight years, ending as a buyer.

About this time Mr. Noonan failed in business, and at the bankrupt sale Mr. Benton and Edward Cramer purchased the typefoundry, and the former, with his usual energy, began to learn the business, and when the intricacies of that business are appreciated the task before him may be understood. He patiently and persistently labored to perfect matrices and molds, cast leads and slugs, and studied and wrought almost without cessation — whenever he saw an opportunity to economize time and labor his inventiveness was immediately at work, and almost never has he sought to solve a problem in labor-saving machinery without success.



BENTON PUNCH CUTTING MACHINE.
Height, 5 feet 4 inches. Floor space, 22 by 28 inches.

Mr. Cramer sold his interest in the business in about a year to Mr. Frank Gove, and the firm of Benton, Gove & Co. continued for eight years, when Mr. Gove died. Mr. Benton purchased from Mrs. Gove the share her husband had held, and in 1882 sold an interest to Mr. Waldo, and the firm of Benton,

Fig. 7.13: In *The Inland Printer* (June 1893), p. 237[38]

[38]From {[Benton 1893]}, p. 237. Smithsonian digitization. Public domain.

238 THE INLAND PRINTER.

Waldo & Co. still continues, though the foundry has been taken over by the American Typefounders' Company. The firm conduct a large and profitable business in punch cutting in Germany, England and Canada.

One of Mr. Benton's inventions—the well-known self-spacing type — is a labor saver of the simplest and most perfect character. It enables the compositor to accomplish twenty-five to thirty per cent more in the same time than by the ordinary type, and for such justifications as are exemplified in railway tariffs, pedigree charts, etc., it is invaluable. Among skilled mechanics Mr. Benton's masterpiece is the automatic punch cutter, a description of which we attempt.

For the production of steel punches by machinery a sheet of calendered book paper is clamped on a table which is provided with a metal top, and on this paper is drawn in outline with a lead pencil the lower-case "m" and "o" and the cap "H" and "O" (which are known among typefounders as characteristic letters). The shape, heft, etc., of these first letters so drawn determines the general style of all the balance of the letters in the font. These outline drawings, still fastened to the drawing table, are by the use of the pantograph process, reproduced (somewhat diminished in size) on a wax-covered plate, and an electrotype taken from this wax tracing constitutes the pattern which is used in the engraving machine proper.

The lead pencil drawing is about sixteen thousand times larger than brevier, while the electrotype taken from the wax tracing is about one thousand times larger than brevier. The size of the punch produced in an engraving machine from an electrotype pattern is varied by changing the leverage of the machine. The limits in size of punches cut by the changing of leverages vary from a character which is so small as to be imperceptible without the aid of a magnifying glass, up to a size of an inch square. From a typefounder's standpoint the advantages derived by the use of this machine are:

1. It produces punches at a minimum cost.
2. Punches made by the machine are very much more perfect in form, and the cutting is more accurate than it is possible to produce in hand cutting.
3. The "picking" on type cast from matrices made from these punches is much less than on type which is cast from matrices made from hand-cut punches.
4. The machine cuts a bevel at any angle, and a counter to any depth.
5. A letter can be cut in position so that by the use of guides a strike can be made nearly in position, thereby saving much time in fitting and justifying matrices.

The most perceptible advantage derived by the type consumer is that, as all punches cut on this machine present an absolutely perfect and uniform inside and outside angle, it follows that the type will of necessity produce a very much more perfect stereotype or electrotype matrix.

This perfection of angles or bevels insures a uniform wear on the type, and prevents the distortion which is always apparent in partly worn type which is made from hand-cut punches. To demonstrate this advantage, type made from machine-cut punches has been taken and filed or rubbed down an amount equal to a ten years' wear, the result being that the face would still retain its exact contour throughout. We understand this remarkable machine will be on exhibition at the Columbian Exposition. Type made from these punches and worn down so that it was $\frac{9}{1000}$ too low to paper has still presented a fair printing surface.

The exquisite minuteness and exactitude with which this marvelous device can perform its work was illustrated not long since when a facsimile of a signature consisting of two initials and six lower-case letters was cut absolutely perfect in a script so small that it could not be distinguished without the aid of a powerful magnifying glass. The total length of the signature did not exceed the thickness of two sheets of writing paper.

Mr. Benton is reported the best practical typefounder in the country, and is a valued director in the American Typefounders' Company. He is also the mechanical expert in the same association, sharing the exacting duties in that regard with Mr. Henry Barth. He is at present in charge of the exhibit of the association at the World's Fair, and his energy and ability will, without doubt, make the display one of the most attractive to the printers of the country and to the public in general.

Mr. Benton is, like most men who have accomplished much, modest in discussing his achievements. Genial and accessible, he is an entertaining companion, and a compendium of facts on the technique of typefounding.

Fig. 7.14: In *The Inland Printer* (June 1893), p. 238[39]

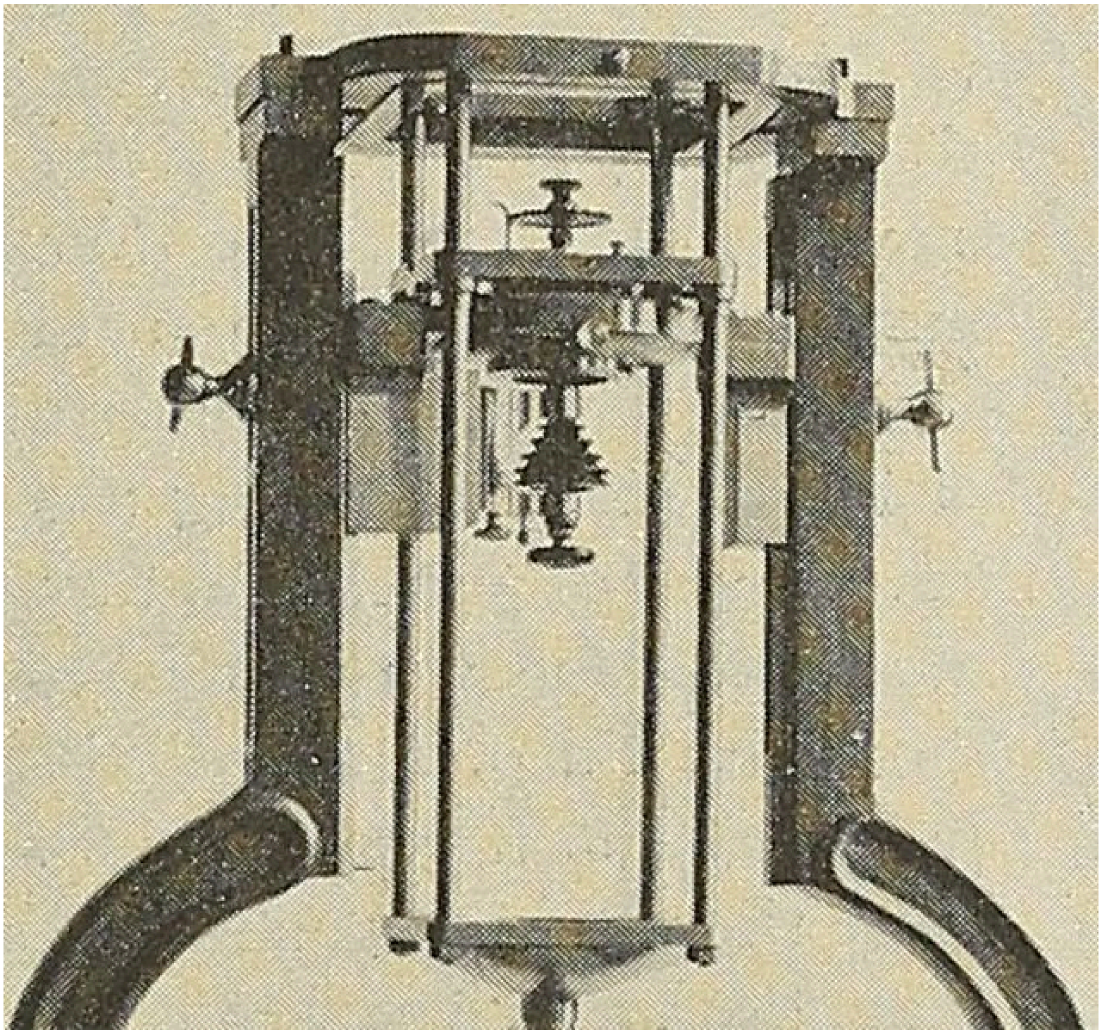


Fig. 7.15: BEM Type 1b, Detail (1893)[40]

The claims made in this article are not necessarily of great interest; every inventor claims that their machine is perfect. Some of the technical details which may be gleaned from this article and its photograph are, however, very interesting.

TO DO: Some of this really needs to move to the sections about the Type 1a/b Bentons.

The Spindle

From the photograph, we can observe that the cutting spindle[41] is still a headstock from a watchmaker's lathe, as was specified in the 1884 patent.[42] A critical feature of the Benton

[41]The cutting spindle used in all Type 2 Benton machines (and all surviving genuine Benton pantographs known are Type 2) is a cylindrical removable unit called (in ATF terminology) a "quill." The spindle of the Type 1 machines, while removable, is essentially a watchmaker's lathe headstock (and is referred to as such in Benton's patent). It does not seem correct to call it a "quill."

[42]The original ATF quills for BEM No. 53 (the Type 2a machine owned by the author) use Moseley No. 1 series collets. This was determined primarily by measurement, with partial confirmation also from Ed Rayher (who, in an email to the author dated 2023-02-21, has observed that some of the original collets for the ATF quills on his BEM are marked "Moseley"). The Moseley No. 1 style of collet is one of the earliest collet styles for watchmaker's lathes. It is

engraving machines (and, independently, Hofer's in the 1870s) was the ability to remove the entire spindle as a unit for sharpening. The reason for this is that if a cutter breaks and requires resharpening it is in practical terms impossible to remove a cutter, resharpen it, and return it to exactly the same depth into the cut. Registering off of the sharp tip of a cutter is not feasible. But if the entire spindle unit is removable, the machine and accompanying cutter grinder may be designed so that the spindle banks against each in a repeatable way. The cutter can therefore always be resharpened so that its tip is in the same relationship to the spindle as it was before, and the spindle can always be returned to the same place. This allows the cutter/spindle unit to be removed, resharpened, and returned to the same depth of cut.

In a Type 2 BEM, this is done with a removable spindle cartridge, called a "quill" in ATF terminology.[43] In the Type 1 BEMs, this is done by removing the entire watchmaker's lathe headstock as a unit.[44]

Overall Construction

The overall shape of the machine and the style of construction of the gimbal which suspends the pantograph arm greatly resemble the later Type 2 BEMs.

The workholding mechanism, though, is clearly that shown in the 1884 patent. This is a workholder adapted for cutting punches and patrices, not matrices. Further, this workholder is not easily removable from the machine for inspection between cuts. In matrix engraving it is important to be able to remove the workholder to examine the current depth of cut (for reasons similar to those for the cutter, the entire workholder rather than just the blank must be removable).

Patterns

The third important technical point is in the description of the patternmaking process. The patterns used with Hofer's pantographs in the 1870s and those used at first with Benton's in the 1880s were simple zinc plates which had the design scribed into them. The method described here differs; this gives us a terminus ante quem for the introduction of the wax plate method at ATF.[45]

There is one point of potential confusion in the way this is described. When the article says that the original drawings are reduced to a smaller size on a wax plate "by the use of the pantograph process," it is not meant that the Benton vertical pantograph is used. An ordinary

incompatible with the later "WW" (Webster-Whitcomb) style collets introduced in 1889 and by 1900 would have been obsolete. But in 1884, when Benton built his first machine, A Moseley watchmaker's lathe headstock would have been a clear choice.

[43] Benton's US patent 744,030, "Grinding-Machine," filed 1900-05-05, describes the cutter grinder used.

[44] Benton's US patent 422,874, "Tool-Grinder," filed 1890-03-04, describes the cutter grinder used.

[45] That is, for the vertical pantographs. Zinc plates were used with the Ad Cut machine throughout its operational career.

drafting-style four-bar pantograph would have been employed for this, equipped with a fixed (not rotating) sharp stylus. Similar pantographs are shown in the view of the engraving room in the 1912 ATF specimen book, for example.

7.2.11• The World's Columbian Exposition (1893)

In 1893, the American Type Founders Company barely existed as a cohesive corporate entity. It had been formed in February 1892 out of a merger of 23 of the 37 type foundries then in operation in the US.[46] It had begun the process of consolidating its operations, but several of the foundries out of which it was formed continued as if they were still their own businesses. Still, at the World's Columbian Exposition they managed to create a unified display that gathered (at least) Benton's pantograph and self-spacing type (from the Northwestern Type Foundry in Milwaukee), Barth's automatic type-casting machine (from the Cincinnati Type Foundry), and their space and quad casting machines (these were the Ziegler typecasting machines from MacKellar, Smiths and Jordan in Philadelphia[47]).

This was an impressive achievement, and they were not shy about promoting their success — and Benton's pantograph.

7.2.11.1• The ATF Display

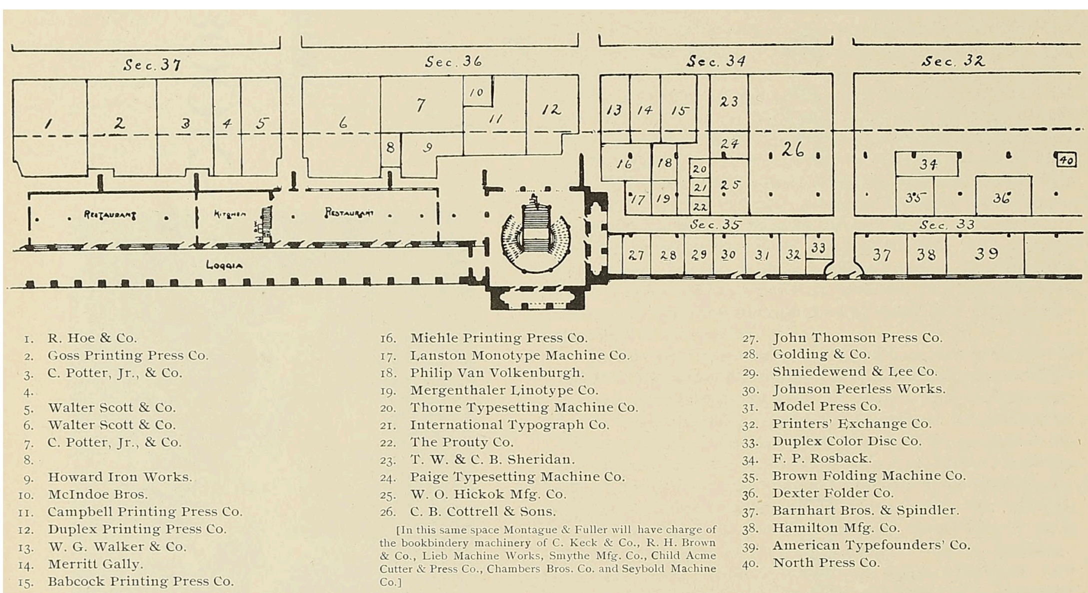


Fig. 7.16: ATF in Machinery Hall (1893)[48]

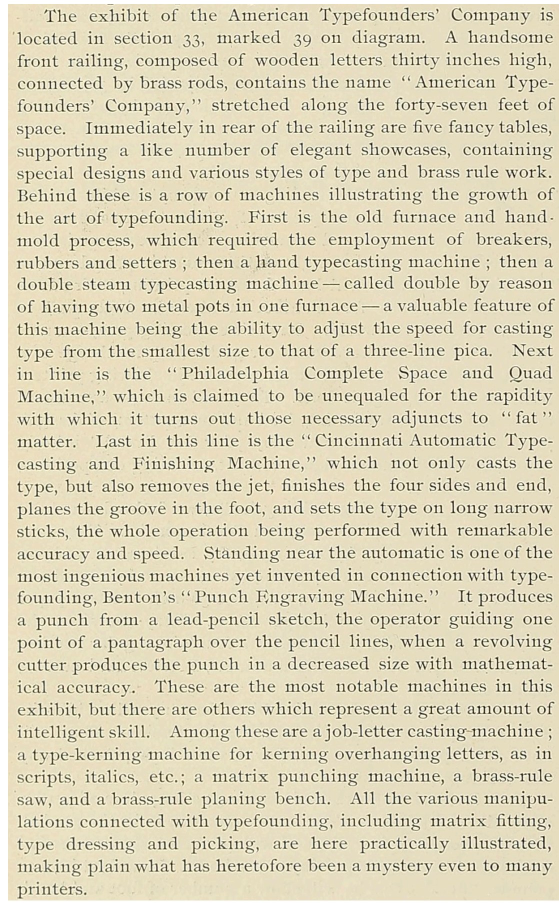
[46]See the CircuitousRoot Notebook "American Type Founders: Early History Through 1906" for more about this: `https://circuitousroot.com/artifice/letters/press/noncomptype/typography/atf/history-early/index.html`

[47]Whether these were the same space and quad machines that were scrapped at the 1993 ATF auction is something I have yet to resolve.

ATF occupied Space 39 in Machinery Hall. I have not yet found a photograph of their display.

The article from the May 1893 *Inland Printer* (the month the Exhibition opened) on “Printing Exhibits at the World’s Fair” has a relatively long section on ATF. They had a 47 foot wide booth. It lists their historical casting exhibits (hand casting, hand pivotal casting, steam-powered pivotal casting), and then their more modern casting (the Philadelphia Complete Space and Quad Machines, the Cincinnati Automatic Type-casting and Finishing Machine (that is, the Barth)).

Then they describe Benton’s “Punch Engraving Machine,” which “produces a punch from a lead-pencil sketch, the operator guiding one point of a pantograph over the pencil lines, when a revolving cutter produces the punch in a decreased size with mathematical accuracy.” Note that the writer is over-simplifying here, conflating the production of a design (in pencil) and the use of a pattern (which would have been an electrotyped plate).



The exhibit of the American Typefounders’ Company is located in section 33, marked 39 on diagram. A handsome front railing, composed of wooden letters thirty inches high, connected by brass rods, contains the name “American Typefounders’ Company,” stretched along the forty-seven feet of space. Immediately in rear of the railing are five fancy tables, supporting a like number of elegant showcases, containing special designs and various styles of type and brass rule work. Behind these is a row of machines illustrating the growth of the art of typefounding. First is the old furnace and hand-mold process, which required the employment of breakers, rubbers and setters; then a hand typecasting machine; then a double steam typecasting machine — called double by reason of having two metal pots in one furnace — a valuable feature of this machine being the ability to adjust the speed for casting type from the smallest size to that of a three-line pica. Next in line is the “Philadelphia Complete Space and Quad Machine,” which is claimed to be unequaled for the rapidity with which it turns out those necessary adjuncts to “fat” matter. Last in this line is the “Cincinnati Automatic Type-casting and Finishing Machine,” which not only casts the type, but also removes the jet, finishes the four sides and end, planes the groove in the foot, and sets the type on long narrow sticks, the whole operation being performed with remarkable accuracy and speed. Standing near the automatic is one of the most ingenious machines yet invented in connection with typefounding, Benton’s “Punch Engraving Machine.” It produces a punch from a lead-pencil sketch, the operator guiding one point of a pantagraph over the pencil lines, when a revolving cutter produces the punch in a decreased size with mathematical accuracy. These are the most notable machines in this exhibit, but there are others which represent a great amount of intelligent skill. Among these are a job-letter casting machine; a type-kerning machine for kerning overhanging letters, as in scripts, italics, etc.; a matrix punching machine, a brass-rule saw, and a brass-rule planing bench. All the various manipulations connected with typefounding, including matrix fitting, type dressing and picking, are here practically illustrated, making plain what has heretofore been a mystery even to many printers.

Fig. 7.17: ATF At the World’s Fair[49]

It is significant, I think, that this coverage concludes with the remark:

> All the various manipulations connected with typefounding, including matrix fitting, type dressing and picking, are here practically illustrated, making plain what has heretofore been a mystery even to many printers.

The same might be said of such a display even today.

[48] From {ATF 1893} (*The Inland Printer,* Vol. 11, No. 2 (May 1893): 146.) Smithsonian digitization. Public domain.

[49] From {ATF 1893} (*The Inland Printer,* Vol. 11, No. 2 (May 1893): 146.) Smithsonian digitization. Public domain.

7.2.11.2• Self-Promotion by ATF

682 THE INLAND PRINTER.

PERFECT PROCESSES PERFECT TYPE

SEVEN HIGHEST AWARDS

WORLD'S COLUMBIAN EXPOSITION

1.—BENTON PUNCH CUTTER

"Cuts type-founders' punches absolutely correct, and at the greatest rate of speed known to the art. The sensitive minuteness and absolute precision of working mechanisms and cutting tools enable an operator, by following prepared patterns, to produce a type-founder's steel punch of perfect contour, with any angle of bevel and any desired depth of counter. . . . . Value of this perfectly constructed and rapidly working machine to the type-founders' art is inestimable. Produces type punches at minimum cost, and insures an accuracy and speed not otherwise obtainable. . . . . Machine is the embodiment of highest order of mechanical construction; cuts a line in steel one-ten-thousandths of an inch, and produces perfect type punches."

2.—BARTH AUTOMATIC TYPE-CASTING AND FINISHING MACHINE

"Machine possesses high merit in compactness and convenience, accuracy in operation, and efficiency, while being operated at highest speed. Large productive capacity; complete finish of yield. Adapted to American principle of manufacturing metal type. Novelty, in that type can be taken from machine for examination at any stage of development. Practical in operation. Highly perfected in design and construction."

3.—PROCESS OF MANUFACTURING AND FINISHING TYPE

"Exhibition of machinery, appliances and processes of the manufacture of movable metal type, beginning with the perfectly constructed and minutely adjusted Benton Punch-Cutting Machine, and ending with the well designed and highly efficient Barth Automatic Steam-Power Type-Casting and Type-Finishing Machine, in the production of Copper Alloy Type of the correct proportions of toughness, hardness, uniform accuracy, and high degree of utility."

4.—SPACE AND QUADRAT MACHINE

"Automatically casts spaces and quadrats, displaces jets, grooves bottoms and removes burrs. . . . . With micrometer and graduated dial to adjust mold to any sized type. Good design; first-class workmanship in construction; smoothness in operation of automatic mechanisms; highest merit in efficiency, performance and volume of product."

5.—TYPOGRAPHICAL DISPLAY

"Illustrating the use of type, borders and ornaments in combination. Forms varied in size and unique in design. Absolutely without fault as to artistic effect and justification. Specimen Book, specially noticeable for its size and completeness and perfection, shown in the art of founding artistic type faces."

6.—SELF-SPACING TYPE

"Type constructed to reduce time of justification to a minimum. Value of self-spacing type self-apparent in tabular work. Greatly reduces time required to justify lines, and secures more even wearing surfaces for stereotype processes and printing presses, because of true justification. Possesses great labor-saving merit, economy in composition and correcting. Insures great durability and consequent increased commercial value over type which can be only approximately justified."

7.—EXHIBIT OF EVOLUTION IN THE MANUFACTURE OF TYPE

"Type-casting method employed in 1793, consisting of hand mold; rotary type-casting machine of 1840, operated by hand; steam type-casting machine of 1870, with jet-breaking attachment, formerly a hand process; and Barth Automatic Type-Casting and Type-Perfecting Machine of 1893, which delivers 10,000 perfected type characters per hour ready for the printer's uses."

WHY BUY THE SECOND-BEST WHEN . . THE BEST COSTS YOU NO MORE . .

AMERICAN TYPE FOUNDERS CO.

SETS THE FASHIONS IN TYPE

THE BEST TYPE MADE FROM THE BEST PUNCHES . . ON THE BEST CASTING MACHINES BY THE MOST EXPERT FOUNDERS . . IN THE MOST DURABLE METALS

Fig. 7.18: ATF in *The Inland Printer* (1896)[50]

[50]From {ATF 1896 03IP} (*The Inland Printer,* Vol. 16, No. 6 (March 1896): 682.) Smithsonian digitization. Public domain.

As the advertisement on the previous page indicates, ATF was given several awards at the exhibition. One of these was for the "Benton Punch Cutter and Benton Self-Spacing Type" (called out as two separate awards in the preceding ad, but actually a single award). I have not been able to find an image of this that I can reproduce here. I have a photograph of a photograph once owned by the late Henry Weiland of this award, but do not yet have permission to reprint it. Even that, though, is not legible at text size.

The text of this award was printed in at least two journals in 1896: *The Typographical Journal* {ATF 1896 TF} and *The Fourth Estate* {ATF 1896 FE}. The fact that the text and title are identical in each suggests that it was copy supplied by ATF.

Other than these advertising and public relations items from ATF, the items exhibited by ATF in 1893 seemed to excite no particular attention in the press. I have not been able to find a single technical account between 1893 and DeVinne's *Plain Printing Types* of 1900.

Foundation of Good Type.

The prime necessity in making good type is a perfect punch. At the World's Columbian Exposition in Chicago, it was conceded that the most perfect mechanical exhibit was the punch cutter invented by Mr. L. B. Benton, and the award given to this machine by the judges is in the highest degree commendatory. A medal was granted, and the accompanying award says: "Cuts typefounders' punches absolutely correct, and at the greatest rate of speed known to the art. The sensitive minuteness and absolute precision of working mechanisms and cutting tools enables an operator, by following prepared patterns, to produce a typefounders' steel punch of perfect contour, with any angle or bevel and any desired depth of counter. Produces type punches at minimum cost and insures an accuracy and speed not otherwise obtainable. This machine is the embodiment of the highest order of mechanical construction; cuts a line in steel to one ten-thousandth of an inch, and produces perfect type punches." This machine is one of the most valuable inventions owned by the American Typefounders' Company, and is used by that company for the benefit of printers in producing artistic and useful type faces with marvelous rapidity.

Fig. 7.19: Text of ATF's Benton Award[51]

[51]From {ATF 1896 TJ}. This is its appearance in *The Typographical Journal*. Google digitization of a University of California copy. Public domain.

7.2.11.3 • Coverage In The International Press

The response to the 1893 exhibition of Benton's engraving machine in the international press, or at least in the German press, was different.

It received some kind of coverage in the October 1893 number of the *Journal für Buchdruckerkunst.*[52]

In May 1894 (well before the awards came out) it received a four-page, front-page, illustrated article in the *Buchgewerbeblatt.*[53] The initial response of the author ('O') was to note that the use of pantographs and direct matrix engraving was already well established in Germany:[54]

> Die Bohrmaschinen für Schriftgiessereizwecke sind ja in Deutschland nichts Neues, denn schon seit zwei Jahrzehnten werden Matrizen mittels ähnlicher Maschinen, wie sie zum Gravieren von Petschaften benutzt werden, gebohrt resp. graviert; ... {[Benton 1894]}: col. 581.
>
> Milling machines for type foundry purposes are nothing new in Germany, as matrices have been machined or engraved using machines similar to those used for seal engraving for two decades.[55]

However, the potential of Benton's machine specifically for punch and patrix cutting seemed interesting — though the price raised eyebrows.

> Diese Maschine, welche den Beifall hervorragender
> Fachmänner fand, dürfte manche Umwälzung in der
> Schriftgiessereibranche hervorrufen und auch bald in Deutschland
> Einführung finden, obgleich der Erfinder nicht weniger
> als 5000 Dollars den Käufern abnimmt!
>
> This machine, which has received the approval of eminent experts, is likely to bring about considerable upheaval in the type foundry industry and will soon be introduced in Germany, even though the inventor is charging buyers no less than $5,000!

Rather than butchering the German language further, I'll simply reprint this article on the four pages which follow.

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[52] I have not yet seen this. It is referred to in the May 1894 article in the *Buchgewerbeblatt*.

[53] "Book Trade Journal."

[54] For more examples, see 8, "Type Foundry Practices in Germany, 1877–1900," on page 149.

[55] 1894 - 20 = 1874, which is the date at which Hofer introduced his pantograph for (initially) seal-engraving.

BUCHGEWERBEBLATT
HALBMONATSSCHRIFT
FÜR ALLE ZWEIGE DES BUCHGEWERBES.

Jahrgang II. MAI 1894. *Heft 15.*

INHALT: BENTONS Maschine zum Schneiden oder Gravieren von Schriftstempeln von O. Mit zehn Abbildungen. — Ostermess-Fachausstellung des Mitteldeutschen Papiervereins zu Leipzig. — Neuerungen an Tiegeldruckpressen von CARL MÜLLER. Mit zwei Abbildungen. — Patentliste. — Buchgewerbliche Rundschau XV. — Kleine Mitteilungen. — Litteratur. — Anzeigen.

Bentons Maschine zum Schneiden oder Gravieren von Schriftstempeln.

Mit zehn Abbildungen.

Auf der Columbischen Weltausstellung in Chicago war von der AMERICAN TYPE FOUNDERS Co., Cincinnati eine komplette Schriftgiesserei ausgestellt worden. Das Bemerkenswerteste in derselben war jedoch ein neuer Apparat von LINN BOYD BENTON in Milwaukee (Wisconsin, V. St. A.) zum Stempelschneiden und Bohren. Die Bohrmaschinen für Schriftgiessereizwecke sind ja in Deutschland nichts Neues, denn schon seit zwei Jahrzehnten werden Matrizen mittels ähnlicher Maschinen, wie sie zum Gravieren von Petschaften benutzt werden, gebohrt resp. graviert; jedoch hat sich dieses Verfahren bei uns nicht sehr eingebürgert, weil es keine grossen Ersparnisse sicherte. Die ausgestellte Maschine nun schneidet Stempel in Stahl, die dann später in das Matrizenmetall eingeschlagen werden. Die ausgestellte BENTONsche Maschine, deren Höhe 5 Fuss 4 Zoll betrug und eine Grösse des Fundaments von 22 × 28 Zoll besass, ist in der Hauptsache ein ausserordentlich genau wirkender Pantograph, bei dem durch Umfahren des in grossen Dimensionen ausgeführten Musters eines Buchstabens mit einem Fahrstift, ein sehr feiner Bohrer (Fraiser) den beliebig, selbst bis zu mikroskopischer Grenze verkleinerten Stempel aus einem Stahlblock ausbohrt. Neuerdings soll der BENTONsche Apparat auch mehrfach zum Bohren der Matern für die Linotype benutzt werden. Diese Maschine, welche den Beifall hervorragender Fachmänner fand, dürfte manche Umwälzung in der Schriftgiessereibranche hervorrufen und auch bald in Deutschland Einführung finden, obgleich der Erfinder nicht weniger als 5000 Dollars den Käufern abnimmt!

Das »Journal für Buchdruckerkunst«, welches in seinem Ausstellungsbericht im Oktober ziemlich kurz auf die BENTONsche Erfindung zu sprechen kam, betont u. a. folgendes: »Die bis jetzt einzige Beschreibung, welche über diese Maschine gemacht ist, nämlich die in der Nr. 3, 1893 des »Inland Printer«, welcher in Chicago erscheint, ist recht fehlerhaft und unzuverlässig. So sagt sie, dass die ursprüngliche Zeichnung des Buchstaben, welche für den Maschinenschnitt notwendig ist und die nachher pantographisch verkleinert wird, 16000 mal grösser als Petit ist — der Schriftgiesser müsste sich ja eins der 20stöckigen Häuser Chicagos mieten, wenn er ein derartiges Alphabet zeichnen wollte.«

Wir haben den betreffenden Artikel des »Inland Printer« zwar nicht zu Gesicht bekommen, doch scheint uns hier unzweifelhaft eine missverständliche Auffassung des »Journals« vorzuliegen, indem letzteres sich eine 16000fache Linearvergrösserung vorstellte, während die amerikanische Kollegin offenbar die Vergrösserung der Fläche meinte. Da man nun die einer bestimmten Flächenvergrösserung entsprechende lineare Vergrösserung dadurch erhält, dass man aus ihr die Quadratwurzel zieht, und ferner die Quadratwurzel aus 16000 rund 126 beträgt, so handelt es sich in vorliegendem Falle um einen Musterbuchstaben, welcher linear nur 126 mal grösser zu sein braucht als Petit, also ganz rationelle Dimensionen besitzt.

In Nachstehendem wollen wir nun eine genaue Beschreibung der BENTONschen Maschine geben und zwar an der Hand unserer Abbildungen Fig. 1—10. Unsere Fig. 1 zeigt eine perspektivische Ansicht der Maschine und Fig. 4 einen Vertikalschnitt durch dieselbe. Fig. 9 zeigt das geschärfte Ende des Stichels in starker Vergrösserung, wie auch eine schematische Darstellung, welche die Aufeinanderfolge der Stiche oder Schnitte zeigt, die zur Bildung der Matrize oder des Schriftstempels gehören.

A in Figur 1—4 ist ein Ständer mit einem breiten Fuss *F*, oben mit einem gabelförmigen Arm *G* versehen, zwischen dessen beiden Zinken oder Schenkeln ein Ring *L* drehbar

BUCHGEWERBEBLATT, MAI 1894.

Digitized by Google

Fig. 7.20: *Buchgewerbeblatt* (May 1894), Columns 581–582[56]

[56]From {[Benton 1894]}. Google digitization of the Bavarian State Library copy. Public domain.

befestigt ist. In dem Ring *L*, und zwar den Befestigungspunkten desselben diametral gegenüber, ist ein zweiter Ring *K* drehbar angebracht, so dass beide zusammen ein Universalgelenk bilden, welches den Rahmen *T* trägt. Zwischen seinen Schwingungsachsen hat der Ring *K* vier Ansätze, an denen die Stäbe *e e* sitzen, deren untere Enden in dem Rande der Scheibe *H* befestigt sind, wodurch der Rahmen *T* entsteht.

In der Mitte der besagten Scheibe *H* ist der Führungsstab *C* befestigt, dessen Achse mit der des Rahmens *T* genau in einer Linie liegt. Im unteren Ende des Stabes *C* ist eine senkrechte Hülle gebildet, in welcher der kleine runde Zapfen *w* sitzt, Fig. 4, 7 und 10, über der sich eine Spiralfeder *X* befindet.

Auf das untere Ende des Zapfens *w* werden verschiedene Röllchen oder Scheiben *S S* gesteckt, ausserdem ist aber dieser Zapfen ausgebohrt und dient diese Ausbohrung zur Aufnahme der Stifte 4 und 5, deren Zweck weiter unten beschrieben wird.

Um Schriftstempel verschiedener Art und Grösse gravieren zu können, ist es nötig, dass man, besonders für grössere Sorten, Führungsstäbe *C* von verschiedener Länge hat oder, was demselben Zwecke entspricht, dass der Führungsstab, etwa wie in Fig. 10, von veränderlicher Länge ist. In letzterem Falle lässt sich der untere Teil B^2 des Führungsstabes im oberen Teil C^2 verschieben und dann in gewünschter Position mittels Stellschraube D^2 wieder feststellen.

Um das Muster oder die Vorlage in passender Stellung zu erhalten, bedient man sich des Tischchens *D*, welches eine Nabe *d* hat, mittels welcher es am Ständer *A* befestigt ist und an diesem auf- und niedergeschoben werden kann. Im Ständer *A* ist an der hinteren Seite eine senkrechte Nute angebracht; ebenso ist in der Nabe *d* eine der vorigen entsprechende Nute vorgesehen. Ein in diese beiden Nuten geschobener Keil gestattet senkrechte Verschiebung des Tisches *D*, verhütet aber gleichzeitig seine Drehung um den Ständer *A*. Eine Stellschraube in der Hülse *d* gestattet die Feststellung des Tischchens in beliebiger Höhe.

n n sind Seitenstücke, zwischen welche das Muster in seiner Stellung festgekeilt werden kann; *a*, Fig. 1, ist eine Einstellschiene, die auf der Führung *b* geradlinig verstellbar ist und genaue Einstellung des Musters gestattet. *P* ist ein hohler Cylinder, der durch eine Öffnung der Platte *h*, Fig. 6, hindurchgeht; dieselbe ist oben auf dem verstellbaren Block *N* befestigt.

Der Cylinder *P* hat einen Bund $p^1 p^1$, der auf der Platte *h* aufliegt; unterhalb des Bundes p^1 ist der Cylinder *P* abgedreht, und sitzt auf diesem abgedrehten Ende der Flantsch *U*, welcher sich an der Unterseite von *h* anlegt, so dass der Cylinder *P* in seiner Stellung festgehalten wird. Beide Teile, der Cylinder *P* und der Flantsch *U*, werden mittels einer Scheibe *W*, die als Mutter wirkt, gegeneinander gepresst und damit an der Platte *h* festgehalten. Der Cylinder *P* bildet eine Stütze für den Werkstückhalter (d. h. den Halter für das Arbeitsstück) *R* und ist mit dem oscillierenden Rahmen *T* mittels Universalgelenkes, bestehend aus konzentrischen Ringen *I* und *M*, verbunden.

Die Stäbe *e e* gehen durch Löcher des Ringes *M*, in denen sie frei verschiebbar sind: der letztere ist oben am Cylinder *P* derart drehbar befestigt, dass der Cylinder die seitliche Bewegung des Rahmens *T* mitmacht, aber nichtsdestoweniger stets einen rechten Winkel mit der Achse des Apparates bildet, indem ihn die Platte *h* in dieser Richtung festhält.

Der Block *N* ist auf der Führung *f* senkrecht verschiebbar, die vorn an dem Ständer *A* befindlich ist, und kann durch eine Stellschraube *k* beliebig festgestellt werden; diese Stellschraube reicht durch einen Schlitz des Ständers *A* und der Führung *f* hindurch. Vorn am Block *N* ist der drehbare Stichelhalter *B* so montiert, dass er mit dem Block, sowie mit *P* verschoben werden kann. Ein kleiner Stift oder Ansatz 6, der auf dem Block *N* angebracht ist, dient zur Führung, die gestattet, dass man den Sticheltrager jederzeit genau mit Bezug auf den Cylinder *P* einstellen kann. Ein kleiner verschiebbarer Block *O* hat einen Ansatz, in dem eine Stellschraube *g* befindlich ist; *O* kann unter dem Block *N* auf *f* verschoben und in beliebiger Höhe festgestellt werden vermittelst der Schraube l^1, die ebenfalls durch den Schlitz des Ständers *A* reicht. Um nun zu ermöglichen, dass der Block *N* für eine gegebene Grösse oder Sorte von Lettern eingestellt werden kann, wird der Block *O* mit einer Stellschraube r^1, Fig. 1, versehen, deren Spitze in die seitlichen Löcher an der Führung *f* eingreift, so dass der Block *O* in irgend einer Höhe befestigt werden kann.

Die Löcher können numeriert sein, so dass jedes derselben passende Stellung für eine gewisse Grösse hat. Auf der unteren Seite des Blockes *N* befindet sich ein Loch mit Schraubengewinde, in welches die im Block *O* vorgesehene Stellschraube *g* eingeschraubt ist, und kann man durch Vor- oder Rückwärtsdrehen derselben die Höhe des Blockes *N* auf das Genaueste einstellen.

In den Cylinder *u* des Sticheltrágers *B* wird ein Stichel *o* eingeführt und mit dem Klemmbacken *p*, Fig. 5, festgehalten. Die Klemmbacken sitzen mit ihrem röhrenförmigen Ende, um welches auswendig Gewinde eingeschnitten ist, in dem Cylinder *u*. Am unteren Ende dieser Röhre ist ein Knopf *q* befestigt. In der inneren Seite des Cylinders *u* befindet sich ebenfalls Gewinde. Wird nun an dem Knopf *q* gedreht, so wird das cylindrische Ende der Klemmbacken in den Cylinder *u* ein- oder ausgeschraubt. Werden die Klemmbacken *p* nach unten gezogen, so werden sie in ihrem schrägen Sitz an *u* herangepresst und drücken sich oben zusammen, wodurch der Stichel *o* festgehalten wird. In das untere Ende der Spindel *u* wird eine innen und aussen mit Schraubengewinde versehene Hülse *r* geführt. In dem inneren Gewinde bewegt sich die kleine Stellschraube *s*, deren Spitze gegen das Ende des Stichels drückt. Auf diese Weise kann der Stichel auf ganz geringe Längen und mit der allergrössten Genauigkeit eingestellt werden, so dass man den Stichel nachschleifen kann, was mit grösster Sorgfalt und mittels spezieller Vorrichtung geschehen muss, damit der Abstand des Stichels vom Arbeitsstück unverändert bleibt und man den Stichel nicht jedesmal von neuem zu regulieren hat.

Durch den Stift *t*, welcher in die Schnurscheibe des Stichelhalters geschoben werden kann, hält man den Stichelhalter in seiner Stellung fest, während man den Stichel zuschärft oder dergleichen.

R, Fig. 4 und 6, ist der Werkstückhalter, bestehend aus einer cylindrischen Hülse $a^1 a^1$ mit einer Messingauskleidung $h^1 h^1$, in deren Mitte ein viereckiges Loch vorgesehen ist, das zur Aufnahme des Stückes c^1 dient, aus dem der Schriftstempel gemacht werden soll. Auf h^1 und c^1 liegt der cylindrische Block b^1.

Auf dem Block b^1 ruht eine Spindel *X* mit einem runden Kopf i^2, derselbe wird durch den in der Hülse a^1 eingeschraubten Deckel d^1 gegen den Block b^1 gedrückt. In dem in der Mitte des Deckels d^1 befindlichen Loch kann sich die Spindel *X* frei drehen. Der Raum, der sich zwischen der inneren Wandung des Cylinders a^1 und der Peripherie des Kopfes *i* befindet, wird durch einen Ring m^1 ausgefüllt. Derselbe

Fig. 7.21: *Buchgewerbeblatt* (May 1894), Columns 583–584[57]

dient dazu, um ein zu tiefes Einschrauben des Deckels d^1 in a^1 zu verhüten, da sonst der Kopf *i* festgeklemmt würde.

Es muss also m^1 eine Wenigkeit höher wie *i* sein. Hat sich der Kopf *i* abgenutzt, so dass er zwischen Block b^1 und Deckel *d* wackelt, so muss von der Höhe des Ringes m^1 nach Bedürfnis abgeschliffen werden.

Der Werkstückhalter *R* kann sich im Cylinder *P* nicht drehen, da dies durch eine Nase verhindert wird, die in eine senkrechte Nute des Cylinders a^1 greift. Der Werkstückhalter wird mittels der Schraube *m* festgehalten und kann in passende Höhe im Cylinder *P* mittels eines Steges *V V* gebracht werden.

In diesem Steg, der auf dem Cylinder *P* mit kleinen Schräubchen *y y* befestigt ist, ist ein Gewinde eingeschnitten, mit welchem die Spindel *X* gehoben oder gesenkt werden kann; dieser als Mutter wirkende Teil des Steges *V* ist auf dem oberen Ende gespalten und auch von aussen mit Gewinde versehen, um welches ein Ring 3 geschraubt werden kann; diese Vorrichtung hat den Zweck, etwaige Abnutzungen auszugleichen; je weiter der Ring 3 aufgeschraubt wird, um so mehr werden die gespaltenen Teile von *V* zusammengezogen.

Oberhalb des Steges *V* ist eine mit einer Skala versehene Scheibe *Y* angeordnet, die auf der Spindel *X* mittels Stellschraube, welche auf einen in *Y* befindlichen Keil drückt, festgestellt werden kann. Eine Federklinke *z*, die auf *V* angebracht ist, greift in die feinen Einschnitte der Skala auf dem Rand der Scheibe *Y*.

Auf diese Weise kann man den Werkstückhalter mit der grössten Genauigkeit auf die kleinsten Abstände einstellen. Damit man nun mit dieser Maschine einen tieferen, stärkeren Schnitt machen kann, dürfte es sich in manchen Fällen empfehlen, den Werkstückhalter *R* viereckig zu machen, was dann kleine Abweichungen in der Konstruktion, nicht aber im Prinzip verursacht.

Das Arbeitsverfahren ist wie folgt:

Der Stichel *o* wird passend geschliffen, und zwar so, dass sich konvex konvergierende, dreieckig facettierte Schnittflächen bilden, deren Kurve der Hervorbringung der erforderlichen Abschrägung in dem Schriftstempel angepasst ist.

Der Stichelträger *B* wird in der passenden Stellung auf dem Block *N* befestigt, und zwar mit dem Stichel nach aufwärts in der Achsenlinie der Maschine, Fig. 1 und 4.

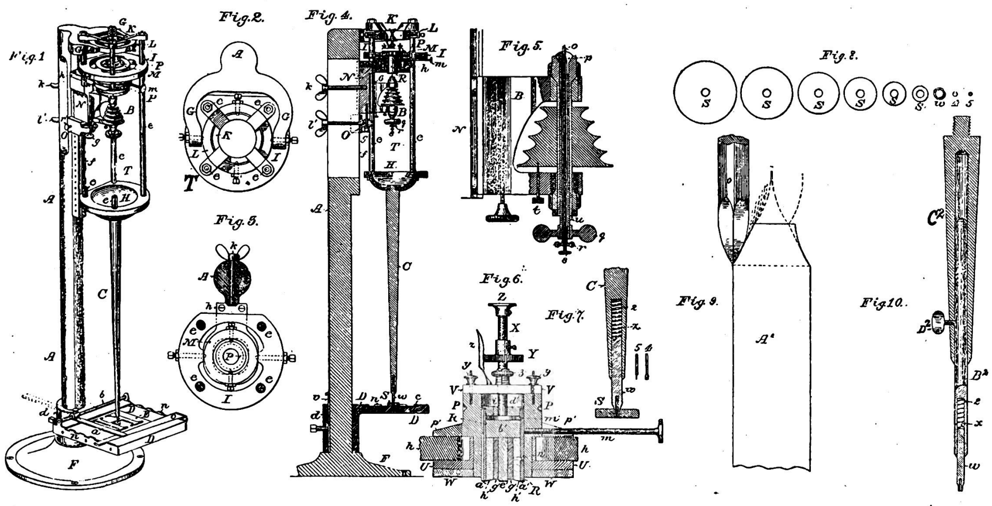
Der Block *N*, der die Stellung des Cylinders *P* und des Stichelträgers *B* mit Bezug auf die Drehungsachse des Rahmens *T* bestimmt, wird so eingestellt, dass zwischen dem Arbeitsstück und dem Muster das richtige Grössenverhältnis entsteht. Um nun Stangen verschiedener Grösse zu schneiden, benutzt man Führungsstäbe *C* von verschiedener Länge oder besser einen Stab, dessen Länge veränderlich ist, Fig. 10; sodann wird Tischchen *D* auf passende Höhe am Support befestigt. Je näher man das Arbeitsstück dem Drehpunkt vom Rahmen *T* rückt und je weiter man das Muster von demselben entfernt, um so mehr reduziert man die Arbeit in Grösse im Vergleich mit dem Muster. Entfernt man die Arbeit und bringt das Muster dem Drehpunkt näher, so wird die Arbeit im Verhältnis weniger reduziert.

Das zu gravierende Stück e^1 wird in das Innere des Werkträgers *R* eingebracht, und ist dasselbe zu klein, um die Öffnung ganz auszufüllen, so werden Einsatzstücke g^1 g^1 benutzt und das Ganze durch Schrauben n^1 festgehalten, die durch den Cylinder a^1, sowie durch die Ausfütterung h^1 desselben hindurchreichen.

Das vorstehende Ende von e^1 wird sorgfältig auf gleiche Höhe mit den Rändern von a^1 a^1 abgeschliffen.

Ein Führungsstab *C* von passender Länge wird benutzt, um die nötige Reduktion der Dimensionen zu bewirken. Das Muster wird auf dem Tischchen *D* befestigt und von Keilen *c* festgehalten. Der Werkstückhalter *R* wird dann so eingestellt, dass der Stichel *o* von vornherein seinen tiefsten Schnitt macht.

Der Buchstabe wird gebildet, indem die Tiefe der Schnitte nach und nach abnimmt, sowie man sich der Schriftfläche nähert, Fig. 9.



BENTONS Maschine zum Schneiden oder Gravieren von Schriftstempeln.

Fig. 7.22: *Buchgewerbeblatt* (May 1894), Columns 585–586[58]

Zu diesem Zwecke sind eine Anzahl von Führungsscheibchen S vorhanden; die grösseren werden für die ersten Schnitte benutzt, die von der Schriftfläche am entferntesten sind, die kleineren Scheiben, die Enden w für den Führungsstab und endlich die Stiftchen 4 und 5 für die letzten Schnitte.

Man kann auch beliebig andere Mittel benutzen, um denselben Zweck zu erreichen, z. B. die Kanten der Muster können abgeschrägt oder in Stufenform gebildet sein und ein einziger Führungsstab dem Muster in seinen verschiedenen Abstufungen folgen, deren Höhe je nach der Entfernung von der Schriftfläche verschieden ist.

Das Muster kann auch durch eine Anzahl von Vertiefungen gebildet werden, deren innerste den Umriss des fertigen Schriftzeichens bildet, oder man kann noch eine Reihenfolge von verschiedenen Mustern benutzen.

Für jeden Schnitt wird das Werkstück gehoben und je ein kleineres Scheibchen eingesetzt, und zwar nach der durch Erfahrung gelehrten Reihenfolge und in Übereinstimmung mit dem Grade, in welchem man die Spindel X in dem Stücke V gedreht hat (was an der Skala auf Y abgelesen werden kann). Die Grösse der Scheiben bestimmt die Entfernung zwischen dem Schnitt und dem Umriss des Schriftzeichens; das Vorrücken der Spindel X bestimmt die Tiefe des Schnittes.

Für die ersten, tiefen Schnitte bedient man sich eines Stichels, dessen Spitze etwas stumpf geworden ist, so dass die Späne leicht abgehen; für die letzten Schnitte benutzt man einen vierseitigen Stichel mit gebogenen Kanten, Fig. 5, die die Abschrägung zwischen dem Stempelkörper und der Schriftfläche bilden; die ersten Schnitte sind dem Rande am nächsten, die letzten der Schriftfläche, Fig. 9.

Fig. 9 zeigt in vergrössertem Massstabe ein Arbeitsstück A^2 und den Stichel o, wenn er seinen tiefsten Schnitt macht. Die punktierten Linien zeigen die aufeinander folgenden Schnitte, mittels deren die Abschrägung von der Kegeloberfläche nach der Schriftfläche zu erzeugt wird.

Den Schnittkanten wird eine solche Kurve gegeben (indem man die Facetten passend zuschleift), dass eine Aufeinanderfolge von Schnitten mit dem Teil oberhalb der Spitze die nötige vorerwähnte Abschrägung hervorbringt. Je stärker die Biegung der Schneidkanten oder je stumpfer der Stichel, um so grösser ist der Winkel der Abschrägung, und umgekehrt.

Für den ersten Schnitt greifen sowohl Spitze wie Schneidkanten ein; für die späteren Schnitte, bis auf den letzten, greift nur ein kleiner Teil der Schnittkante oberhalb der Spitze an, die Spitze selbst aber berührt das Werkstück nicht wieder, bis zum allerletzten Schnitt, der dann mit der Spitze allein gemacht wird.

Da ein etwas stumpfes Werkzeug für die tiefsten Schnitte besser ist als ein ganz scharfes, und da ein für diesen Zweck gebrauchter Stichel bald zu stumpf würde, um die feinen Schnitte auszuführen, werden zwei separate Stichel benutzt, einer stumpf und einer scharf; statt jedoch die Stichel im Stichelhalter auszuwechseln, was beim Wiedereinsetzen Schwierigkeiten machen würde, benutzt man Stichelhalter, die je einen der Stichel tragen.

Um die Muster zum Einschneiden oder Gravieren von irgend einer Serie von Schriftzeichen (geradlinig oder gebogen) auf denselben Stempel einstellen zu können, bedient man sich der Einstellschiene a, die auf b verschiebbar ist und rechts und links an das Muster angelegt werden kann, wie in Fig. 1 gezeigt ist.

Wenn das Musterstück richtig eingesetzt ist, so kann die Einstellschiene zurückgeschlagen werden, damit sie nicht hinderlich wird, wie in derselben Figur punktiert gezeigt ist. Man kann auch Einlegestücke benutzen, um den Raum zwischen dem Muster und den Teilen $n\,n$ an den Seiten des Tischchens D auszufüllen.

Hat man die passende Justierung vollendet, so wird der Stichel mit seinem Träger in rasche Umdrehung versetzt und man folgt mittels des Führungsstabes dem Muster, wobei die Scheibchen am Führungsstabe durch die Feder x gegen das Muster zu gehalten werden, und die Feder gestattet, die Scheibchen bezw. Stifte und dergl. nach Belieben zu heben und auszuwechseln oder sie in die Aussparungen in den inneren Teilen des Musters einzuführen.

Während die Scheibchen dem Muster folgen, wird das Arbeitsstück bewegt und der Stichel schneidet die Linien in dasselbe, jedoch sind letztere verhältnismässig reduziert.

Ehe man zu gravieren beginnt, empfiehlt es sich, das Arbeitsstück glatt abzuschleifen und nach vollendeter Gravierung dasselbe zu wiederholen, um die Kanten zu glätten. Dabei dient nun das Gehäuse a^1 des Werkstückhalters R als Führung beim Schleifen.

Ohne vom Prinzip vorliegender Erfindung abzuweichen, können die bezüglichen Stellungen des Arbeitsstückes und des Stichels umgekehrt werden, so dass das Arbeitsstück unbeweglich, der Stichel aber mit dem Führungsstab beweglich wird.

Benton, welcher in den Vereinigten Staaten von N.-A. sowie im Deutschen Reiche auf seine Maschine Patente erhalten hat, führt das Gestell A derselben der grösseren Stabilität halber neuerdings oft zweiseitig aus, so dass der Graviermechanismus sich also zwischen zwei Ständern befindet. O.

Fig. 7.23: *Buchgewerbeblatt* (May 1894), Columns 587–588[59]

7.2.12• Other Benton Type 1 References

In the 1890s, the number of references to the Benton "punch-cutting machine" increases, although type-making was never headline news even in the printing industry. Curiously, Benton does not receive an article in William E. Loy's 28-part series "Designers and Engravers of Type" which appeared in The Inland Printer from 1898 to 1900 (though both Schroeder and Werner do).

At Mergenthaler Linotype (1892)

The first annual report of the Mergenthaler Linotype Company, issued in late 1892, apparently contained a sentence praising Benton's machine. This report has been digitized from an unknown library but is not yet freely available; I have not seen it. This sentence has been quoted twice in the published literature (once in {Bullen 1922 LBB}, pp. 62–63, and once in correspondence from Benton to David Gustafson in 1932 (as quoted in {Cost 2011}, p. 70)): "By the acquisition of the Benton punch-cutting machine a seeminly insurmountable obstacle to our success has been overcome."

By Skopeo, of No. Six (1896)

The Typographical Journal was the official publication of the International Typographical Union, and "No. Six" was its large and influential New York local. In 1896, one of its members, writing under the pseudonym "Skopeo," published a good two-part article on "The Typefounder's Art." It spends a considerable amount of time (given the overall length of the article) on Benton's "punch-cutting machine," though it is short on technical details. It concentrates on the importance of this machine to the Linotype.

The article is also interesting on two other counts. First, it suggests that Benton's "invention of self-spacing type led him to the more important one of the punch-cutting machine, as he found it impossible to hire enough punch-cutters to bring out self-spacing type in any reasonable time." Be-

The recent invention by L. B. Benton of a punch-cutting machine has simplified the work of punch-cutting. This punch-cutter is in use in both hemispheres and is considered to be one of the most marvelous mechanical inventions of the day, its product surpassing in accuracy the finest hand work, while it cuts many sizes from one pattern. It cuts in steel or softer metals, and overcomes what has heretofore been a serious difficulty in punch-cutting, because no matter how expert a punch-cutter may be he can never cut two of the same characters exactly alike. The Benton machine reproduces any number of the same characters without the slightest deviation. How important this achievement is may be judged by the fact that the linotype machine, which has worked such havoc in our ranks, was doomed to failure while it depended for matrices on punch-cutters who worked by hand. The matrices on the linotype are constantly giving out, and the punch-cutter could never make an accurate facsimile, the consequence being that the appearance of the face soon became irregular and as if full of wrong fonts.

When the Benton punch-cutter was secured by the Linotype Company the greatest obstacle to the success of its machine was successfully overcome. The career of Mr. Benton illustrates the possibilities of success for a workman with genius and that necessary adjunct to genius—perseverance. He was at first an all-round country printer, but on becoming part owner of a small type foundry in Milwaukee he set to work to master the details of this intricate business. His invention of self-spacing type led him to the more important one of the punch-cutting machine, as he found it impossible to hire enough punch-cutters to bring out self-spacing type in any reasonable time. Mr. Benton is manager of the construction department of the American Typefounders' Company and the patents upon his self-spacing type and punch-cutter are, I understand, owned and operated by that company, which, I may remark parenthetically, judging from the constant appearance of its advertisements in the JOURNAL, has solved the true idea of advertising—always keep your name before the public, in season and out of season.

Fig. 7.24: Skopeo, of No. Six (1896)[60]

[60]From {Skopeo-1896}: 214.

cause “any reasonable time” is a matter of opinion, this is not an unreasonable claim. It may be compared to Bullen’s later assertion that there were not enough punchcutters in the world to undertake this vast project.

Second, it notes that ATF had (even by 1896) mastered the art of advertising. A large part of our current narrative about the history of typemaking comes from 20th century ATF advertising and the writings of the ATF Librarian, Henry Lewis Bullen.

By DeVinne (1895, 1900)

Benton is also mentioned by the great scholar-printer Theodore Low DeVinne.

The article on “Type-founding” in *Johnson’s Universal Cyclopædia* of 1895 is the earliest instance of this presently known {DeVinne 1895}: 326. He says little, but mentions its importance to the Linotype and emphasizes the “exact” scaling of types.[62]

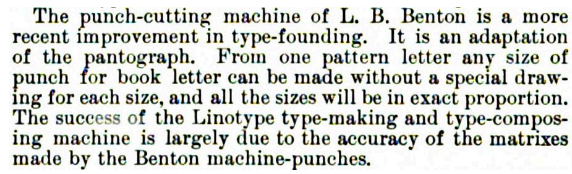

The punch-cutting machine of L. B. Benton is a more recent improvement in type-founding. It is an adaptation of the pantograph. From one pattern letter any size of punch for book letter can be made without a special drawing for each size, and all the sizes will be in exact proportion. The success of the Linotype type-making and type-composing machine is largely due to the accuracy of the matrixes made by the Benton machine-punches.

Fig. 7.25: By DeVinne (1895)[61]

DeVinne devotes much chapter XIV of his magisterial book *The Practice of Typography: … Plain Printing Types* to “Benton’s Punch-cutting Machine” {DeVinne 1900}: 350–353.[64] Much of DeVinne’s account is similar to that of the 1893 *Inland Printer* article on Benton. He does, however, draw attention to the importance of Benton’s “machines for shaping and sharpening the cutting tools” (p. 353).

He also provides a line drawing which is similar to that of the 1893 *Inland Printer* article but which shows slightly more detail (it shows the arrangement for securing the pattern to the table, for example, two rows of followers arranged on the right side of the table, and the driving belt).

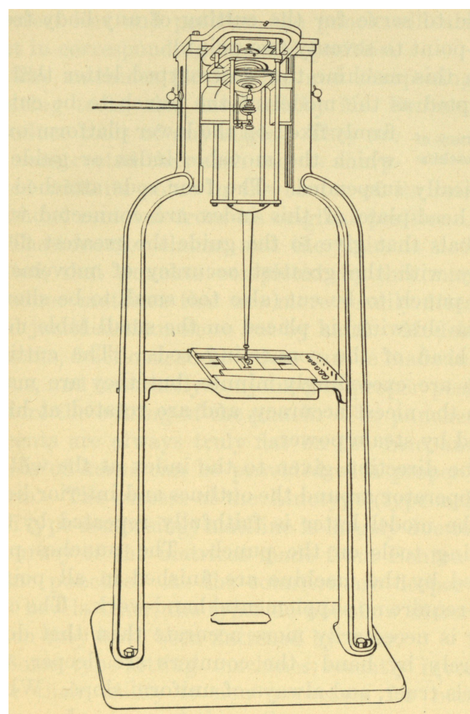

The Benton punch-cutting machine.
Height, 5 feet 4 inches; floor space, 22 × 28 inches.

Fig. 7.26: By DeVinne (1900)[63]

[61]From {DeVinne 1895}: 326. By Google from Princeton. Public Domain

[62]This is something that later became a subject of some debate. See Updike (1922) and Carter (1937).

[63]From {DeVinne 1900}: 351. Internet Archive digitization from a University of California copy. Public domain.

[64]There is a slight typographical error on p. 353, note 1, of his account. He meant to cite the article “L. B. Benton” in *The Inland Printer,* Vol. 11. Instead he cited “vol. xii”. See {[Benton 1893]}.

Of course, just as DeVinne was writing this[65] Benton was filing for his second pantograph patent. The Type 2 machines based on this patent supplanted the Type 1 machines at ATF, although it is not clear when the last Type 1 machine was scrapped.[66] Just as the world got its first published glimpse of the Type 1b Benton, it was being supplanted by Type 2 machines.

Legros, 1908/1916

TO DO: Re-scan illustrations from my copies of Legros 1908 and LG 1916.

TO DO: Legros 1908 does not show the 1884/5 patent drawings, but instead shows drawings of a Type 1b machine.[67]

TO DO: Legros 1916 shows the same, but (confusingly) prepends the main patent drawing to it – EXCEPT that it is not literally the patent drawing. It is a redrawn version which is thus less trustworthy but may be slightly clearer. It at least shows an interpretation of the slot in the Standard (which isn't at all clear in the actual patent drawings, US or GB). But it implies that the Way f is flat, where the patent drawings show it to have beveled edges.

TO DO: Legros & Grant 1916 p. 198 shows the only drawing I have yet found of the workholding mechanism of a Type 1b Benton (or at least they say it is).

TO DO: Check Legros & Grant 1916 p. 201 to see how their drawing of Benton's cutter grinder compares to Benton's patent drawing.

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[65]The copyright date of his book is 1899, though it was published in 1900.

[66]The sole attested Type 1a machine was preserved under glass by Bullen in the ATF Library at least until that library was sold to Columbia University in 1936. Its fate is unknown. Cost says that Theo Rehak had two pantographs at The Dale Guild. One of these must have been No. 55, the Type 2a machine now at Project Letter-kunde. But the other, she says, dated back to "the Milwaukee foundry" and must therefore have been a Type 1 machine. At present, I know nothing more about this machine. {Cost 2011}, p. 72.

[67]These are not from the UK version of the Benton patent.

7.3• The Benton Type 1a Machine

In the terminology used in the Benton *Census*,[69] "Type 1" Benton Engraving Machines (BEMs) are those whose operation is based on his 1884 patent.[70] Within these, Type 1a machines are those which actually look like the patent drawings. These have a distinctive single column (or "standard" in the patent's terminology) to support them. These patent drawings have received wide circulation, but surprisingly little information survives about any actual machines constructed to this pattern.

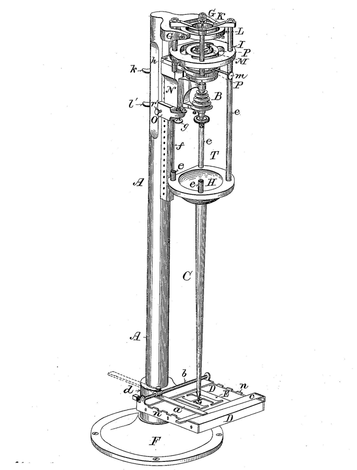

Fig. 7.27: Type 1a, Patent[68]

The earliest known *photograph* of any Type 1 Benton is the one appearing on the cover of a circa 1891 Benton, Waldo advertising pamphlet entitled *Benton's Punch Engraving Machine*. This has been reproduced in Cost's book on the Bentons {Cost 2011}, p. 68)). This photograph is the same as the one which appears in the 1893 *Inland Printer* article "L. B. Benton" {[Benton 1893]}. However, even at this relatively early date it shows a Type 1b machine, not a Type 1a.

Indeed, only one photograph of a Type 1a Benton is known to exist, and even then it is shown only incidentally. This photograph, showing a Type 1a Benton in a glass cabinet in the ATF Typographic Library and Museum, appeared first in 1929 and was reprinted in 1936. Were it not for this photograph, there would be no evidence that any machine of a style similar to the patent drawings was ever constructed.

The publication of this photograph therefore bears some examination. Early views of the ATF library do not show it. For example, two views of the library appear in a guidebook that the Library published in 1914 to accompany an exhibit of its materials at a printing exposition in New York City. Neither shows a pantograph.

[68]From {US 332,990 Benton 1884}, Fig. 1.

[69]*A Census of Benton and Related Pantographic Engraving Machines,* {MacMillan 2023}.

[70]US patent 332,990, filed 1884-02-29 and issued 1885-12-22 {US 332,990 Benton 1884}. In most cases, it is best to cite patent numbers consistently on the basis of their date of issue. However, with Benton matters of timing and priority are important enough that it seems best to cite his pantograph and cutter grinder patents based on their date of filing.

Fig. 7.28: ATF Library, West End (1914)[71]

Fig. 7.29: ATF Library, East End (1914)

The ATF Library moved into new rooms in 1925. No pantographs are visible in photographs of it which appeared in a catalogue of a loan exhibition of European printing in 1926. (Keep an eye on the (West) Reception Area and the location of the bust on the right-hand side of figure 7.30, though.)

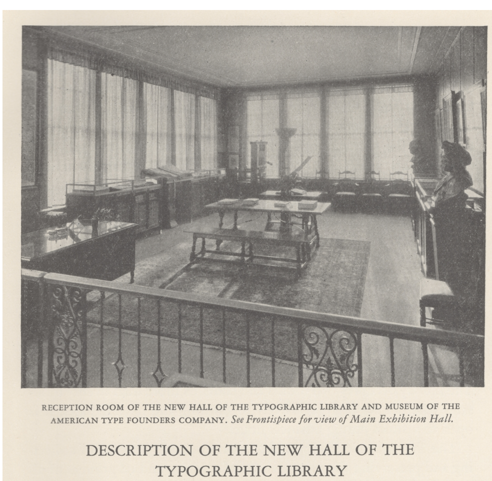

Fig. 7.30: ATF Library, West (1926)[72]

Fig. 7.31: ATF Library, East (1926)

In a 1929 article for *The Pacific Printer and Publisher*, “The Typographic Library and Museum at Jersey City,” Henry Lewis Bullen published the same two views shown above (more or less), but as the Library appeared at this later date. The view to the west (what had been called the “Reception Room” in 1926) is particularly interesting.

[71]From {ATF 1914}: pp. 9, 11. Public domain.

[72]From {ATF 1926}: frontis. and end sheet. Scanned from my own copy. Public domain.

View of main room, looking west toward front entrance. Under exhibit cases are closets for books

Fig. 7.32: ATF Library, West (1929)[73]

In place of the bust, there is now a tall glass cabinet (with an electric fan perched on top of it). In that cabinet is a Type 1a Benton Engraving Machine. Here are two closer views:

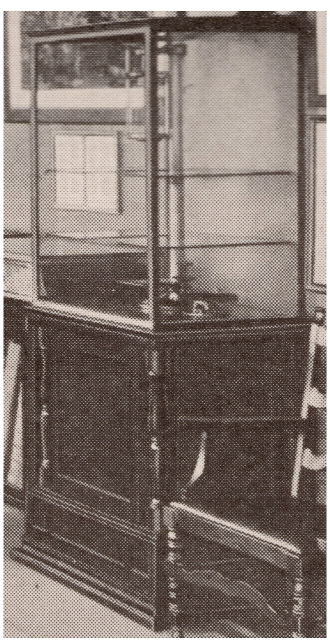

Fig. 7.33: Cabinet

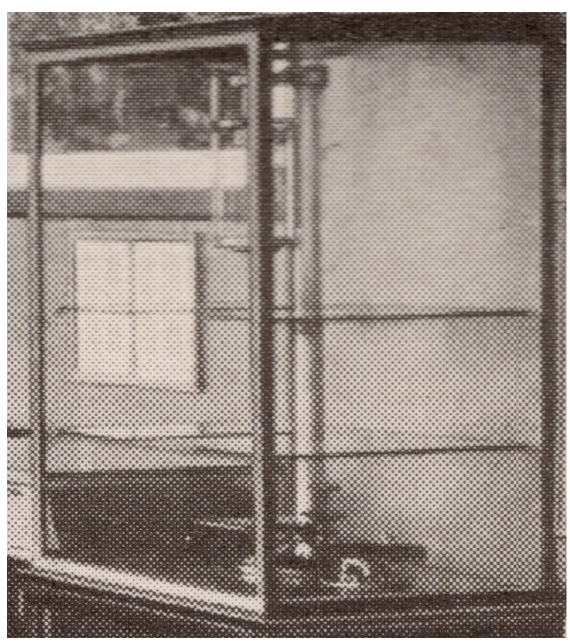

Fig. 7.34: Closer

[73]From {Bullen 1929}: p. 2. Scanned from my own copy. Public domain.

This same photograph, slightly cropped and much darker, appears in a sale catalog prepared by Bullen to dispose of duplicates from the library

II *Catalogue of Duplicates of Books, etc. and Museum Pieces*

Looking West in the Main Hall of the Library. The main entrance opens from a corridor in the right-hand lower corner.

Fig. 7.35: ATF Library with a Type 1a BEM (1936)[74]

Clearly there were not many Type 1a machines constructed. We do not know how many. However, plausible arguments can be made that no more than either one or two were made If this is the case, then it is not unreasonable to believe that the one shown in the 1929 ATF Library photograph is serial number 1, probably preserved by Benton until near his death in 1932.

In part 2 of his 1924 article on the Linotype for the *Inland Printer*, Bullen published a photograph of a Type 1b BEM and said of it that it was the "second machine built by Benton" {Bullen 1924 L2}: 937. This is a different photograph from the one in ATF's 1893 *Inland Printer* article[75] and this is a slightly different machine (look at the construction of the gimbal).[76] Bullen continues by saying "The Mergenthaler Printing Company bought No. 3 in 1889…"

While Bullen remains a highly unreliable source, the purchase of machine Serial No. 3 by Mergenthaler in 1889 is corroborated by independent evidence (the Benton, Waldo "Day Book," as reprinted in *Practical Typecasting*). So it is possible that Bullen was telling the truth in this instance. Their 1891 brochure suggests that Benton, Waldo and Company were leasing Type

[74]From {ATF 1936}. Scanned from my own copy. Public domain.

[75]{[Benton 1893]}: 237.

[76]See section 7.4, "Benton Type 1b Machines," on page 140 below, for a reproduction of this photograph.

1b machines, not Type 1a. So machine serial number 3 was *probably* a Type 1b. That would mean that at most two Type 1a machines were built.

If the Type 1b pantograph illustrated by Bullen was in fact serial number 2, as Bullen says, then Benton must have constructed only a single example of a Type 1a machine.

The ATF Library was acquired by Columbia University in an extended process between 1936 and 1941. Its contents were subsequently dispersed into its various libraries (and some of its museum artefacts, which were not officially a part of the sale, were either sold by ATF in the 1936–1941 timeframe or given away by Columbia). I have discovered no records of whether or not Benton pantographs Nos. 1 and 2 were a part of this acquisition or whether they have survived. Scrap drives during World War II were not kind to institutional collections of cast iron.

Once again, it is important to emphasize how little evidence we really have. A single, poor, photograph proves the existence of at least one Type 1a machine. A trade note by Benton's firm confirms that it was cutting punches in steel by 1884. [77] A statement by a most untrustworthy source says that the second machine made was of Type 1b. We have the patent as issued in December of 1885. We know *nothing* more about Benton's first pantograph.

However, from this scant evidence and a bit of context it is plausible to conjecture the following narrative: In 1884 Benton constructed a single example of a Type 1a BEM and used it to cut both patrices in soft metal and punches in steel. All subsequent BEMs were of Type 1b or later. This sole Type 1a machine went with Benton's foundry to ATF and remained there, either in production or, more likely, in Benton's own workshop, until some point before August of 1929 (Benton died in 1932). After that it moved to Bullen's library at ATF. Its disposition either before or with the sale of the ATF library to Columbia is unknown; one can only hope that it might survive.[78]

[77] A photograph survives which shows the back of a zinc pattern plate

[78] If it is in the ATF Library's subject card catalog, {Lohf 1980}, I cannot find it. Mallison, in his study of Bullen and the ATF Library, does say that after 1953 some "museum items which had come to Columbia by default when Bullen had been unable to sell them were "now stored" or "given to an appropriate new owner." {Mallison 1976}: 294–295.

7.4• Benton Type 1b Machines

In the terminology employed in the Benton *Census*, a Type 1b Benton Engraving Machine is one whose operation is based on Benton's 1884 patent but which differs in construction style from the drawings in the patent and which, further, was made either by Benton, Waldo & Co. or by American Type Founders.[79]

No Type 1b BEMs are known to survive, though all avenues of inquiry have not been exhausted.

7.4.1• Photographic Evidence

Only three illustrations (two photographs and one drawing) specifically of Type 1b BEMs have ever been published. Additionally, one or more of them may be visible in views of the type engraving room at ATF and one *may* be visible as a few halftone dots in a 1929 photograph of the ATF Library and Museum.

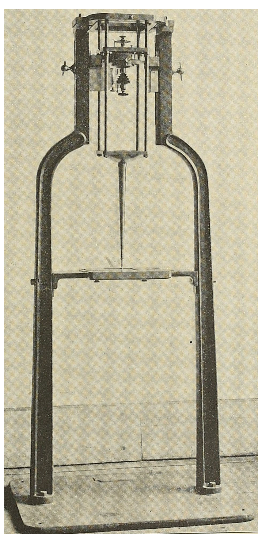

Fig. 7.36: In 1893.[80]

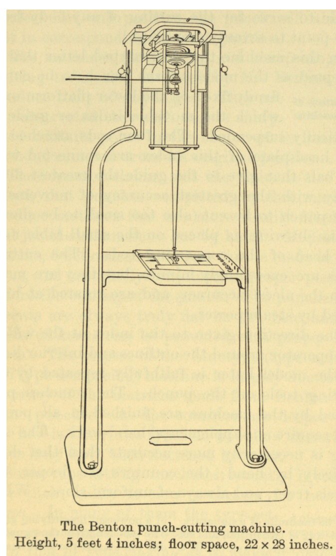

Fig. 7.37: In 1900

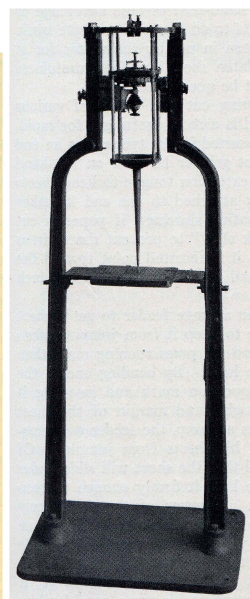

Fig. 7.38: In 1924

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[79] Machines in this style not made by Benton are designated 1c, 1d, etc. in the Census. Several are known from the 20th century, in Europe. No copies of Type 1b machines appear to have been made in the United States. It is likely that there were copies or closely inspired machines made in Europe in the 1890s, but at present little is known about them. (For example, Wilkes reproduces an illustration showing a line of perhaps a dozen Type 1b (or derivative) engraving machines "in deutscher Geißerei, vor 1900" {Wilkes 1990}: 58.) See *A Census of Benton and Related Pantographic Engraving Machines* {MacMillan 2023} for further information.

[80] The 1893 photograph is from {[Benton 1893]}: 237. Smithsonian digitization. The 1900 drawing is from {DeVinne 1900}: 351. Internet Archive digitization from a University of California copy. The 1924 photograph is from {Bullen 1924 L2}: 937. Scan from my own copy. (The original version as printed isn't any better.) All public domain.

The 1893 photograph shown above is the same photograph that appeared in a circa 1891 Benton, Waldo & Co. pamphlet advertising it for lease. See {Cost 2011}, 68).

The view of the Matrix Engraving Room in the 1912 ATF specimen book shows the right side of the room (as you face the windows). All of the engraving machines are Type 2 BEMs. However, in an undated (but probably circa 1912) booklet of views of the ATF Central Plant there is a view showing the left side of this room {ATF 1912 CP}. At the left side of that view are two belt-driven BEMs (and a third machine, far left, which is quite indistinct). These two may be Type 1b machines.

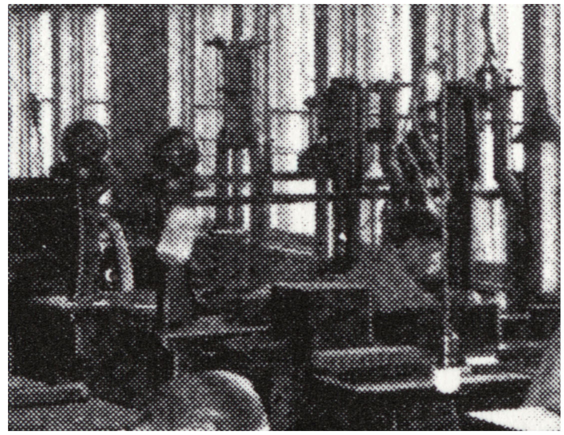

Fig. 7.39: Possible Type 1b (1912)

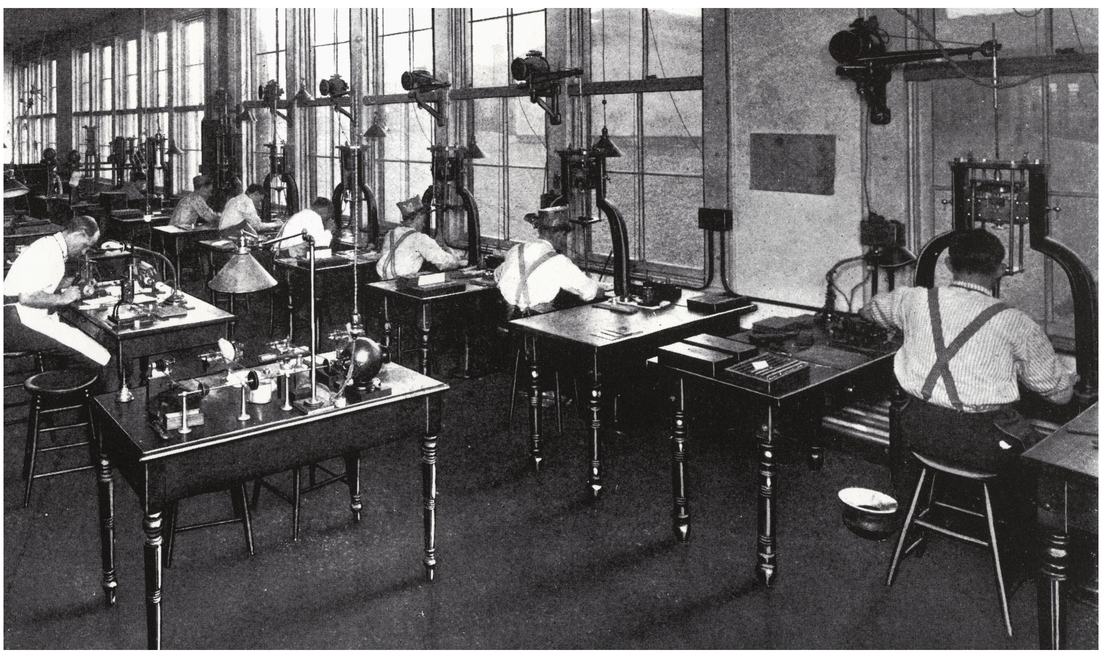

Fig. 7.40: Matrix Engraving Room, Central Plant (1912)[81]

[81] From {ATF 1912 CP}. This photograph is public domain.

In the same 1929 article for *The Pacific Printer and Publisher* in which the Type 1a Benton appears, another photograph shows the view to the east in the ATF Library. There, if you look closely at the second tall cabinet on the left and if you use a bit of imagination, it is possible to think that it contains the Type 1b Benton that Bullen said his Library had in 1924.[82]

Fig. 7.41: ATF Library, East (1929)[83]

Fig. 7.42: Maybe a Benton Type 1b?

[82]Note that Bullen's 1924 article predates his 1926 photographs of the Library which do not show the Type 1a machine.

[83]From {Bullen 1929}. Scanned from my own copy. Public domain.

No other historical information about Type 1b BEMs survives. None were present in the 1993 ATF auction. Despite their great importance, these machines have vanished.

7.4.2• Benton Serial No. 2

We know that a Type 1a Benton pantograph was indeed made (from the 1929 photograph of such a machine in the ATF Library). If we assume that Benton Serial No. 1 was not some otherwise unattested prototype machine which was significantly different, then it is reasonable to assume that serial No. 1 was the Type 1a machine shown in the 1929 photograph. Whether serial No. 2 was a Type 1a or the first Type 1b is harder to say

The question is whether it is reasonable to infer that the machine upon which Benton was cutting punches in steel in 1884 (and probably both punches and patrices from at least 1883) was of essentially the same Type 1a design as shown in the patent as issued in 1885, or was it a Type 1b machine?

At very least, it must have been a Type 1 machine (rather than some otherwise unknown earlier prototype). This assumes that the machine in the patent as filed was substantively the same as that shown in the patent as issued (which is all we have). Benton filed this patent in Feburary of 1884 and announced the ability to cut punches in steel in July of 1884. It is unreasonable to think that he was still using some prototype machine when he had the design of the quite accomplished machine shown in the patent.

On the other hand, we do not know anything with certainty about what Benton was actually using in the years immediately following this patent filing. The claims of his 1884 patent would cover equally well machines of both Type 1a and Type 1b forms. So even if he had developed the Type 1b in the period between the patent filing (February 1884) and its issuance (December 1885) there would have been no need to complicate his life by altering the patent filing.

So this gives us an earliest possible date for a Type 1b Benton of March 1, 1884.

Under the assumption[84] that Benton serial No. 3 (leased to the Mergenthaler company on Febuary 13, 1889) was a Type 1b, this gives a latest possible date for the introduction of the Type 1b Benton of early 1889.

Together, these give a five year period between 1884 and 1889 during which Benton must have built serial No. 2. We have no information at all on when it was built. There is, however, one suggestion (I hesitate to call it "evidence," given its source) that this was a Type 1b machine.

[84]This is discussed in §11.6.2.

In a 1924 article in *The Inland Printer* about the Linotype, Henry Lewis Bullen published a photograph of a Type 1b Benton pantograph. Bullen says several things about this machine, all of which must be treated with caution. In his text, he writes:

> By the merest chance the existence of the punch-cutting machine of Linn Boyd Benton came to the knowledge of Philip T. Dodge, then patent attorney for the Mergenthaler company. Dodge immediately went to Milwaukee and convinced himself of the extraordinary exactness and rapidity of the work done on Benton's machine. He brought back to New York a sample steel punch;
>
> …
>
> Fig. 6 is a picture of the second punch-cutting machine made by Benton. It was on this machine that the sample steel punch was cut for Dodge. The first Benton punch-cutting machine acquired by the Mergenthaler Printing Company was shipped from Milwaukee on February 13, 1889. ({Bullen 1924 L2}: p. 937)

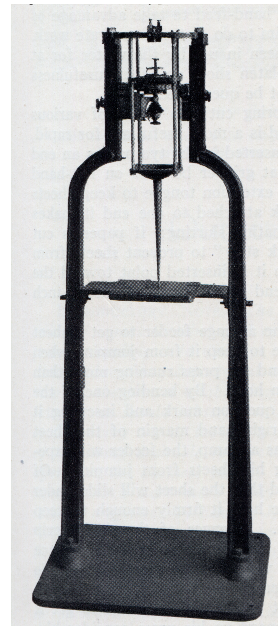

Fig. 6.—The Benton punch-cutting machine, on which the first steel punch was cut for the Mergenthaler linotype machine. The second machine built by Benton. The Mergenthaler Printing Company bought No. 3 in 1889 and several others shortly after. Without this invention Mergenthaler's invention was impracticable. This machine is in the Typographic Library and Museum of the American Type Founders Company, in Jersey City.

Fig. 7.43: In Bullen on the Linotype (1924)[85]

In the caption to the photograph he writes:

> The Benton punch-cutting machine, on which the first steel punch was cut for the Mergenthaler linotype machine. The second machine built by Benton. The Mergenthaler Printing Company bought No. 3 in 1889 and several others shortly after.

This account should be compared with Bullen's account of the same in his 1922 biographical article "Linn Boyd Benton — The Man and His Work" {Bullen 1922 LBB}. In the 1922 article, Bullen tells an elaborate story about the meeting between Dodge and Benton, as a result of which Dodge convinced Benton to cut his first punch in steel. This story is entirely false: if it had happened, it would have been years after Benton had already advertised the ability to cut punches in steel in 1884.[86] Here, however, he tells a different, simpler, and possibly correct story: that Dodge visited Benton, admired Benton's work, and brought back a sample steel punch. Bullen's date for lease (he says "bought," but that distinction isn't important) of the first machine to Mergenthaler (February 13, 1889) and his citation of that machine's serial number (3) are also correct.

Bullen says that the machine in the photograph "is in the Typographic Library and Museum of the American Type Founders Company, in Jersey City." This is certainly something that he

[85]From {Bullen 1924 L2}: 937. Scan from my own copy. Public domain.

[86]See section 11.1.4, "Closer Looks at Bullen's Misinformation," starting on page 179.

would know, as the curator of that library. It is also, as has been seen earlier, possible that it is visible in one of the 1929 photographs of the library.

Bullen further asserts that the machine in the photograph is “the second machine built by Benton” (thus, serial No. 2). In the caption, he says that it was the machine “on which the first steel punch was cut for the Mergenthaler linotype machine.” In the text he says “It was on this machine that the sample steel punch was cut for Dodge.”

It is possible that all of these statements are true.

If they are, then the Type 1b machine pictured is Benton serial No. 2. This would, in turn, imply that only a single Type 1a machine was built. Certainly this is plausible.

Bullen’s information still does not pin down the date when this machine was built. Through my own inattentive reading, I mistakenly thought that he implied that this was the machine “on which the first steel punch was cut.” That would have placed it before July 1884, when Benton advertised this capability. That would have been suspiciously close to the patent filing date.

However, what Bullen actually says is that it is the machine “on which the first steel punch was cut for the Mergenthaler linotype machine.” In other words, Benton had been cutting steel punches since 1884. Dodge visits in 1887 or very early 1888[87] and Benton cuts for him a steel punch suitable for his use. This narrows down the introduction of the Type 1b machine slightly, to the 1884–1887 range.

[87]We know from evidence presented by Basil Kahan in his book on Mergenthaler that on January 10, 1888 Whitelaw Reid of the Mergenthaler firm ordered “100 steel blanks of the proper size for cutting a long primer or small pica face” to be sent to Benton, Waldo and Co. {Kahan 2000}, p. 48. See §7.2.7.

7.5• Type 1 Benton Technology and Operation

TO DO: (all of this)

TO DO: Make drawings of the machine geometry, right-and-wrong-reading operation, relation of pattern to punch/patrix, etc.

TO DO: First Cutter Grinder

TO DO: Note that the patent explicitly cites right-reading patterns as a goal (p. 1, line 43), although this not actually a part of the claims. Note also that the patent claims only punch-cutting (not matrix engraving).

7.6• The Problem of Benton's Leased Machines

In his account in *Practical Typecasting* of the terms under which Benton sold his foundry as a part of the 1892 ATF amalgamation, Rehak presents us with a puzzle. He says that one of Benton's terms was "to recover all B&W devices leased to competitor firms, mainly Linotype and Monotype" (p. 105). Rehak says that "All of these conditions were eventually accomplished," but he does not give dates for the recovery of these machines.

The problem, of course, is that Benton's US patent for his punch-cutting machine, patent 332,990 granted in 1885, did not expire until 1902.[88] Benton's British patent for the same did not expire until 1889.[89] These firms later transitioned to machines of their own design and manufacture: English Linotype to Barr machines (1900), the Mergenthaler firm to machines of as-yet unknown provenance, and both Monotype firms to Pierpont machines (1906). But what of the period from 1892 to 1902? Without punch-cutting pantographs, the four Linotype and Monotype firms would be in serious trouble.

In a telephone conversation in 2023, Theo provided an answer: it was simply a "gentleman's agreement" (as he put it) to allow these firms to continue to use Benton's machines until they developed their own. Unless additional primary archival evidence emerges, this is likely to be the best answer we have.

[88]Between 1861 and 1994 the duration of US patents was 17 years from the date of grant.

[89]The British patent is No. 11,894 of 1885, issued Oct. 6, 1885. (It was issued under the name of Julius Boult for Benton.) British patents under the UK Patents, Designs and Trade Marks Act of 1883 had a duration of 14 years.

8• Type Foundry Practices in Germany, 1877–1900

This chapter is primarily a placeholder for future research. We know from refrences beginning in the 1890s that matrix engraving was well established in German type foundries. At present, though, most of the details of this remain undiscovered.

Here are some examples to illustrate the widespread knowledge in Germany, at that time, of the use of Hofer-style pantographs to directly engrave matrices. In 1894, writing about the Benton Type 1b pantograph exhibited by ATF at the World's Columbian Exposition in Chicago, a reviewer in the *Buchgewerbeblatt* in Leipzig wrote:

> Die Bohrmaschinen für Schriftgiessereizwecke sind ja in Deutschland nichts Neues, denn schon seit zwei Jahrzehnten werden Matrizen mittels ähnlicher Maschinen, wie sie zum Gravieren von Petschaften benutzt werden, gebohrt resp. graviert; … {[Benton 1894]}: col. 581.
>
> Milling machines for type foundry purposes are nothing new in Germany, as matrices have been machined or engraved using machines similar to those used for seal engraving for two decades.[1]

In a 1911 festschrift for the Imperial Austrian printing office, Smalin wrote:

> Matern ohne Stempel zu schaffen, indem man die Buchstabenbilder mittels einer pantographisch arbeitenden Graviermaschine von Hofer direkt in geeignete Metallstücke bohrte, wurde teilweise schon längere Zeit ausgeführt. {Smalin 1911}: 30.
>
> Creating matrices without stamps by drilling the letter images directly into suitable pieces of metal using a pantographic engraving machine from Hofer has been practiced for some time.

Writing in 1925 at the introduction of the first Michael Kampf pantograph, M. Essigke wrote:

> Wem die sogenannte Hofer'sche Graviermaschine bekannt ist, welche zur Herstellung von gebohrten Petschaften und Schriftgußmatrizen heute noch viel Verwendung findet, wird in der vorliegenden Bauart der Kämpf'schen Maschine Bekanntes herausfinden. {Essigke 1925}: 465.
>
> Anyone familiar with the so-called Hofer engraving machine, which is still widely used today for the production of drilled seals [Petschaften] and type-casting matrices, will find something familiar in the present design of the Kämpf machine.[2]

[1] 1894 - 20 = 1874, which is the date at which Hofer introduced his pantograph for (initially) seal-engraving.

[2] Essigke goes on to point out that both machines move the workpiece underneath a fixed cutter. Although the Hofer and the Kampf pantographs appear very different at a casual glance, they are kinematically very similar.

In addition, pantographs very similar in style to Hofer's were used for purposes other than typemaking. Hofer's machine was originally a general engraving machine and it would certainly have continued in that use.

There is also at least one example of a machine very similar to Hofer's which was at least used in other industries and which *may* have been used for typemaking. This would be the engraving pantograph patented in 1891 by Paul Otto. This machine appears to be a 3-dimensional pantograph (what would have been called a “die sinking” machine in the 20th century). The feature(s) adapting it for this use are not directly applicable to typemaking, but the patent for it does explicitly call out “stempeln [and] matrizen” as uses. For more on this machine, see Appendix K, Paul Otto's 3-D Pantograph (1891), on page 255.

9• Commercial Matrix Engraving in the US, 1888–

9.1• Schrœder and Werner (1888–1891; 1891–1894)

TO DO - but much of this has already been covered

9.2• Inland Type Foundry (1894–1912)

TO DO - but much of this has already been covered; work for Stephenson, Blake

9.3• Wiebking and Hardinge (1894–1927)

note survival of three (was four) machines from the Ludlow era; illustrate mine and Patrick's

10• Benton's Type 2 Pantographs (1899)

10.1• The Evidence of Benton's Type 2 Pantographs

10.1.1• Benton's Patents (Filed 1899 & 1900)

TO DO

{US 809,548 Benton 1899}, "Matrix and Punch Cutting Machine" (issued 1906-01-09).

{US 774,030 Benton 1900}, "Grinding-Machine" (issued 1904-11-01).

10.1.2• Benton (1906)

TO DO

include his recognition of punch/patrix vs. matrix styles of pantographs.

10.1.3• Kaup in *American Machinist* (1909)

TO DO This article is very good at a technical level

10.1.4• Photographs and Film, 1909–1993

TO DO:

Kaup 1909 (photo, teken for *The American Machinist*)

ATF 1912 specimen book

ATF 1912 Views of the Central Plant

Bullen 1922 LBB; the machine for Japan

ATF 1923 specimen book

Type Speaks!

Former Dale Guild former website photographs taken just prior to the 1993 ATF auction

10.1.5• Unpublished Documents

TO DO

An example cutting slip in Rehak PT

An example cutting slip in Cost 283

Cutting slips preserved in the archives of Project Letter-kunde.

10.1.6• Documents Not Yet Available

TO DO: (In particular, I need to inquire with the Columbia University Libraries)

Benton's instructions for the use of this machine for its Japanese purchasers. In the ATF Library; may be at Columbia.

The operating manual for the Tsugami (in Japanese, no copies known outside of Japan).

10.1.7• Lost Documents

TO DO

journal of voyage to Japan; cover in PT but now lost

Benton, Waldo "Day Book"; one page in PT but now lost

10.1.8• Post-1993 Work

TO DO:

A quick survey of Rehak-era Dale Guild references

Micah Currier's short film

ATF presentations (Patrick, Juri)

Ed's book on The Benton Protocol

10.2• Technical Differences from Type 1

TO DO

note two sizes

note that it is better adapted to cutting matrices than Type 1; this is purely a matter of the physical configuration of the machine.

note that it can cut punches; photos of punch jig at Patrick's

10.3• Surviving Type 2 Pantographs

TO DO: Mostly direct the reader to the Benton Census, but do a one-page photographic survey of all eight.

10.4• Type 2 Benton Technology and Operation

TO DO: (all of this)

TO DO: Diagrams of geometry, etc.

TO DO: Second Cutter Grinder. Benton/early ATF operation vs. DG/Letter-kunde and Swamp Press operation.

The definitive book on the operation of the Type 2 Benton Engraving Machine is Ed Rayher's *The Benton Protocol: Theory and Practice for Matrix Engraving* {Rayher 2025}. Note, however, that there have been multiple and very different protocols for operating a BEM, from the zinc plates of the earliest days to digital methods today. The method described by Rayher works extremely well and is in use in production today, but it is not the same as the various methods used by Benton and his successors at the Northwestern Type Foundry or ATF.

11• Interpreting Benton

Our understanding of Benton's typemaking comes not from those sources which may be regarded as primary (including Kaup's 1909 article for *The American Machinist*) but instead from secondary accounts. These begin with the writings of Henry Lewis Bullen and were reinforced continuously in the marketing literature of American Type Founders.

11.1• Bullen's Stories

If you trace back through the chain of sources, each generation usually just quoting the one before it, you find that a surprising percentage of what we now take as fact in the history of type and typemaking in the United States begins with the writings of the prolific Henry Lewis Bullen.

It is tempting to treat Bullen as a primary source. He was there and he had direct access to people and equipment. He knew Benton and the library he created was in the same building as Benton's workshop and the ATF Matrix Engraving Room. This was the same plant that contained the largest collection of pivotal and automatic typecasting machinery ever assembled. His own Typographic Library and Museum in the ATF Central Plant was an extraordinary achievement which, had it been preserved intact as he wished, would today be the finest typographical library in the world. He believed passionately in the importance of type and its history.

Unfortunately, if you probe deeply into what he presented as fact, often you will find that it is fiction.[1]

The definitive biography of Bullen remains the doctoral thesis of David Walker Mallison, *Henry Lewis Bullen and the Typographic Library and Museum of The American Type Founders Company* {Mallison 1976}. There is also some biographical information on him in his obituary in *The Inland Printer* {Horgan 1938}.

TO DO: Some biographical details of Bullen. Add two portraits of him, young and old.

[1] TO DO: PIVOTAL PIN

11.1.1• Discursions (1907)

TO DO: Introduce article; it is reprinted on following pages.

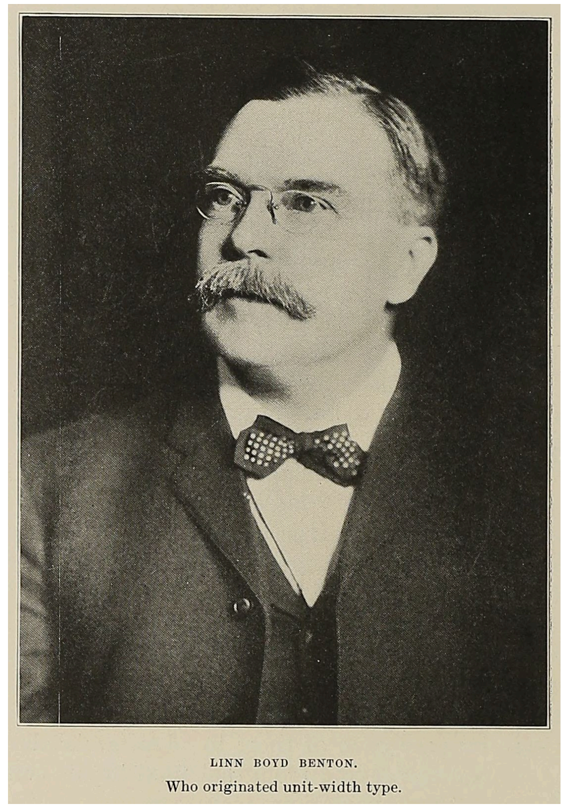

Fig. 11.1: Benton in Bullen's "Discursions" (1907)[2]

[2]From {Bullen 1907}: p. 514. Smithsonian digitization, public domain.

THE INLAND PRINTER 517

type business has been most valuable to printers. Printers, however, should remember that the point system was introduced entirely at the expense of the typefounders, who, in addition, sustained a tremendous loss in the gradual depreciation of value of large stocks of old body-types, much of which went direct from the shelves to the metal-pot. No increase in demand nor in price compensated the typefounders for this great expenditure and greater loss.

No history of the introduction of the point system can be complete without an acknowledgment of the active and effective work of THE INLAND PRINTER in educating the printers and supporting the efforts of John Marder.

John Marder, whose enterprise conferred on the printers of North America incalculable savings, was born March 5, 1835, in Greentown, Stark county, Ohio, of German parents, who arrived in this country in 1820. Until the age of sixteen he worked on his father's farm, attending the district school in the winter months. At sixteen he entered a printing-office in Akron, learning the business and adding to his education; at twenty-one he went to Davenport, Iowa, where he was employed for three years in the book store which was owned by his future partner, A. P. Luse, and afterward was a department of the business of which the printing firm of Egbert, Fidlar & Chambers is the successor. In 1860 John Marder went to Chicago, and became bookkeeper for the Chicago Type Foundry, which was then a branch of Charles T. White & Co.'s New York Type Foundry, now A. D. Farmer & Son Typefounding Company. Two years later this business was acquired by D. Scofield & Co., Mr. Marder being one of the partners. From that time to the present John Marder has been one of the most notable of American typefounders. At the present time he is the manager of the Chicago branch of the American Type Founders Company, to whom he sold his business in 1892, retaining a large interest. At the age of seventy-one he displays a vigor which might put much younger men on their mettle, the evidence of a well-spent life. He has three sons: John W. Marder, principal owner of the Peerless Printing Press Company of Palmyra, New York; Walter S. Marder, manager of the Jersey City manufacturing department of the American Type Founders Company, and Clarence C. Marder, manager of the manufacturing department of the Chicago branch of the same company. The Chicago Type Foundry was the first in Chicago. The first type cast in Chicago was a dress for the *Journal* of Springfield, Illinois, in 1855. Notwithstanding the serious loss resulting from the total loss of the foundry in the great fire of 1871, Mr. Marder extended credits to the burned-out printers to an amount exceeding $300,000 to replenish their offices, on the strength of former satisfactory connections, not one in ten having any basis for credit so far as money went after the fire; and it is to the credit of the printing fraternity that the loss on this credit was less than two per cent.

The point system of Didot and Marder related only to type-bodies. In 1883 Linn Boyd Benton, senior partner in the Northwestern Type Foundry, of Milwaukee, was granted a patent for type that was "point system both ways." This is the so-called "self-spacing" type, the first type made systematically to units of width (or set, as the typefounder calls it), accurate both widthwise and bodywise. Figures, points, and a few other characters and spaces and quads excepted, the widths of type were, up to that time, determined by the eye of the fitter solely with a view to securing proper distance between the characters. Mr. Benton is the originator of unit-width type, and the history of his invention and what grew out of it is one of the most interesting in the annals of typography. Mr. Benton started to invent an automatic justifying typesetting machine. For this machine he devised a system of casting body-types on eight different widths, instead of the more than one hundred widths found in an ordinary body-type font. When testing the first font of body-type made on this system the compositor discovered that there was a marked gain in the speed of hand composition. It is an authenticated fact that this gain was in many cases as much as twenty-five per cent on straight matter and much greater on tabular work. This discovery induced the inventor to suspend work on his typesetting machine, for the purpose of putting "self-spacing" type on the market. The term "self-spacing" is, of course, a misnomer; it originated in a very suggestive remark made by the compositor who was testing the first font that "the d — d thing spaced itself." To put this unit-width type on the market involved cutting thousands of steel punches, and a dearth of steel punch-cutters threatened to make this the task of years. In this dilemma Mr. Benton invented the wonderful or rather wonder-working engraving or punch-cutting machine which bears his name.

Metal-engraving machines had been made and used before 1885 in Germany, and William Schraubstadter made and used one in this country in 1881, but these all lacked precision and required to be supplanted by hand work. So far as perfectness is possible in a machine the Benton punch-cutter is perfect, completing the whole operation unaided and with greater delicacy, exactness and finish than is possible with human hands; and it has no rival. It has engraved the autograph

Fig. 11.2: Bullen, "Discursions," No. VII (1907), p. 517[3]

[3]From {Bullen 1907}: p. 517. Smithsonian digitization, public domain.

"Benton" lengthwise in a width of two points, the detail sharply visible under a microscope. Its range is limited only by the requirements of the typemaker. Quite unexpectedly the success of one of the most revolutionary and beneficial inventions in typography — the Mergenthaler Linotype machine — depended upon this punch-cutting machine. The principle of the Linotype machine had been perfected after tremendous effort by Otto Mergenthaler; the machine was in use; the capitalists behind the invention were promised big dividends; but a final and exasperating obstacle presented itself. With each machine hundreds of matrices are required. Every one of my readers has seen a Linotype matrix; on one edge of a thin piece of brass the matrix is made by driving into the brass a steel punch on which the character is engraved. For every character used on a Linotype machine a steel punch was required to be made with greater exactness as to the position of the character on the punch than a typefounder demanded. Men who could cut steel punches were scarce, their work slow. Punches soon wore out; they might last one hour or a year, as breakages were frequent. The Linotype company was paying as high as $8 per letter-punch. If, under the conditions then existing, it would have taken Benton five or six years to produce the punches for a few series of self-spacing type, what time would be required to make punches for Linotype matrices? A typefounder, after using a steel punch to make a matrix may not use it for years, while in the interval he is casting hundreds of pounds of letters from the matrix, but each Linotype machine is provided with sets of matrices, each driven by a steel punch which may be used five thousand times where a typefounder would use it once. The Linotype company was blocked. It would take years to train efficient cutters; their work would be slow and expensive; and, worse than all else, it is practically impossible to duplicate a steel punch accurately by hand, so that, as the matrices break, grave variations would occur, and the symmetry of the design be eventually lost. While Benton and his machine were still unknown to the managers of the Linotype company, his partner, R. V. Waldo, went to New York for the purpose of selling self-spacing type to the larger newspapers. Among others he visited the *Tribune*, the only office in which the Linotype was then in use, and that because Whitelaw Reid, its owner, was financially interested in the new machine. In those days there was little faith in the Linotype, especially among typefounders, and doubtless Mr. Waldo was astounded to find that the *Tribune* had no use for his type; nevertheless he persisted in unloading his story, and part of it related to the advantages it possesses for stereotyping from because it is made from punches cut on a machine! Splendid news, which straightway found its way to Messrs. Reid and Dodge, who more than its owners knew the value of such a machine. Philip Dodge was very soon in Milwaukee. Ultimately a very good bargain for the Linotype company was made, and they became the purchasers of a machine which vanquished their last great obstacle. Had Benton known of their dilemma he could have secured a comfortable fortune on the spot — instead of which he sold one machine at a fair profit. Many more machines were afterward required, not only by the Linotype company, but also by the Lanston Monotype and the Monoline manufacturers, in both America and Europe.

Thus an invention designed to aid the typefounder became the greatest ally of a machine which at that time was expected to destroy the typefounding industry. Gloomy, indeed, at one period, not so long ago, was the outlook of the typefounder; the Linotype appeared to be a monster of evil omen to the compositor and the typemaker. How mistaken we all were. The Linotype has expanded the printing trades in every direction. It has increased the work and the wages of compositors. By enabling publishers to print enlarged newspapers and journals, it has increased the demand for presses, paper, ink, men, and of type made by the typefounder. To the whole printing fraternity the invention of Otto Mergenthaler has proved a beneficence, and Linn Boyd Benton made that invention practicable. The most effective detail on the Linotype is the spacing device. Quite independently of Mergenthaler, and before him, Merritt Gally,* better known as the inventor of the Universal printing-press, invented a machine for assembling matrices and automatically spacing them by wedges, and casting lines from the matrices. His patents for this invention are dated July 16 and 23, 1872, and

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* Note.— While Merritt Gally's name is before us it is interesting to note that he is the original inventor of the self-playing instruments, now so popular, known as the Pianola and Æolian organ. The first automatic musical instruments in America, other than the ordinary street organs, was a crude reed instrument operated by a wide belt of paper having slots therein corresponding to the wind openings to the reeds, through which the air of the bellows passed, producing the tones. Mr. Gally's inventions, dating from 1876, consist of a rolling and re-rolling apparatus and a set of pneumatic appliances acted upon by a succession of small, graded perforations in a long narrow sheet of paper, which passes over a tubed "tracker-range." The perforations in the paper control the pressure of air in a peculiarly sensitive pneumatic apparatus, embodying an entirely new philosophical principle, which enables the instrument not only to produce the music notes but to automatically render every gradation of tone as perfectly as an artist. His experiments resulted in the production of the Orchestrion and the Gally Automatic Piano, and his patents were later purchased by the Æolian Company. His devices are now used in the Pianola, the Æriol, the Angelus, the Apollo, the Chase & Baker, the Harmonist, the Simplex and Peerless piano players. The orchestrions of Welte & Sons, Freiburg, Germany, and of New York, the most celebrated constructors in the world, are now built on the Gally pneumatic system, under licenses issued by Mr. Gally. Among the notable printers who have benefited the world by their inventions Merritt Gally stands in the front rank.

Fig. 11.3: Bullen, "Discursions," No. VII (1907), p. 518

were sold to the parties interested in the Linotype in 1884. I have been told on excellent authority that Mergenthaler's early idea was to make a line-casting machine to be sold for about $200, to be used by reporters, and in law offices, etc., much as we use typewriting machines to-day, delivering the lines to the printer instead of copy.

But to return to unit-width type. Benton established an arbitrary unit for each character in a font: thus lower-case " a " was always four units, and capital " A " five units. His unit is variable, but always a subdivision of a twelve-point em, for a condensed face the units in a twelve-point em are increased, and for a round face decreased; thus he made eight-point faces of nine, ten and eleven units to the twelve-point em, giving three widths of face without departing from the system of units. There are eight widths in each modern roman series and nine widths in the old-style roman series in every body-type font, which, including the italics and the spaces and quads, contain 232 characters or separate casts. The italic characters are put on the same widths as the corresponding roman characters. In order to get this equality of widths Mr. Benton abandoned the conventional italic in favor of a sloped roman face, which gives greater emphasis (the object of an italic), while losing nothing in beauty. I believe that in the other unit-width systems to be described below, it has been found practically impossible to put the roman and italic characters on equal widths. Benton's purpose was to aid the publishers of papers to reduce the cost of body-type composition by making justification simple and easy. He accomplished his purpose completely, but in use in general printing-offices where more than one series of body-type of a size are used certain drawbacks developed. Had the Linotype not entered the field of newspaper composition, we would have seen self-spacing type in general use, because of its undoubted time-saving quality. It is the fewness of widths in a font which makes it possible to justify and correct self-spacing type more rapidly than any other. It is excelled in this respect only by typewriter type which has one width for all characters and spaces. As you increase the number of widths you increase the number of manipulations in justifying, and therefore increase the time required to justify. It is easy for the compositor to memorize eight or nine invariable unit widths, and this aided the speed. The chief drawback to the general adoption of self-spacing type, outside of newspaper offices, is the differences in widths of the spaces and quads, when two or more series of one size of body-type are used in one plant. In practice it is impossible to keep the spaces separate, and when they are mixed the justifying economies are lost. In most of the existing series of modern roman self-spacing a distortion of certain characters is observable, due to making the design conform to the width of the body. This is most noticeable in the round character " e " which is three-unit, and the " o " which is four unit, thus giving the " o " an unfortunate prominence. In the italic and old style series these distortions disappear, and they are indeed beautiful. In the later modern roman series the cutting shows marked improvement, and had body-type not been practically banished from newspaper offices I believe that designs would have been produced and the arrangement of widths modified to overcome these defects. Self-spacing type was the commencement and a long step forward in a reform which is of great advantage to the printers.

The next development of the unit-width idea was Barnhart's point set, which was applied to two series of body-type. For some sizes the unit was one point; for others it was one-half a point. This effort, however, was not carried any further. In 1894 the Inland Type Foundry commenced business with all its type — body and job — cast to a system of units which is so satisfactory that it has since been adopted by all progressive American typefoundries and also by the leading British typefoundries. The unit is one-eighth of one point, which is used on very small and condensed faces, while as the bodies and expansion increase they are put on widths that are multiples of quarter-point, half-point, or one point. The number of widths used on body fonts varies from thirteen to twenty. This system, by its compromise between the speed advantage of a lesser number of widths and the requirements of the designer, and its use of justifiers interchangeable and applicable to all fonts, overcomes all the drawbacks of Benton's system. William Schraubstadter is entitled to the credit of perfecting this extension of the unit-width system.

Linn Boyd Benton, born May 13, 1844, in Little Falls, New York, was taken to La Crosse, Wisconsin, at an early age. His father, a lawyer by profession, was register of lands at La Crosse, previous to which he was one of the editors and founders of the *News* of Milwaukee, the leading Democratic organ. Young Benton learned the printing trade in La Crosse. He then entered the typefoundry of J. A. Noonan, in Milwaukee, as bookkeeper, advancing to the position of buyer for Noonan's wholesale paper warehouse. In 1873 Benton & Cramer purchased Noonan's typefoundry. Here Benton's great mechanical talent found a fertile field, and he advanced in all branches of typemaking until his inventions made him one of the most conspicuous personalities in that

Fig. 11.4: Bullen, "Discursions," No. VII (1907), p. 519

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Fig. 11.5: Bullen, "Discursions," No. VII (1907), p. 520

Bullen makes a number of claims about and for Benton in this article. Some are true. One[4] is extremely perceptive. Many are false. They all require examination.

1. Benton "originated unit-width type." (p. 517 & portrait caption)

TO DO: not true; this was well-known (see Munson in the IP)

2. Benton "started to invent an automatic justifying typesetting machine." (p. 517)

There may be a glimmer of truth behind this. Benton's self-spacing type patent, {US 290,201 Benton 1883}, does make a very curious claim that its unit-set type, if used in a non-justifying typesetting machine, would allow the operator more easily to justify the lines manually at the machine. This is a far cry from an "automatic justifying" machine, though. See section 11.1.4.3 on page 182, "That Benton Was Building a Typesetting Machine," for a more detailed look at this.

3. Lack of punchcutters forced Benton to invent his pantograph (p. 517)

In the form as stated here, this statement is not unreasonable. It is an echo of what "Skopeo, of No. Six" wrote in *The Typographical Journal* in 1896 {Skopeo-1896}: 214. However, by 1922 Benton had inflated this claim to an unsupportable degree. See section 11.1.4.2 on page 181, "That No Punchcutters Were Available," for a more detailed look at this.

4. "Metal-engraving machines ...before 1885 in Germany." (p. 517)

The beginning of this statement, "Metal-engraving machines had been made and used before 1885 in Germany,..." is true. As discussed earlier, Herrmann Hofer had introduced one in 1874 and, even limiting the scope of this claim specifically to pantographic engraving machines, his certainly was not the first.

5. Schraubstadter in 1881.

Bullen confirms that William Schraubstadter was engraving for type in the early 1880s (his date, 1881, is likely too early by a year). However, it seems clear that he is incorrect when he asserts that the machines in Germany and the one used by Schraubstadter "all lacked precision and required to be supplanted by hand work."

See chapter 5, "The First Known Success: Ludwig & Hofer (1877ff)," on page 65 and chapter 6, "The Second Known Success: Schraubstadter (1882)," on page 85 for a considerable body of evidence demonstrating that these machines were more than capable.

6. The Benton machine "has no rival"

Passing over the claim of perfection (a staple of advertising literature, but something that all machinists know is impossible), the claim that the Benton engraving machine "has no rival" fails on an examination of the number of competitive engraving machines in use in foundries and at

[4] The problem of spacing material in self-spacing type.

matrix manufacturers at the time. These included not only Benton-inspired vertical machines (e.g., Pierpont at Monotype) but also completely independent machines (e.g., Hofer/Bernent and Gursch (in Germany), Wiebking & Hardinge (in the US), the Inland Type Foundry machines, Schokmiller's in use at Stephenson, Blake, etc.)

In order really to understand the typographical pantograph, it is crucial to understand that Benton's machines were only two among many others, both before them and after.

7. Engraving Benton's Signature (pp. 517–518

Bullen actually understates his case here. He says that a BEM "has engraved the autograph "Benton" lengthwise in a width of two points." Two American printer's points come to 0.027,6″. In 1893, in an article for *The Inland Printer* which certainly must have been supplied by Benton and ATF, it is asserted that:

> … a facsimile of a signature consisting of two initials and six lower-case letters[5] was cut absolutely perfect in a script so small that it could not be distinguished without the aid of a powerful magnifying glass. The total length of the signature did not exceed the thickness of two sheets of writing paper. {ATF 1893}

An ordinary sheet of paper is about 0.003″ thick. Two sheets, at 0.006″, would be less than ¼ of the size Bullen claimed.

8. That the Linotype depended upon machine punchcutting.

TO DO — it is true, but the Blower Linotype began with electroformed matrices.

9. That Linotype learned of Benton through Waldo

TO DO: maybe true; we don't know; Kahan says so, but without source (so his source might have been Bullen); plausible.

But the story here differs greatly from the one Bullen recounted in 1922.

10. Views on Ottmar Mergenthaler

Benton's comments about Ottmar Mergenthaler here are generally not negative. He does try to take some credit away from Mergenthaler by claiming, incorrectly, that Merritt Gally anticipated the basic elements of the Linotype in 1872.[6]

Bullen's remarks on Ottmar Mergenthaler in 1907 should be compared to his petty and libelous attacks on Mergenthaler's character in his 1922 article on Benton ({Bullen 1922 LBB}, p. 60) and his 1924 article on the Linotype ({Bullen 1924 L2}: 938).

11. Unit-set type.

[5]We do not know what the actual letters were. One plausible guess, of course, would be "l.b.benton".

[6]This matter is not directly relevant to Benton's pantographs, but Bullen's errors concerning Gally and the origins of the Linotype should be corrected. See I.4, "Gally's 1872 Patents and the the Linotype," on page 250 in Appendix I.

Bullen's explanation of Benton's unit-width ("self-spacing") type is correct. Benton explained it differently:

> The thinnest space in all fonts is some exact fraction of a Pica, and this fraction of Pica is called the unit of measure. All characters, spaces and quads in the font are made some exact multiple of this unit in width. … This unit of measure may be one-sixth, one-seventh, one-eighth, one-ninth, one-tenth, etc. of a Pica em, as may be desired, to produce condensed, medium or extended faces. {Benton 1886}: [unpaginated; first page of his "Explanation"]).

Bullen says instead:

> Benton established an arbitrary unit for each character in a font: thus lower-case "a" was always four units and capital "A" five units. His unit is variable, but always a subdivision of a twelve-point em, for a condensed face the units in a twelve-point em are increased, and for a round face decreased; thus he made eight-point faces of nine, ten and eleven units to the twelve-point em, giveng three widths of face, without departing from the system of units. (p. 519)

Additionally, Bullen deserves considerable credit for pointing out a significant problem with this system: that at each body size the spacing material comes in different widths for each variation in width of face. To take Bullen's example, at eight point (that is, Brevier) the three units for condensed, normal, and extended widths are 1⁄11 pica (1.09 points), 1⁄10 pica (1.2 points), and 1⁄9 pica (1.33 points). If a form were set using, say, both condensed and normal variations of an eight point face, it would contain, *inter alia*, two-unit condensed spaces of 1.18 points and one-unit normal spaces of 1.2 points. Distributing these correctly back to the cases would have been quite difficult, but, as Bullen says, "when they are mixed the justifying economies are lost."

12. Biographical Details

TO DO: It would be good to cross-check these details with independent sources (that is excluding sources which cite Bullen). Curiously, the only detail missing from Cost's biography of the Bentons is Linn Boyd Benton's date of birth.

Bullen's statement here on Benton's engraving machines is fine:

> His punch-cutter, originally designed for relief engraving, has been perfected to engrave in intaglio, cutting the matix in copper without any intervening processes, and capable of infintesimal graduations in all directions. (p. 520)

11.1.2• Benton Biographical Article (1922)

Bullen's longest single piece on Benton is a five page biographical and semi-technical sketch in *The Inland Printer* in 1922 {Bullen 1922 LBB}. It begins with a lovely portrait of Benton in his later years (which appears as the frontispiece for the entire issue) and contains an excellent photograph of a Type 2a Benton Engraving Machine (one of the four sold to Japan). This is the same photograph which appeared in the 1912 ATF specimen book. The reproduction here is not as good, but, usefully, Bullen identifies one of the people in it (W. F. Lietke).

Directly or, more commonly, indirectly, this is probably the most-cited article ever written about Benton. It is reprinted in its entirety on the following pages.

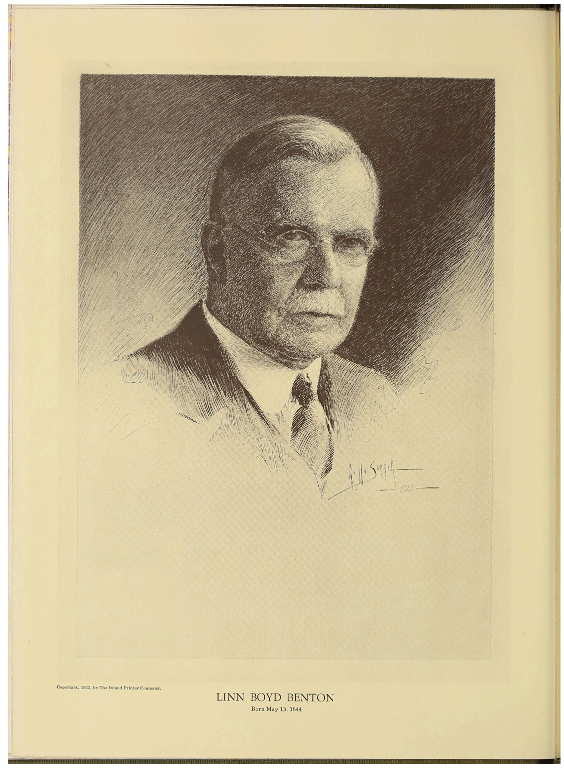


Fig. 11.6: Bullen, "Linn Boyd Benton" (1922), Frontis.[7]

[7]{Bullen 1922 LBB}, Frontis. (This appears as the frontispiece for the entire issue, as an unpaginated sheet between pages 48 and 49). Smithsonian digitization. Public domain.

60 THE INLAND PRINTER *October, 1922*

Linn Boyd Benton—The Man and His Work

BY HENRY LEWIS BULLEN

IN this series of biographies we have endeavored to make clear the causes and the personalities underlying epochal changes in the art and the machinery of printing. Thus far we have been concerned with men of the past. It is now our loving duty to acquaint this generation of printers with the services to them, and to succeeding generations, of a printer, now living, who is the greatest mechanical genius our art has fostered. If hitherto printers, in general, have been unaware of their indebtedness to the genius of Linn Boyd Benton, it is chiefly because of his modesty and the fact that his inventions are process machines, the use of which is limited to less than a score of manufacturing concerns, though the products of the machines are the most vital parts of the equipment of a majority of the printing houses of the world.

Gutenberg's inventions of movable types and a printing press were clever adaptations to printing purposes of appliances already in use in other crafts. König's invention of the flat-bed cylinder press was a successful adaptation of the unused and unusable invention of Nicholson. Bullock's invention of the web perfecting press was a successful adaptation of earlier inventions, including Nicholson's. Richard March Hoe's type-revolving press was similar in principle to at least three other presses, all of which failed through lack of an effective means of holding the types on the cylinders, which lack Hoe supplied by means of his wedge-shaped column rules. Mergenthaler had little originality — he was persistent in developing other men's ideas, but never satisfactorily, and was by no means a brilliant mechanic. When he severed his connection with those who had poured out nearly two million dollars in experiment, the linotype machine was a failure. It was made marketable by Philip T. Dodge, who utilized the inventions of Benton and Schuckers and Rogers to make it the huge success it ultimately became. This we declare on the highest authorities. It is the plain truth. Lanston invented a most ingenious composing machine, but he was not a good enough mechanic to make his ideas practicable. Lanston's ideas were made practicable by Sellers and Bancroft, who had the mechanical genius which Lanston lacked. But Benton's invention of the machine for cutting letter punches was entirely novel in conception, and perfect in execution at the beginning, leaving little room for improvement in doing the work for which it was specially designed, though the scope of its usefulness was greatly extended a few years after it had made practicable both the linotype and the monotype composing machines.

Benton, self-taught in typefounding, had the imaginative genius to conceive an entirely original machine, and the mechanical genius to make his ideas practicable, even to the point of constructing every part of it himself. Benton's punch-cutting and matrix-cutting machines, with the various appliances he invented as accessories of these machines, have completely revolutionized the method of making typefounders' matrices. These machines have made the cutting of letter punches by hand almost a lost art. A generation ago the hand punch-cutters were the mainstay, the principal craftsmen of the typefounding art; today we would be surprised to learn that more than two are employed in American typefoundries, and these men are not employed in cutting type faces.

Linn Boyd Benton, whose portrait is the frontispiece of this issue, was born in Little Falls, New York, May 13, 1844. His father, Charles Swan Benton, was a lawyer, who established in 1832 the *Mohawk Courier & Little Falls Gazette*, now owned by Stebbins & Barney under the name of *Journal & Courier*. From October 3, 1833, to July 3, 1834, the proprietors of the *Mohawk Courier* were C. S. Benton and J. Bartow. The next publisher was Josiah A. Noonan, with C. S. Benton as editor, until 1836 and probably later, or until C. S. Benton was elected to Congress, serving two terms. About 1853 the elder Benton went to Milwaukee and became editor and part owner of the *Milwaukee Daily News* (not the present *News*), the firm name being Huntsman, Clason & Benton. About the same time J. A. Noonan went to Milwaukee, became a partner in a paper mill and opened a paper warehouse and a typefoundry — the Northwestern Type Foundry. The tradition is that the plant of the typefoundry came from Albany. There was, after 1847, a small typefounding plant for sale, one established in 1826 by Richard Starr, which afterwards came into the possession of Lemuel Little, a well known bookseller, under the name of the Albany Type Foundry. This is supposed to be the typefoundry which J. T. Reton took west in 1854, intending to use it in Chicago, which had no typefoundry at the time. When Reton arrived in Chicago it was a smaller town than Milwaukee, and he was persuaded to set up his typefoundry in the latter city, to his subsequent great regret. When Noonan acquired this typefoundry is not known, but it is known that Reton was on Noonan's pay roll in 1866. As this typefoundry had a decisive influence in Linn Boyd Benton's career, we reproduce a picture of the cover of the 1826 specimen book of the Albany Type Foundry. J. T. Reton established a typefoundry in Kansas City in 1872. His son is now manager of the St. Louis branch of the American Type Founders Company.

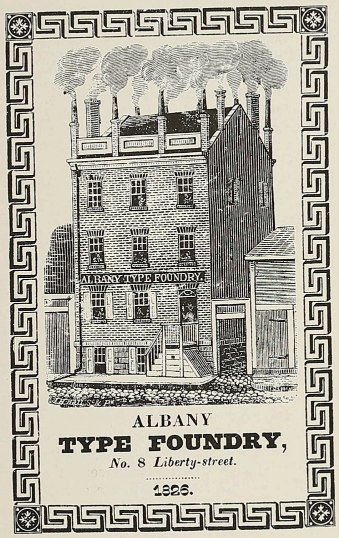
In 1855 the younger Benton joined his father in Milwaukee and, as a pastime, learned to set types in the composing room of the *Daily News*. In 1856 the elder Benton was appointed United States registrar of lands and established his office in La Crosse, where he afterwards became a judge of the circuit court. The younger Benton's education was rather peripatetic. He remembers attending schools in Little Falls, Mohawk (near Little Falls) and Milwaukee. He was sent to Galesville College in Galesville, Wisconsin (which institution at that time called itself a university), and took lessons for about two years in Latin and Greek and other advanced subjects with a private tutor in La Crosse, " completing " his education at the age of sixteen, when he began to learn to print in the office of Charles Seymour's *La Crosse Republican*.

By the time young Benton was of age he had acquired an insight into the mystery of printing so far as Seymour could help him, but he preferred to earn his daily bread by bookkeeping for a leather house in La Crosse. We can imagine that he made an exact bookkeeper. In 1866 he became bookkeeper for J. A. Noonan in the Northwestern Type Foundry. In 1873 Noonan went into bankruptcy, and Benton, with a partner named Cramer, purchased the type and electrotype foundry. Benton's knowledge of typefounding and electrotyping was what he may have gained by observation while attending to his bookkeeping duties. In after years Benton said that if he had known anything about typefounding he would have thrown the plant into the lake as a measure of economy. It was probably the worst equipped typefoundry in America. He was now twenty-nine years of age, and proceeded to master the mystery of typefounding. In 1874 Cramer weakened, and his half interest was purchased by Lieutenant-Commander Frank M. Gove, a man utterly ignorant of the

Fig. 11.7: Bullen, "Linn Boyd Benton" (1922), p. 60[8]

[8]From {Bullen 1922 LBB}, p. 60. Smithsonian digitization. Public domain.

business, but who in time proved to be a most efficient and popular salesman, eventually making it possible for Benton to devote himself mainly to manufacturing. The firm was now Benton & Gove. In 1882 Gove died, and his half interest was purchased by Benton, who in the same year sold a third interest to R. V. Waldo, formerly a wholesale grocer, who



Albany Type Foundry, 1826-1847. Reduced reproduction from cover of the 1826 specimen book. The plant equipment of this typefoundry was taken to Milwaukee early in the fifties of last century, where it was known as the Northwestern Type Foundry. Linn Boyd Benton became an owner of it in 1873.

eventually proved to be an ideal partner. The firm name was now Benton, Waldo & Co., but there were only two partners.

Before Gove died Benton had completed his self-instruction in typefounding and found himself on the most intimate terms with decimal fractions and measurements of ten thousandths of an inch. He had and still has a mania for accuracy to the vanishing point, not only knowing, as the books tell us, that a hot breath impinged on a small piece of steel changes its dimensions, but actually taking that solemn fact to heart, grieving that it can not be overcome. The bane of Benton's career has been the limitations of error which are made necessary by the disposition of all metals to refuse to resist molecular action. What other mortals cheerfully accept as accuracy Benton regards as a calamity. Mold and matrix makers and type-casters brought up under Benton's microvisioned direction were drilled in a hard school, and most of them believe that a Bentonian degree of accuracy is unobtainable. The only criticism of Benton we have heard in an acquaintance of nearly forty years is that he is " too accurate." No man can be perfect, so Benton had to have one fault.

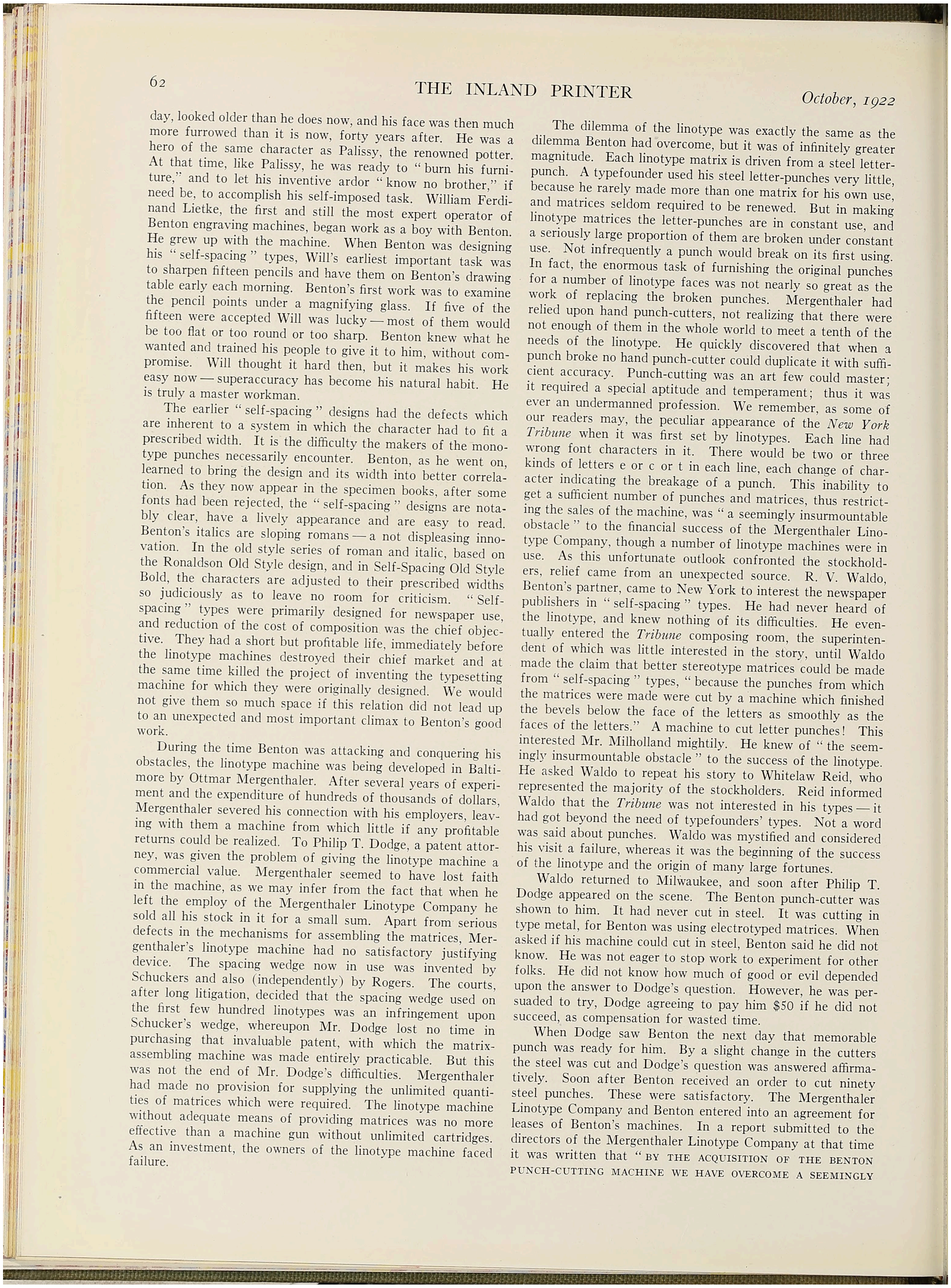
In 1882 Benton's thoughts turned toward the invention of a typesetting machine, in which a near approach to self-justification was to be effected by casting all the characters and spaces and quads of a complete body type font of roman and italic on nine widths, instead of on the more than one hundred widths found in the average font of body types. This was an important time-saving idea, basically the same as that which Lanston successfully employed in later years on his monotype machine. We all agree that when types and spaces are cast on one width, that is, a unit of twelve points, as we find it in typewriter types, the time of composition is greatly reduced. Thus time was saved in setting Benton's " self-spacing " types — the time required for justification was reduced to a minimum by reducing the widths to a minimum consistent with even spacing. The term " self-spacing," as applied to hand setting is, of course, a misnomer. It was applied to Benton's invention by a compositor, Walter Stoddard, afterwards known to thousands as chief guide in the establishment of the Curtis Publishing Company in Philadelphia. Stoddard was employed to ascertain what gain, if any, was to be had by the use of unit-width types in comparison with that obtained from a non-unit font of the same width of lower-case alphabet. Three comparative trials showed that Stoddard set the unit-width types thirty-three and a third per cent faster than the non-unit types. Stoddard's average with unit widths, per one thousand ems, was forty-five and one-half minutes as against an average of sixty minutes. When asked what he thought of the justification, he pondered a while and said, " I never thought of that — why, the d——d thing spaces itself! " The types had not been named, and thus it came to be called " self-spacing." Benton was granted a strong pioneer patent for this system of making types. This unexpected merit of unit-width types, first invented by Benton, caused him to defer the creation of the typesetting machine for which they had been made to be used. In any case, fonts of various bodies, old style and modern, had to be made before the machine could be utilized. Punches for every character were required to be engraved and matrices made. There were more than three thousand punches to be cut and not one punch-cutter was available either in America or in Europe. This dilemma was the turning point of Benton's career — it eventually disclosed to himself that he had mechanical genius of the highest order.

Benton determined to make a machine to cut punches. He had never cut a punch, and punch-cutting was the most difficult work in typefounding. What experience could Benton draw on to aid in his ambitious project? We must go back a few years to answer that question. For three years he was tutored by the learned clergyman at La Crosse. It was agreed that if he recited his lessons correctly in the forenoon he could do as he liked with his afternoons. What he liked to do, and did, was to work with the local tombstone maker. Thus he learned to design letters and cut them in stone in relief and in intaglio. Thus Baskerville learned to make letters on tombstones, laying the foundation of his fame as a letter designer and typefounder. Meanwhile a jeweler settled in La Crosse, and young Benton left the tombstones to work on watches. He learned to repair watches at a time when there were no interchangeable parts and every broken part had to be remade.

In 1884 Mr. Benton had his first punch-cutting machine in use. It worked perfectly, showing that the principle was correct. The second machine did no better work but was easier to manipulate. His third machine is the machine as now sold. In 1885 he was granted a patent. By that time " self-spacing " types were selling freely. Benton's typefoundry was steadily enlarged, but for a long period it was necessary to run night and day. The price was higher than for non-unit types, but in many parts of the West the scale for setting " self-spacing " types was 5 cents less than for other body types. How was this notable success achieved?

Benton had to design thousands of characters to fit his width units. The punch-cutting machine had to have a pattern for each character. Benton, the ex-tombstone letterer and manipulator of jewelers' tools, had to design each letter on a large scale and cut metal patterns to the same scale. That was a strenuous task. Mr. Benton, working night and

Fig. 11.8: Bullen, "Linn Boyd Benton" (1922), p. 61[9]



62 THE INLAND PRINTER *October, 1922*

day, looked older than he does now, and his face was then much more furrowed than it is now, forty years after. He was a hero of the same character as Palissy, the renowned potter. At that time, like Palissy, he was ready to " burn his furniture," and to let his inventive ardor " know no brother," if need be, to accomplish his self-imposed task. William Ferdinand Lietke, the first and still the most expert operator of Benton engraving machines, began work as a boy with Benton. He grew up with the machine. When Benton was designing his " self-spacing " types, Will's earliest important task was to sharpen fifteen pencils and have them on Benton's drawing table early each morning. Benton's first work was to examine the pencil points under a magnifying glass. If five of the fifteen were accepted Will was lucky — most of them would be too flat or too round or too sharp. Benton knew what he wanted and trained his people to give it to him, without compromise. Will thought it hard then, but it makes his work easy now — superaccuracy has become his natural habit. He is truly a master workman.

The earlier " self-spacing " designs had the defects which are inherent to a system in which the character had to fit a prescribed width. It is the difficulty the makers of the monotype punches necessarily encounter. Benton, as he went on, learned to bring the design and its width into better correlation. As they now appear in the specimen books, after some fonts had been rejected, the " self-spacing " designs are notably clear, have a lively appearance and are easy to read. Benton's italics are sloping romans — a not displeasing innovation. In the old style series of roman and italic, based on the Ronaldson Old Style design, and in Self-Spacing Old Style Bold, the characters are adjusted to their prescribed widths so judiciously as to leave no room for criticism. " Self-spacing " types were primarily designed for newspaper use, and reduction of the cost of composition was the chief objective. They had a short but profitable life, immediately before the linotype machines destroyed their chief market and at the same time killed the project of inventing the typesetting machine for which they were originally designed. We would not give them so much space if this relation did not lead up to an unexpected and most important climax to Benton's good work.

During the time Benton was attacking and conquering his obstacles, the linotype machine was being developed in Baltimore by Ottmar Mergenthaler. After several years of experiment and the expenditure of hundreds of thousands of dollars, Mergenthaler severed his connection with his employers, leaving with them a machine from which little if any profitable returns could be realized. To Philip T. Dodge, a patent attorney, was given the problem of giving the linotype machine a commercial value. Mergenthaler seemed to have lost faith in the machine, as we may infer from the fact that when he left the employ of the Mergenthaler Linotype Company he sold all his stock in it for a small sum. Apart from serious defects in the mechanisms for assembling the matrices, Mergenthaler's linotype machine had no satisfactory justifying device. The spacing wedge now in use was invented by Schuckers and also (independently) by Rogers. The courts, after long litigation, decided that the spacing wedge used on the first few hundred linotypes was an infringement upon Schucker's wedge, whereupon Mr. Dodge lost no time in purchasing that invaluable patent, with which the matrix-assembling machine was made entirely practicable. But this was not the end of Mr. Dodge's difficulties. Mergenthaler had made no provision for supplying the unlimited quantities of matrices which were required. The linotype machine without adequate means of providing matrices was no more effective than a machine gun without unlimited cartridges. As an investment, the owners of the linotype machine faced failure.

The dilemma of the linotype was exactly the same as the dilemma Benton had overcome, but it was of infinitely greater magnitude. Each linotype matrix is driven from a steel letter-punch. A typefounder used his steel letter-punches very little, because he rarely made more than one matrix for his own use, and matrices seldom required to be renewed. But in making linotype matrices the letter-punches are in constant use, and a seriously large proportion of them are broken under constant use. Not infrequently a punch would break on its first using. In fact, the enormous task of furnishing the original punches for a number of linotype faces was not nearly so great as the work of replacing the broken punches. Mergenthaler had relied upon hand punch-cutters, not realizing that there were not enough of them in the whole world to meet a tenth of the needs of the linotype. He quickly discovered that when a punch broke no hand punch-cutter could duplicate it with sufficient accuracy. Punch-cutting was an art few could master; it required a special aptitude and temperament; thus it was ever an undermanned profession. We remember, as some of our readers may, the peculiar appearance of the *New York Tribune* when it was first set by linotypes. Each line had wrong font characters in it. There would be two or three kinds of letters e or c or t in each line, each change of character indicating the breakage of a punch. This inability to get a sufficient number of punches and matrices, thus restricting the sales of the machine, was " a seemingly insurmountable obstacle " to the financial success of the Mergenthaler Linotype Company, though a number of linotype machines were in use. As this unfortunate outlook confronted the stockholders, relief came from an unexpected source. R. V. Waldo, Benton's partner, came to New York to interest the newspaper publishers in " self-spacing " types. He had never heard of the linotype, and knew nothing of its difficulties. He eventually entered the *Tribune* composing room, the superintendent of which was little interested in the story, until Waldo made the claim that better stereotype matrices could be made from " self-spacing " types, " because the punches from which the matrices were made were cut by a machine which finished the bevels below the face of the letters as smoothly as the faces of the letters." A machine to cut letter punches! This interested Mr. Milholland mightily. He knew of " the seemingly insurmountable obstacle " to the success of the linotype. He asked Waldo to repeat his story to Whitelaw Reid, who represented the majority of the stockholders. Reid informed Waldo that the *Tribune* was not interested in his types — it had got beyond the need of typefounders' types. Not a word was said about punches. Waldo was mystified and considered his visit a failure, whereas it was the beginning of the success of the linotype and the origin of many large fortunes.

Waldo returned to Milwaukee, and soon after Philip T. Dodge appeared on the scene. The Benton punch-cutter was shown to him. It had never cut in steel. It was cutting in type metal, for Benton was using electrotyped matrices. When asked if his machine could cut in steel, Benton said he did not know. He was not eager to stop work to experiment for other folks. He did not know how much of good or evil depended upon the answer to Dodge's question. However, he was persuaded to try, Dodge agreeing to pay him $50 if he did not succeed, as compensation for wasted time.

When Dodge saw Benton the next day that memorable punch was ready for him. By a slight change in the cutters the steel was cut and Dodge's question was answered affirmatively. Soon after Benton received an order to cut ninety steel punches. These were satisfactory. The Mergenthaler Linotype Company and Benton entered into an agreement for leases of Benton's machines. In a report submitted to the directors of the Mergenthaler Linotype Company at that time it was written that " BY THE ACQUISITION OF THE BENTON PUNCH-CUTTING MACHINE WE HAVE OVERCOME A SEEMINGLY

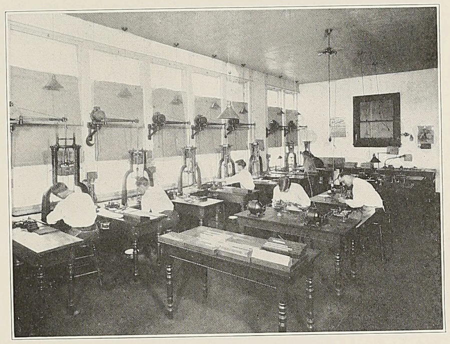
Fig. 11.9: Bullen, "Linn Boyd Benton" (1922), p. 62[10]

INSURMOUNTABLE OBSTACLE TO OUR SUCCESS." Nothing is surer than that without the Benton machine, or a similar invention (apparently not in any other man's mind) the Mergenthaler Linotype Company could not have recovered the cost of its long series of experiments before its patents had expired — if at all. The same is true of the Lanston Monotype Machine, which also depended upon Benton's wonderful invention to make it practicable. Benton had achieved greater things than he ever imagined.

In 1892 the Northwestern Type Foundry was merged into the American Type Founders Company, of which Benton became a director. In 1894 the Northwestern Type Foundry was removed to New York, Benton having been appointed New York manager of the American Type Founders Company in 1893. Until that time the Benton machine had not been used in any other typefoundry. The old-fashioned typefounders "didn't believe it could be done," just as they didn't believe that types could be composed from matrices. In New York Benton's first work was to cut a series of punches in collaboration with Theodore L. De Vinne. This was named the Century series, and was used in the *Century Magazine*. When Robert W. Nelson became general manager of the American Type Founders Company he gave Benton the authority to establish a letter-designing department, in which Morris Benton was (and is) chief designer. This department soon became a most important asset of the type company, and soon after it was established it was determined to abandon the use of punches and engrave the matrices on the machine in intaglio, thus eliminating the punch, and the driving of the punch to form a matrix, besides saving much time in fitting the matrix. When the Benton punch-cutting machine is required to cut a punch the outside of the pattern is used; when it is required to engrave a matrix the inside of the pattern is used. The first font of type to be made from matrices directly engraved on the Benton machine was twenty-four-point Roycroft, October 4, 1900. Next month eleven-point Cheltenham Old Style was engraved. Since that time the Benton machines have produced the matrices for an extensive and admirable procession of type designs. The hand punch-cutters' occupation was gone. It would have been impossible to carry out Mr. Nelson's policy of issuing great families of type designs, with which to provide a market to replace that which the composing machines had taken away — the bulk of the body types — if he had been compelled to rely upon hand punch-cutters.

The Benton method of making matrices has not yet been explained in text books, although it has been in use in the more advanced typefoundries for a quarter of a century. The best description of typemaking in the English language is found in De Vinne's "Treatise on the Processes of Typemaking, the Point System, the Names, Sizes, Styles and Prices of Plain Printing Types," one of the series of four books on "The Practice of Typography," issued in 1899. In this work the processes of punch and matrix making are described as being identical with the processes used when Moxon described typemaking, in 1683, in his "Mechanick Exercises." In De Vinne's treatise Benton's invention receives brief mention, towards the end of the book. De Vinne evidently did not foresee that what he had written about punch and matrix making was being made obsolete by the Benton methods. We will now describe how Mr. Benton makes matrices in the central plant of the American Type Founders Company.

The original drawing of a letter or ornament may be of any size, but preferably not larger than ninety-six typographic points. Each character of the artist's design is placed under the microscope on the Benton delineating apparatus, a refined pantograph, with microscope attachment. On the face of the microscope two single filaments of silk are placed, crossing each other in the center of the focal point. A sheet of drawing paper is placed on the bed of the apparatus, under the tracing point of the pantograph, which holds a small pencil lead. Grasping the pencil holder, and keeping his eyes entirely on the focal point of the microscope, the operator focuses the intersection point of the silk threads on the outline of the design, which he follows by moving the pencil holder, the lead in which traces an enlargement of the design, usually ten inches high on a capital H. This enlarged reproduction of the outline of the original design may be made with micro-



The Matrix Engraving Room of the American Type Founders Company, with seven Benton Matrix-Cutting Machines. At the left is W. F. Lietke, foreman, who grew up with the machine. He is measuring the chisel edge of a tool through a microscope. Next to him is an operator sharpening a cutting tool on the Benton Tool Sharpener.

scopic accuracy, if desired. With this outline before him, a type designer proceeds to adjust it to the limitations which the standard lining system and the point system and the exigencies of typecasting prescribe. The drawings of a letter designer not thoroughly trained and experienced in the typemaking art must always be adjusted by a type designer. When the enlarged outline drawing is adjusted, it is again placed on the bed of the Benton Delineator, from which the microscope attachment is removed, and in place of it a tracing pen is attached. The operator now proceeds to reduce the design to a practicable size. He may choose to know how it will look on thirty-six-point body or on any other body. He puts a tracing pointer (instead of the pencil) in the tracing end, and guides the pointer carefully over the ten-inch outline design, whereupon the tracing pen makes a reduction in outline on a small piece of paper. When this reduced outline is inked in it has all the appearance of a sharp impression from a type. If upon the first reduction the design is not satisfactory, alterations are made in the ten-inch outline drawing, and the process of reduction and inking-in is repeated until the letter or ornament is approved.

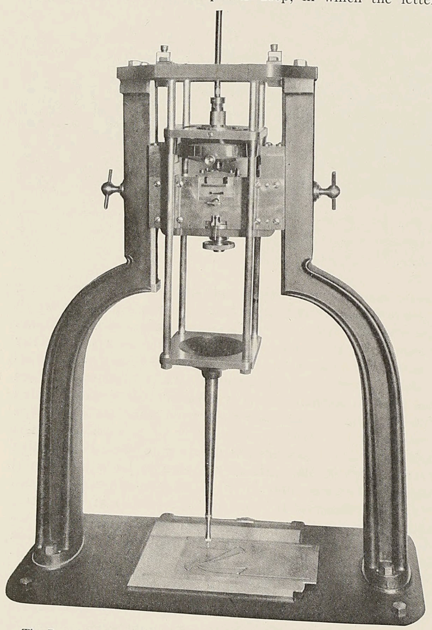
This seems simple enough, but many mechanisms in the Delineator are unique. It has a tracing pen that inks in a line of equal thickness in whichever direction it is guided; from one drawing it can enlarge a letter normal with the drawing, or condensed, or extended, or italic, or back slope, and during these extraordinary performances the microscope attachment automatically conforms with the varying focal points. One Benton's Delineating Apparatus is sufficient for the purposes of the American Type Founders Company, and thus a second has never been built. It is a miracle of accuracy and flexibility. When Mr. Benton applied for a patent his application was promptly rejected on the ground that he was trying to patent "a mechanical impossibility." He showed the patent office that "the mechanical impossibility" had been in use for months, and quickly received his patent. Prior to this ingenious invention new designs of types had to be

Fig. 11.10: Bullen, "Linn Boyd Benton" (1922), p. 63[11]

64 THE INLAND PRINTER *October, 1922*

cast and printed before they could be criticized. With Mr. Benton's invention each letter may be examined separately and in combination with other characters before the matrix has been made, thus saving a great deal of time and expense.

When the ten-inch outline drawing of a letter has been tested on the Benton Delineator and has been approved, it is placed on the bed of Benton's Wax Plate Machine. This also is a pantograph machine. It holds a brass plate, coated with electrotyper's ozokerite, face down, while a tracing tool attached to the pantograph engraves an outline of the design in the wax, as the operator carefully follows the outline drawing with a pointer. As the design is reproduced in the wax it is reduced about one-third. When the design is thus reproduced on the wax plate, it is electrotyped, with the result that all the lines cut in the wax come out as raised surfaces, forming a pattern about three points deep, in which the letters



The Benton Matrix-Cutting Machine. The follower is engaged in a pattern of a Japanese word character. Photograph is from one of two machines sold to the Imperial Printing House of Japan for use in its typefoundry. This is one of the most perfect mechanisms made in America.

are three inches from head to foot. This pattern may be used to cut punches or matrices, as desired.

The electrotype pattern is now placed on the bed of a Benton Matrix-Cutting Machine, of which we show a picture. From this large pattern matrices are cut in any desired size in an alloy much harder and more durable than the copper formerly used in matrices. Letters are cut for souvenirs to visitors to Mr. Benton's department which are small enough to go on a half-point (144th of an inch) body, if a type mold so small were made, which are readable only through a powerful microscope. From the same pattern the same letters may be cut to fill a 144-point (2-inch) body. With the Benton Punch-Cutting Machine the sixty-eight words of the complete Lord's Prayer have been cut and matrices made for casting them on the square of twelve points. There are various cutting tools — some for clearing and others for cutting in corners and also for smoothing the bottom of the matrices to give a perfect printing surface. These tools have chisel edges, and vary in length from one one-thousandth to eighty one-thousandths of an inch. They revolve at a speed of from eight thousand to twelve thousand a minute, sinking about one-eighth inch into the hard metal. As the accuracy of the matrices depends upon the accuracy of the cutting tools, Mr. Benton invented a special grinding machine which grinds with automatic accuracy when the gage is properly set. The dimensions of these cutting tools are so minute that they can only be gaged under microscopes. Across the center of the lenses of these microscopes a fine scale is arranged, the spacing between the lines being one-half of one one-thousandth of an inch, about half the thickness of a cigarette paper. As a tool with a cutting edge of eight one-thousandths of an inch looks like a heavy nail under these microscopes, the cutting tools are easily gaged by the eye — the 0.025 tool covering 160 lines on the lens, the 0.001 tool two lines.

When the matrix metal and the proper cutting tool are in position and the machine is adjusted for the size of type required to be cast in the matrix, the cutter is directed by means of the follower or pointer resting within the electrotyped pattern on the bed of the machine. It would be tedious to explain fully the marvelous mechanical movements of Mr. Benton's machine — even if we were competent to do so, which we are not — but one marvel may be readily grasped: With a pattern which may be as large as five by nine inches, in tracing which the pointer is deflected to all points of the compass, the cutter is made automatically to adjust itself, so that at all times it makes a cut of equal depth, insuring uniformity of height of the types to be cast from the matrix. When the matrix leaves the Benton machine it is complete, but not quite ready for casting purposes. It goes to a matrix fitter, who gives it its final adjustments for line, width and depth. These adjustments are effected in a much shorter time than was possible with punch-driven matrices.

As head of the general manufacturing department of the American Type Founders Company, Mr. Benton has constantly applied his inventive genius to the improvement of the product and of manufacturing methods. He has made important improvements in the Barth Automatic Typecasting Machines and in type molds. One of his important inventions is a machine for making brass rules. During the past century many brass rule machines have been invented at great cost, but not one of them proved practicable until Mr. Benton undertook to solve the difficulties in the way. He achieved complete success in a comparatively short time with very few changes from the first plans he put on paper.

American types, as now made, are the most accurate of any manufactures produced in great quantities. This distinction is largely due to Mr. Benton's inventions and his devotion to an unprecedented degree of accuracy in all the work done under his direction. He knows no way of doing anything but the right way, and believes that in the end that way is the cheapest.

At the age of seventy-eight years, Mr. Benton outdoes his youthful years in humor and geniality. An observant man, he has accumulated a great fund of genial anecdotes. With a clean life, based upon absolute probity, he commands the admiration and respect of all his associates. He has as ardent an interest now in every detail of typefounding as ever he had when confronting its most difficult problems in earlier years. He permits nothing to interfere with a most punctual attention to his duties, though these are largely self-imposed. His vocation knows no avocation. The printing industry has been immensely benefited by this, the most modest of inventors, whose name will live forever in the annals of typography.

Fig. 11.11: Bullen, "Linn Boyd Benton" (1922), p. 64[12]

There are many points made in this article which need to be addressed.

Attacks on Ottmar Mergenthaler (1922)

Bullen begins with one of his more egregious attacks on Ottmar Mergenthaler as a person, because apparently this is how you promote Linn Boyd Benton. See Appendix I.3 on page 249 in Appendix I, "Mergenthaler and Character Defamation," for a discussion of this.

Benton's Originality

Bullen's statement that "Benton, self-taught in typefounding, had the imaginative genius to conceive an entirely original machine, and the mechanical genius to make his ideas practicable, even to the point of constructing every part of it himself.[13]" is true and well said.

Punchcutting a Lost Art

This is a matter of degree; Bullen does say "almost." Pantographs engraving machines, including Benton's, did supplant hand methods. Punchcutting and patrix cutting, though, have never been lost arts. They were practiced through the entire 20th century and several hand punchcutters (generally working in steel) are at work today.[14]

Biographical Details (pp. 60–61)

TO DO: Again, it would be good to cross-check these.

A Typesetting Machine (p. 61)

The idea that Benton began (here Bullen says in 1882) by trying to invent a typesetting machine has already appeared in Bullen's 1907 article. It cannot be disproven, but neither is there any real evidence for it. See "That Benton Was Building a Typesetting Machine," section 11.1.4.3 on page 182, for a more detailed look at this.

Self-Spacing Type (p. 61)

This again contains content (abbreviated) from his 1907 article. In this version, though, he omits any reference to the problems of Benton's self-spacing type.

It is not true, as Bullen says here, that unit-width types were "first invented by Benton." There were at least three patents prior to his, and this had been discussed in the pages of the *Inland Printer*.

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[13] While we have no information on the actual construction of the first BEM, it is clear that Benton knew his way around machine tools. [TO DO: I have a visual memory of a photograph of Benton's workshop at ATF, including a lathe — find it.] Whether the North-Western Type Foundry owned machine tools sufficient to construct the first BEM in-house, and whether Benton literally did so with his own hands, are not really relevant questions. Even if he didn't, he certainly could have.

[14] Stan Nelson and Annie Bocel, for example. Nellie Gable has retired. I know of at least two amateurs working to learn. I can attest from personal experience that Stan is an excellent teacher of the art of punchcutting in steel.

See section G.5, "Self-Spacing Type, Prior Art," on page 244 in Appendix G.2 for further information.

That Not One Punch-Cutter was Available

This is a more intense version of an idea found earlier both in Bullen's 1907 article and elsewhere. In a milder form it may well have some truth in it. Benton may not have been willing to pay enough to attract punchcutters or may not have been able to attract them at all to Milwaukee (Midwest winters were much more severe in the 1880s than they are today).

But in this instance Bullen both understates and overstates. Benton's project required far more than three thousand punches, on the one hand, and this project was no greater than the projects of any of dozens of other type foundries at the time to bring new products to market. Benton certainly made a wise choice in deciding to build a patrix and punch cutting machine, but this choice was driven by his own inclinations and, perhaps to some extent, the inventive spirit of his age. It was in no way consequent upon the lack of punchcutters. See section 11.1.4.2, "That No Punchcutters Were Available," on page 181 for more on this.

Bullen's Three Machines (p. 61)

TO DO: Decide whether or not to move this to "Closer Looks..."; it is one of Bullen's major items of misinformation.

This is the most difficult to interpret, and at the same time the most damaging, of Bullen's statements. There is a way to read it as true, but it is far more likely to produce confusion and create "phantom" machines which never existed.

Bullen writes:

> In 1884 Mr. Benton had his first punch-cutting machine in use. It worked perfectly, showing that the principle was correct. The second machine did no better work but was easier to manipulate. His third machine is the machine as now sold. In 1885 he was granted a patent. (p. 61, second column, near the bottom)

One interpretation of this, in light of the actual data we have about Benton's machines, is that the first machine was a Type 1a machine built as the prototype and resembling the patent. This probably was the machine in the glass case at the ATF Library in 1936. The "second machine," in this interpretation, would be not machine serial No. 2 but, rather, all Type 1b machines (the floor-standing, two-standard model). Type 1a and Type 1b machines are visually quite distinct (even if, kinematically, they are identical) and so it is not unreasonable for a nontechnical viewer to think of them as different machines. The "third machine," which is "as now sold" would have to be the Type 2 machine. ATF generally did not engage in the business of selling Benton pantographs, but there was one exception: Four were sold to customers in Japan. One of these is illustrated in this article. (All other leases and sales of Benton pantographs were of Type 1 machines, and so could not be the machines "as sold now.") Finally, yes, Benton did receive a patent in 1885 (but for the Type 1 machine, not for the Type 2 “as sold now.”)

This is a very convoluted interpretation, and it conflicts with other material provided by Bullen himself. For example, two years later when writing about the Linotype, Bullen illustrates a Type 1b BEM and says that it is

> The Benton punch-cutting machine, on which the first steel punch was cut for the Mergenthaler Linotype machine. The second machine built by Benton. The Mergenthaler Printing Company bought No. 3 in 1889 and several others shortly after. Without this invention Mergenthaler’s invention was impracticable. This machine is in the Typographic Library and Museum of the American Type Founders Company, in Jersey City ({Bullen 1924 L2}: 937).

Since we have independent confirmation from primary evidence (the Benton, Waldo “Day Book” page reprinted by Rehak in *Practical Typecasting*) that machine No. 3 was in fact leased[15] by the Mergenthaler Printing Company in 1889, it follows that the machine Bullen illustrates in 1924, “the second machine built by Benton,” is serial number 2. This would imply a reading of this passage where machine one was the prototype, machine 2 was serial number 2, and machine 3 was serial number 3. This reading fails on the assertion that machine 3 was “as now sold.”

However, this is the reading that subsequent writers have taken. The anonymous writer of Benton’s 1932 obituary in *The Inland Printer,* for example, acknowledges Bullen’s 1922 article as a source and writes:

> So in 1884 he put his first punch-cutting machine into successful operation. His second machine was easier to manipulate, and his third machine, patented in 1885, was the model which revolutionized the typefounding business ({[Benton 1932]}: 54).

The misinterpretations prompted by Bullen’s confusing and contraditory passage only become amplified over time. When Patricia Cost attempts to sort out the matter in 2011, she has to take into account other factors. These include Bullen’s entirely fictitious story that P. T. Dodge of the Linotype firm convinced Benton to try to cut punches in steel.[16] Cost does an extraordinary job of trying to make sense of this, but there is no way to do it.[17] She finally concludes:

> To summarize, the first version of Benton’s pantograph machine was engraving type-metal originals at Benton, Waldo & Co. in Milwaukee by 1884. The second version of the machine cut the sample steel punch for Dodge. Benton received a patent for the third version in 1885, and it was this version of the machine that the Mergenthaler Printing Company leased. …{Cost 2011}, p. 68)):

[15] Rehak says leased rather than sold. That distinction does not matter here.

[16] See 11.1.4.1, “That Dodge Induced Him to Try Punchcutting,” on page 179 for a detailed discussion of this.

[17] For a more extensive consideration of how Cost grappled with Bullen’s misinformation, see section 11.5, “Recontextualizing Cost’s Reconstruction,” on page 190.

This has Benton constructing three distinct machines by 1885, the third of which would have been a Type 1a machine (as shown in the 1884/5 patent) — when the Mergenthaler firm leased Type 1b machines as shown in the Benton, Waldo 1891 sales pamphlet. To this we would have to add the Type 2 machines of the 1899/06 patent for a total of four distinct Benton vertical pantographs. This is neither internally consistent nor does it line up with the evidence, but it is the inevitable result of Bullen's inconsistent and confusing statement in this 1922 article.

William Ferdinand Lietke (p. 62)

Bullen's story about Lietke has no independent confirmation (Cost's passage about him comes from this 1922 article) but it is a charming story which does no harm.

Visual Design of Self-Spacing Types (p. 62)

Any discussion of the aesthetics of type design is a very good way to start a fight.

History of the Linotype (p. 62)

While there are some true things in Bullen's account (P. T. Dodge was important, Schuckers did invent a spaceband which, while different in form from the Linotype spaceband, did provide the basis for a blocking patent) this historical account is imperfect. It seems to be present primarily to cast Ottmar Mergenthaler in a bad light.

Linotype Setting of *The New York Tribune* (p. 62)

Bullen's recollection here, that the *Tribune* was marred by wrong font characters due to punch breakage, is a product of fantasy. As Carl Schlesinger has demonstrated (and as an examination of Mergenthaler's patents confirms) the "Blower" Linotype which first set the *Tribune* was using electroformed matrices.[18]

Dodge's $50 Bet (p. 62)

This is the best of Bullen's stories: exciting, detailed, and false. It has been repeated through the decades and continues to impede scholarship today.

See section 11.1.4.1, "That Dodge Induced Him to Try Punchcutting," on page 179 for a detailed discussion of this.

Not Used at Any Other Typefoundry (p. 63)

Bullen's assertion that Benton's engraving machines "had not been used in any other typefounder" than Benton's own before their use at ATF appears to be true, so far as our data goes. This is indeed interesting, as presumably Benton would have been happy for such a lease.

Two other things emerge from this as interesting. The first is to consider where the machines *were* in use: the Linotype firm (US), the Linotype firm (UK), the Rogers Typographic [sic] Co.,

[18] See {Schlesinger 1989}, which reprints the first page. See also {US 347,629 Mergenthaler 1886}, Figs. 6, 21, and 35–39.

the Lanston firm, and at least two at the Minneapolis Electro Matrix Co. (which was behind the Goodson Graphotype composing machine). Every one of these firms was a maker of a composing machine.

Second, it is important not to read Bullen's statement as "no other typefounders were using pantographs." Many were, and had been for some time: the Central Type Foundry, Schraubstadter & Werner, Barnhart Brothers & Spindler (Ballou and Dedrick machines), and perhaps most importantly Ludwig & Mayer (since 1877), and other as-yet unidentified German foundries. In addition, MacKellar, Smiths and Jordan were using a non-cutting pantograph in conjunction with patrix making (since at least 1872).

Patterns, Outside and In

TO DO:

see analysis of geometry

TO DO: DOUBLECHECK geometry for punchcutting on Type 1 vs. Type 2

Hand Punch-Cutter's Occupation Was Gone (p. 63)

Bullen writes of the first type production at ATF under Benton and says "The hand punch-cutters' occupation was gone." This is almost, but not entirely, true.

I had several telephone conversations with Theo Rehak in 2023 concerning my own Benton Type 2a Engraving Machine, Machine No. 53. It is an unusual machine which clearly has been the subject of much experimental additional equipment (most of which has been removed, though an unusual rotating table remains). The reason for this, Theo explained, was that one branch of matrix making had remained unmechanized at ATF: cutting patrices for electroforming curved-face matrices for casting curved-faced type for us in marking wire. This was still cut by hand. It was a profitable line and ATF wished to mechanize this patrix cutting to ensure its continuation after their last patrix cutter might retire. They experimented with No. 53, in ways which are not recorded and which would be difficult to reverse-engineer from what survives. Theo said that ultimately they failed and returned the machine to ordinary service (though it was sitting unpowered and disused before the 1993 ATF auction).

TO DO: Photograph some of my wire marking type; show. Show a photo of wire-marking type in a Barth at Piqua.

Traditional Punchcutting; DeVinne (p. 63)

Bullen is correct: DeVinne's "Plain Printing Types" is very good.[19]

[19] He doesn't quite cite its title correctly, but it is a long title: *The Practice of Typography: A Treatise on the Processes of Type-Making, The Point System, the Names, Sizes, Styles and Prices of Plain Printing Types.* His citation of the date is also slightly wrong. Its copyright date is 1899, but the date on its title page is 1900. See {DeVinne 1900} for a more formal citation and for links to digital editions.

The "Benton Delineator" (p. 63)

Much of p. 63 of Bullen's article discusses the machine he calls the "Benton Delineator." This is a difficult name, because the term "delineate" was used in reference to two completely different pantographs at ATF. In Kaup's article for *The American Machinist,* for example, Figure 1 shows "Delineating the Characters" on the machine described in Benton's 1899/1905 US patent 790,172, "Tracing Apparatus". Figure 2 shows "Delineating on Wax Plate" on one of the ATF wax plate pantographs. {Kaup 1909}, p. 1042.

Bullen's description of the 1890/1905 patent machine is basically correct and matches that in Kaup and in Benton's own 1906 description for *The Building of a Book* {Hitchcock 1906}, pp. 33–33.

All three accounts, however (even Benton's), fail to describe the machine adequately. See section 12.3, "Benton's 1899 "Delineating Machine"," on page 204 in chapter 12.

It is worth observing that for all of its ingenuity, this machine's years of use were limited. It was developed around 1899, and so played little part in the patternmaking for Type 1 machines. It had been scrapped by the time Theo Rehak joined ATF in 1980.

The Wax-Plate Method (pp. 63–64)

TO DO: note briefly the several methods of patternmaking at ATF: zinc, wax plate, engraved (Gorton), etc.

TO DO: Photograph an ATF pattern and show it.

TO DO: Illustrate an ATF wax-plate pantograph; link to section on them in Other Typographical Pantographs of the 1890s.

The Benton Matrix-Cutting Machine

In general terms, Bullen's description of the operation of the Benton Engraving Machine, the Benton Cutter Grinder, the measuring microscope, and the matrix fitting machine are correct.

TO DO: note that 144 point bodies may be cut only on Type 1b BEMs (not the Type 1a shown).

TO DO: Doublecheck claim of 8-12k spindle speed. The motor for BEM No. 99 (which motor/stand I now own) has a motor with a rated speed of 3450 RPM. Measure the increase in speed to the bowden cable. 12k rpm is plausible.

11.1.3• On the Linotype, Part 2 (1924)

In 1924, Bullen published a two-part article on the "Origin and Development of the Linotype Machine." The portions concerning the history of the Linotype are not of concern here.

The portions which concern Benton's pantograph are toned down considerably from 1922. Dodge learns of Benton only "by the merest chance" and then "went to Milwaukee and convinced himself of the extraordinary exactness and rapidity of the work done on Benton's machine." (p. 937).

Bullen illustrates a Type 1b BEM and (as noted earlier) says in its caption:

> The Benton punch-cutting machine, on which the first steel punch was cut for the Mergenthaler Linotype machine. The second machine built by Benton. The Mergenthaler Printing Company bought No. 3 in 1889 and several others shortly after. Without this invention Mergenthaler's invention was impracticable. This machine is in the Typographic Library and Museum of the American Type Founders Company, in Jersey City ({Bullen 1924 L2}: 937).

If we accept this as machine *serial* number 2 (implying that only a single Type 1a machine had been made before it) this is plausible.

In the text, he cites February 13, 1889 as the date of acquisition by the Linotype firm of their first Benton engraving machine. This matches the Benton, Waldo "Day Book."

His only other comments in this article about the Benton machine extoll its "genius and originality" — and indeed it deserves this praise.

11.1.4• Closer Looks at Bullen's Misinformation

For a quick survey of other reasons why Bullen's writings cannot be trusted, see Appendix I, "Other Problems with Bullen as a Source," on page 249.

11.1.4.1• That Dodge Induced Him to Try Punchcutting

TO DO: see also Bullen. Inland Printer. Vol. 38, No. 4 (January 1907): 518, which gives a different (but also incorrect) story.

This story is the most compelling one that Bullen tells about Benton. It is worthy of a Hollywood film — and is just as accurate.

It occurs in only one version of Bullen's account of the origins of Benton's pantograph, his 1922 biographical article on Benton. Having first set the stage by explaining the need of the Mergenthaler Linotype Company[20] for a machine to cut punches in steel (a need that was very real; Bullen is not wrong there), he describes a visit by Philip T. Dodge of the Mergenthaler company to Benton in Milwaukee:

> … and soon after Philip T. Dodge appeared on the scene. The Benton punch-cutter was shown to him. *It had never cut in steel.* [italics mine] It was cutting in type metal, for Benton was using electrotyped matrices. When asked if his machine could cut in steel, Benton said he did not know. He was not eager to stop work to experiment for other folks. He did not know how much of good or evil depended on the answer to Dodge's question. However, he was persuaded to try, Dodge agreeing to pay him $50 if he did not succeed, as compensation for wasted time.
>
> When Dodge saw Benton the next day that memorable punch ws ready for him. By a slight change in the cutters the steel was cut and Dodge's question was answered affirmitively {Bullen 1922 LBB}, p. 62.

It's a good story and it has had a long history. Paraphrased versions[21] have appeared in classic works such as James Eckman's *The Heritage of the Printer* {Eckman 1965}, p. 111 and Walter Tracy's *Letters of Credit* {Tracy 1986}, p. 36. It appears in Kahan's history of Mergenthaler and the Linotype {Kahan 2000}, p. 48 and Cost's biography of the Bentons {Cost 2011}, pp. 66–67.

Here's the problem. The first limited-production Linotype, the so-called "Blower" Linotype, went into service in July of 1886. We know from the work of the late Carl Schlesinger that for the first months of its use it employed electroformed matrices.[22] These did not prove to be

[20]Actually, it was through this period either the National Typographic Company or the Mergenthaler Printing Company. See {Kahan 2000}. for one of the better accounts.

[21]Sometimes very closely paraphrased versions.

[22]This is discussed in Schlesinger's edition of Mergenthaler's autobiography {Schlesinger 1989}. He demonstrates

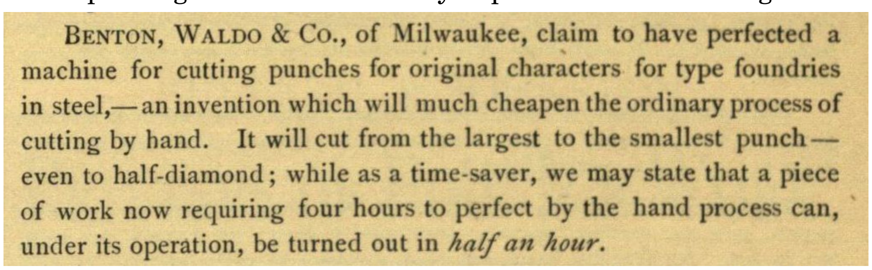
sufficiently durable, so they switched to matrices made using hand-cut steel punches. Ottmar Mergenthaler was well aware of the disadvantages of these, but he indicates in his autobiography that he did not know of any punch engraving machine at the time {Schlesinger 1989}, p. 29.

The earliest documented evidence we have of any knowledge by the Mergenthaler Printing Company of Benton dates to January 10, 1888. On that date, Whitelaw Reid of the Mergenthaler company wrote to order "100 steel blanks of the proper size for cutting a long primer or small pica face" to be sent to Benton, Waldo and Co. {Kahan 2000}, p. 48. The first Benton Punch Engraving Machine was leased to the Mergenthaler Printing Company about a year later, on Feb. 13, 1889.[23]

But in July 1884, three years earlier (and two years before the Blower Linotype), a trade notice by Benton, Waldo & Co. in *The Inland Printer* announced that they had

> … perfected a machine for cutting punches for original characters for type foundries in steel, … {*Inland Printer* 1884} (Vol. 1, No. 10 (July 1884): 21.)

It may be worth reprinting in facsimile this very important trade notice again:



BENTON, WALDO & Co., of Milwaukee, claim to have perfected a machine for cutting punches for original characters for type foundries in steel,—an invention which will much cheapen the ordinary process of cutting by hand. It will cut from the largest to the smallest punch—even to half-diamond; while as a time-saver, we may state that a piece of work now requiring four hours to perfect by the hand process can, under its operation, be turned out in *half an hour*.

Fig. 11.12: *Inland Printer* (July 1884)[24]

The Blower Linotype went to work in July 1886 using electroformed matrices. Had anyone in the Linotype firm known of Benton's pantograph then, it would have used punched matrices. But at least two years before that (more likely three) Benton had already advertised to the world that he could cut punches in steel.

Bullen's story of P. T. Dodge and his fifty dollars, repeated as truth for over a century now, never happened.

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it by an analysis of consistent flaws in Linotype-cast type as printed in the New York *Tribune* during this period. Evidence for this may also be found in Ottmar Mergenthaler's US patent 347,629 (filed Oct. 23, 1885 and issued Aug. 17, 1886) for this machine, which contains clear depictions of electroformed matrices in Figs. 6, 21, and 35–39 {US 347,629 Mergenthaler 1886}.

[23]This information is from the Day Book of Benton, Waldo and Co., a page of which is reprinted in {Rehak 1993}, p. 109.

[24]From {*Inland Printer* 1884} (Vol. 1, No. 10 (July 1884): 21.) Scanned by DMM from the University of Wisconsin copy. Public domain.

11.1.4.2• That No Punchcutters Were Available

This part of Bullen's story of Benton is a matter of tone and what that tone conveys.

Benton himself wrote, nearly 50 years after the fact, that the task of punchcutting for his self-spacing types prompted his development of an engraving machine:

> Unable to engage the services of expert type-punch cutters, I was compelled to invent my type-punch engraving machine[25]

At a relatively early point, there was acknowledgment in the literature that this was the case. In an 1896 article on "The Typefounder's Art" in *The Typographical Journal*, an anonymous writer under the pseudonym "Skopeo, of No. Six"[26] wrote:

> [Benton's] invention of self-spacing type led him to the more important one of the punch-cutting machine, as he found it impossible to hire enough punch-cutters to bring out self-spacing type in any reasonable time {Skopeo-1896}: 214.

Even in his earlier writing on the subject, Bullen displays some moderation. In his 1907 account, Bullen says:

> To put this unit-width type on the market involved cutting thousands of steel punches, and a dearth of steel punch-cutters threatened to make this the task of years {Bullen 1907}: p. 517.

All of these are quite reasonable statements.

But in the 1922 version of the Benton story, Bullon ramps up the rhetoric to a point where he misrepresents the state of type-making in America at the time:

> In any case, fonts of various bodies, old sytle and modern, had to be made before the machine could be utilized. Punches for every character were required to be engraved and matrices made. There were more than three thousand punches to be cut[27] and *not one punch-cutter was available either in America or in Europe.* [italics mine] This dilemma was the turning point of Benton's career … [he] determined to make a machine to cut punches {Bullen 1922 LBB}, p. 61.

[25]This is quoted from {Cost 2011}, p. 57, who in turn has it from a letter by Benton to David Gustafson in 1932 in research for his two-part article "Who's Who in Printing in the United States." Cost's citations from this correspondence are particularly valuable, because in the end no entry for Linn Boyd Benton appeared in {Gustafson 1933–1934}.

[26]The *Typographical Journal* was the journal of the International Typographical Union. No. 6 was ITU Local No. 6, in New York.

[27]Bullen underestimates. In the circa. 1896 Benton, Waldo specimen book, 27 different fonts are offered. For a standard font of Self-Spacing Old Style, Benton identifies 233 sorts (including roman, italic, small caps, etc.) If in fact he cut all of them, that would give 6,291 distinct matrices which would have had to have been produced. (Five of these fonts are identified as "Circular Fonts." I have not been able to discover the sorts included in a "Circular Font" (one for circular work, meaning "small job-work [including letters, notes, business invitations, &c." {Lockwood 1894}, p. 99.) It is possible that such a font contained fewer sorts.)

To say that "not one punch-cutter was available" is unsupportable. While punch and patrix engraving were never mainstream occupations, this field was vibrant in the 1880s. We can even identify punchcutters working freelance at the time.[28]

To quantify this a bit, in 1882 there were at least 36 type foundries operating in the US. While some of the smaller of them were no doubt subsisting on purchased or electrolytically pirated matrices, most of these were producing original work in substantial quantities. Benton's situation was no different from that of any other foundry, yet they did not perish for lack of a pantograph.

In 1898–1900 Loy published biographical sketches of 25 engravers for metal type.[29] Of these, 20 were active in 1882.[30] Moreover, there was considerable movement of these engravers between foundries. An analysis of this in the Johnston-Saxe edition of Loy reveals that only three of the 25 worked exclusively for a single foundry. Loy's tally of engravers cannot be taken as exhaustive. There were surely more engravers at work than he highlighted. Neither does his tally include apprentices (he notes that Ruthven, who preferred cutting patrices in soft metal, had as many as twelve apprentices at a time).

To say that Benton was unable to hire enough punch-cutters is one thing,[31] but Bullen's hyperbole feeds into the myth of punchcutting as a nearly lost art.

11.1.4.3• That Benton Was Building a Typesetting Machine

The last item to be considered here is perhaps the strangest, but also the least important: that Benton's self-spacing type came out of a project to build a typesetting machine.

The notion that in 1882 Benton began building such a machine appears in two of Bullen's articles: a 1907 installment of his "Discursions of a Retired Printer" {Bullen 1907}: p. 517. and his 1922 biographical article about Benton {Bullen 1922 LBB}, p. 61

In 1907, Bullen wrote:

> Mr. Benton started to invent an automatic justifying typesetting machine. For this machine he devised a system of casting body types on eight different widths, instead of the more than one hundred widths found in an ordinary body-type font.

In 1922, he wrote:

> In 1882 Benton's thoughts turned toward the invention of a typesetting machine,

[28]William W. Jackson is one example.

[29]Plus William H. Page, who worked in wood type, and a quick overview of early American punchcutters.

[30]This count subtracts three who died earlier (Gilbert, Kilburn, and Wehrle), David Bruce, Jr. (who had ceased cutting around 1865), and Nicholas Werner (who began cutting in the mid-1880s with the Central Type Foundry's pantograph.

[31]A quick online search indicates that the record low temperature in Milwaukee for the winter of 1883 was 23 degrees below zero Fahrenheit.

> in which a near approach to self-justification was to be effected by casting all of the characters and spaces and quads of a complete body type font of roman and italic on nine widths, instead of on the more than one hundred widths found in the average font of body type.

Continuing, Bullen says that

> [The] unexpected merit of unit-width types, first invented by Benton, caused him to defer the creation of the typesetting machine for which they had been made to be used.

This idea has resurfaced in {Cost 2011}, p. 48)) and more recently in {Nemeth 2017}, pp. 38–39.[32]

However, I have been unable to discover any evidence for this typesetting machine which is independent of Bullen.

In Bullen's accounts, Benton's typesetting machine gave him reason to develop his self-spacing types. These in turn (in Bullen's narrative) forced him to invent his pantograph engraving machine.

There is a certain degree of plausibility here, for two reasons.

First, at least two of the unit-set type systems which preceded Benton's were for typesetting machines.[33]

Second, Benton's patent does in fact mention the possibility of using his unit-set types in a composing machine:

> In setting my improved type by the use of a composing-machine, it will be found that the operator can, with a little extra care and by either actually or mentally spacing the copy, justify the type as he sets it. (US 290,201, p. 2, lines 33–37)

But there are two issues here.

First, this passage seems to be appended (as the last paragraph before his claims); most of the patent is framed in terms of hand setting type, with no mention of machine composition.

Second, this is a very strange passage if you consider it in the context of the history of composing machines.[34] Machines which simply set individual types in order are relatively simple and were known from the first half of the 19th century (again, see Huss for many examples).

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[32]Nemeth cites Cost as his source.

[33]Martin Wiberg's British patent No. 1548 of 1854-07-14 was for a composing machine where the "thickness of each type is a multiple or sub-multiple of the thickness of the rest." {GB 1548 of 1854 Wiberg}. James E. Munson's composition system (from 1881 onward) also employed unit-set types. It isn't entirely clear when Munson adopted these, but he was aware of Wiberg's earlier work. See the CircuitousRoot Notebook on "Munson's System of Power-Type Composition" at: `https://circuitousroot.com/noncastcomp/munson/index.html`

[34]See, for example, Richard E Huss' *The Development of Printers' Mechanical Typesetting Methods, 1822-1925* for more on this {Huss 1973}.

But this is not the hard part. The two hard parts are, first, justifying the lines and, second, distributing the type back into type typesetting machine after printing. The difficulty of these two problems is such that, in the end, they doomed typesetting machines in favor of hot metal composing machines.

What Benton is suggesting here is that if you had a composing machine which just arranged the types in order, then you could do away with the need for machine justification by letting the operator do the justification (though it isn't entirely clear how an operator "mentally spacing the copy" without actually inserting spaces would produce an actual justified line). If you had a simple typesetting machine where the operator manually justified the set lines, then indeed unit-set types would simplify this effort. This, though, would hardly be the "automatic justifying typesetting machine" of which Bullen wrote in 1907.

More to the point here, Benton's suggestion that his types might be of use in such a machine in no way implies that he was himself developing one. Moreover, as far as I have seen, the published literature promoting Benton's self-spacing type is all framed in terms of an increase in speed in *hand* composition.

It is of course not possible to prove that Benton did not begin designing a typesetting machine, or even that thinking about one inspired him to (re)invent unit-set type. We don't know what he was thinking, and the absence of evidence is not the evidence of absence. But given Bullen's lack of credibility in most other things he wrote about Benton, until independent primary evidence is discovered for this machine we cannot accept it as real.

11.2• Benton Obituary, *Inland Printer* (1932)

An anonymous obituary for Benton appeared in *The Inland Printer* in 1932.[36] Its author relies on Bullen's information (and cites Bullen's 1922 article). Because of this, it repeats several of the errors of this article — and then goes further.

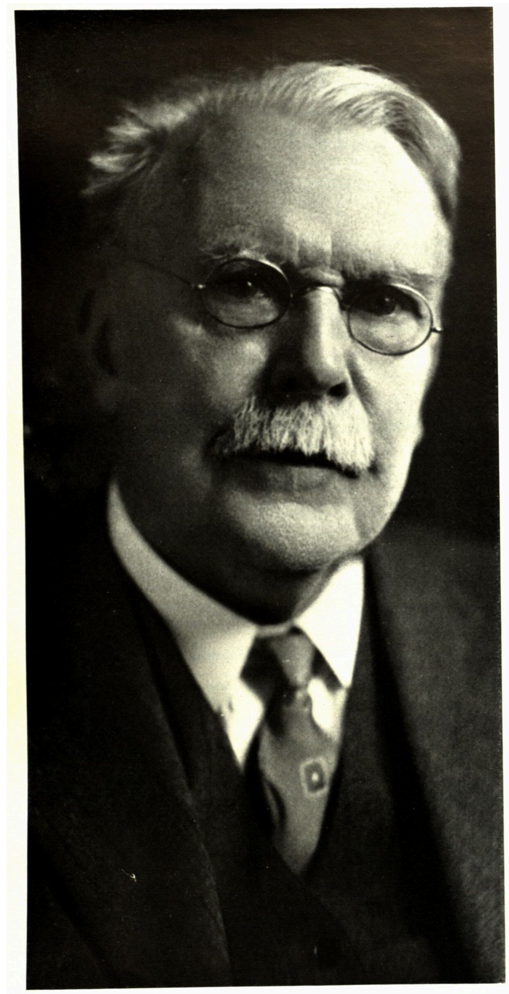

Fig. 11.13: Benton Obituary (1932)[35]

It repeats the story that Dodge of the Linotype firm discovered Benton through a sales trip by Waldo (which might be true). Then it goes on to repeat a stripped-down version of Bullen's story of Dodge inducing Benton to cut punches in steel. Here the author says only that "after some preliminary work, which he [Dodge] paid for,..." (p. 53, Col. 2).

After this, though, it adds a new twist: "he [Dodge] made a contract with Mr. Benton by which Benton's machines were sold by the Mergenthaler company" (p. 53, Cols. 2 & 3). This comes out of thin air. At no point in its long corporate history did the Mergenthaler firm ever sell Benton pantographs.

The author then repeats the unverified story that Benton was developing a typesetting machine, though here this is amplified slightly to "All this development [of self-spacing types] was achieved incidentally by Benton because of his dominant plan of inventing a typesetting machine." (p. 54, Col. 1).

Next there is a toned-down version of the unavailability of punchcutters. After this, though, comes a remarkable first. As discussed earlier, this author takes Bullen's confused statement about Benton's three machines and irons it out into a clear (but false) claim that Benton had developed three distinct machines which culminated in his 1885 patent:

> So in 1884 he put his first punch-cutting machine into successful operation. His second machine was easier to manipulate, and his third machine, patented in 1885,

[35]From {[Benton 1932]} (*Inland Printer,* Vol. 89, No. 5 (August 1932)): Frontis. (cropped). DMM overhead scan from the University of Wisconsin copy. Public domain.

[36]It gives his date of death as July 15, 1932.

was the model which revolutionized the typefounding business ({[Benton 1932]}: 54).

Except for the date of the patent, every aspect of this is false. Benton's 1885 patent covered a single mechanism which was constructed in two forms: a single-standard machine visually similar to the patent drawings and a two-standard, floor-standing, version. This second version of this machine became one of several which, starting two decades earlier in Germany, did revolutionize the typefounding business.

Most of the rest of this obituary simply praises Benton, which is unobjectionable.[37]

The full text of this obituary is reproduced on the following two pages.

[37]There is a slight inconsistency in dates when it places the direct engraving of matrices (in intaglio) after 1903. We can date this to at least the filing of his 1899 patent for his second vertical engraving machine.

Achievements of Linn Boyd Benton Vital to Industry's Progress

WHILE the poet of former days sang about great men who, departing, might leave behind them footprints on the sands of time, the great man of the printing industry who quietly departed this life at Plainfield, New Jersey, on July 15, left behind him impressions of his handiwork upon the type matrices of the whole printing industry. Linn Boyd Benton is a name that should and will rank in the annals of the printing industry with the names of other great men whose devotion to their work and consequent achievements placed our industry in the dominant position it holds today.

Intimate friends of Mr. Benton say that while his inventions have been of inestimable value to the development of modern type manufacturing, yet his extreme modesty was responsible for his being so little known among those men whose pleasure and livelihood are dependent upon the graphic arts. These friends, in appraising his value to the industry, say that what Edison was to the general use of electricity, and what Bell was to the development of telephonic communication, Benton was to the modern use of type in the graphic-arts industries.

Without use of the inventions of Benton, the typesetting machines of Mergenthaler and Lanston probably would have been abandoned as impracticable, like so many proposed machines the discarded wreckage of which marks the path of mechanical progress all through the history of the industry.

The story of the life and work of Linn Boyd Benton was told in an article by Henry Lewis Bullen which appeared in THE INLAND PRINTER for October, 1922. In that story Mr. Bullen described the dilemma of the stockholders of the Mergenthaler Linotype Company, who had invested several million dollars in the machine and then discovered that the replacement of the broken punches made the use of the machines of questionable value. Mergenthaler had relied upon hand punch-cutters, not realizing that there were not enough of these in the whole world to make punches for one-tenth of the matrices required for the linotype. Because punch-cutting was an art which few men could master, and the cleverest mechanic was not able to cut two letters precisely alike, almost every line of type which was cast on the first linotype machines used in composing rooms would contain the equivalent of wrong-font letters.

About the time when Philip T. Dodge and Whitelaw Reid, chief backers of the Mergenthaler linotype, realized its inadequacy to meet the needs for practical typesetting, R. V. Waldo, associate of Mr. Benton in the conduct of the typefounding firm of Benton, Waldo & Company, of Milwaukee, called at the office of the New York *Tribune* to offer a supply of the so-called "self-spacing" types developed and patented by Mr. Benton. Mr. Waldo, in his sales talk, referred to the fact that better stereotype matrices could be made with the use of these types because punches were uniformly cut with a machine of Mr. Benton's personal invention.

Mr. Waldo sold no type, and he returned to Milwaukee thinking that his visit to the East had been profitless. But soon afterward Mr. Dodge appeared in Milwaukee, and, after some preliminary experimental work, which he paid for, he made a contract with Mr. Benton by which Benton's machines were sold by the Mergenthaler company. In a subsequent report to the directors of the company the statement was made that "by the acquisition of the Benton punch-cutting machine we have been enabled to overcome a seemingly insurmountable obstacle to our success."

Commenting upon this use of Benton's invention, Mr. Bullen remarked: "Nothing is surer than that without the Benton machine, or a similar invention, apparently not in any other man's mind, the Mergenthaler Linotype Company could not have recovered the cost of its long series of experiments before its patents had expired—if at all. The same is true of the Lanston monotype machine, which also had to depend upon Benton's wonderful invention to make it practicable. Benton had accomplished greater things than he had ever imagined."

Now that we have referred to the importance to the industry of one of the twenty patents obtained by Mr. Benton, eighteen of which relate to the art of typemaking, it might be interesting to readers to understand how he became associated with the typefounding business in which he was destined to achieve such remarkable success.

Linn Boyd Benton was born in Little Falls, New York, May 13, 1844. His father, a lawyer by profession, became editor of a newspaper in practice, and moved to Milwaukee in 1853, where he became the editor and part owner of the then Milwaukee *Daily News*. A former partner of the elder Mr. Benton, a J. A. Noonan, also moved from the East to Milwaukee, where he became a partner in a paper mill and established what became known as the Northwestern Type Foundry. Young Benton became familiar with typesetting by reason of his association with the printers in his father's newspaper office, and later learned the trade in a newspaper office at La Crosse, Wisconsin, in which city his father had been made a judge of the circuit court. However, young Benton decided to become a bookkeeper for a leather house.

LINN BOYD BENTON

May 13, 1844—July 15, 1932

In recognition of the benefits showered upon the industry through the genius of this great figure, some of whose achievements are here recorded, the seat of honor, as it were, in this issue is given over to his most recent portrait. Turn to the frontispiece (page 24), study the kindly, intelligent features, recognize that he worked to benefit you—even after years of practical blindness—until past eighty-eight, and remember him as one of the truly great in the industry's march of progress.—The Editor.

53

Fig. 11.14: *Inland Printer* (August 1932), p. 53[38]

[38]From {[Benton 1932]} (*Inland Printer,* Vol. 89, No. 5 (August 1932)). Internet Archive digitization from microfilm. Public domain.

He later went to the Northwestern Type Foundry, of Milwaukee, as bookkeeper. When in 1873 this firm failed, Benton, with a partner named Cramer, bought the plant. A year later Cramer sold his half-interest, and the name was changed to Benton, Gove & Company. Gove died in 1882 and his interest was bought by Benton, who later sold one-third interest to R. V. Waldo, and the firm name became and remained Benton, Waldo & Company until 1892, when the business was one of twenty-three typefoundries which comprised the newly formed American Type Founders Company, now so widely known.

It was only after Mr. Benton became part owner of the typefoundry that he began the process of learning the business. As a bookkeeper he had trained himself to exactness in all his habits of thinking and working. As a typefounder he thought in terms of measurements down to .0001 inch. He applied his mania for accuracy to his business of typefounding, with the result that unit-width type faces were cut by him.

These types became famous among compositors of that time, who applied the term "self-spacing" to the Benton types. Tests indicated that compositors could save 20 per cent of their time with the new Benton product. Benton was granted a basic patent for making these unit-width types. All this development was achieved incidentally by Benton because of his dominant plan of inventing a typesetting machine.

In order to make progress in developing the typesetting machine, punches must be engraved for each of about three thousand characters to be used. Here was the big problem for Benton to solve. Punch-cutters—artists who could carve letters in steel, and had the right sense of proportion for the letters—were few and unavailable. The cost of making the punches, if the punch-cutters had been available, would have been prohibitive. Benton decided to solve his problem by developing a machine to do work which human hands had always done before. So in 1884 he put his first punch-cutting machine into successful operation. His second machine was easier to manipulate, and his third machine, patented in 1885, was the model which revolutionized the typefounding business.

The use of the machine in his own business resulted in his being able to meet the increased demand for the Benton "self-spacing" types, which reduced composition costs in newspaper offices. Just as success was increasing, the deal was made with the Mergenthaler Linotype Company for the use of the machines in the process of making matrices for the new typesetting machine.

Until the formation of the American Type Founders Company, in 1892, the Benton engraving machine had not been used in any but the Benton, Waldo & Company foundry. This foundry was removed by the new company from Milwaukee to New York City, and Mr. Benton went along with it to serve the new firm as a member of the board of directors and as chief technical advisor. The value of his connection with the new organization, and of his inventions, was noted in an editorial concerning the formation of the new company which appeared in The Inland Printer soon after the completion of the new organization. In part the editorial said: "The new company has control of elaborate modern casting machines which make type in large quantities much cheaper than it can be turned out by machinery now used, and they claim that the product of their machines is superior to the ordinary type. They also own the system of punch-cutting by machinery, invented and patented by L. B. Benton of Milwaukee, which not only can furnish better punches but which largely reduces the cost of this most expensive element in the production of new faces."

In 1903 Mr. Benton became the manager of the general manufacturing department of the consolidated plant of the American Type Founders Company, at Jersey City, New Jersey. In this new position he applied his inventive genius to the task of improving most of the machinery and processes then used in type designing and manufacture. He also improved his own machine by which the punch, and the process of driving the punch to form the matrix, were eliminated. This was accomplished by engraving the matrices upon the Benton machine in intaglio.

Mr. Benton had been in active relationship with the American Type Founders Company until June 30 of this year, at which time he retired. His death two weeks thereafter, on July 15, was sudden, only twenty minutes elapsing from the time of his being taken ill until he passed away. His achievements mark him as having been one of the great men of the printing industry.

In a recent autobiographical statement Mr. Benton said: "In 1890 I and my son, Morris, went to Washington to assist Lanston, then inventing the monotype machine, who had bought several of my machines, and to instruct his organization in the use of them. Since that date the monotype matrices have been made, both in this country and in England, on my machines or copies of them. Though a typefounder, I am fully appreciative of the great importance of the composing machines to the printing industry. It is a great satisfaction to me to have aided in their efficiency."

How Business Men Pay for Printing Obsolescence

By C. M. LITTELJOHN

To correct the public's notion that it can ever secure something for nothing—a fallacy tenaciously clung to despite all better judgment—is to perform a public service. Scouting this idea in the heads of any business executives who may possess it, the Western Printing Company, Seattle, has issued a broadside dwelling upon "Printing Obsolescence" the text matter of which reads as follows:

> Many people believe that when they take orders to a printer downstairs under a bird store they're going to save money.
>
> If they only knew the truth, they are not only paying a high price figured in *results per dollar,* but also are often paying an excessive actual price. Printing costs are all figured on the basis of TIME. Printers with out-of-date machinery, slow methods, and imperfect organization cannot hope—except by cutting the quality—to compete with prices in a highly efficient, modern high-speed shop.
>
> You pay no *obsolescence costs* at the Western Printing Company. Up-to-date, modern machinery, the highly trained printing specialists, and perfect organization "high-ball" your order through the plant in the least possible time (consistent with good quality), and consequently at the *lowest possible cost.*
>
> Let us prove it to you on your next order, whether it is large or small.

Thus a matter which apparently still persists in being mixed with obscure reasoning is made plain, and the direct advantages of modern printing machinery and modern methods are strikingly revealed. Failure properly to advise business executives of the possession of the finest mechanical devices for modern typography may mean neglect of opportunity, and business gained by default for obsolete printing machinery.

54 THE INLAND PRINTER FOR AUGUST, 1932

Fig. 11.15: *Inland Printer* (August 1932), p. 54

11.3• ATF Marketing Literature

TO DO: reproduce extracts

1912 specimen book

1923 specimen book

Type Speaks!

TO DO: Find other instances

11.4• Eckman (1960)

It may be worth noting briefly that Dr. James Eckman, writing in the journal *Printing and Graphic Arts* (aka “PAGA”) was aware of Schraubstadter’s matrix cutting at the Central Type Foundry.[39] He did not have Werner’s own writings at hand, but he cited one of E. G. Gress’ “Observations” column in *The Inland Printer* ({Gress 1932}), who in turn quoted Werner. He also cites Bullen’s 1907 condemnation of the quality of this work. {Eckman 1961}: p. 31, n4, n5.

Knowledge of Schraubstadter’s work was present, if only sporadically, throughout the 20th century.

[39] I am indebted to Patricia Cost for identifying this reference. I had missed it.

11.5• Recontextualizing Cost's Reconstruction

Patricia Cost's 2011 study of both Linn Boyd Benton and his son Morris Fuller Benton[40] is magnificent. It is one of those rare books which is at the same time highly readable and a mine of information to be returned to again and again. It has also had the salutary effect of helping to place Morris Fuller Benton in his proper place in the pantheon of great type designers.

Any book on Linn Boyd Benton will have to address the question of the development of his typographical pantographs. The problem Cost faced here is that Bullen's confusing and often simply false stories, which have been the basis of our understanding of Benton for decades, made this task impossible. No one can build a true account from false data.

11.5.1• Benton's Typesetting Machine and Self-Spacing Type

Cost generally follows Bullen's lead on this (pp. 47–53) and accepts his claim that Benton began by working on a typesetting machine. While there is no actual evidence for this claim, it cannot be refuted and it does not really affect questions of which machines Benton built and when.

Cost does introduce two new references, one of which is of great value. First, she cites Legros & Grant's monumental *Typographical Printing Surfaces* {Legros & Grant 1916}: 77–88. Unfortunately, they fail to understand Benton's type and assert, incorrectly, that its unit is always "one-sixth of the body". More significantly, Cost cites an excellent article by James Eckman, "The Inland Type Foundry, 1894–1911" in *PAGA* vol. 8 {Eckman 1961}. Eckman does a good job of distinguishing the Inland's unit-set type from Benton's earlier self-spacing type.[41]

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[40]*The Bentons: How an American Father and Son Changed the Printing Industry* {Cost 2011}. At the time of writing (2025) this book is still in print and availble. It belongs in the library of every student of type history. See also her 1986 thesis at Rochester Institute of Technology {Cost 1986}.

[41]As a parting shot in favor of self-spacing type, Cost does add another claim of her own: "since typecasting machines must be stopped and readjusted each time type of a different set width is cast, reducing the number of set widths in a font of type greatly reduced the amount of time that the machines were idle" (p. 53). This is true, but I am not sure that it is overly important. Changing the set of most fixed-mold typecasting machines does require time, so the fewer times you must change the set the less time the machine is not casting. For example, all Japanese and Chinese type is fixed-set (within each body size) and anyone who has seen video of a 1960s vintage Hakko typecasting machine in Japan running with an automatic matrix changing attachment will be amazed at its speed.

However, there are two issues with this, one technological and one a matter of practice.

On the technological side, this does not apply to typecasting machines which adjust their set automatically. This was the case with early Thompson Type-Casting Machines using Linotype matrices, in which the mold set mechanism banked against the matrix. (This was changed in later Thompsons with the addition of Group 41TC "Micrometer-set-adjusting device.") More importantly, all pivotal typecasters, when running with a properly justified matrix font, adjust their set automatically by banking on the matrix. Pivotal casters remained in use from their introduction in the 1840s to the end of the era of cast metal type.

On a practical side, as a trained typecaster, I would take issue with the word "greatly." My mentor in typecasting,

11.5.2• Before Benton

Before examining Cost's account of machine engraving before Benton, it is useful to remember that by the late 20th century "electro" matrices were remembered by even well-informed American[42] typographers only for their role in pirating types. Knowledge of patrix cutting, by hand or machine, had passed from memory even while it continued to be employed.

Cost did groundbreaking work in reintroducing patrix cutting into the narrative of typemaking (see pp. 13–16.) She also corresponded with Theo Rehak about this and, in a very important contribution to the literature, reprinted correspondence with Rehak documenting the recollections of William Charles Gregan, "the last master engraver at [ATF]," who had in turn spoken with Morris Fuller Benton and who had "deduced that Linn Boyd Benton originally used his pantograph invention to engrave the original models to be used for making electrotype matrices" (see pp. 60–61 and also 73).

For all this, the idea that electro matrices from patrices were inferior informs Cost's analysis of machine matrix making before Benton.

She is aware of Schraubstadter's work at the Central from Werner's 1932 article on Wiebking. But she accepts Bullen's 1907 claim that "these all lacked precision." In support of this claim, she writes:

> … Apparently the Central Type Foundry's matrix engraving machine was not adequate for the job, since William's brother Carl Jr. wrote a few years later in the *Inland Printer*[43] about the prevalence of the electrotype process for making matrices. (p. 59)

If this were true, then one might well claim that Benton's second (1899 patent, Type 2) pantograph was a failure because ATF continued to cut patrices into at least the 1920s.

Cost also dismisses the Central's machine because, as Werner reports, it was a "flat pantograph" as opposed to "Benton's patented upright machine." This is simply the prejudice that

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Sky Shipley, can do a set-width changeover on a Thompson in 90 seconds. (At my very fastest, it takes me more than twice as long.) The time it takes to cast an entire production run for a single matrix font varies, of course, but typically at Skyline was two or three days for a 72 sort Lanston Monotype display face. Not every sort requires a new set. If in round numbers you assume about 60 set changes at 90 seconds each, that's 90 minutes. With Benton's type at 8 set changes that would be 12 minutes. Whether this constitutes a "greatly reduced" time over the course of two or three days of work is a matter of opinion.

On a Barth type caster, a matrix changeover in total (including set adjustment) takes a few minutes. But the Barth is designed as a production machine: you set it up for a single sort and cast very large quantities. They were casting weight fonts, not job fonts. Matrix changeover is a small part of this time.

[42] Again, this knowledge was never lost in Germany and patrix cutting was presented in the literature there throughout the 20th century.

[43] In "Electrotype Matrices," {Schraubstadter 1887}.

holds that only a Benton or Benton-like pantograph is capable of typemaking. In fact many type foundries, as well as matrix manufacturers such as Wiebking (and Ludlow) used horizontal pantographs.

Cost also cites the early work of Herman Wiebking and the later work of his son Robert (p. 59). She discusses these primarily in the context of the influence they might have had on Benton, and her conclusion that there is no evidence of this is sound. Herman Wiebking's work was not successful. Robert Wiebking's work was very successful, but it postdated Benton's first machine by a decade. In any case, given the Robert Wiebking's intense secrecy, it is unlikely that anyone other than his partner Hardinge had any technical knowledge of his machines until the Ludlow Typograph Company persuaded him to set up their punchcutting operation.[44]

11.5.3• Benton's First Machine

Cost does a great service in her initial discussion of Benton's original machine by emphasizing its use for cutting punches and patrices rather than direct matrix engraving (p. 60–61). The literature has not always been clear about this

Then a problem comes up. She is aware of, and quotes in its entirety, the 1884 Benton, Waldo trade note in *The Inland Printer* in which the firm claims "to have invented a machine for cutting punches for original characters for type foundries in steel." This should be unproblematic: Benton's first machine would have been equally capable of cutting patrices and punches, and there is no reason to believe that it wasn't doing both from the outset. Here, though, Bullen's stories lead the narrative astray.

Cost continues with a digression into the history of the Linotype (p 61–66). This leads direcctly to Bullen's 1922 story of Dodge visiting Benton, who (in the story) didn't know if his machine could cut steel punches and was convinced by Dodge, against $50 if his time was wasted, to try it (p. 61–62).[45]

Of course, as discussed earlier, we know that this never happened because the dates can't

[44]There is only one minor point of confusion in this account. It conflates the matrix engraving machine(s) of Herman Wiebking (from at least 1878 to at least 1882) with the machines developed later by Robert Wiebking and Henry Hutchins Hardinge. These latter machines were capable of cutting punches (and patrices, of course) and matrices. This is attested in two ways. First, Middleton (who knew these machines at the Ludlow Typograph Company) said that Wiebking "was ready to accept commissions for engraving punches or matrices" two years after leaving his apprenticeship (thus, 1894). {Middleton 1937}: 13. Second, as the owner of one of the surviving Wiebking pantographs rescued from Ludlow by Middleton, I can attest that it would be a simple matter to construct either a punch/patrix workholder or a matrix workholder for it.

[45]Using the MeasuringWorth.com calculator: `https://www.measuringworth.com/calculators/uscompare/relativevalue.php`, $50 in 1887 would be $1,700 in 2024 (based on the consumer price index) or $14,500 (based on production-line labor value). Benton was both a skilled mechanic and business owner, not just a production worker. $50 in 1887 was a lot of money.

line up. Dodge couldn't have done this until well after July of 1886 (I suspect that 1887 is more likely), but Benton announced his ability to cut punches in steel in July 1884.

Where this leads, two pages later, is a timeline of Benton's inventions:

> To summarize, the first version of Benton's pantograph machine was engraving type-metal originals at Benton, Waldo & Co. in Milwaukee by 1884. The second version of the machine cut the sample steel punch for Dodge. Benton received a patent for the third version in 1885, and it was this version of the machine that the Mergenthaler Printing Company leased. The arrangement with Mergenthaler became so successful that Benton, Waldo & Co. began planning to lease more machines. {Cost 2011}, p. 68)):

As discussed earlier,[46] this summary is quite similar to the description of Benton's process of invention by Bullen in 1922:

> In 1884 Mr. Benton had his first punch-cutting machine in use. It worked perfectly, showing that the principle was correct. The second machine did no better work but was easier to manipulate. His third machine is the machine as now sold. In 1885 he was granted a patent. ({Bullen 1922 LBB}: p. 61, second column, near the bottom)

It also echoes the summary in the anonymous 1932 *Inland Printer* obituary for Benton

> So in 1884 he put his first punch-cutting machine into successful operation. His second machine was easier to manipulate, and his third machine, patented in 1885, was the model which revolutionized the typefounding business ({[Benton 1932]}: 54).

This sequence of three machines before 1885 is incorrect. There is evidence for only one.

Once we realize that there is no essential difference between a machine for patrices in soft metal and one for cutting punches in steel, and once we realize that Bullen's 1924 story about Dodge convincing Benton to try punchcutting is fiction, the need to hypothesize multiple machines by 1885 disappears.

Taking these things into account, a summary of Benton's initial pantograph development would run like this:

Benton created a vertical pantographic punch and patrix engraving machine for which he filed a patent in February 1884. He made at least one machine in a form visually resembling the patent drawings ("Type 1a" in the terminology of the Benton *Census*).[47] He then changed the general frame of the machine from the single-standard version shown in the patents to a two-standard, floor-standing version as shown in the 1891/1893 photograph ("Type 1b" in the

[46] In section 11.1.2, "Benton Biographical Article (1922)," on page 166.

[47] Whether he might have made a second in this style depends on whether you think that the caption in Bullen's 1924 photograph which reads "the second machine built by Benton" means machine serial number 2 or a machine of Type 2. See §7.4.2, Benton Serial No. 2 on page 143.

terminology of the Benton *Census*). Machine serial number 3, which must have been in this style[48] was leased to the Mergenthaler Printing Company in 1889. In terms of mechanism and operation, both styles of these machines are the same. By his 1884 patent and through the period up to his next vertical pantograph patent filed in 1899, Benton had created *one* machine,[49] made in two visually distinct but functionally identical styles. He built at least one (maybe two) in the first (Type 1a) style and all the rest in the second (Type 1b) style.

Returning for a moment to this passage in Bullen's 1922 account, there is one possible way to interpret it which can fit these facts.[50] Repeating it again here, Bullen wrote:

> In 1884 Mr. Benton had his first punch-cutting machine in use. It worked perfectly, showing that the principle was correct. The second machine did no better work but was easier to manipulate. His third machine is the machine as now sold. In 1885 he was granted a patent. ({Bullen 1922 LBB}: p. 61, second column, near the bottom)

The natural or obvious interpretation of this is the one presented in the anonymous 1932 obituary in *The Inland Printer*: 1884 punchcutting machine, then a second but easier machine, then a third machine in 1885:

> So in 1884 he put his first punch-cutting machine into successful operation. His second machine was easier to manipulate, and his third machine, patented in 1885, was the model which revolutionized the typefounding business ({[Benton 1932]}: 54).

But look at Bullen's 1922 sequence again:

He says first tht "In 1884 Mr. Benton had his first punch-cutting machine in use." This is true. This would have been a Type 1a machine. He says then that "The second machine did no better work but was easier to manipulate." This could be a reference to the Type 1b machines. A Type 1b machine certainly looks very different from a Type 1a; the subtle fact that their mechanism was identical could easily have escaped Bullen's attention. He was a printer, not a patent attorney.

Then Bullen says "His third machine is the machine as now sold." While he was an independent type founder, Benton leased his machines, but once he joined ATF at its inception they were not generally offered for sale. However, four were sold to Japan.[51] Bullen's 1922 article

[48]Because all subsequent copies of Benton Type 1 punchcutting machines look more or less like it, not like the patent drawings.

[49]If you went back in time and built a Type 1b machine to compete with Benton, it would have infringed on his 1884 patent. That is, I believe, an adequate definition of the two machines as "the same."

[50]This interpretation applies only to the brief passage as quoted here. Other aspects of Bullen's 1922 article, including his story about Dodge's $50 offer to Benton, are simply false.

[51]One, possibly machine No. 59, was sold to the National Printing Bureau in 1912. One (possibly machine No. 61) was sold in 1921 to the Tokyo Tsukiji Letterpress Factory Co., Ltd. Another (known to be machine No. 49) was sold to Tsukiji in 1922. The fourth machine (possibly machine No. 62) was sold to the Sanseido publishing firm (ordered

shows one of these.[52] In this context, it is not unreasonable for Bullen to have written about the Benton "as now sold." But this was a Type 2 machine (based on his 1899/1906 patent), not a Type 1.

What confuses things further is that Bullen then writes: "In 1885 he was granted a patent." This is true. If, however, Bullen's sentences are read as a chronological narrative (as the 1932 writer of the obituary did) then this implies that the "third machine as now sold" existed by 1885. This makes no sense.

If instead you read the sentence about the patent in 1885 as a random fact inserted at the wrong time and, instead, move it two sentence earlier in Bullen's narrative, things might make sense:

- (Type 1a) punch-cutting machine in 1884; works.
- Patent in 1885, covering all Type 1 machines.
- (Type 1b) "second machine"; easier to use.
- (Type 2) machine "as now sold" in 1922.

But it is no surprise that the anonymous obituary writer in 1932 did not reconstruct this order of events. The more natural, but incorrect, version of the 1932 obituary has misled writers on Benton ever since.

11.5.4• Benton's Second Machine

Cost says little about Benton's second distinct vertical pantograph (the one described in patent filed in 1899). She identifies it primarily as an improved version of his earlier machines.[53]

She does present a very important piece of evidence, citing an article by Stevens L. Watts from *Printing* in 1957 that Cheltenham was the first face that Benton engraved directly as matrices — in March 1899.[54]

This is important because it gives us some indication of the date at which Benton began direct matrix engraving. (The patent filing date gives us a terminus ante quem, but doesn't tell

in 1921 but not put into service until 1925). See *A Census of Benton and Related Pantographic Engraving Machines*, {MacMillan 2023}, for more details.

[52]He says that it was for "the Imperial Printing House of Japan," but this is probably an error. That machine had been sold a decade earlier. The machine Bullen illustrates in 1922 is probably one of the three sold either to Tsukiji or Sanseido.

[53]Whether or not it is "improved" is a matter of opinion. ATF appears to have thought so, because they retired all Type 1 machines. But this may simply reflect their move to direct matrix engraving over the course of the 20th century. The physical layout of the Type 2 makes holding a matrix blank easier. Pantographs derived from Benton's Type 1b, however, remained in service in Europe at Monotype and elsewhere.

[54]Cost cites Stevens L. Watts, "Chelt' Really Got Around," (*Printing*. Vol. 81, No. 5 (May 1957): 78. I have not yet seen this source.

us when he actually started.)

11.5.5• Other Remarks

Cost also says that Benton had received an offer from MacKellar, Smiths, and Jordan to purchase his patents (p. 70). This is of course possible. They had been working with pantographs since at least 1872 and had Charles H. Beeler, Jr. in their employ. The only source for this claim, though, appears to be a December, 1924 article in *The Inland Printer* by Bullen. {Bullen 1924 Era}, p. 764. Until this is confirmed by a source independent of Bullen, it cannot be accepted.

Cost cites an anonymous article about the Bentons in *The Inland Printer* in 1925 which claims “All the matrices used in composing machines throughout the world are made by machines and appliances invented by Linn Boyd Benton” (pp. 70–71, citing {*Inland Printer* 1925}: 453). She quite correctly notes that this is not true because the Ludlow Typograph Company used Wiebking machines. (She says only that “Robert Wiebking once sold the Ludlow Company one of his engraving machines.” In fact, Wiebking manufactured several machines for Ludlow and set up their engraving department.) She wonders if this article is by Bullen, and indeed its tone suggests that it might be. However, the fact that it says that “Mr. Benton did not have composing machines in mind when he invented his punch-engraving machine,” which contradicts Bullen’s insistent claim that Benton began by working on a typesetting machine, suggests that it is by someone else.

11.6• Reviewing the Known and the Unknown

In any area where a significant quantity of misinformation or disinformation[55] has been injected, such as Bullen's stories in the Benton narrative, it becomes difficult to distinguish fact from fiction. So much time is spent debunking the fiction that through the pure quantity of discussion it can remain a part of the story that it should be removed from. This is a basic technique of political and business propaganda.

It may be useful, therefore, to review what we know, what we can infer, what we do not know, and what we should not infer about Benton's pantographs.

11.6.1• Prototypes?

We know nothing.

Benton was surely working on a pantograph in 1883 (a February 29, 1884 patent filing date is too early in the year to suggest that he only started after January 1 of 1884) and possibly in 1882 (see §7.2.1). It is entirely likely that he constructed prototype machines or mechanisms which differed from those shown in his 1884 patent. On the other hand, it is equally possible that he conceived of the rather brilliant mechanism of the Type 1a pantograph all at once. We simply have no information about any of this.

It should be noted that patents may change between their filing and their issuance. It is not impossible that Benton made alterations to the patent before it was issued in December of 1885. If he did so, we have no knowledge of it. It is unlikely, as well, that a patent examiner would have allowed truly substantive changes.

11.6.2• Concerning Benton Serial No. 1

What We Know with Certainty

1. On Feburary 29, 1884, Linn Boyd Benton filed a US patent application for a vertical pantograph engraving machine with the stated purpose of punchcutting. (See §7.2.3.)
2. That this patent was issued in December 22, 1885, after clerical delays. Its description, claims, and drawings are known as of this date. (US 332,990. See §7.2.3.)
3. That at least one machine visually resembling the patent drawings was made. We know this because such a machine was photograhed in a glass case in the ATF Typographic Library and Museum in 1929. (See §7.3)
4. That in July of 1884 the *Inland Printer* published a trade notice from Benton, Waldo & Co. which claimed their ability to cut punches in steel by machine. (See §7.2.4)

[55]There are harsher terms for this in plain language.

Anything beyond these four facts involves some degree of assumption or inference.

Other Actual Evidence Without Certainty

There is one piece of physical evidence which does or did exist (and which is in this simple sense real) which nevertheless cannot be taken as certain. The metal pattern in the possession of the Benton family which has been annotated with a date of "about 1882", which we know through a photograph, suggests a belief within the Benton family that he was at work on a pantograph at that time. As this is a later annotation by an as yet unknown hand, however, this date cannot be taken as certain. (See §7.2.1.)

What We Can Assume from Engineering and Metalworking

The following points would, I believe, be held to be true by any reasonably informed engineer or experienced typemaker.

1. There is no essential difference between a rotary cutter engraving machine capable of cutting punches in steel and one cutting patrices in typemetal. The operator might change the cutter geometry in each case, alter the spindle speed, and change the way in which the tracer was manipulated. None of these things require any change to the engraving machine itself.
2. Machines of the style shown in the 1884 patent drawings (Type 1a machines, in Benton Census terminology) and machines of the style shown in the circa-1891 (reprinted 1893) photograph (Type 1b machines) differ in visual form but are, from a kinematic point of view, the same. If you could time-travel back to the end of 1885 and construct a Type 1b machine, it would infringe upon Benton's patent.

What We Can Assume from the History of Typemaking

It is reasonable to assume that Benton's first pantograph(s), which we know to have been used for cutting punches in steel (see above), were also used for cutting patrices in soft metal. We can assume this primarily because Patrix cutting by hand, known since the 1840s, was very common at the time (see §2.1.) To this we can add Benton's own skill as an electrotyper. For evidence of this skill we need look no further than his second patent, filed in 1875, in which he applies the electrotyping technology to a nontypographical invention (see Appendix F.2.) This assumption is also backed up by the research and deductions of the ATF engraver William Charles Gregan, as recorded by Theo Rehak and presented by Patricia Cost (see {Cost 2011}: pp. 60 & 73 and also §11.5.2 and §7.1.)

What We Can Reasonably Infer

It seems clear that Benton was working entirely independently, without knowledge of other successful pantographic typemaking. He would have framed his 1884 patent differently if he had such knowledge. (See §7.2.3.)

11.6.3• Concerning Benton Serial No. 3

(Yes, this is out of sequence. But there are facts and inferences concerning this machine which illuminate machine serial no. 2.)

What We Know

We know with certainty that on February 3, 1889, Benton Punch-Cutting Machine No. 3 was either leased (most likely) or sold (less likely) to the Mergenthaler Printing Company (the corporate predecessor of the Mergenthaler Linotype Company). Based on the other machines noted in the page from the Benton, Waldo "Day Book" from which this information comes, this number (3) is clearly a serial number (see {Rehak 1993}: 109 and §7.2.8).

What We Can Infer

We can reasonably infer that machine No. 3 was a double-standard floor-standing machine similar to the one shown in the 1891/1893 photograph. We do not know this with absolute certainty, as we have no direct information about it other than its serial number, its lease date, its name, and the lease customer. It is reasonable to make this inference, though, because:

- This is the style of machine that Benton, Waldo & Co. were promoting a very short while later in their 1891 pamphlet.
- Except for a single photograph of a Type 1a machine in the ATF Library, every known photograph or drawing of a Benton punch-cutting / Type 1 machine or of a copy of it is of Type 1b.

What We Do Not Know

We do not know when this machine was built. For more on potential early dates for Type 1b machines, see section 7.4.2, Benton Serial No. 2.

11.6.4• Concerning Benton Serial No. 2

What We Know With Certainty

It must have been made after serial No. 1, and that in turn was almost certainly made before (or contemporary with) the filing of Benton's patent for it in February 1884. It must have been made before serial No. 3, which was leased to the Mergenthaler Printing Company in February 1889.

Other than that, we know nothing with certainty.

What We Might Infer

It is possible that this machine was made by 1887 and that it is the Type 1b machine illustrated by Bullen in 1924. See section 7.4.2, Benton Serial No. 2.

11.6.5• Some Remaining Type 1 Unknowns

Since what we don't know so greatly outweighs what we do, it is no surprise that there are a number of outstanding questions.

- What happened to the Type 1a Benton (probably serial No. 1), which is last attested in a 1929 photograph of the ATF Typographic Library and Museum?
- What happened to the Type 1b Benton (possibly serial No. 2), which is last clearly attested in a 1924 photograph in *The Inland Printer* and which may or may not be visible in a 1929 photograph of the ATF Typographic Library and Museum?
- What was the total production of Type 1 machines by Benton, Waldo and ATF (excluding copies and derivative machines by others)?
- When was the last Type 1 machine built?
- When were particular Type 1 machines scrapped?
- What is the more complete leasing history of Type 1 machines?
- In various photographs of European type foundries, which (if any) Type 1b style machines were of genuine Benton, Waldo / ATF construction and which were copies or derivatives?
- When did the last Type 1b machine go out of service at ATF?

See *A Census of Benton and Related Pantographic Engraving Machines* {MacMillan 2023} for more on some of these questions.

11.6.6• Concerning Type 2 Benton Pantographs

What We Know

We have considerable evidence concerning the physical arrangements of Type 2 Benton pantographs, because eight survive. Also, the Tsugami machines are exact copies. Several of these survive.

What We Do Not Know

Almost all information about how these machines were used at ATF, from a typemaker's / operator's point of view, has been lost. The methods in use today are those developed by Ed Rayher (Swamp Press). Jurie Florijn is also contributing new ideas to this process. These methods are effective, but they are new methods, not ATF's.

We know a few things about general procedures (for example, that originally they used zinc patterns and later electroformed patterns) but the details about how to go from a typographical idea to a drawing to a pattern to matrices/patrices/punches *across entire series and families of type* have been lost. Reconstructing these as best as can be done from the fragmentary evidence remaining will be an important research project.

About the history of the introduction of these machines and their manufacture, we know nothing. We do not know the date of manufacture of the first one, the last one, or any particular machine (surviving or not). We do not know how their "machine numbers" were assigned or if they have some significance (they are not manufacturing serial numbers). We do not know the dates at which ATF scrapped particular machines. We do not know if any were sold by ATF beyond the four sold to Japan.

See *A Census of Benton and Related Pantographic Engraving Machines* {MacMillan 2023} for more on some of these questions.

My own Benton, Machine No. 53, has a unique set of unknowns associated with it. Theo Rehak told me that it was the subject of an attempt to mechanize the production of matrices for curved-face zinc type used for wire marking. These were cut by hand at ATF and this type was an important source of revenue.[56] ATF, quite reasonably, feared the loss of this revenue when their last punch/patrix cutter retired. However, this attempt to use No. 53 for this purpose failed and most of the experimental equipment was removed. What remains is a machine with an unusual pattern table and many inexplicable tapped holes.[57]

[56] One of the Barth typecasting machines now with the Printing Stewards was set up to cast such type.

[57] It sometimes feels like all of them are tapped to needlessly unusual threads, just because they could.

12• Other Typographical Pantographs of the 1890s

12.1• Ballou for BB&S (1895)

In 1895, Barnhart Brothers & Spindler in Chicago purchased a matrix engraving machine designed by George F. Ballou. I have not been able to discover a patent for it. Based on his other patents, however, it would seem that Ballou was involved with the typewriter manufacturing industry. His pantograph for BB&S was well-known enough to be pictured in {Legros & Grant 1916}, pl. 12 / Fig. 211, but there is no evidence as to the extent of its use.[2]

This is a single-arm vertical format pantograph arranged so that the cutting spindle is out-of-line with the pantograph arm and is actuated by sliders.

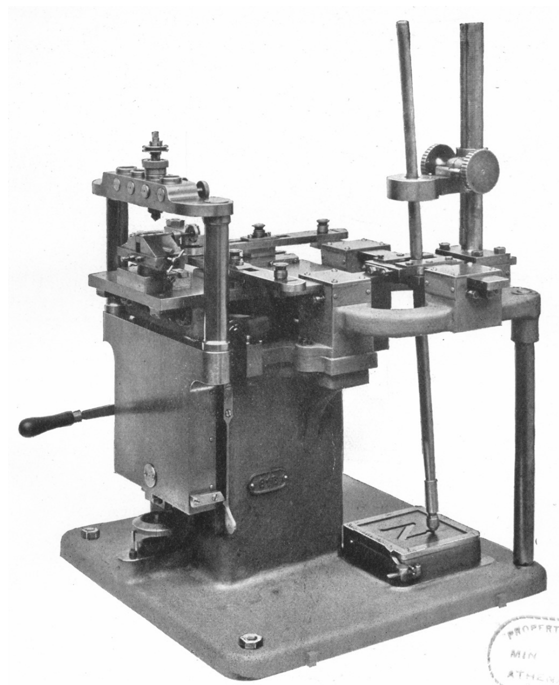


Fig. 12.1: Ballou for BB&S in 1895[1]

12.2• Dedrick for BB&S (1897)

Nicholas Dedrick (of Manitowoc, Wisconsin) filed a patent on April 16, 1897 for a punch or matrix engraving pantograph (US patent 614,845, issued November 29, 1898). It was a horizontal format machine with a spindle support not unlike the "storchschnabel" (crane's bill) arrangement of many German pantographs. The remainder of its mechanism, however, is of almost overwhelming complexity. He also patented a four-position rotating pattern and workpiece holding arrangement for it (US patent 645,164).[4] In addition, he patented a cutter grinder for the machine (US patent 645,165).

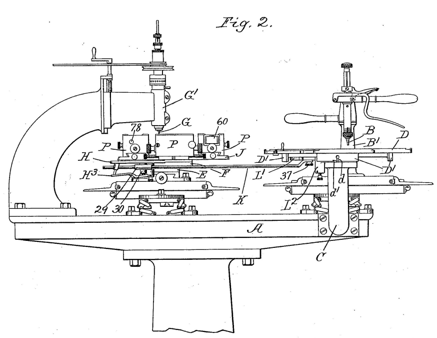


Fig. 12.2: Dedrick for BB&S in 1897[3]

[1]From {Legros & Grant 1916}, pl. 12 / Fig. 211. Scan by DMM. Public domain.

[2]Ballou's full name and the date of the machine are from an unpublished letter by Charles R. Murray to Henry Lewis Bullen in 1931 which is cited in James Eckman's article on the history of BB&S {Eckman 1961}, p. 16.

[3]From {US 645,164 Dedrick 1900}, Drawing 2, Fig 2. This shows the machine more clearly than its first patent.

[4]Legros and Grant refer to this capability in their one-sentence note on Dedrick's machine (p. 236).

James Eckman, in his article on the history of BB&S, says that it was used in that foundry in "1896 or 1897" and that one was sold to the Peignot foundry in France in 1901. {Eckman 1961}, p. 16.

12.3• Benton's 1899 "Delineating Machine"

TO DO: Also, decide if this should stay here or if there should be a new, separate chapter on "The Process" - patterns (zinc and wax plate, with ref to 20th c. engraved methods), correcting and generating design (hand, optical, role of delineating machine), cutter grinding, matrix fitting machines, etc. The problem is that all of this is important and it was always done, but most of our information is 20th c. (but the arbitrary cutoff date here is 1900).

TO DO: Review this. Right now it's basically what I wrote in 2019. Add/Include uses cited in Kaup (1909) and Benton (1906) as a proofing pantograph; even Bullen (1922) gets this right. (Should I note that both Monotype UK and Mergenthaler used optical projection for this? – that's getting very 20th century) Note that they *all* ignore its use for copying existing types. Only Benton really mentions its capabilities for generating altered drawings by tilting the tracing plane.

Overview

Benton built several pantographs other than his two vertical designs. Of these, perhaps the most ingenious is the one described in his US patent 790,172 (filed July 21, 1899 and issued May 16, 1905 {US 790,172 Benton 1899}). This machine does not survive.[5] It was described in two sources which may be considered primary (its patent and a 1906 book chapter by Benton himself {Benton 1906}) and one nearly so (a 1909 article by W. J. Kaup in *American Machinist* {Kaup 1909}). Other sources are less certain and sometimes introduce errors.

[5]The late Theo Rehak once told me that while working at ATF he used to eat his lunch using as a table a heavy metal plate which, he discovered later, had been the base of the machine.

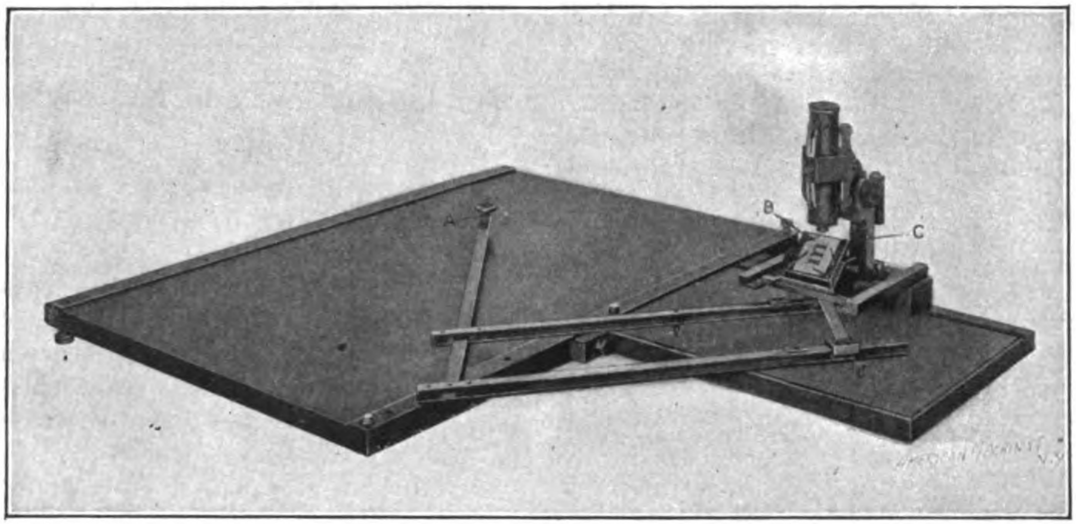


FIG. I. DELINEATING THE CHARACTERS
A, tracing point; *B*, fingers for clamping character; *C*, bed plate showing angle possibilities.

Fig. 12.3: *American Machinist* (1909)[6]

This machine's pantographic mechanism is a conventional four-bar pantograph arranged for enlarging. In the most common industrial pantographs the operator guides a tracer around an intaglio or relief pattern (holding the tracer in physical contact with the pattern) and the machine reproduces the pattern in reduced scale on the workpiece. Here, this arrangement is reversed. In this machine the pattern is the smaller item. The operator observes it through a microscope equipped with cross-hairs (without ever touching it) and manipulates a pencil or other tracing instrument[7] at the larger end so as to draw an enlarged copy of the smaller original. Legros and Grant say that it "is stated to have a range of production from 0-point to 96-point." {Legros & Grant 1916}, p. 210. Unfortunately, every example of the 0-point type was soon lost.

Both Types and Drawings as Patterns

The patent envisions two kinds of patterns to be placed at the small end of this pantograph: actual printing types or drawings.[8] The use of existing types as patterns is interesting. It also provides a rationale for the use of a purely optical method of following the pattern. While magnification would certainly be useful in all cases, a drawing may be followed using a physical stylus. This is not possible when using an existing type. No operator has a steady enough hand to guide a stylus over the exact edge of the face of a type. Following this edge optically in the cross-hairs of a microscope would be entirely possible.

[6]From {Kaup 1909}, p. 1042.

[7]The patent says "the reproducing tool or follower is formed by a pencil or other tool."

[8]In his 1906 chapter, Benton does not mention the use of actual types as patterns. But his chapter is a brief account of the generation of new types from original designs, not a comprehensive account of all methods.

Non-Proportional Ortholinear Reproduction and Microscope Focus

The second truly ingenious feature of this device has to do with its abilities to produce what it calls "non-proportional ortholinear reproduction" {US 790,172 Benton 1899}, p. 5 line 77. That is, the type design may be expanded or condensed both horizontally and vertically. This is done by tilting the pattern (whether an existing type or a drawing). If a type in ordinary orientation is tilted parallel to its horizontal axis, the operator viewing it through the microscope will see (and follow and trace) a vertically foreshortened view. This condenses or (depending on the original rotation) expands the type vertically while retaining the same horizontal size. If variation in the other axis is required, the type or pattern is rotated by 90 degrees.

However, there is a problem with this arrangement as described so far. If the pattern is horizontal, the microscope can of course easily be focussed on it. But if the pattern is tilted, then the microscope will be out of focus for all but one line across the pattern. Benton compensates for this most ingenously. He provides a mechanism whereby the vertical height of the microscope relative to the machine as a whole is varied automatically during tracing so that the microscope remains a constant distance from the tilted pattern surface (and thus remains always in focus). See {US 790,172 Benton 1899}, pp. 5–6 and Fig. 17.

Variations in Weight and Slope

Variations in weight are accomplished by providing tracers of both circular and oblong styles in various sizes. But where these in another pantograph would be implemented using disks, in this pantograph they are implemented using reticles for the microscope. {US 790,172 Benton 1899}, pp. 6–8 and Figs. 13–16.

Forward and back-sloping variants[9] from an upright pattern are accomplished by rotating the pattern. {US 790,172 Benton 1899}, pp. 8–9 and Figs. 5 and 5a.

In Context of the Process

In his 1906 chapter, Benton describes the use of this pantograph. He first says that in new designs "capital letters [are] drawn about an inch high.[10]

> After the design has been drawn, it is placed in a "delineating machine," where an enlarged outline pencil copy, or tracing, is made, so large that all errors are easily seen and corrected. New designs may, however, be drawn in outline by hand on the enlarged scale, thus rendering unnecessary both the pen-and-ink drawing and the tracing.
>
> With the aid of the delineating machine, the operator, besides being able to produce an accurately enlarged outline pencil tracing of a design, is also enabled, by various adjustments, to change the form of the pencil tracing in such a manner that it

[9]The patent refers to these forward-sloping variants as italics, but they are not true italics.

[10]The size of original type design drawings has varied substantially.

> becomes proportionately more condensed or extended, and even italicized or back-sloped. That is, from a single design, say Gothic, pencil tracings can be made condensed, italicized, and back-sloped, as well as an enlarged facsimile. {Benton 1906}, pp. 32–33.

The product of this pantograph was a drawing, at enlarged size, of the type. Once corrected by hand (if necessary), this drawing then became the input to the next stage: making a working pattern in metal. By 1906, ATF had developed a "wax plate" method of work,[11] {Monotype 1956}.

Here is Benton's 1906 description of the process:

> The next operation consists in placing the enlarged outline pencil drawing in a machine [the ATF "wax plate" pantograph] which enables the operator to reproduce the outline drawing, reduced in size, on a metal plate, evenly covered with wax, with the line traced entirely through the wax. The plate is then covered with a thin layer of copper, electrically deposited, and is "backed up" with metal, and trimmed and finished, …A copper faced metal plate is thus produced, on which are the raised outlines of a letter. This is called the "pattern." From this pattern all regular type sizes may be cut. It determines the shape of the letter, but the size and variations from the pattern are determined later by the adjustments of the engraving machine in which it is used. {Benton 1906}, p. 33.

(It is interesting to note that Benton is in the somewhat awkward position of having developed two pantographs to be used successively in the process, each of which is capable of producing variations in the letter.)

Additional Use: Proofing at Size?

Two sources mention an additional use of this pantograph. One of these, Bullen's highly problematic 1922 article on Benton, might by itself be discounted {Bullen 1922 LBB}, p. 63. The other, however, is Kaup's 1909 article in *American Machinist*. He writes:

> When the original design submitted is large, the machine reproduction is backward, and reproduces it in small form by removing the microscope attachment and in its place attaching a small pencil arm which traces the outline of the letter by moving the long arm pencil over the large outline. This small letter is then filled in solid, that is, leaded, and carefully inspected. This solid letter lends itself more readily to criticism. {Kaup 1909}, p. 1043.

There is of course nothing unreasonable about this. Viewing a type design at the actual type size is useful, and it wouldn't be difficult to modify the machine to run "backwards" as described.

[11]Earlier methods at ATF are not yet fully understood (at least by me). The wax plate method in general is best documented in the 1956 English Monotype film *'Making Sure' At the Monotype Works: Type Faces In the Making*

The only problems are (1) there is no mention of this style of use anywhere in the patent, and (2) in this use the machine is functioning as an ordinary drafting pantograph. A machine suitable for this purpose could have been purchased from any drafting material supply house.

Not a Gimballed Machine

One error has crept into the discussion of this machine in the literature. In a message by Rehak to Cost, quoted in her book, Rehak says that the "delineator was actually the working gimbel [sic] mechanism of the Benton engraver" {Cost 2011}, p. 9. This is not the case. An inspection of both the patent and the surviving published photograph of the machine reveals a conventional four-bar pantograph without gimbals of any kind.

Rehak's comment remains interesting and useful, however, because it accurately reports the oral history of this machine at ATF at the time at which he apprenticed at ATF.

Complexities of Name

Modestly, Benton only referred to this as a "delineating machine." It was not named in Kaup's 1909 article, but, confusingly, the word "delineating" was used in two separate photographs for two separate pantographs (this one, shown "Delineating the Characters" in Kaup's Fig. 1, and the ATF Wax Plate pantograph shown "Delineating on Wax Plate" in Fig. 2). Bullen called it "The Benton Delineator" and "Benton's Delineating Apparatus" in {Bullen 1922 LBB}, pp. 63, 64. Rehak refers to the "Benton Delineator." {Rehak 1993}, p. 108.

So long as it is understood that the wax plate pantograph is not being referred to, and that this machine had nothing in common with the punch/patrix/matrix engraving machines, any name with "delineate" in it would seem to be adequate.

12.4• Beeler in 1899

In 1899, Charles H. Beeler (who had earlier constructed a pantograph for MSJ) was "about completing a machine for engraving type which will not only alter the proportions of letters from the one fixed templet, but will also cut a back-slope or italic from the same template."[12] The claim for this machine appears in Loy's biographical sketch of Beeler, for which he appears to have interviewed Beeler. What makes this especially interesting is that in 1899 Beeler was in the employ of ATF. If true, this would indicate that ATF did not employ Benton's machines as exclusively as has always been thought.

Potential avenue of research: In the view of the Matrix Engraving Room in the circa 1912 *Photographic Views of Central Plant* there is a machine at the far left which is not belt-driven like the two potential Type 1b machines next to it. It appears to have no power at all, and appears to be taller than even the Type 2b machines.

[12] See {Loy 1899-12 No. 23}

12.5• Unidentified Pantographs

12.5.1• The ATF Ad-Cut and Related Machines

TO DO: Add what we know from Rehak. Define as commercial horizontal machines adapted to take Type 2 BEM quills.

date unknown; may not be before 1900. Manufacturer undetermined.

12.5.2• Wax-Plate Drag-Engraving Machines

TO DO

origins of the later two-step processes are not well documented

we know that ATF used wax plates from at least 1893.

can illustrate best from Kaup 1909

can illustrate also with examples from ATF 1912 specimen book and from Monotype UK (but the latter not reprintable here)

there must have been other machines more or less conventionally used for making working patterns, but we have no information about them

this topic/section may not be important, as these appear to have been conventional drafting machines (for the ATF and Monotype wax plate methods, at least)

TO DO: Leave this as a note here, but don't make it a separate section; this is 20th c.:

Engraved patterns, as later used, required cutting pantographs. ATF used a cut-down Gorton. Goudy used a Deckel (until his studio burned, then he used an EPM vertical machine as a stopgap — but this was recorded in the literature and distorts our view of his work). Rimmer used a Taylor-Hobson.

12.6• Incorrect Identifications

Newton (1850)

Wilkes, in *Das Schriftgießen*, calls a kind of a double-4-bar pantograph patented by Alfred Vincent Newton in 1850 in Great Britain a "matrizenbohrmaschine." It is not. It is a 3-dimensional pantograph for wood and "slab" engraving. It does, however, have the same general mechanical layout as the 4-bar matrix-engraving pantographs later used extensively in Germany. {Wilkes 1990}: 58.

TO DO: Find copyright-clean illustration.

13• Summary and Conclusion

TO DO: Evaluate whether or not I need this here. It might have been covered up front in the TL;DR section.

The state of our knowledge is always changing, as new evidence emerges (or is rediscovered) and as old arguments are reevaluated. At the present point in time, the following things may be said about the introduction in the 19th century of machine methods in making the matrices used in casting metal printing type.

patrix/electro

regularization

Ludwig/Hofer

Schraubstadter

Benton

Appendices

A• Sources for Early Typographical Electroforming

The literature of early electrotyping and electroforming is scattered in many publications which tend to be obscure either because of their age or their technical nature (or both). It is much easier now to access these documents than it was when Rollo Silver studied the matter in the 1970s (though it would be a mistake to think that everything has been digitized). But while accessible, the sources remain scattered.

This is an imcomplete compendium of some of these sources. When possible, there are links to extracts presented locally (that is, at the canonical distribution location for this book). The bibliographic citations link, when possible, to the complete documents. (So for example there will be a local PDF of an article of interest while the bibliographic citation, when followed, will have the location online of the complete issue of the journal in which it appeared.)

TO DO: All of this.

General Studies

Silver 1974. In copyright; cannot be reprinted. Identify locations of references to matrix electroforming in Silver's article: p. 90. pp. 100–103

Heinrich 1938

TO DO: Locate a copy of Stock, John S. and Mary Virginia Orna, eds. *Electrochemistry, Past and Present.* ACS 1989 (ACS Symposium Series 390). SBN-10 0841215723. ISBN-13 978-0841215726.

TO DO: Locate Vol. 1 of: Ostwald, Wilhelm. *Electrochemistry: History and Theory.* [Trans. by N. P. Date of *Elektrochemie: Ihre Geschichte und Lehre,* 1895] New Delhi, India: Amerind Publishing Co., Pvt., Ltd. [for the Smithsonian Institution and the National Science Foundation, Washington, D. C.], 1980. (vol. 2 is at The Internet Archive: `https://archive.org/details/bwb_W7-CSH-714_2/`)

Histories of Electrotyping/Electroforming

Reprint the sections from: McMillan 1890. Langbein. 1891

Origins of Electrodeposition

Faraday

Daniell (see Heinrich 1938)

Early Sources for Electrotyping

The presentation here is chronological.

de la Rue. On Voltaic Energy &c. 1836. See Savage, Dictionary of the Art of Printing, 1841

Jacobi's letters ca. 1838 (to Fuss, Bequerel. see Heinrich 1938)

Jacobi. London & Edinburgh Philosophical Magazine and Journal of Science 1839.

Jacobi. reports in France and England (1839). See Heinrich 1939

Jacobi. Die Galvanoplastik. 1840.

Jordan. 1839

Boettger. 1840. relief plates. See Wahl 1883 p. 20.

Spencer

Dircks (is 1863, but concerns the events of the Jacobi/Spencer/Jordan controversy)

Rollo Silver's table I of American reprints of British papers, January to September 1840

American Repertory of Arts, Sciences and Manufactures. 1840, 1841 electrotype articles

Stauffer on Saxton, 1907 (see Silver pp. 88–89)

Solly 1840. See Silver, pp. 89n See American Repertory, June 1840, p. 351: London and Edinburgh Philosophical Magazine (April 1840)

Smee 1840 (see Silver pp. 90n)

Since the focus of the present book is on matrix making rather than electrotyping *per se,* I'll stop here. Silver's article takes this history considerably further. Electrotyping of plates was about to become a major component of the printing industry.

It would be good to try to locate Fillmer's 1858 article(s) under the title "Electro-Metallurgy" in *The Printer,* Vol. 1, No. ? (1858-1859). Volume 1 of *The Printer* has not been digitized.

Early Sources for Matrix Electroforming

American Repertory v1 n6 1840–07 435–436 already reprinted, above.

"James Conner" in *The Printer,* Vol. 2 (1859–1860) I have never seen the original of this. Volume 2 of *The Printer* has not been digitized.

Reprint of Ringwalt's reprint in the-typographic-v01-n05-1871-12

Thomas F. Adams. Typographia. Second edition. Philadelphia, 1844. See Silver p. 101.

Starr patent. US 4,130 1845-08-04. Possibly just refer back to presentation in chapter 2?

Later Sources

Point here to the CircuitousRoot Notebook on these.

B• Later Patrix Cutting References

TO DO: Probably move some of the intro material here to Section 2.1 on Patrix Cutting

TO DO: Note that: The point of reviewing 20th century references here is to confirm the continuing importance of patrix cutting in the 20th century when, at the same time in the United States, all knowledge of it had disappeared from the awareness of historians of type.

Since the very existence of patrix cutting by hand and of matrix electroforming for reasons other than piracy had been forgotten by late 20th century Anglophone typographers and type historians, it is useful to review contemporary instances in the literature where it is mentioned.

Much of this has been online since the mid-2010s in the CircuitousRoot Notebook "The Issue of Patrix Cutting in Soft Metal: A Survey of the Data".[1] See also the CircuitousRoot Notebooks "The Issue of Patrix Cutting in Soft Metal: A Survey of the Errors"[2] and "Patrix Cutting in Soft Metal by Hand: A Survey of the Technical Literature."[3] Note, however, that those Notebooks have not been updated properly since the research of the late Stephen O. Saxe involving the development of matrix electroforming, completed by 2013, was published in {Saxe 2016} and {Nelson et al. 2020}.

Patrix Cutting TL;DR

Writing in 1930,[4] the English typographical historian and typefounder Harry Carter wrote:

> Since the application of electrolysis to matrix-making, by Starr of Philadelphia in 1845, large letters and ornaments are always cast from deposited matrices 'grown' upon originals cut in typemetal or brass. The present practice is to cut letters larger than 14-point in soft metal, with a certain loss of artistic effect.

Q.E.D. If it was good enough for Harry Carter, it's good enough for me.

Terminological Notes

In the 19th century sources cited here, "metal" means "typemetal." When writers such as Schraubstadter or Loy mean steel, they say "steel."

I will attempt consistently to adopt the term "patrix," even though there was never any consistency in this regard in the literature (and even though many of the writers cited here would

[1] https://circuitousroot.com/artifice/letters/press/typemaking/the-issue-of-patrix-cutting-in-soft-metal/survey-of-data/index.html

[2] https://circuitousroot.com/artifice/letters/press/typemaking/the-issue-of-patrix-cutting-in-soft-metal/survey-of-errors/index.html

[3] https://circuitousroot.com/artifice/letters/press/typemaking/literature/patrix-cutting/index.html

[4] In his translation of Fournier's *Manuel Typographique* {Fournier 1764 Carter 1930}: 40n1.

never even have heard the word). Sometimes the term "pattern type" is used in the literature instead. I'm using "patrix" because that's the term Jim Rimmer used.

Origin Dates for Matrix Electroforming

The late Stephen O. Saxe, citing primarily the work of Theodore Low DeVinne and Rollo Silver[5]

Werner (1927)

Werner (1927): 765, col. 1.

Werner on Wiebing (1932)

Werner on Wiebking (1932): 71, col. 3.

[5]See DeVinne's *The Practice of Typography: [Volume 1] Plain Printing Types* {DeVinne 1900} and Silver's "Trans-Atlantic Crossing: The Beginning of Electrotyping in America" {Silver 1974}.

C• Early Pantographs Using Unrelated Mechanisms

TO DO. But not a complete survey - just a taste of the variety of “pantographs” which were neither four-bar nor single-arm.

Nartov

D• Chrétien, Saint-Mémin, and Hawkins

As noted earlier within section 2.4, Pantographs for Silhouettes, the Chrétien's "physionotrace" (and Saint-Mémin's "phisiognotrace") and Hawkins' "physiognotrace" have a place in the history of silhouette machines and thus a place in the background story of the present narrative. However, there have been so many errors in published accounts of them that understanding them from a mechanical point of view has been made confusing. Disentangling these misunderstandings requires a detailed look at them and is, really, outside of the scope of this study of typograhical pantographs. It should be published separately, but for the moment it is here.

TO DO: This Appendix is incomplete. I now have most of the sources required, but need to sort them out.

D.1• Chrétien's Physionotrace

The most successful device of the late 18th century which began to mechanize the process of portraiture itself seems to have been the "physionotrace" introduced by the musician Gilles-Louis Chrétien in 1786. It was not a pantograph (though it has frequently, mistakenly, been called one) and in itself it is not a part of the direct lineage of typographical engraving. But it was an important part of the development of mechanized portraiture (which in turn led to the first use of a machine in typemaking). Its is also often described inaccurately and conflated with the entirely different "physiognotrace" of Hawkins.[1] It may be useful to digress for a moment to clarify this situation.

In order to have a more accurate visual frame of reference while doing this, it may be useful to observe that the portraits created using Chrétien's Physionotrace were not silhouettes. They were complete drawings (usually then cut as engravings and printed — sometimes with color added). The portrait of Chrétien himself shown in Figure D.1, done with the physionotrace, can serve as a good example of this. In Henry Vivarez' 1906 article (from which this image is taken) it bears the caption (from 1906): "G. L. CHRÉTIEN / Musicien du Roi / Inventeur du physionotrace / (Gravé par lui-même en 1792 [engraved by himself in 1792])"

Fig. D.1: Gilles-Louis Chrétien (1792)[2]

[1]This has been done by even the best academic authorities. See, for example, {Miles 1994}: 43.

[2]From {Vivarez 1906}: [plate of three portraits following page 186]. From the Google digitization of the New York Public Library copy. Public domain.

D.1.1• Physionotrace Sources & History

While the physionotrace was popular around the turn of the 18th century, and while portaits made by it continued to be known to collectors and historians, it became obsolete immediately upon the development of photography. No machine survives, and until the early 20th century no drawing or significant technical information about it was known to have survived.

There are a very few surviving primary sources which contain any important technical or historical details of the machine itself. TO DO: Quenedey. G. Chrétien's reply to Q name: physionotrace; his claim of invention.

The best secondary sources come from the early 20th century, when interest in the physionotrace increased as a part of the study of the history of photography. Paul Fromageot presented a brief biography in "Notice sur Gilles-Louis Chrétien, Inventeur du Physionotrace" {Fromageot 1908}.[3] Two years earlier, and before the discovery of the only surviving drawing of the machine, Henry Vivarez published a four-part article on the physionotrace and Chrétien, "Un précurseur de la photographie dans l'art du portrait à bon marché", in the journal *Le Vieux Papier* {Vivarez 1906}.

The exact date of Chrétien's invention of the Physionotrace, if in fact it can be reduced to a single point in time, is not entirely certain. The most commonly cited date is 1786. That is the one suggested by Vivarez in 1906.[4] However, in 1925 at a dinner of the Société «Le Vieux Papier», Gabriel Cromer (who had then recently reconstructed the mechanical operation of Chrétien's Physionotrace) suggested a date of 1783 and explicitly rejects 1786 {Cromer 1926}: 481. He did not really give evidence for this. In 1928, though, he followed this up with an announcement of the discovery of a Physionotrace portrait dated 1784.

> Peu après la parution de cet article [his 1925 article deciphering the mechanism of the device] au cours d'un examen de la collection de portraits au *physionotrace* conservée à la Bibliothèque d Art et d'Histoire de l Université de Paris (fondation Doucet), nous y rencontrâmes un exemplaire portant, gravée, cette inscription: *Fecit Chrétien 1784 Melle Quêtier*. {Cromer 1928}: 295–296.
>
> Google renders this: Shortly after the publication of this article, during an examination of the collection of physionotrace portraits held at the Art and History Library of the University of Paris (Doucet Foundation) [I believe this is now the La Bibliothèque d'art et d'archéologie de Jacques Doucet], we found there a copy bearing

[3] This accompanied Courboin's initial publication of the only known drawing of the physionotrace.

[4] "Chrétien était donc graveur en même temps que musicien et, en 1786, il combina un appareil méchanique qui, en quelque minutes, permettait de reproduire fidèlement ele profil d'une personne." {Vivarez 1906}: 185. Google renders this: "Chrétien was therefore an engraver as well as a musician and, in 1786, he combined a mechanical device which, in a few minutes, made it possible to faithfully reproduce the profile of a person."

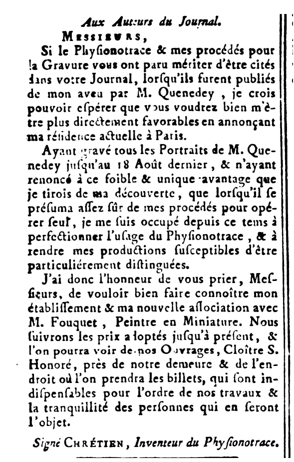
the engraved inscription: Fecit Chrétien 1784 Melle Quêtier.

Cromer continues:

> … Chrétien né en 1754 avait alors vingt neuf ans.
>
> Ce portrait exécuté à l'eau-forte pure, semble-t-il, par Chrétien en 1784, était accompagné de quelques autres, tous différents, non signés, dépourvus d'inscription, mais présentant exactement les mêmes caractères, donc provenant du même auteur, simple trait, dessin assez peu assuré, planche ronde, papier blanc, vergé et un peu épais; seule l'intensité de l'encrage était irrégulière dans ces rarissimes incunables du *physionotrace*, dans ces précieux premiers essais de Chrétien. (p. 296)
>
> Google Translation: Chrétien, born in 1754, was then twenty-nine years old. This portrait, executed in pure etching, it seems, by Chrétien in 1784, was accompanied by several others, all different, unsigned, without inscription, but presenting exactly the same characteristics, therefore coming from the same author, simple line, rather tentative drawing, round plate, laid white paper, somewhat thick; only the intensity of the inking was irregular in these extremely rare incunabula of the physionotrace, in these precious early attempts by Chrétien.

Whether or not we accept Cromer's date of 1783 for these apparently early pieces, we can at very least accept 1784 as a terminus ante quem for Chrétien's Physionotrace.

Around 1788, Chrétien entered into an association with Edme Quenedey des Riceys,[6] but they soon parted company. Both continued to produce work using physionotrace machines (they would not have been difficult to construct). Chrétien, at least, was not pleased with the turn of affairs. He published an open letter in the *Journal de Paris* on 1789-12-24 promoting his own establishment over Quenedey's work.[7] It is worth reproducing Chrétien's letter in facsimile here for two reasons. First, it confirms the spelling of "Physionotrace" that he used himself (this term will become problematic later). Second, it establishes firmly his assertion that he was in fact the inventor of the Physionotrace.



Aux Auteurs du Journal.

MESSIEURS,

Si le Phyſionotrace & mes procédés pour la Gravure vous ont paru mériter d'être cités dans votre Journal, lorſqu'ils furent publiés de mon aveu par M. Quenedey, je crois pouvoir eſpérer que vous voudrez bien m'être plus directement favorables en annonçant ma réſidence actuelle à Paris.

Ayant gravé tous les Portraits de M. Quenedey juſqu'au 18 Août dernier, & n'ayant renoncé à ce foible & unique avantage que je tirois de ma découverte, que lorſqu'il ſe préſuma aſſez ſûr de mes procédés pour opérer ſeul, je me ſuis occupé depuis ce tems à perfectionner l'uſage du Phyſionotrace, & à rendre mes productions ſuſceptibles d'être particuliérement diſtinguées.

J'ai donc l'honneur de vous prier, Meſſieurs, de vouloir bien faire connoître mon établiſſement & ma nouvelle aſſociation avec M. Fouquet, Peintre en Miniature. Nous ſuivrons les prix adoptés juſqu'à préſent, & l'on pourra voir de nos Ouvrages, Cloître S. Honoré, près de notre demeure & de l'endroit où l'on prendra les billets, qui ſont indiſpenſables pour l'ordre de nos travaux & la tranquillité des perſonnes qui en ſeront l'objet.

Signé CHRÉTIEN, *Inventeur du Phyſionotrace.*

Fig. D.2: Chrétien on Quenedey (1789)[5]

[5]From {Chrétien 1789}. This brief extract is in the public domain in the United States under the doctrine of Fair Use. It is also in the public domain in the United States under the decision of Bridgeman Art Library v. Corel Corp., 36 F. Supp. 2d 191 (S.D.N.Y. 1999). However, it is from a 1968 reprint edition owned by the Univerisity of Michigan, digitized by Google, and presented via The Hathi Trust; it may or may not be in the public domain in your jurisdiction until 2044, fully 255 years after its publication.

[6]For a detailed study of Quenedey, see René Hennequin's *Edme Quenedey des Riceys: Portraitiste au Physionotrace.* {Hennequin 1926–1927}.

[7]See Figure D.2. This is also quoted in full, but not presented in facsimile, in {Hennequin 1926–1927}: 22.

Drawing discovered.

First published by Courboin 1908.

note that I cannot find the article by Courboin in Archives d'l'art français (1907) mentioned in Vivarez 1910

availability of the drawing: BNF - cite; for sale only. Link URL.

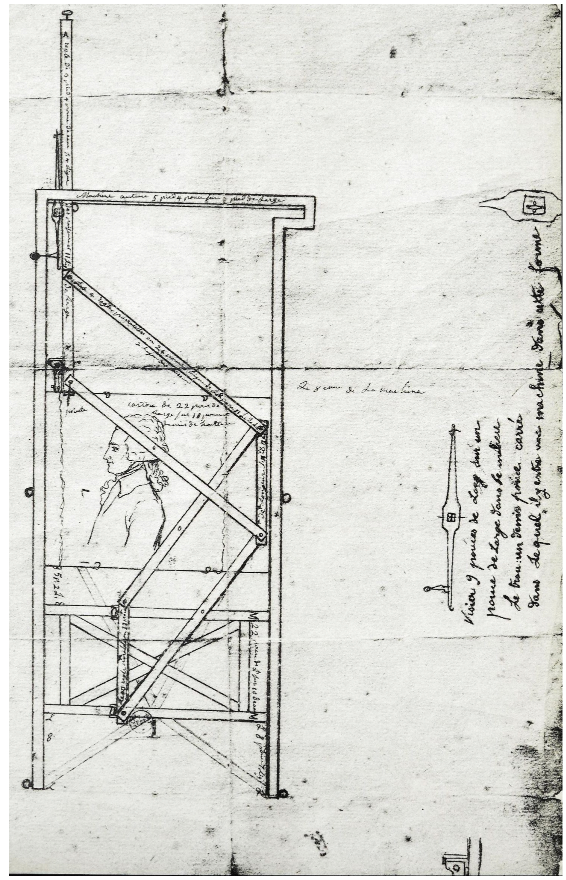


Fig. D.3: Quenedey's Drawing[8]

[8]From {Courboin 1908}: [Plate following p. 40, cropped slightly. From the University of Heidelberg Library's digitization. Public domain.

D.1.2• The Mechanism of Chrétien's Physionotrace

TO DO

D.1.3• Saint-Mémin's Phisiognotrace

TO DO

D.2• Hawkins' 4-Bar Physiognotrace

With Hawkins' "physiognotrace," we leave the world of Chrétien's fully engraved portraits and return to silhouettes. These had for some time been produced by direct shadow projection at full size and then reduced to more portable sizes by the use of a conventional drawing pantograph.

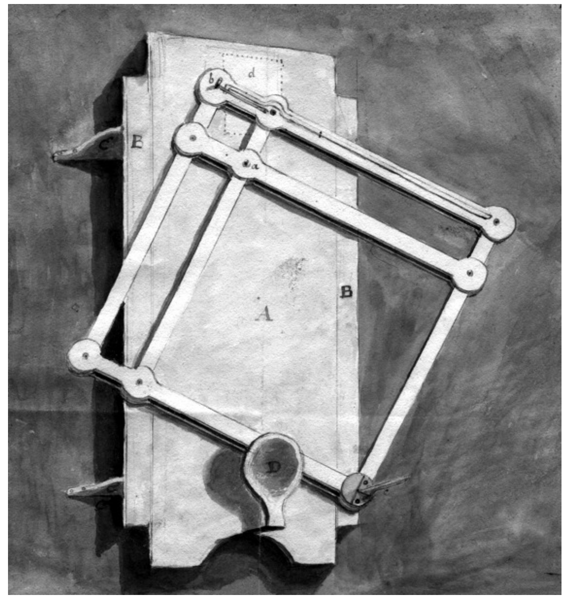


Fig. D.4: Hawkins' (1803)[9]

Using a pantograph directly to trace silhouettes at the desired final size was perhaps no great leap of the imagination. Of the several four-bar pantographs devised to do this, that invented by John Isaac Hawkins, an American living at the time in England, and patented by him in England on September 24, 1803,[10] is relatively well-known through its association with US president Thomas Jefferson. See for example Silvio Bedini's *Thomas Jefferson and His Copying Machines* {Bedini 1984}: 40–52.

However, a thorough technical analsyis of Hawkins' device(s) has never been done. The image in figure D.4 is a drawing by the American artist, naturalist, and private museum operator Charles Willson Peale in a letter to Jefferson describing this instrument. It is dated 1803-01-28, but it differs considerably from all of the versions shown in Hawkins' 1804 English patent. That patent, in turn, describes not a single machine but rather a whole collection of related drawing instruments.

Beyond Jeffersonian hagiography, Hawkins' "physiognotrace" (as it became known) has a small but significant place in American history because for many years it was operated in Peale's Museum by Moses Williams, a manumitted black slave formerly owned by Peale. Williams' skill with this machine was such that Peale freed him a year earlier than Pennsylvania law then required.[11] The Physiognotrace, operated by Williams, was immensely popular. Peale said that 8,800 silhouettes were cut in 1803 alone (its first full year of operation) and it remained in

[9]From {Peale 1803}. Public domain.

[10]See {Hawkins 1803 (1804)} for his English patent. His US patent of 1803-05-17 for a "Pentegraph and parallel ruler" was lost in the 1836 US Patent Office fire. It has been assigned the "X-patent" number: 453X. See the Directory of American Tool and Machinery Patents: `https://datamp.org/patents/advance.php?pn=453X`

[11]This was recorded by Peale's son, Rembrandt Peale {Peale 1857}: 308, though for more on the law and Peale's role in it see {Shaw 2005}: 25.

operation for some decades.[12]

Hawkins' pantograph at Peale's museum was by no means the only silhouette-making pantograph then in use, either to Hawkins' design or by others. Rembrandt Peale wrote of them that "the Physiognotrace, thus made popular at the Museum, was purchased by many an itinerant but humble *artist,* who travelled over all the States, making a good living, and some indeed a small fortune" {Peale 1857}: 308. This popularity indicates the degree to which the pantograph had become an accepted analog information processing machine even at this early date. Everything being done with it would be done today by a computer and image processing software. This general adoption of the pantograph as an information processing machine only increased during the rest of the 19th century and found a natural expression in the four-bar matrix engraving pantograph of Hofer and Ludwig in the 1870s.

[12] See {Brigham 1995}: 68–82 and {Shaw 2005}.

E• Hofer Data Points

```
ADD THIS TO FIRST CITATION:
Hofer's advertisements appear frequently in the
\textit{Illustrirte Zeitung}\footnote{This is the
Leipzig \textit{Illustrirte Zeitung} (literally, ``Illustrated Newspaper'')
published from 1843 to 1944.
It is unrelated to the perhaps better-known
\textit{Berliner Illustrirte Zeitung.}}
during this period.
```

The purpose of this Appendix is to gather references to the machine and instrument maker ("mechanikus und optikus") Herrmann Hofer. Most of these references are unimportant in isolation, but taken as a whole they may begin to sketch a picture of him and of his activities. The arrangement here is chronological.

1844. G. Hofer, Widow

TO DO: FINISH.

G. Hofer, Wittwe, Kamm-Fabr. Niederwallstr. 35

G. Hofer, Widow, Comb-maker. Niederwallstr[aße]. 35.

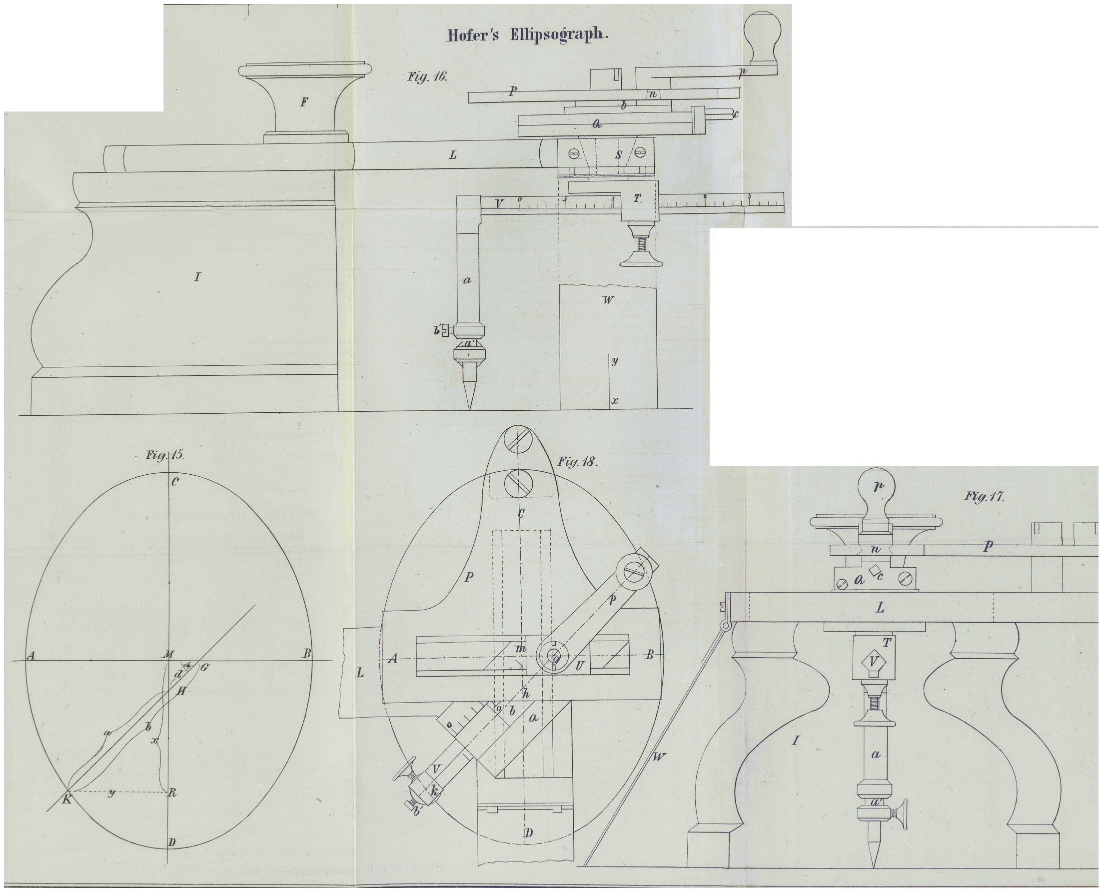
Ein Sortiment berschied. horn-waaren u.

[a different assortment ?]. horn ware

1863. Ellipsograph

From *Dingler's Polytechnisches Journal.* {Dingler 1863}. An account of an ellipsograph constructed by "Mechaniker H. Hofer" and offered for sale (by the writer of the article, I think) at between 15 and 20 Thaler.[1] This is a somewhat elaborate version of the well-known "elliptical trammel" used in drafting.

[1] A quick search online suggests that this would have been a relatively expensive machine at the time.



1865. Name given as Herrmann Hofer

From *Amts-Blat der Königlichen Regierung zu Potsdam under der Stadt Berlin.* {Hofer 1865 ARP}. This is from PDF page images 174 and 176 of the digitization, which are pp. 74–75. of Stück 7, 17 Februar 1865. See p. 75, line 4.

Nachweisung
der im Monat Januar 1865 mit Bestallung versehenen Schiedsmanns-Beamten
im Departement des Kammergerichts.

Stadt Berlin. 1) Der Tapezierer Carl August Sesselberg, Mauerstraße Nr. 62, als 2ter Stellvertreter für den Dreifaltigkeits-Bezirk Nr. 53, 2) der Kaufmann Franz Koch, Oranienstraße Nr. 126, als 1ster Stellvertreter für den 1sten Jacobi-Kirchhof-Bezirk Nr. 66a, 3) der Rentier Robert Seibert, Weberstraße Nr. 26, als 1ster Stellvertreter für den Marcus-Kirch-Bezirk Nr. 96, 4) der Kaufmann Maximilian Rudolph Felix Appelius, Schiffbauerdamm Nr. 33, als Schiedsmann für den Unterbaum-Bezirk Nr. 74B, 5) der Kaufmann Franz Alexander Friedrich Wilhelm

75

Kahn, Roßstraße Nr. 11, als Schiedsmann für den Roßstraßen-Bezirk Nr. 12, 6) der Korbwaaren-Fabrikant Albert Koeppner, Roßstraße Nr. 9, als 2ter Stellvertreter für denselben Bezirk, 7) der Kaufmann Wilhelm Mertens, Hausvoigteiplatz Nr. 5, als Schiedsmann für den Hausvoigteiplatz-Bezirk Nr. 27, 8) der Mechanikus Herrmann Hofer, Niederwallstraße Nr. 35, als 2ter Stellvertreter für denselben Bezirk, 9) der Kaufmann Johann Friedrich Bornadel, Waßmannsstraße Nr. 15, als Schiedsmann für den Waßmannsstraßen-Bezirk Nr. 94, 10) der Weinhändler Johann Friedrich Otto Immich, Königsstraße Nr. 40, als 2ter Stellvertreter für den Hohen Steinweg-Bezirk Nr. 14, 11) der Stadtverordnete Dr. Franz Eberhard Marggraff, Sophienstraße Nr. 12, als Schiedsmann für den Sophien-Kirch-Bezirk Nr. 78, 12) der Schulvorsteher Georg Ernst Heinrich Roth, Bell-Alliancestraße Nr. 46, als 2ter Stellvertreter für den Pionierstraßen-Bezirk Nr. 103, alle zwölf verpflichtet am 4. Januar 1865.

1877: Bohrmaschinen für Schriftgießerei

In the 1877 edition of the *Berliner Adreßbuch,* Hofer (of Niederwallstr[aße] 35) is listed as follows. Note that this list includes “Matrizen” and “Bohrmaschinen für Schriftgießerei” {[Hofer 1877 AB}.

Hofer, Moritz, Kfm., Neue Königstr. 42. I. f. Dennhardt u. Schultze.
— C., Maler, Müllerstr. 163. I.
— Herm., Mechaniker für Instrumente und Maschinen, Matritzen, Bohrmaschinen für Schriftgießerei und Inhaber e. Fabrik für engl. gebohrte Petschafte, Bezirksvorst. d 15. Stadtbezirks, Niederwallstr. 35. I.; in Bezirkssachen - 10.

—, Herm., Mechaniker für Instrumente und
Maschinen, Matrizen, Bohrmaschinen für
Schriftgießerei und Inhaber e. Fabrit für
engl. gebohrte Petschafte, [? Desirksvorst. d
15. Stadtbezirts, ?] Niederwallstr. 35. I.; in
[Bezirksfachen ?] 10

— [Hofer], Herm., Maker of instruments and
machines, matrices, pantographs for
typefoundries and owner and maker for
English engraved seals, …
… Niederwallstr[aße] 35. …

F• Benton's First Two Patents

In her biography of the Bentons, Cost notes that Benton said that in 1875 and 1876 he had received patents not related to "the art of type." These would have been Benton's first patents, but they have remained unidentified. Cost does provide one very useful lead: a transcription of a letter to Benton, Gove & Co in 1877 thanking them for "Benton's Patent Float" as used in their Steam Boiler Feed Regulator {Cost 2011}, 93–94.[1]

With the advent of mass digitization it is now much easier to discover old patents than it was in 1984 when Cost found this letter.

Benton's first patent was US patent No. 162,521, "Price-Tag Needle," filed on January 18, 1875 and issued on April 27, 1875 to Linn Boyd Benton, of Milwaukee, Wisconsin. Not assigned. It is clearly unrelated to the "art of type": it is an easily threaded needle for affixing price tags. Because of the fame of its inventor and its previous obscurity, I have reproduced it on the following pages.

Benton's second patent was US patent No. 172,956, "Improvement in the Manufacture of Floats," filed November 27, 1875 and issued February 1, 1876 to Linn B. Benton, of Milwaukee, Wisconsin. Not assigned.

This patent is much more interesting. The object itself is not type or printing related: it is a hollow floating copper ball. A *Scientific American* article about the "Patent Copper Ball" confirms that it was intended for use in steam boilers. (Benton's patent does not mention a specific application, but does indicate that the float must be "capable of resisting a large pressure without leaking or bursting.") But the patent is not really for the ball itself. It is for the method of making the ball.

Benton starts with two hollow copper hemispheres and joins them into a ball around a central ring. The problem the patent addresses is how to seal the joints. Benton does this by hanging the float "in a galvanic copper solution, and a perfect joint [is] made by the filling up with copper of the beveled edges of the hemispheres."

Any 19th century printer or typefounder would see that he is, in contemporary terminology, "electrotyping" the ball. That is, he is doing heavy electroplating on it just as a printer would electrotype a printing form or a typefounder would make an "electro" matrix from an original type (a patrix). So Benton, the typefounder, created a method to use the electrotyping equipment already present in his type foundry in an innovative, non-printing, line of business. There should be little doubt that Benton would have been quite comfortable using his pantograph engraving machine to cut patrices in soft metal for electroforming matrices.

[1]This is a curious document (Cost reproduces a photograph of it). It is addressed *to* Benton, Gove & Co., but it appears *on* the stationery of Benton, Gove & Co.

F.1• Price Tag Needle (1875, Unrelated)

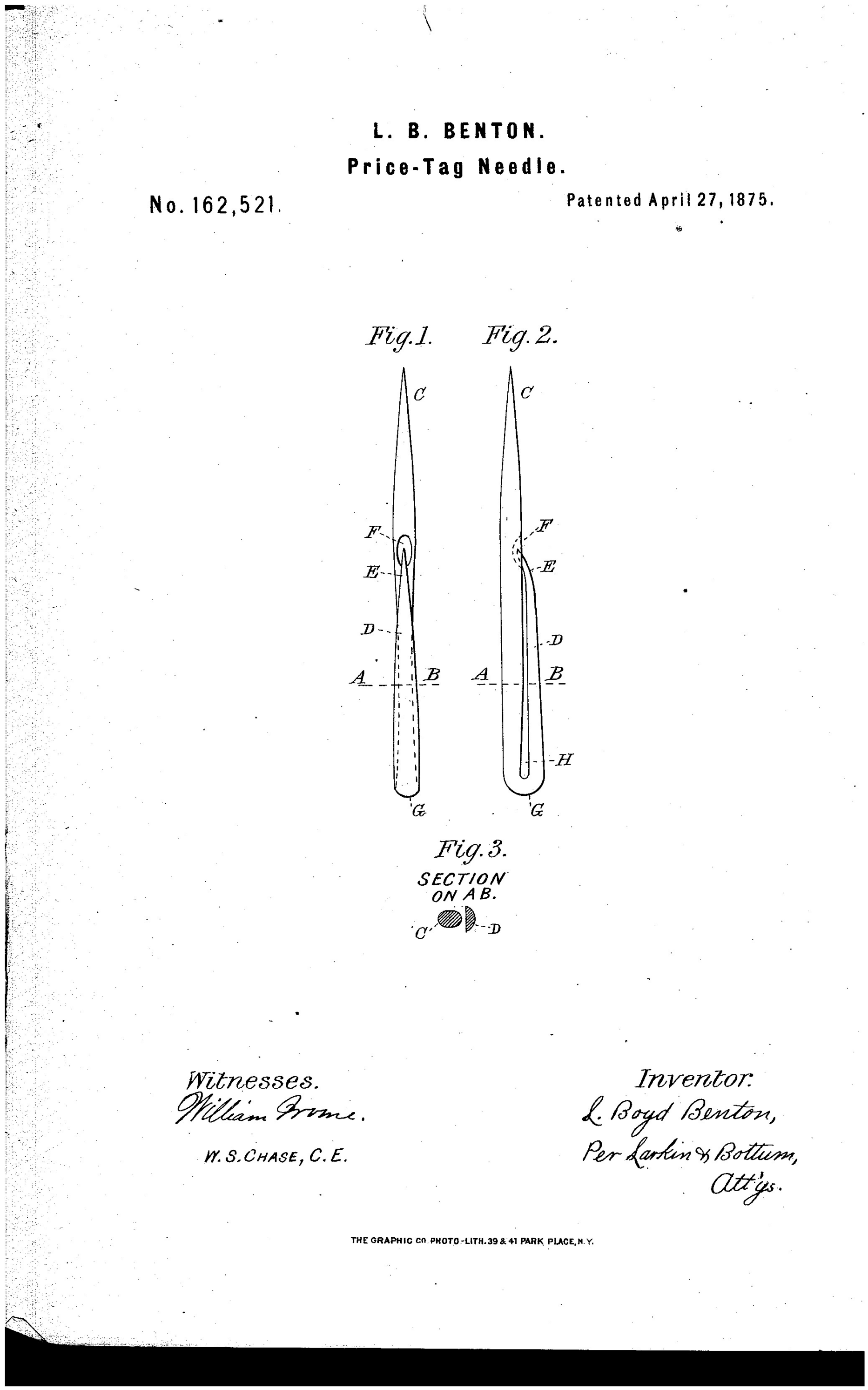


Fig. F.1: Benton Patent 162,521 (1875), Drawings[2]

[2]From {US 162,521 Benton 1875}. USPTO digitization. Public domain.

UNITED STATES PATENT OFFICE.

LINN BOYD BENTON, OF MILWAUKEE, WISCONSIN.

IMPROVEMENT IN PRICE-TAG NEEDLES.

Specification forming part of Letters Patent No. **162,521**, dated April 27, 1875; application filed January 18, 1875.

To all whom it may concern:

Be it known that I, L. BOYD BENTON, of the city of Milwaukee, State of Wisconsin, have invented a Price-Tag Needle, of which the following is a specification:

The object of my invention is a needle suitable for use in attaching price-tags and similar articles to cloths or other soft material. The needle is peculiar in having an "eye" into or out of which a loop of cord can be caught instantly, without drawing through the "eye" the single end of the cord, as in the common operation of threading a needle.

In the accompanying drawing, which forms a part of this specification, Figure 1 is a representation of my improved needle. Fig. 2 is a side view of same, and Fig. 3 is a transverse section on line A B of the same.

Similar letters refer to like parts in all the figures.

The needle consists of a piece of steel wire, or other suitable material, bent double at G, the loop H forming the eye of the needle, as shown in Fig. 2. This loop should be of a size such that the thread will pass freely and loosely in or out of it. One end of the wire thus doubled forms the main part and point of the needle C. The other part D reaches about half-way to the end of C. It is pointed, and the point E, preferably, though not necessarily, slightly curved toward C, fits into the grooved recess F, formed in C. It is not of course necessary that the relative lengths of C and D should be as stated, but it is found most convenient in use. About midway between G and E the parts C and D should be made of a shape shown in Fig. 3—that is, the side of D facing C should be flattened, and the two sides of C, at right angles to the flat side of D, should be filed away, so as to allow the thumb and finger of the hand of the user to catch hold of D readily, and thus slightly separate it from C.

My improved needle operates as follows: The tag of the well-known kind, formed of a disk of card-board, with a short piece of cord, whose extremities are knotted together, passing through it, is held in one hand, and the point of the needle held in the other is caught in a loop of the cord. A very slight pressure upon D at B, accompanied with a slight pulling of the tag, separates D at E from C, and allows the cord to pass into the eye of the needle. D springs back into its former position, and the needle can then be readily passed through the cloth or other material, drawing the cord after it. The point E of D, being depressed below the adjacent surface of C, permits the needle to pass through the material, readily carrying the cord with it. E is held in F by the spring of the needle at G. The end G of the needle holds the loop of the cord open, through which the tag is passed, thus securing it in the usual well-known manner. The needle can then be withdrawn by allowing the cord to slip out between D and C at F. Instead of forming the needle of one continuous piece, it may be formed of two pieces joined at G. It is also useful for other purposes besides that of attaching tags. In many cases it will be found useful to have C formed with a curvature at its point. C may also be made smaller than D, as well as to be filed away at A, as described.

I claim as my invention—

In a needle constructed substantially as described, the recess F for the reception of the point E, and the portion D made wider than the portion C at the line A B, substantially as shown and described, for the purpose set forth.

LINN BOYD BENTON.

In presence of—
W. L. HINSDALE,
FRANK H. WHIPP.

Fig. F.2: Benton Patent 162,521 (1875), Text

F.2• Thinking Like An Electrotyper (1876)

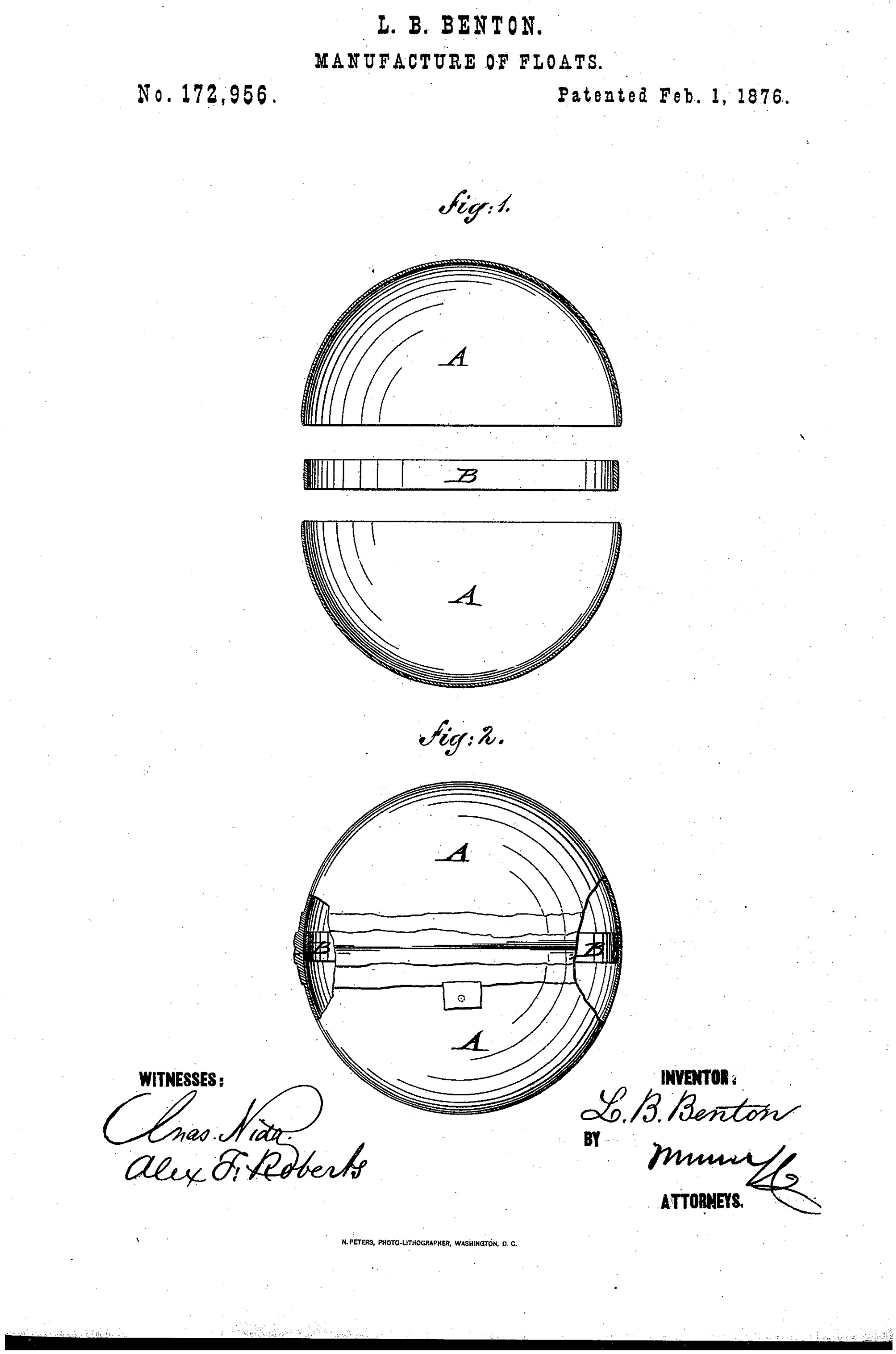


Fig. F.3: Benton Patent 172,956 (1876), Drawings[3]

[3]From {US 172,956 Benton 1876}. USPTO digitization. Public domain.

UNITED STATES PATENT OFFICE.

LINN B. BENTON, OF MILWAUKEE, WISCONSIN.

IMPROVEMENT IN THE MANUFACTURE OF FLOATS.

Specification forming part of Letters Patent No. **172,956**, dated February 1, 1876; application filed November 27, 1875.

To all whom it may concern:

Be it known that I, LINN BOYD BENTON, of Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented a new and Improved Float, of which the following is a specification:

In the accompanying drawing, Figure 1 represents a vertical central section of my improved float, with parts detached to show construction; and Fig. 2 is a side view, with parts broken out to show connection of hemispheres.

Similar letters of reference indicate corresponding parts.

My invention has reference to an improved float that is spun of copper and joined in a perfect manner; and the invention consists of two hollow hemispheres of spun copper, fitted on a circular band, and soldered together in a galvanic solution.

In the drawing, A A are two hollow hemispheres, which are spun up out of copper of suitable thickness, so as to be capable to withstand the pressure to which the float is exposed. The hemispheres A are connected at their circumference by being slipped on a circular band or ring, B, that is slightly turned or beveled toward the edges, to correspond to the curvature of the hemispheres, which are joined at the center line of the band, forming a closely-fitting and neat joint therewith. The edges of the hemispheres are also slightly beveled at the outside, as shown in Fig. 1, to bind intimately on the band B when being driven thereon. The float is then hung in a galvanic copper solution, and a perfect joint made by the filling up with copper of the beveled edges of the hemispheres. The float is then taken out of the solution, and the quantity of solution at the interior removed by boring two small holes into the float and blowing the solution out. The holes are then plugged, and the plug-holes covered with a thin layer of copper by placing the float again in the solution, so as to preclude completely any chance of leakage around the plugs. A second layer may also be deposited over the joint to secure the strong and perfect connection of the parts.

The band serves mainly the purpose of connecting the spun hemispheres, and admit of their being hung in the solution for soldering without taking the temper out of the copper.

A float so made is capable of resisting a large pressure without leaking or bursting, and thus a superior mode of constructing floats for various purposes is formed.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. A float made of spun hemispheres forced on a beveled connecting band or ring, and soldered at the joint, substantially in the manner and for the purpose set forth.

2. The method herein described of connecting the copper spun hemispheres of a float without taking the temper out of the metal, consisting in forcing them on a beveled connecting band or ring, soldering the joint in a galvanic copper solution, and removing the solution from the interior of the float, substantially as specified.

LINN BOYD BENTON.

Witnesses:
F. M. GOVE,
W. HANSEN.

Fig. F.4: Benton Patent 172,956 (1876), Text

THE BENTON PATENT COPPER FLOAT.

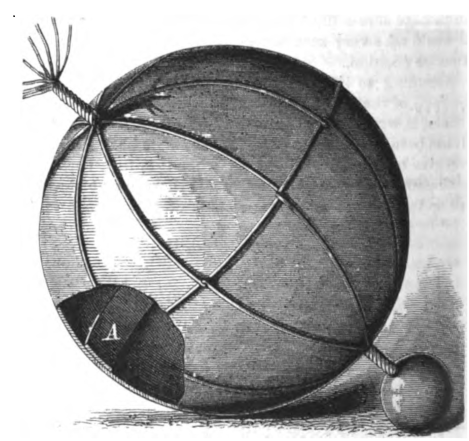
In the annexed engraving is represented a copper float, such as is used in steam boilers, etc., made by a new process. The manufacturers claim that the float is the only one yet invented which will stand the action of steam in a boiler for any length of time, without leaking and becoming filled with water, and consequently useless. The device, it appears from actual test, is extremely strong, and is altogether indifferent to the effects of sudden and wide changes of temperature.

Two hollow hemispheres are spun out of sheet copper of suitable thickness. These are connected at their circumference by being slipped upon a circular ring, A, that is slightly beveled at the edges, to correspond with the curvature of the hemispheres. The latter are also beveled so as to bind intimately on the ring when they are driven thereon.

The float is next suspended in a galvanic copper solution, and a perfect joint is made by the filling up, with copper, of the beveled edges of the hemispheres. The float is then removed, and such of the solution as has entered the interior is blown out through two small holes, bored for the purpose. These holes are then plugged and the plugs, covered with a thin film of copper, by again placing the globe in the solution. A second layer may also be deposited over the joint to secure the strong and perfect connection of the parts.

The test to which these floats are subjected are very severe. They are first placed in a steam-tight tank, into which steam is admitted until they are highly heated, the water of condensation being constantly drawn off. The steam valve is then shut, and cold water is suddenly admitted until the tank is about three fourths filled. The lower half of each float under test is thus suddenly covered, while the upper half remains hot. Under these conditions, we are informed, no sighs of separation at the joint, through contraction or expansion of the metal, appear. The floats are also tested with a cold water pressure of 400 lbs. to the square inch. The manufacturers state that they have experimented with the joint by beating out the copper until it was as thin as tissue paper; and that they will guarantee it to stand until the copper itself is eaten away. Our engraving shows a mode of slinging the float in copper wire, to which a brass is attached to keep the device in proper position.

Patented through the Scientific American Patent Agency, February 1, 1876. For further information address the



manufacturers, Messrs. Benton, Gore & Co., Milwaukee, Wis.

Fig. F.5: *Scientific American.* Vol. 34, No. 20 (1876-05-13): 310[4]

[4]From {[Benton 1876]}. Public domain.

G• What Was Benton's Self-Spacing Type?

Linn Boyd Benton's "self-spacing" type (so called) is likely to cause a certain amount of confusion for a reader who has not set type by hand. Its name, which is just a marketing gimmick, doesn't help at all.

G.1• The Context of Regularization

In pricipio, type was made at whatever body size the typemaker chose and individual types were made with whatever set width seemed right. It cannot be argued that this approach gives the greatest degree of artistic freedom to the designer. All limitations on this limit that freedom (and every time such a limit was imposed, it has been objected to on these grounds).

From an early period, individual foundries standardized their production of type body sizes. These were the old named sizes: pica, great primer, bourgeois, canon, etc. In general terms, these body sizes became common between foundries, but even through the 19th century there was no guarantee that the great primer from one foundry would be the same size as the great primer from another.

The standardization of body sizes to fixed external measures (the pica, subdivided into points) has a long prehistory going back to France. In the Anglophone world, though, it became a reality in 1886. By the early 20th century, all American and English foundries had adopted point-based type body dimensions.[1]

The next item of standardization was lining (the vertical arrangement of the type's printing face on the body). This was simply the idea that (within reason) all of the baselines of a given body size of type would line up with each other.[2] This became a topic of considerable controversy in the late 19th century, with Nicholas Werner and the Inland Type Foundry taking a leading role. Much of the work done by Linn Body Benton and Morris Fuller Benton in the early years of ATF consisted of reworking many of the types ATF had inherited from its various foundries so that they would line together. This culminated in ATF's "American Line" type of their 1906 specimen book.

[1]The definitive history of the standardization of point bodies is Rich Hopkins' *Origin of the American Point System for Printers' Type Measurement* {Hopkins 1976}.

[2]Type lines up on its bodies, not on the baselines of whatever face it happens to have. Lettering lines up by baselines. Nearly all digital "type" is actually digital lettering.

G.2• Unit-Set Type

The next dimension of regularization is the set width of each individual piece of type. If given full artistic freedom, designers will make the set width whatever they feel best fits the design. This makes life difficult for compositors setting type by hand, though, because, in order to justify a line, arbitrary spacing material had to be added. Thin spacing in metal wasn't enough; typesetters were notorious for using scraps of paper just to make it work.

The rational printer might wish that all types had set widths which were simple multiples of some common unit. This would limit the necessary spacing to a few thicknesses and in turn simplify and speed up typesetting. This is "unit-set" type. Benton's "self-spacing" type was simply a form of unit-set type.

Note that he patented this in 1883, three years before the definition of the American Printer's Point. The final evolution of unit-set type might appear be point-set type, where the unit selected was the printer's point. But while it is possible to construct a unit-set system where the units are based on point dimension, it is also possible to construct a point-set system which just uses simple fractions or multiples of points without regard to reducing the different kinds of spacing required in composition.

TO DO: (does the following really help at all?): A mathematician might think of it in this way: In traditional type, set widths are real numbers. In point-set type, set widths all have sizes which are integral points plus simple-denominator fractions of points. In unit-set type, set widths are a limited number of multiples of a single, arbitrary, number. A hypothetical system which was both point-set and unit-set would be the best of both worlds for the compositor and an artistic nightmare for the type designer - like forcing Leonardo to create the Mona Lisa as cross-stitch.

In any event, neither unit-set nor point-set type has never been fully accepted. Even today, types which were once unit-set are now being cast so as to fit as tightly as possible because that is what the contemporary printer's eye demands.[3]

G.3• Benton's Self-Spacing Type

Benton's "self-spacing" type was an interesting variation on unit-set type where, instead of establishing a single unit throughout the system a different unit was selected for each font. These units were all fractions of a pica, as the pica was taken to be the standard unit for line measure.[4]

---

[3]This was the case in the typefoundry where I apprentices. We cast everything as tightly as the beards of the types permitted, disregarding the established set width values.

[4]The pica is the basic unit of the point system; the point is 1/12 pica. In this sense, once Benton's foundry had converted to the point body system, his self-spacing type might be called point-set type. It is unlikely, however, that

A font of metal type is an individual thing at each body size (Nonpareil, Minion, Bourgeois, Pica, etc.) and for each variation in width (condensed, extended, etc.), so each size/expansion combination had its own unit.

Bullen makes the excellent observation that:

> The chief drawback to the general adoption of self-spacing type, outside of newspaper offices, is the differences in widths of the spaces and quads, when two or more series of one size of body-type are used in one plant. In practice it is impossible to keep the spaces separate, and when they are mixed the justifying economies are lost. ({Bullen 1907}, p. 519.)

It may be best to let Benton explain his self-spacing type in his own words. The two pages following are from the Benton, Waldo & Co.[5] 1886 specimen book.

most printers would think of something which had a unit of (for example) 1/7 of a pica (1.714 points) as "point set."

[5] They were not using the name "North-Western Type Foundry."

EXPLANATION

OF THE PRINCIPLE OF

BENTON'S SELF SPACING TYPE.

THE common widths of book pages, miscellaneous jobs and newspaper columns are some number of Pica ems, therefore the Pica em is taken as the basis for Self Spacing type. The thinnest space in all fonts is some exact fraction of a Pica, and this fraction of Pica is called the unit of measure. All characters, spaces and quads in the font are made some exact multiple of this unit in width, so that the sizes of all faces will work perfectly together in the regular labor-saving measures. This unit of measure may be one-sixth, one-seventh, one-eighth, one-ninth, one-tenth, etc. of a Pica em, as may be desired, to produce condensed, medium or extended faces. The following table gives the sizes of bodies, units of measure, and lengths of alphabets. In the first column will be found the various sizes of bodies; in the second, the number of units contained in one em Pica; and in the third the measurements of a lower case alphabet in the ems of each particular body:

Body.	Number Units to Pica em.	Length of Alphabet.
5½ Point (Agate)	13	15⅝
5½ Point (Agate)	12	16⅞
6 Point (Nonpareil)	13	14⅓
6 Point (Nonpareil)	12	15½
6 Point (Nonpareil)	11	16⅞
6 Point (Nonpareil)	10	18⅝
7 Point (Minion)	12	13¼
7 Point (Minion)	11	14½
7 Point (Minion)	10	16
8 Point (Brevier)	10	14
8 Point (Brevier)	9	15½
8 Point (Brevier)	8	17½
9 Point (Bourgeois)	10	12⅜
9 Point (Bourgeois)	9	13¾
9 Point (Bourgeois)	8	15½
10 Point (L'g Primer)	9	12⅜
10 Point (L'g Primer)	8	14
11 Point (Small Pica)	8	12⅔
11 Point (Small Pica)	7	14½
12 Point (Pica)	8	11⅝
12 Point (Pica)	7	13¼
12 Point (Pica)	6	15½

In the foregoing table will be noticed a Nonpareil with one-twelfth of Pica as the unit of measure. This is one sixth of the body of Nonpareil, or the six-to-em-space, which preserves in this particular font the old three-to-em space and the old en and em quads. The same is true of the Brevier on one-ninth of Pica, the Bourgeois on one-eighth of Pica and the Pica on one-sixth of Pica.

The Minion on one-twelfth of Pica will have as its unit a seven-to-em-space, or one-seventh of the Minion body, and will set at right angles or work into squares of the body, as will also the Pica on one-seventh of Pica. The Nonpareil on one-tenth of Pica has the old five-to-em space of Nonpareil as its unit, and will work into squares of Nonpareil or Pica.

In a complete font of the old kind of body type there are about 190 widths of bodies. Appended is a table showing the different widths of bodies of Self Spacing Old Style. It will be readily seen that there are but nine widths of bodies all told, and that the four-unit width predominates largely over any other, there being fifty-nine characters of this width. We omit the Italic characters from the table as they all go on the same widths of bodies, and are interchangeable with the Roman:

1 unit —Space 1
2 units—Space, f i j l , : ; . - ' ! ı ȷ ′ |.. 16
3 units—Quad, c e r s t z ?)] * † ‡ § ‖ ¶ I J s z – ° 22
4 units—Quad, a b d g h k n o p q u v x y ﬁ ﬂ ﬀ $ £ 1 2 3 4 5 6 7 8 9 0 S Z A B C D E F G L N O P Q R T U V X Y & .. – ⎱ ∫ ⌋ { ⌉ | 59
5 units—æ A B C D E F G L N O P Q R T U V Y H K M 21
6 units—Quad, m ct w ﬃ ﬄ œ H K X & w Æ Œ ℔ ℘ @ — ... ¼ ½ ¾ ⅓ ⅔ ⅛ ⅜ ⅝ ⅞ 28
7 units—M W 2
8 units—Æ Œ 2
12 units—Quad, ... —— ☞ ☜ 5
9 sizes. Roman characters. 233
Italic charactters 77
233

In Roman fonts, except Old Style, there are but eight widths of bodies, the eight unit width being omitted.

Any compositor can see that no combination of units can be made that will not come

Fig. G.1: Benton, Waldo Specimen Book (1886), Explanation p. 1[6]

[6] From {Benton 1886}. Scanned by Stephen O. Saxe from his copy. Public domain.

within a certain number of exact units of filling a line. If a line of matter lacks, it must lack one or more exact units.

Self Spacing type sets line for line with the ordinary Roman, where the lengths of the alphabets are the same.

Repeated experiments with the new type have shown that the average compositor gains about twenty-five per cent. in speed, with no trouble in justification whatever. In the matter of the correction of proofs the gain is enormous. Say there is an "a" for an "e"; as "a" is four units wide and "e" three, "e" and a one-unit space justify the line perfectly. Even this measure of trouble is avoided in many instances. As twenty-six of the most common lower case characters are of the same width, they can be substituted for one another without the change of a space.

Another item worthy of consideration is the greater durability of the type. It is always on its feet, and therefore is not worn by "pounding."

In tabular work there is a great gain in speed and neatness. By the addition of a new character, viz: "|", it is easy to set perpendicular lines of any length, line upon line.

Self Spacing type does not require a conscious effort to master its principle—the compositor acquires intuitively and at once all that is necessary for the perfect use of the system. He is relieved of the mental process of spacing and justifying which he now goes through.

This system secures a proper relation between letters, spaces and figures. Under the present lack of system in the old kind of type, the three-em space and the en figure are used, no matter whether the face be expanded or compressed; in Self Spacing type every character and space will be increased or decreased in width relatively with the face of the type.

The italic letters have been made to harmonize with the Roman letters.

It may be repeated that the compositor has nothing to learn in handling the Self Spacing type. There is but a single direction to be given—to set that which looks like the em quad (six-unit quad) with the nick out.

Whoever will study the principle on which the Self Spacing type is based, will readily admit that it is bound to secure easy and perfect justification, greatly increased speed and consequent enormous saving, simplicity and rapidity of proof correction, and increased accuracy and ease in the setting of tables. All these points are beyond question, as certainly as the proposition that two and two make four is not open to argument. No rational person can doubt them.

<table>
<tr><th>No. 1</th><th>No. 2</th><th>No. 3</th><th>No. 4.</th><th>No. 5</th><th>No. 6</th><th>No. 7</th></tr>
<tr><td>i|and</td><td>I|&H</td><td>I|DLE</td><td>s|aturday</td><td>i|&H</td><td>I|and</td><td>'|DLE</td></tr>
<tr><td>s|mit</td><td>I|NK</td><td>S|MW</td><td>is|thmusy</td><td>s|NK</td><td>S|mit</td><td>I|MW</td></tr>
<tr><td>b|rot</td><td>S|LY</td><td>B|AIT</td><td>ne|vermet</td><td>d|LY</td><td>B|rot</td><td>S|AIT</td></tr>
<tr><td>si|tly</td><td>E|LS</td><td>M|OK</td><td>Th|ursd'y</td><td>si|LS</td><td>M|tly</td><td>E|OK</td></tr>
<tr><td>m|an</td><td>H|IE</td><td>W|AD</td><td>line|of the</td><td>m|IE</td><td>W|an</td><td>H|AD</td></tr>
<tr><td>su|it;</td><td>M|W</td><td>SE|ES</td><td>nine|units</td><td>su|M</td><td>SE|at</td><td>SI|LS</td></tr>
<tr><td>wi|st</td><td>Æ|X</td><td>PU|SS</td><td>incre|ased</td><td>mi|X</td><td>PA|st</td><td>BI|ts</td></tr>
<tr><td>tw|it</td><td>SA|T</td><td>HA|M</td><td>comp|ress</td><td>we|T</td><td>HA|D</td><td>SU|it</td></tr>
<tr><td>gla|d</td><td>FO|Z</td><td>FLI|T</td><td>Repea|ted</td><td>gla|S</td><td>FLI|Z</td><td>FO|x</td></tr>
<tr><td>mit|e</td><td>CH|I</td><td>SEA|S</td><td>second|on</td><td>mit|I</td><td>SEA|I</td><td>CH|e</td></tr>
<tr><td>will|i</td><td>$34|!</td><td>NOT|I</td><td>say the|re</td><td>this|!</td><td>NOT|i</td><td>234|i</td></tr>
</table>

To further explain and illustrate the ease with which table work is done with Self Spacing type, we show above an example of miscellaneous justifications, which is absolutely impossible to accomplish with the old kind of type. In column No. 1 the first line begins with the lower case "i", two units wide, which is followed by the upright dash "|", two units, and the characters "a", four units, "n", four units, "d", four units, comprising sixteen units to accurately fill the column. The second line begins with "s", three units wide, which throws the space rule one unit further to the right than in the preceding line. In each succeeding line lower case characters are employed to the total width of sixteen units, and such characters are chosen for the first part thereof as will admit of advancing the space rule to the right exactly one unit in each succeeding line.

In column No. 2 the same plan is followed, the only change being the substitution of capital for lower case letters. No. 3 is also a repetition of the example with small cap characters.

The central column, No. 4, is thirty-one units wide, contains upper and lower case characters, and the space rule is carried to the right two units in each succeeding line.

In columns Nos. 5, 6, and 7, caps, small caps, lower case characters and figures are used promiscuously, all columns coming perfectly justified in lines perpendicularly at a width of sixteen units in each.

This piece of composition was done in a full measure stick, and set line upon line in the ordinary manner of straight reading matter.

Fig. G.2: Benton, Waldo Specimen Book (1886), Explanation p. 2

G.4• Visual Design of Benton's Self-Spacing Types

The final complexity of Benton's "Self-Spacing" type has to do with the regularization of typefaces. It was developed during the period where the idea of a typeface was just emerging. See section 2.2.4 "The Concept of a Typeface," on page 36, for a discussion of this. Benton was forward-looking in technology, but he left forward thinking in type design to his son Morris Fuller Benton.

Benton's "Self-Spacing" types are all basically similar Roman faces. (They don't really have corresponding Italics; instead, they are furnished with a slanting Roman which fits on the same unit bodies as the upright.) They are simply numbered. A few are, additionally, called "Old Style" and differ a bit.[7] They were cut in text sizes only, from agate to pica. The differences between them are subtle.

A copy of the 1886 Benton, Waldo specimen, scanned by the late Stephen O. Saxe from his collection, is online in the CircuitousRoot Notebook on the "North-Western Type Foundry [Benton et. al.]" at `https://www.circuitousroot.com/artifice/letters/press/noncomptype/typography/north-western-benton/index.html`

Benton's self-spacing types are also shown in the 1895/6 ATF "Collective" specimen book (edited by Bullen). This is a rare and expensive book which has not yet been digitized from the original. However, it was reprinted in facsimile in 1981 by Garland Publishing (with a valuable Bibliographical Note by John Bidwell). The facsimile portion of this, which is in the public domain, has been reprinted (poorly) in the CircuitousRoot Notebook "American Type Founders "Collective Specimen Book" (1895/6)" at `https://circuitousroot.com/artifice/letters/press/noncomptype/typography/atf/atf-collective-specimen-garland-badscan/index.html`

G.5• Self-Spacing Type, Prior Art

TO DO: (finish)

Although Benton's "self-spacing" concept was certainly an original, independent, invention, he wasn't in fact the first person to have this idea. At least one British and two American inventors predated him.

TO DO: Wiberg (1854, UK)

TO DO: Thorp (1881)

TO DO: Munson (1882)

TO DO: Julius Herriet, Jr., (1881, Boston); point-set

[7] A "German" (Fraktur) face was also cut in at least four sizes.

TO DO: Bledsoe (Texas) in 1886, claiming "self-spacing" type (by that name) as his own. His announcement: Inland Printer v3 p 473. Benton's rebuttal: Inland Printer v3 pp 716–717, citing Fort Worth Gazette. I have found no patent by Bledsoe.

See the CircuitousRoot Notebook "Unit-Set Type" for more on this.[8]

[8] `https://circuitousroot.com/artifice/letters/press/noncastcomp/unit-set-type/index.html`

H• Do Benton's Vertical Pantographs Distort?

Fig. H.1: Hollerith Card Punch[1]

Fig. H.2: HCP, Detail

Nicholas Werner is in error when he asserts, in his 1931 "Address," that Benton's vertical pantograph necessarily distorts the cutting with respect to the pattern (see section 6.2.3 on page 92, ""An Address" (St. Louis, 1931; 1941)," for his full statement). His mistake is not an unreasonable one, though, because many single-arm pantographs do distort. A single arm from a pivot in two dimensions describes a segment of a circle. In three dimensions it describes a segment of a sphere.

This can be seen in a two-dimensional example above. This is a punched card punching single-arm mechanism developed by Hermann Hollerith for entering census data. The punched card carries information in straight rows and columns. The single arm, pivoted at the back, must describe a circular motion and the pattern of the registration holes for the tracer (held in the operator's hand) must be curved in two dimensions.

In a vertical typographical pantograph, the pattern must be planar[2] and so therefore a fixed working point on the arm must describe a sphere.

The genius of Benton's vertical pantograph design is that not only is the pattern flat but that it constrains the working point to a plane as well.

In both types of Benton pantograph, the pattern is flat and this is accommodated by allowing the arm (called the "wand" in Benton terminology) to lengthen and shorten.

In the "Type 1" machines after his 1884 patent, the workpiece is constrained to move only in a single plane parallel to the pattern.

---

[1]Photograph of a Hollerith punch by the United States Census Bureau. `https://www.census.gov/library/photos/card_punching_1940.html` This is an official work of the federal government of the United States and therefore is in the public domain.

[2]Theoretically, of course, one could make a pattern which is a segment of a sphere. This would not be even remotely practical.

TO DO: Illustrate from the patent drawing.

In the “Type 2” machines after his 1899 patent, the cutting spindle (called the “quill” in Benton terminology) is constrained to move in a single plane parallel to the pattern.

TO DO: Illustrate with photographs from my Benton No. 53.

Given this constraint, it is a matter of constructing similar triangles to prove that the motion of the workpiece over the cutter (Type 1) or the cutter over the workpiece (Type 2) is in the same proportion to the motion of the tip of the wand over the pattern regardless of the location of the wand on the pattern.

Less rigorously, the diagram below shows a single two-dimensional example which illustrates this. Regardless of whether the wand is close-in or further out, a 2 unit motion of the wand produces (in this example) an 0.4 unit motion in the workpiece plane.

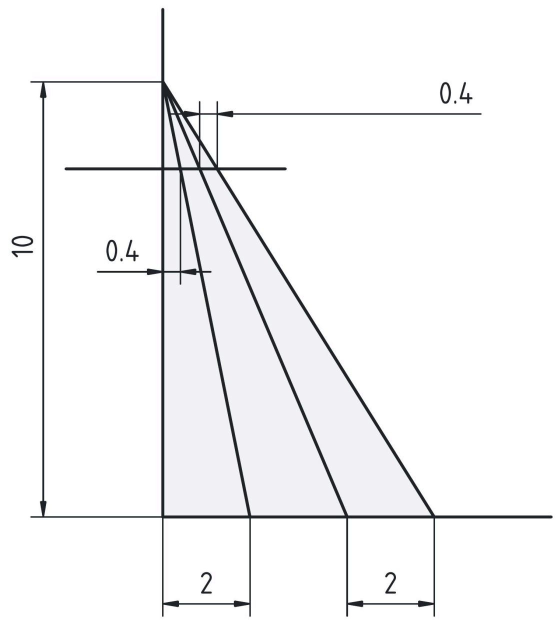


Fig. H.3: Vertical Pantograph Example[3]

[3]Drawing by DMM. Done in FreeCAD (Sketcher workbench). License: CC BY 4.0 International.

I• Other Problems with Bullen as a Source

TO DO

in addition to CITE ABOVE

Bullen cannot be accepted without independent corroboration (which makes him useless as a source)

I.1• The Pivotal Type Caster Discharging Pin

TO DO

I.2• Embezzling and Prison

TO DO

TO DO? Potential repercussions for the National Compositype Company

I.3• Mergenthaler and Character Defamation

TO DO. In particular, aside from noting the ungentlemanly aspect of Bullen's remarks, point out that Ottmar Mergenthaler independently rediscovered binary counting in the distributor mechanism of the Linotype. This was something which kept the Linotype competitive in the era of the Teletypesetter. By way of contrast, the lack of this insight into coding hampered the Monotype and contributed to their inability to adapt in the second half of the 20th century. I am by no means the highest authority, but speaking as a trained computer programmer, the plain truth is that Ottmar Mergenthaler's inventions were innovative and brilliant.

In 1922

> Mergenthaler had little originality — he was persistent in developing other men's ideas, but never satisfactorily, and was by no means a brilliant mechanic. When he severed his connection with those who had poured out nearly two million dollars in experiment, the linotype machine was a failure. It was made marketable by Philip T. Dodge, who utilized the inventions of Benton and Schuckers and Rogers to make it the huge success it ultimately became. This we declare on the highest authorities. It is the plain truth. ({Bullen 1922 LBB}, p. 60.)

I.4• Gally's 1872 Patents and the the Linotype

In installment VII of his "Discursions of a Retired Printer," Bullen attempts to cast doubt upon Mergenthaler's originality by saying:

> Quite independently of Mergenthaler, and before him, Merritt Gally, better known as the inventor of the Universal printing-press, invented a machine for assembling matrices and automatically spacing them by wedges, and casting lines from the matrices. His patents for this invention are dated July 16 and 23, 1872, and were sold to the parties interested in the Linotype in 1884. {Bullen 1907}: p. 517,

I have no information on the sale of Gally's patents to "the parties interested in the Linotype." If the rest of Bullen's statement were true, though, it would have been blocking prior art for the basic Linotype patent on slugcasting and potentially on the Schuckers spaceband. It is, however, false.

Merritt Gally did receive patents on the dates cited: Nos. 129,331 and 129,725, both entitled "Improvement in Combined Stereotyping and Telegraphing Machines." However, the machine they describe, a combined telegraph and stereotype flong impressing machine, had nothing to do with matrices, their assembly, or slugcasting from matrices. It was, instead, a direct-impression stereotype composing machine. (This is an idea which appeared many times in the long history of composing machines.) It did employ a more or less wedge-shaped piece for spacing, but this was just a single stepped wedge, not the double-wedge of the Schuckers spaceband.

In 1924, in the first part of Bullen's article "Origin and Development of the Linotype Machine," Bullen presents a more accurate picture of Gally's invention ("a machine to punch letters into papier maché"). However, the reason that he mentions Gally at all is to assert that Gally's wedge justifier anticipated the method of line justification in Mergenthaler's "second band machine." His illustration for this is from Mergenthaler's patent 313,224 (filed 1884-08-30, issued 1885-03-03). Mergenthaler's patent, however, is for a mechanism very different from Gally's. Gally's punch-bars are justified by stepped wedges placed between them. Mergenthaler's matrix-bars are uniformly tapered (not stepped) and contain, integral to them, raised sections for spacing.[1]

TO DO: reprint page 1 of Gally's 129,331 and Figures 8 and 9 of Mergenthaler's 313,224.

Bullen's remarks are useful in bringing Gally's 1872 device to our attention. It does not appear in Richard Huss' very comprehensive book *The Development of Printers' Mechanical Typesetting Methods, 1822-1925* {Huss 1973}.

[1]These are marked 'b' on Mergenthaler's Fig. 9. see also p. 1 lines 47–63 and p. 3 line 120 to p. 4 line 1.

1.5• Further Issues

TO DO

See Mallison p. 222: Updike's disagreement with Bullen's romantic story of Garamond.

See Mallison pp. 224–228; problems with a translation of the Nuremburg Chronicle.

See Mallison pp. 229ff; attacks on scholars and printers

J• US Type Foundries in 1882

In 1882, the year in which Schraubstadter engraved the first matrix in the US and the year before Benton filed is “self-spacing type” patent, these were the type foundries in operation in the US:

- Baltimore Type Foundry (Charles J. Cary & Co., Baltimore)
- Barnhart Brothers & Spindler (The Great Western Type Foundry, Chicago)
- Benton, Waldo & Co. (The North-Western Type Foundry, Milwaukee)
- Boston Typefoundry (Boston)
- P. H. Bresnan Type Founding Company (New York)
- Bruce’s New York Type Foundry (George Bruce’s Sons & Co., New York)
- Buffalo Type Foundry (Lyman & Son, Buffalo)
- California Type Foundry (San Francisco)
- Central Type Foundry (St. Louis)
- Cincinnati Type Foundry (Cincinnati)
- Cleveland Type Foundry (H. H. Thorp Mfg. Co., Cleveland)
- Collins & McLeester (Philadelphia)
- James Conner’s Sons (United States Type Foundry, New York)
- Curtis & Mitchell (Boston)
- Dickinson Type Foundry (Phelps, Dalton & Co., Boston)
- Farmer, Little & Co. (New York)
- Franklin Type Foundry (Allison & Smith, Cincinnati)
- Hagar Type Foundry (New York)
- H. C. Hansen Type Foundry (Boston)
- P. H. Heinrich (New York)
- Illinois Type Founding Co. (Chicago)
- Kansas City Typefoundry (Kansas City)
- Lindsay Type Foundry (Robert Lindsay & Co., New York)
- A. W. Lindsay & Co. (New York)
- MacKellar, Smiths & Jordan (Philadelphia)
- Marder, Luse & Co. (Chicago Type Foundry, Chicago)
- Mechanics Type Foundry (Chicago)
- J. G. Mengel & Co. (Monumental Type Foundry, Baltimore)
- Minnesota Type Foundry (St. Paul)
- New England Type Foundry (Boston)
- Palmer & Rey (San Francisco)
- Pelouze & Co. (Philadelphia Type Foundry, Philadelphia)

- Richmond Type Foundry (Henry L. Pelouze, Richmond, VA)
- John Ryan & Co. (Baltimore)
- St. Louis Typefoundry (St. Louis)
- Washington Type Foundry (Washington, DC)

Two other foundries were part of the later (1892) ATF amalgamation, but I have not yet determined their starting dates: Hooper & Wilson (Baltimore) and John Graham (Chicago).

The list here differs from that presented in {Cost 2011}, pp. 35–36 because Cost considers the entire span of years in which Benton was in Milwaukee (1873–1892) while this list snapshots one point in time (1882). Her list includes one foundry which closed earlier (Cortelyou) and four which opened later (Empire State, Keystone, Pacific States, and Union).

One consolidation and one expansion might be in order in Cost's list. First, the situation of the firm of Ph. Heinrich and its successor, the Manhattan Type Foundry, is confused, but it would seem reasonable to consider them as a single entity through two periods of ownership. Second, there were actually two foundries bearing the name Lindsay. The original firm, R. & J. & A. W. Lindsay, started in 1852 and continued as an independent firm until 1903. But "by 1870" A. W. Lindsay left and started a separate foundry under his own name. It became part of the 1892 ATF amalgamation.

Charting the convoluted history of American type foundries is extraordinarily difficult, and all lists should be considered permanently provisional.

The primary source for the information here is {Annenberg 1994}.

K• Paul Otto's 3-D Pantograph (1891)

This is an engraving pantograph which was patented in both Germany and in Switzerland in 1891. It received some coverage in the press in 1892. The patent claimed that it was for "Stempeln, Matrizen, Petschaften u. s. w." (punches, matrices, stamps, etc.) In the present state of our knowledge, however, there is as yet no evidence that it was actually employed in type foundries.

It is self-evidently a machine based on one such as that illustrated in {Wernicke 1909}: 35. That machine was manufactured by Bernert and was said to have been made formerly by Hofer. If, therefore, we assume that Hofer's machine of 1877 is similar to its successor by Bernert by 1909, then Otto's 1891 machine may be seen as a derivative of Hofer's.[1]

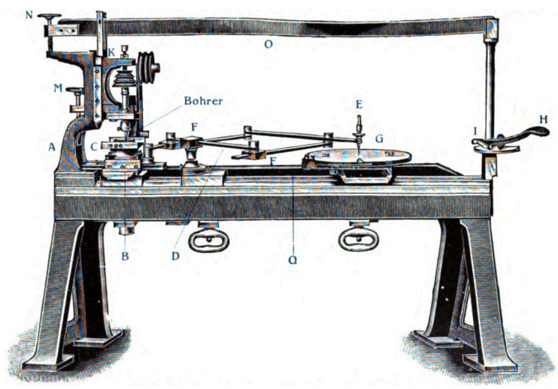


Fig. K.1: Hofer (1877) via Bernert (1909)[2]

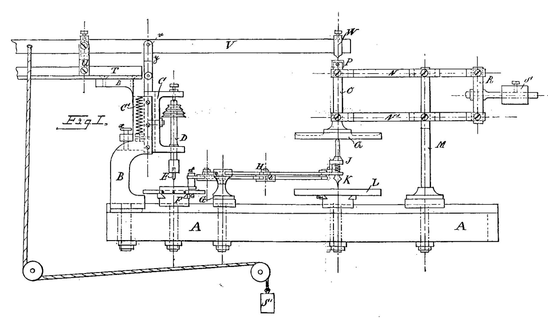


Fig. K.2: Otto (1891)

To understand the technical details of Otto's machine, it may be easiest to start with Hofer's. As show in in Wernicke (see above), Hofer's machine is a horizontal four-bar pantograph set up on a base which is clearly modeled after that of a lathe. The place where a lathe's headstock would be is occupied by a cutting spindle ("Bohrer" in Fig. K.1). The operator's position is on the long front side of the machine, on its right (at tracer 'E' in Fig. K.1).

Fig. K.3: Gursch (by 1909)[3]

Visually, this machine is distinguished by a long and rather awkward bar running above it for its full length. This bar is not a common feature of horizontal pantographs. It is not present,

[1]It is also possible that all of these machines derive from a common ancestor. Even if so, the point about their general similarity remains valid.

[2]The Hofer/Bernert machine is from {Wernicke 1909}: 35. Otto's machine is from the Swiss version of his patent, {Otto 1891 CH}: Fig. 1. Public domain.

[3]From {Wernicke 1909}: 40. The use of the Gursch pantograph for matrix engraving is attested by several surviving examples preserved from type foundries.

for example, on the Gursch pantographs (which otherwise generally resemble Hofer's) used in various typefoundries (see Fig. K.3, above).

On the Hofer/Bernert machine, this bar is simply a lever which allows the operator to raise the cutting spindle above the workpiece.

Otto's machine has an identical general arrangement and function. It has an overhead bar which, like the one on the Hofer/Bernert machine raises and lowers the cutting spindle. The function of this bar on Otto's machine, however, is entirely different. In fact, its function turns the machine into an entirely different form of pantograph. The Hofer/Bernert pantograph is what would be called today a "two-dimensional" machine. Otto's pantograph is a "three-dimensional" pantograph (often called a "die sinking machine" in 20th century industry).

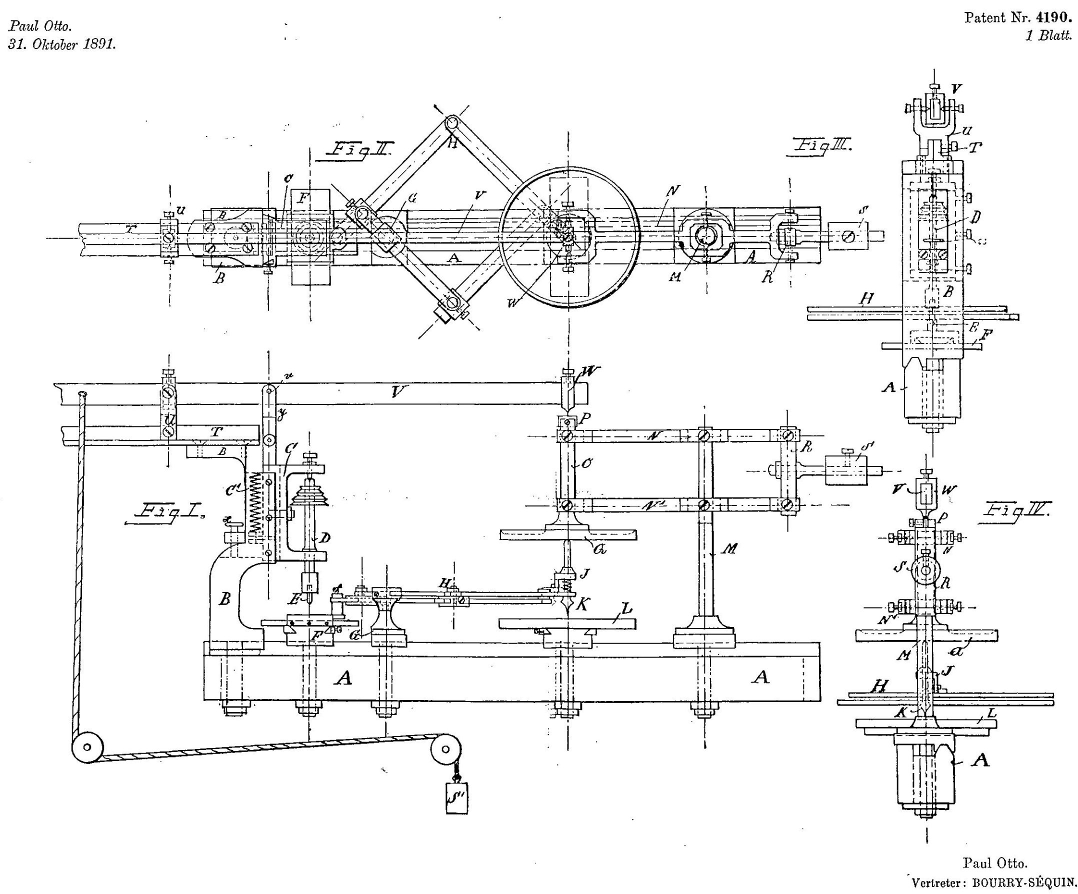


Fig. K.4: Otto's Reliefgravirmaschine (1891)[4]

In Otto's pantograph, the tracer ("Copirstift," copying pin, 'K' on the drawing) can move vertically within bushings at the tracing end of the pantograph mechanism. This motion is translated through the upper arm ('V' on the drawings) to the spindle. This allows the copying

[4]This sheet of drawings is from the Swiss version of Otto's patent, CH No. 4190. The two patents and their drawings differ in small details; the Swiss drawings are, arguably, slightly better. See: {Otto 1891 CH} for the Swiss version and {Otto 1891 DE} for the German version.

not only of two-dimensional outlines but also of three-dimensional forms in low relief (hence the name “reliefbohrmaschine”).

One thing which is remarkable about Otto’s machine is that it is not only a very early 3-D pantograph but that it employs an advanced movement not reinvented until the Gorton “Ratiobar” mechanism in the 1930s.[5] German 3-D pantographs of the 20th century employed, instead, a less accurate mechanism which pivoted the entire pantograph mechanism along with the tracer and the cutting spindle. The difference between the two mechanisms was explained by the Gorton company in their sales literature. Otto’s 1891 pantograph would have been blocking prior art on Gorton’s 1938 patent, had it been remembered.

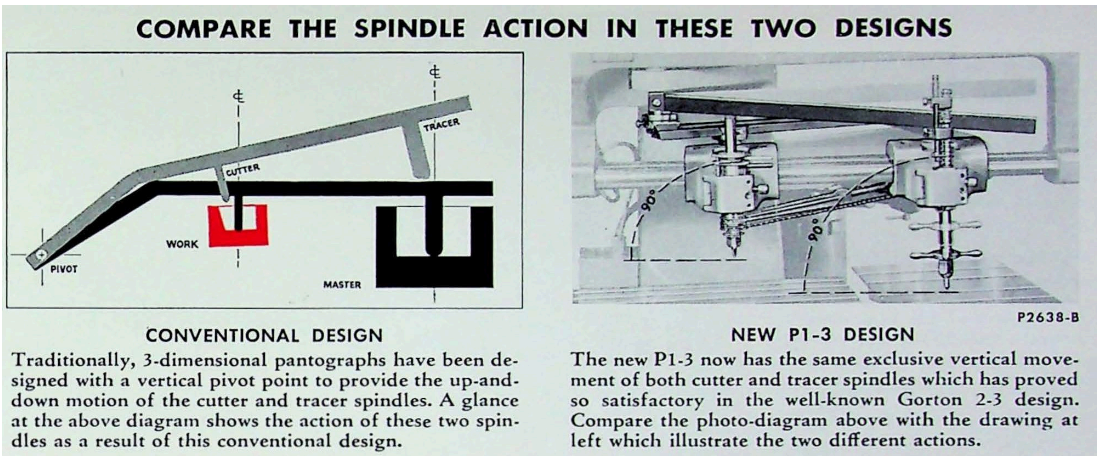


Fig. K.5: Gorton’s “Ratiobar” Mechanism[6]

Otto’s pantograph was reviewed anonymously in 1892 in the *Archiv für Buchdruckerkunst und Verwandte Geschäftsweige.* This describes its use in full relief (thus 3-D operation).

[5] See US patent 2,128,611, filed 1935-07-27. Issued 1938-08-30 to Peter M. Henkes and assigned to the George Gorton Machine Company of Racine, Wisconsin. {US 2,128,611 Henkes 1938}

[6] From {Gorton 1959}: 11. Scanned by Keith Rucker at `https://VintageMachinery.org/`. Public domain.

Neue Reliefgraviermaschine.

Zum Gravieren bezw. Bohren von Stempeln, Matrizen etc. sind bis jetzt Graviermaschinen in Gebrauch, welche die Herstellung genannter Gegenstände durch den Storchschnabel oder Pantographen ermöglichen. Durch diesen wird von einer Schablone in beliebig einzustellender Verkleinerung das Muster in das zu bohrende Stück übertragen. Bei den bisher gebräuchlichen Graviermaschinen wird der Bohrer in eine bestimmte Tiefe eingestellt, in welcher Stellung er so lange verbleibt, bis die Figur fertig gebohrt ist, so dass die Spitze des Bohrers die Grundfläche derselben zu planieren hat. Man erhält auf diese Weise aber immer nur ein Negativ des Modells. Um nun positive oder Reliefgravierungen herstellen zu können, hat der Mechaniker *Paul Otto* in Berlin SW., Bergmannstrasse 102, eine Maschine konstruiert und patentieren lassen, die sich von den bisher gebräuchlichen hauptsächlich dadurch unterscheidet, dass bei ihr gleichzeitig horizontale und vertikale Abbohrung des Musters erfolgt, während bisher nur die erstere in Anwendung war.

Fig. K.6: AfBVG (1892), ¶1[7]

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Matrizen etc. sind bis jetzt graviermaschinen
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ihr gleichzeitig horizontale und vertikale Abbohrung
des Musters erfolgt, während bisher nur die erstere
in Anwendung war.

Fig. K.7: AfBVG (1892), ¶1, Transcribed

Google (with a couple of manual corrections) translates this as:

> For engraving or drilling stamps, dies, etc., engraving machines have been used up to now, which enable the production of these objects using a storchschnabel or pantograph. This transfers the pattern from a template, at any adjustable reduction, to the piece to be drilled. With the engraving machines currently in use, the drill is set to a specific depth, in which position it remains until the figure is completely drilled, so that the tip of the drill has to level the base. However, this method always only produces a negative of the model. In order to produce positive or relief engravings, the mechanic Paul Otto constructed and patented a machine in Berlin SW, at Bergmannstrasse 102, which differs from previously used machines primarily in that it simultaneously drills horizontally and vertically into the pattern, whereas previously only the former had been used.

I believe that the point being made here is that each pass of a Hofer-style pantograph cuts only at a single level. However, this does not mean that it is saying they are restricted to cutting a matrix to full depth in one pass. Matrices are cut in multiple passes, each deeper than the last. All that this passage implies is that each pass cuts to one level.[8]

Otto's machine, by way of contrast, allows the cutter to move in in the third (vertical) dimension simultaneously.

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[7] From {[Otto 1892]}: 47.

[8] I am indebted to Victor Thibout for helping me understand what was being said here. Any errors in the interpretation presented here are of course my own.

Für unsern Beruf ist diese neue Graviermaschine insofern von Wichtigkeit, als sich dieselbe zur Anfertigung von dauerhaften Typen vorzüglich eignet. Nach einem Originalmuster können Buchstaben, Verzierungen, Namensunterschriften etc. in jedem beliebigen Grade in unbegrenzter Anzahl in absolut genauer Wiedergabe hergestellt werden und zwar in den härtesten Metallen, wie Messing und Stahl. Die Maschine wird sich besonders für die Anfertigung von Stahlstempeln für Matern, Ziffern und Buchstaben für Einsatzstempel und Numerierwerke, Schriften für Buchbinder, überhaupt solcher Gegenstände, für die Massengebrauch vorhanden ist, eignen.

Fig. K.8: AfBVG (1892), ¶2

Für unsern Beruf ist diese neue Graviermaschine
insofern von Wichtigkeit, als sich dieselbe zur
Anfertigung von dauerhaften Typen vorzüglich eignet.
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Massengebrauch vorhanden ist eignen.

Fig. K.9: AfBVG (1892), ¶2, Transcribed

This new engraving machine is important for our profession in that it is ideally suited for the production of durable type. From an original pattern, letters, decorations, signatures, etc., can be produced in any desired size, in unlimited quantities, and with absolutely accurate reproduction, even in the hardest metals, such as brass and steel. The machine will be particularly suitable for the production of steel stamps for matrices, numbers and letters for insert stamps and numbering machines, typefaces for bookbinders, and generally for such items for mass use.

Uns eingesandte Muster, Ziffern und Schreibschriftbuchstaben in Messing, zeigen eine saubere und exakte Ausführung. Bezüglich der Leistungsfähigkeit der Maschine behauptet der Erfinder, dass ein geübter Arbeiter mit derselben täglich ca. 500 Messingbuchstaben, bei Schreibschrift ca. 300 Stück herzustellen vermöge. Die Bearbeitung von Stahl geht der Härte dieses Metalls entsprechend langsamer von statten. Der Erfinder nimmt an, dass auf seiner Graviermaschine hergestellte Schreibschriften in Messing etwa zu doppeltem Preise der gegossenen zu liefern wären, ihre Haltbarkeit letzteren aber um das Zehnfache überlegen sei. Messingschriften für Buchdrucker, die bisher gegossen und dann nachgraviert werden, können bei guter Ausführung um 25—50 Prozent billiger geliefert werden. — Jedenfalls verdient die Erfindung des Herrn *Otto* die Beachtung aller Interessenten, besonders glauben wir, dass die Maschine auch in der Messinglinienfabrikation zur Herstellung von Muster- und Zierlinien vorteilhafte Verwendung finden kann.

Fig. K.10: AfBVG (1892), ¶3

Uns eingesandte Muster, Ziffern und Schreibschriftbuchstaben
in Messing, zeigen eine saubere und
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vermöge Die Bearbeitung von Stahl geht der Härte
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Erfindung des Herrn Otto die Beachtung aller Interessenten,
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auch in der Messinglinienfabrikation zur Herstellung
von Muster- und Zierlinien vorteilhafte Verwendung
finden kann.

Fig. K.11: AfBVG (1892), ¶3, Transcribed

Samples of brass numbers and cursive letters sent to us demonstrate a clean and precise execution. Regarding the performance of the machine, the inventor claims that a skilled worker can produce approximately 500 brass letters per day, and approximately 300 for cursive letters. Steel processing is slower due to the hardness of this metal. The inventor assumes that brass cursive letters produced on his engraving machine could be delivered at about twice the price of cast ones, but that

[8]From {[Otto 1892]}: 47.

[8]From {[Otto 1892]}: 47.

> their durability would be ten times greater. Brass lettering for printers, which is currently cast and then re-engraved, can be delivered 25-50 percent cheaper if well executed. In any case, Mr. Otto's invention deserves the attention of all interested parties. We particularly believe that the machine can also be used advantageously in brass line production for the production of pattern and decorative lines.

TO DO: Possibly add some background on Otto. Paul Otto in Berlin SW Bergmannstrasse 102

An evaluation of the importance of Otto's pantograph in type-making is difficult because it depends in part not just on the facts of the machine but also on the state of our knowledge.

In the history of machine tools generally and of die sinking particularly, Otto's pantograph is significant as it is at least a very early 3D engraving pantograph.[9]

As a typographical pantograph considered on purely technical grounds, it could certainly have been used for all methods of type production: punchcutting, patrix cutting, and direct matrix engraving. However, it offers to the matrix maker no advantage over a simpler 2D machine. Typefounding is an expensive business and so typefoundry owners tend to be cautious in their expenses. Otto's machine would be a hard sell.

As a typographical pantograph considered historically, we have insufficient evidence to evaluate it. If the hypothesis that the Bernert (formerly Hofer) pantograph shown in {Wernicke 1909} represents something close to the original form of Hofer's pantograph of 1874/1877, then Otto's machine is clearly a direct development from it and therefore important in the historical narrative (even if it is a side-development). If this hypothesis turns out to be false, then the origins of Otto's machine would require further investigation and might be less significant for the history of type.

[9] It claims to be the first, and indeed might be.

L• The Range of 19th Century Industrial Pantographs

TO DO: just to illustrate the wide range of application. It really was the computer of the Victorian era.

watchmaking

calico printing rolls

coining and medallion making

printing plates

currency and security printing

weaving (Austria)

silhouettes (discussed extensively elsewhere)

M• Moving Into the Twentieth Century

Any complete (or even extensive) survey of 20^{th} century pantographs would be impossible and out of place here. It may be interesting, however, to look at some of the major threads of development which started with the 19^{th} century machines discussed here.

M.1• Direct Developments of Hofer-Style Machines

TO DO: Change the 1909 image here for one of my photographs of one of the Gursch (Gursch-style?) machines at Patrick's.

Gursch

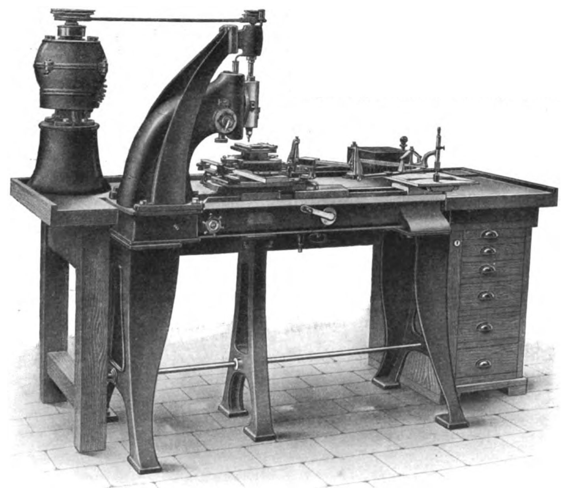

Fig. M.1: Gursch (by 1909)[1]

[1]From {Wernicke 1909}: 40.

M.2• Direct Developments of Benton-Style Machines

TO DO: Mostly direct the reader to the Benton Census, but VERY briefly indicate the existence of the following. This is getting beyond the current scope, but readers should be aware that these machines exist.

TO DO: Direct copies of Benton machines (Tsugami, etc.)

TO DO: Machines inspired by Pierpont, Barr, and Grant-Legros from Benton

M.3• Other?

TO DO: Evaluate. This is probably getting too broad and should be omitted.

Possibly: A miscellany of horizontal machines

Possibly: Adapted commercial machines, if only to show that there's nothing magical about a Benton. Rimmer's Ogata. The Preis used by Duensing, then Walczak, and now Lucas.

Possibly: Use of Reducing Engines in national mints until ca. 2001.

N• Incomplete Lexical Notes

The terminology of typemaking is increasingly unfamiliar. Moreover, it was never standardized and, especially in German, the same thing can be called by several names. Here are a few terms.

TO DO: Add: terminology of patrix.

Benton (1906) calls them “originals”

Legros & Grant (1916) p. 196 call them “master-type”

Werner (1927): 765, col. 1, uses ”master type” He does the same in his letter in Gress (1932)

DeVinne (PPT 1900), p. 353 says ”model letters”, but by this he means the patterns, NOT patrices.

TO DO: electroform vs. electrotype

bohrmaschine (lit: “drilling machine”); in its use in this field, a rotary cutting pantograph

When a modern English-speaking person hears the words “drill” (German: bohr) or drilling in a workshop/industrial context, they probably think of a twist drill (the ordinary style of drill today that you might buy in a hardware store), perhaps used in a drill press (in England, a drilling machine). These words signify a hole-making operation. In the 19^{th} century German literature, however, the word “bohr” did not have the same association. A pantograph (of any format, horizontal or vertical) with a rotating cutter is a very specialized species of what would today be called a vertical milling machine. But the milling machine was in the process of being invented in the 19^{th} century. The rotary-spindle machine tool that most writers would have been more familiar with was the drilling machine. So the references here to pantographical “bohrmaschinen” do not imply a drilling operation but rather vertical milling. (Though of course a bohrmaschine can also be just a drill press.)

graviermaschine

pantograph TO DO: DEFINE. (less commonly, in earlier English language sources, pentagraph or pentegraph) In Bloomington, IL, the name of a local newspaper. In railroads, an entirely unrelated device, so called for a presumed visual similarity with a four-bar pantograph.

schriftgießerei

storchschnabel (lit: “crane’s bill”); sometimes storchenschnabel. One of the several names used in German for the pantograph. Also the name of a flower.

Bibliography

Bibliographic Style Issues

I am aware of issues/difficulties in the citation style. The style guides for bibliography and citation in the humanities have entered into a dark period where citations are expected to flow into the text so smoothly that it is difficult to follow the citation at all. This may suit aesthetics, but it is a discourtesy to the reader and an impediment to the researcher. The best remaining style guide is the *Chicago Manual of Style,* 17th edition (2017), with its (author date) style of citation.

However, the recommendations of *Chicago* 17th fail for many of the more complex references here. To circumvent this, I will use the CircuitousRoot house style.[1] This follows *Chicago* 17th as much as possible but differs in this way: Each citation will consist of a unique {entity date} pair. This pair will be repeated in the Bibliography at the start of each bibliographic entry and will serve to identify it. The entry itself will follow a more traditional form which places the date at the end of the publication information.[2]

Patents are filed by their numbers, not their inventors' names, prefixed by a country abbreviation. Thus {US 332,990 Benton 1884} or {GB 1548 of 1854 Wiberg} (19th century British patent citations are complex). Benton's pantograph and cutter grinder patents are identified by their date of filing, because of the significance of the actual dates of his inventions. All other patents are identified by their dates of issue, as is more conventional.

TO DO: Fix the format of Otto's 1891 DE patent.

TO DO: Add note on how to set things up so that clicking on a "local copy" link actually gets you the PDF.

{Adams 1845} Adams, Thomas F. *Typographia: Or the Printer's Instructor [&c.]* Philadelphia, PA: James Kay, Jun. & Brother, 1845.

Early editions of Adams are surprisingly difficult to come by. The first and second editions have not been digitized. The second edition was reprinted by Garland in 1981, but even this reprint is scarce today. The third edition, scanned from the copy of Bancroft Library of the University of California, is online at The Internet Archive at:
`https://archive.org/details/typographiaorpri00adamrich/`

Here is a local copy of the PDF presentation of this digitization:
`archive-pd-ccby/typographiaorpri00adamrich.pdf`

{*American Stationer* 1884} "Self-Spacing Type." In *The American Stationer.* Vol. 15, No. 10, Whole No. 454 (March 1884): 307.

Digitized by Google from the NYPL copy: `https://books.google.com/books?id=zzpYAAAAYAAJ`

Here is a local copy of the entire volume from Google's digitization:
`archive-pd-ccby/american-stationer-v015-1884-n01-whole-445-01-03-to-1884-06-26-n26-whole-470-google-zzpYAAAAYAAJ-nypl.pdf`

[1]See *CR Bibliographic Style: A Justification and Explanation of The CircuitousRoot House Style for Bibliography and Citation* at `https://www.CircuitousRoot.com/PUTURLHERE`

[2]In *Chicago* 17th it is placed after the author and it is up to the reader to reconstruct the citation from this infix use.

{Annenberg 1994} Annenberg, Maurice. Additions and introduction by Stephen O. Saxe. Index by Elizabeth K. Lieberman. *Type Foundries of America and their Catalogs.* Second Edition. New Castle, DE: Oak Knoll Press, 1994.

{[ATF 1893]} "Printing Exhibits at the World's Fair." In *The Inland Printer.* Vol. 11, No. 2 (May 1893): 146–148.

This volume has been digitized by the Smithsonian Institution Library and is available via the Internet Archive at: `https://archive.org/details/inlandpri111218931894chic`

Here is a local copy of the PDF presentation of this digitization: `archive-pd-ccby/inland-printer-v011-v12-1893-04-to-1894-03-smithsonian-archive-org-inlandpri111218931894chic.pdf`

{ATF 1895/6 1981} American Type Founders Co. "Specimens of Type." [The 1895/6 ATF "Collective" specimen book, edited/assembled by Henry Lewis Bullen. It was issued in several variations by several of the type foundries which made up ATF; titles varied slightly between versions.] Reprinted, with an introduction by Alexander S. Lawson and a bibliographical note by John Bidwell (NY: Garland Publishing, Inc., 1981).

The facsimile portion of this, which is in the public domain, has been reprinted (poorly) in the CircuitousRoot Notebook "American Type Founders "Collective Specimen Book" (1895/6)" at `https://circuitousroot.com/artifice/letters/press/noncomptype/typography/atf/atf-collective-specimen-garland-badscan/index.html`

{ATF 1896 100} *One Hundred Years.* Philadelphia, PA: "MacKellar, Smiths & Jordan" [American Type Founders Company], 1896.

This was published by the Philadelpha manufacturing foundry of the American Type Founders Company four years after the amalgamation of ATF into a single firm. At the time it was published, the former MacKellar, Smiths and Jordan foundry did not exist; it just continued to act as if it did.

{ATF 1896 03IP} "Perfect Processes - Perfect Type" [advertisement]. In *The Inland Printer.* Vol. 16, No. 6 (June 1896): 682.

Volumes 15 and 16 have been digitized together by the Smithsonian Institution. These are available via the Internet Archive at: `https://archive.org/details/inlandpri151618951896chic/`

Here is a local copy of the PDF presentation of that digitization: `archive-pd-ccby/inland-printer-v015-v016-1895-04-to-1896-03-smithsonian-archive-org-inlandpri151618951896chic.pdf`

{ATF 1896 FE} "Foundation of Good Type." In *The Fourth Estate.* Vol. 4, Whole No. 105 (1896-02-27): 15.

Digitized by Google from a University of Wisconsin copy: `https://books.google.com/books?id=tO6wNO4_qN0C`

Here is a local copy of that digitization: `archive-pd-ccby/fourth-estate-v04-n097-1896-01-02-to-v04-n149-1896-12-31-google-tO6wNO4_qN0C-wisc.pdf`

{ATF 1896 TJ} "Foundation of Good Type." In *The Typographical Journal.* Vol. 8, No. 5 (1896-03-02): 196.

This is an unsigned, unsourced piece which contains the text of the award given to American Type Founders for the Benton.

Digitized by Google from a University of California copy: `https://books.google.com/books?id=pKAuAQAAIAAJ`

Here is a local copy of that digitization: `typographical-journal-vol-08-1896-google-pKAuAQAAIAAJ-uc.pdf`

{ATF 1912 CP} *Photographic Views of Central Plant, American Type Founders Company.* Jersey City, NJ: American Type Founders Company, circa 1912. Reprinted with additional editorial material by Theo Rehak, David W. Peat, and Richard L. Hopkins, 2002.

{ATF 1914} [Bullen, Henry Lewis.] *Guide to the Exhibit of the Typographic Library and Museum of the American Type Founders Company at the Second National Printing Exposition, Grand Central Palace, New York City, April 18 to 25, 1914.* Jersey City, NJ: American Type Founders Company, 1914.

This has been digitized by the University of Illinois at Urbana-Champaign and is available via The Internet Archive at: `https://archive.org/details/guidetoexhibitof00amer_0`

Here is a local copy of their PDF presentation: `archive-pd-ccby/guidetoexhibitof00amer_0.pdf`

Here are full-resolution versions, converted to PNG format, of the two images of the ATF Library from this publication: `archive-pd-ccby/guidetoexhibitof00amer_0_orig_0009-atf-library-1914-east-end.png` and `archive-pd-ccby/guidetoexhibitof00amer_0_orig_0011-atf-library-1914-looking-west.png`

{ATF 1923} *Specimen Book & Catalogue* Jersey City, NJ: American Type Founders Company, 1923.

{ATF 1926} *A Catalogue of an Exhibition of Recent European Fine Book and Commercial Printing - Loaned by the Typographic Library of the American Type Founders Company.* Jersey City, NJ: American Type Founders Company, 1926.

By Henry Lewis Bullen. This booklet is notable here only for having photographs of the ATF Library in 1926 which do *not* show the first Benton pantograph.

This Catalogue has not been digitized. The images used here were scanned from my own copy. Here are 2400dpi scans of these two imags: `archive-pd-ccby/atf-1926-exhibition-fine-book-printing-2400rgb-frontispiece.png` and `archive-pd-ccby/atf-1926-exhibition-fine-book-printing-2400rgb-end.png`

{ATF 1929} (For Bullen's 1929 *Pacific Printer and Publisher* article on the ATF Library and Museum, see instead {Bullen 1929}.)

{ATF 1936} [Henry Lewis Bullen.] *Catalogue and List Prices of Duplicates of Books, Prints, Museum Pieces and Broadsides Offered for Sale by the Typographic Library and Museum of the American Type Founders Co.* Jersey City, NJ: American Type Founders Company, 1936.

This volume contains two photographs of the ATF Library, one of which shows the first Benton pantograph on display in a case.

This Catalogue has not been digitized in its entirety. The image(s) used here were scanned from my own copy.

{ATF 1948} ATF. Narrated by Ben Grauer. *Type Speaks!* Film, 16mm, sound, color, 25 minutes, Elizabeth, NJ: American Type Founders Sales Corp., 1948.

This film is online on Doug Wilson's `https://printingfilms.com/` website.

{Bedini 1984} Bedini, Silvio A. *Thomas Jefferson and His Copying Machines.* Charlottesville, VA: University Press of Virginia, 1984.

As of 2026, the Internet Archive digitization of this book is borrowable. See: `https://archive.org/details/thomasjeffersonh0000bedi/` Bedini's book contains the only (at the time of writing) complete reproduction of the plate from Hawkins' 1803 pantograph patent.

{Beeler 1934} "Noted Monotype Engraver Dies." [Obituary for Charles Henry Beeler, Jr.] *The Inland Printer.* Vol. 92, No. 5 (February 1934): 72.

A scan from a poor microfilm of this is online at: `https://archive.org/details/sim_american-printer_1934-01_92_4/` Note, however, that there are several errors in its identification. First, is filenames suggest that it is the *American Printer*. Second, the issue is labeled No. 4 (January 1934) when in fact it is No. 5 (February 1934). This error is compounded because it is missing not only its cover and advertising materials (deliberately, in the making of the microfilm) but also its masthead and other pages (presumably in error).

{[Benton 1876]} "The Benton Patent Copper Ball." In *Scientific American.* Vol. 34, No. 20 (1876-05-13): 310.

This has been digitized by Google from the University of Minnesota copy. `https://books.google.com/books?id=9YI3AQAAMAAJ`

{[Benton 1886]} "Typographic Specimens." Milwaukee, WI: Benton, Waldo & Co., 1886.

This contains, on pages 5–6, the "Explanation of the Principle of Benton's Self Spacing Type."

A copy of this specimen, scanned by the late Stephen O. Saxe from his collection, is online in the CircuitousRoot Notebook on the "North-Western Type Foundry [Benton et. al.]" at `https://www.circuitousroot.com/artifice/letters/press/noncomptype/typography/north-western-benton/index.html`

Here is a local copy of that specimen book: `archive-pd-ccby/benton-waldo-specimen-booklet-1886-sos-0600dpijpg.pdf`

Here is a local copy of the two pages explaining Benton's self-spacing type, from that specimen book: `archive-pd-ccby/benton-waldo-specimen-booklet-1886-sos-extract-pp1-2-explanation.pdf`

{[Benton 1893]} "L. B. Benton." In *The Inland Printer.* Vol. 11, No. 3 (June 1893): 238–239.

This volume has been digitized by the Smithsonian Institution Library and is available via the Internet Archive at: `https://archive.org/details/inlandpri111218931894chic`

Here is a local copy of the PDF presentation of this digitization: `archive-pd-ccby/inland-printer-v011-v12-1893-04-to-1894-03-smithsonian-archive-org-inlandpri111218931894chic.pdf`

{[Benton 1894]} 'O.' "Bentons Maschine zum Scheiden oder Gravieren von Schriftstempeln." in

Buchgewerbeblatt: Halb-Monatsschrift für Alle Sweige des Buchgewerbes. Vol. 2 (1893–1894), No. 15 (May 1894): Cols. 581–588. Leipzig, Germany: Breitkopf & Härtel, 1894.

Digitized by Google from the Bavarian State Library copy:
`https://books.google.com/books?id=z99s6EvdgtIC&pg=PA581`

Local copy of the entire volume: `buchgewerbeblatt-vol-2-1893-1894-google-z99s6EvdgtIC-bavarian-state-library.pdf`

Local copy of the article, extracted: `buchgewerbeblatt-vol-2-1893-1894-google-z99s6EvdgtIC-bavarian-state-library-EXTRACT-no-15-cols-581-588-pdf309-312-benton.pdf`

{[Benton] 1906} Benton, Linn Boyd. "The Making of Type." [a chapter in] Frederick H. Hitchcock. *The Building of a Book.* NY: The Grafton Press. pp. 31–40.

A digitization from the University of California copy is online at the Internet Archive:
`https://archive.org/details/buildingofbookse00hitc`

Here is a local copy of the PDF presentation of that digitization: `archive-pd-ccby/hitchcock-1906-the-building-of-a-book-uc-archive-org-buildingofbookse00hitc.pdf`

{[Benton 1932]} "Achievements of Linn Boyd Benton Vital to Industry's Progress." [Obituary for Linn Boyd Benton.] *The Inland Printer.* Vol. 89, No. 5 (1932-08): 53–54.

Here is a local copy of this article, from a scan by DMM of the original: `archive-pd-ccby/inland-printer-vol-089-n05-1932-08-linn-boyd-benton-obituary.pdf`

This issue has also been digitized by the Internet Archive from microfilm and is available at:
`archive-pd-ccby/https://archive.org/details/sim_american-printer_1932-08_89_5`

Here is a local copy of this issue, in PDF form:
`archive-pd-ccby/sim_american-printer_1932-08_89_5.pdf`

{Bohadti 1954} Bohadti, Gustav. *Die Buchdruck Letter.* West Berlin, Federal Republic of Germany: Ullstein A. G., 1954.

{Brigham 1995} Brigham, David R. *Public Culture in the Early Republic: Peale's Museum and Its Audience.* Washington, DC: Smithsonian Institution Press, 1995.

{Bruning 1948} *General Catalog.* 14th Edition. NY: Charles Bruning Company, Inc., n.d. [1948].

This catalogue itself is undated. However, it contains (slipped in a pocket inside the back cover) a price list for this catalgue edition which is dated August 1948.

{Bullen 1907} "Qaudrat" [Henry Lewis Bullen]. "Discursions of a Retired Printer." No. 7. In *The Inland Printer.* Vol. 38, No. 4 (January 1907): 513–521.

This volume has been digitized by the Smithsonian Institution Library and is available via the Internet Archive at: `https://archive.org/details/inlandprint3819061907chic`

Here is a local copy of the PDF presentation of this digitization:
`archive-pd-ccby/inland-printer-v038-1906-10-to-1907-03-smithsonian-archive-org-inlandprint3819061907chic.pdf`

Here is a local copy of just this article, extracted:
`archive-pd-ccby/inland-printer-v038-smithsonian-archive-org-inlandprint3819061907chic-v038-n4-1907-01-pp513-521-bullen-discursions.pdf`

{Bullen 1922 DB} Bullen, Henry Lewis. "David Bruce, Jr., Inventor of the First Successful Typecasting Machine." *The Inland Printer.* Vol. 69, No. 1 (Apr.): 61-64.

This volume has been digitized by the Smithsonian Institution and is available via the Internet Archive at: `https://archive.org/details/inlandprinter691922chic/`

Here is a local copy of the PDF presentation of that digitization: `archive-pd-ccby/inland-printer-v069-1922-04-to-1922-09-smithsonian-archive-org-inlandprinter691922chic.pdf`

Here is the article itself, as a PDF extracted from the Google digitization of the University of Michigan copy presented via The Hathi Trust: `archive-pd-ccby/inland-printer-v069-n1-1922-04-hathi-mdp-39015086783506-pp0061-0064-bullen-on-bruce.pdf`

{Bullen 1922 LBB} Bullen, Henry Lewis. *Linn Boyd Benton — The Man and His Work. The Inland Printer.* Vol. 70, No. 1 (Oct.): frontis, pp. 60-64.

The portait drawing of Linn Boyd Benton for this article appears as the unpaginated frontispiece for this number of *The Inland Printer*, between pages 48 and 49.

This volume has been digitized by the Smithsonian Institution and is available via the Internet Archive at: `https://archive.org/details/inlandprint7019221923chic/`

Here is a local copy of the PDF presentation of that digitization: `archive-pd-ccby/inland-printer-v069-1922-04-to-1922-09-smithsonian-archive-org-inlandprinter691922chic.pdf`

Here is the article itself, extracted from that version: `archive-pd-ccby/inland-printer-v070-1922-10-to-1923-03-smithsonian-archive-org-inlandprint7019221923chic-bullen-on-benton.pdf`

Here is another copy of the article itself, as a PDF extracted from the Google digitization of the University of Michigan copy presented via The Hathi Trust: `archive-pd-ccby/inland-printer-v070-n01-1922-10-hathi-mdp-39015086783449-bullen-on-benton.pdf`

{Bullen 1924 L1} Bullen, Henry Lewis. "Origin and Development of the Linotype Machine, Part I." *The Inland Printer.* Vol. 72, No. 5 (February 1924): 769–771.

This has been reprinted in the CircuitousRoot Notebook on Henry Lewis Bullen: `https://www.CircuitousRoot.com/artifice/letters/press/typemaking/history/type-scholars/bullen/index.html`

Here is a local copy of it: `archive-pd-ccby/inland-printer-vol-072-no-05-1924-02-pp769-771-uwsc-bullen-on-the-linotype-part-1.pdf`

{Bullen 1924 L2} Bullen, Henry Lewis. "Origin and Development of the Linotype Machine, Part II." *The Inland Printer.* Vol. 72, No. 6 (March 1924): 936-938.

This has been reprinted in the CircuitousRoot Notebook on Henry Lewis Bullen: `https://www.CircuitousRoot.com/artifice/letters/press/typemaking/history/type-scholars/bullen/index.html`

Here is a local copy of it: `archive-pd-ccby/inland-printer-vol-072-no-06-1924-03-pp936-938-bullen-linotype-pt2-0600rgbjpg.pdf`

{Bullen 1924 Era} Bullen, Henry Lewis. “The Creators of the New Era in Typefounding.” *The Inland Printer.* Vol. 73, No, 5 (August 1924): 761–764.

This article covers, briefly, Robert W. Nelson, Joseph Warren Phinney, Henry Barth, and Linn Boyd Benton. It contains the claim that Benton attempted to sell his pantograph patents to MacKellar, Smiths & Jordan.

This issue has also been digitized by the Internet Archive from microfilm and is available at: `https://archive.org/details/sim_american-printer_1924-08_73_5`

Here is a local copy of the PDF presentation of that digitization: `archive-pd-ccby/inland-printer-v073n5-1924-08-sim_american-printer_1924-08_73_5.pdf`

{Bullen 1929} Bullen, Henry Lewis. “The Typographic Library and Museum at Jersey City.” *The Pacific Printer and Publisher.* (August 1929).

My copy of this, deaccessioned from the US Patent and Trademark Office, is an offprint which is paginated consecutively. I do not yet have the original volume, number, and pagination information.

{Burns 2012} Burns, Charles. *Mastering Silhouettes.* Mechanicsburg, PA: Stackpole Books, 2012. ISBN: 978-0-8117-0149-5 (pbk).

{Carrick 1928} Carrick, Alice van Leer, *Shades of Our Ancestors: An Authoritative and Comprehensive Study of the Art of the Silhouette in America.* Boston: Little, Brown, 1928.

{Carrick 1968} Carrick, Alice van Leer, *A History of American Silhouettes: A Collector’s Guide — 1790–1840.* Rutland, VT: Charles E. Tuttle Co., 1968.

{Carter 1937} Carter, Harry. “Optical Scale in Typefounding.” *Typography.* No. 4 (Autumn 1937): 2-6.

Reprinted in the *Printing Historical Society Bulletin.* No. 13 (1984): 144-148.

This article, one of the most important ever written in the field of type design, can be quite difficult to find. However, it remains in copyright and cannot be reprinted here. It is in copyright in the UK through (1982 + 75) = 2057 and in the US through (1937 + 95) = 2032.

{Central-Boston 1892} *Popular Designs for Artistic Printers.* [aka *Artistic Novelties for Printers* as issued by the Boston T.F.] St. Louis, MO: Central Type Foundry [really, American Type Founders]; Boston, MA: Boston Type Foundry [really, ATF], 1892.

The Central began as a branch of the Boston. It became independent and very successful, and so its owners (St. John and Schraubstadter) later purchased the Boston. In Feburary of 1892 these two foundries were part of the initial amalgamation of companies into American Type Founders. This specimen book includes showings of ATF Porson and Heavyface Greek (for example) and so must postdate the formation of ATF. As such, neither the Central nor the Boston Type Foundries actually existed as business entities at this time. The larger of the foundries at the formation of ATF, however, continued for a time to operate as if they were still independent.

This has been digitized by Google from the University of Michigan copy. This copy includes a additional front matter for the Boston Type Foundry which gives the name of the book as *Artistic Novelties for Printers.*

Here is a local copy of that digitization: `archive-pd-ccby/central-boston-1892-google-mich-popular-designs-for-artistic-printers.pdf`

{Central T. F. 1893} [Showings of DeVinne Condensed and DeVinne Italic.] *The Inland Printer.* Vol. 12, No. 1 (October 1893): 68–69.

Volumes 11 and 12 have been digitized together by the Smithsonian Institution. These are available via the Internet Archive at: https://archive.org/details/inlandpri111218931894chic/

The typeface DeVinne Condensed is shown on p. 68 of this number. DeVinne Italic is shown on p. 69.

{Chappell 1953} Chappell, Warren. *Let's Make a B for Bennett.* [No location]: Friends of Paul Bennett, 1953.

The original edition was 1,250 copies, printed by The Thistle Press. Later another 50 copies were printed and appeared as Typophiles Monograph 40.

A digitization of my copy is online at The Internet Archive:
https://archive.org/details/ChappellLetsMakeABForBennett1953/

{Chappell 1970} Chappell, Warren. *A Short History of the Printed Word.* NY: Alfred A. Knopf, 1970.

{Chrétien 1789} Chrétien, Gilles-Louis. [Letter to Editor.] In *Journal de Paris.* Jeudi 24 Décembre 1789, [page 2].

This has been digitized by Google from a volume at the University of Michigan and is available via The Hathi Trust at: https://babel.hathitrust.org/cgi/pt?id=mdp.39015041821144 However, this volume is a 1968 reprint edition, not the original of 1789. It is in the public domain in the United States under the decision of Bridgeman Art Library v. Corel Corp., 36 F. Supp. 2d 191 (S.D.N.Y. 1999).

{Coakley 2003} Coakley, J. F. "Homan Hallock, Punchcutter." *Printing History*. Vol. XXIII, No. 1 (2003): 18–41.

{Coakley 2006} Coakley, J. F. *The Typography of Syriac.* New Castle, DE: Oak Knoll Press; London: The British Library, 2006.

{Courboin 1908} Courboin, François. "Le Physionotrace de Quénédey." In *Bulletin de la Société de l'Histoire de l'Art Français.* Volume of 1908. [Presented at the session of 1908-03-06.] Paris: Jean Schemit, 1908: 38–42 and an unnumbered plate following p. 40..

This entire journal issue was in the public domain until the implementation in US law of the Uruguay round of the GATT in 1996. It re-entered the public domain in the USA in (1908 + 96) = 2004. François Courboin's dates are 1865–1926 (see https://data.bnf.fr/en/ark:/12148/cb12211647j) so this article entered the public domain in Europe and elsewhere in (1926 + 75 + 1) = 2001. The image of the Physionotrace as published in 1908 entered the public domain in Europe and elsewhere in (1908 + 75 + 1) = 1984. However, the use of some digitizations of this journal are restricted by license terms, not copyright law. See the individual citations below for more information.

This issue of this journal has been digitized by the Heidelberg University Library and is available at: https://digi.ub.uni-heidelberg.de/diglit/bshaf1908, DOI: https://doi.org/10.11588/diglit.17393. Since it was digitized in 1016 and it is possible that some of its contributors were alive in (2016 - 75 = 1941) they have marked it as being in copyright. See the discussion above for why the entire journal is in the public domain in the USA and why at least the articles by Courboin and Fromageot and the illustration of the Physionotrace are in the public domain worldwide. The Heidelberg University Library does not assert any additional rights or limitations on this work, so these are in the public domain.

This journal issue has been digitized by the "Gallica" digital library of the Bibliothèque nationale de France at: `https://gallica.bnf.fr/ark:/12148/bpt6k4236237p/f1.item.zoom` This digitization is licensed by them for noncommercial use only. This is perfectly reasonable, but not compatible with the "CC-BY" Creative Commons Attribution license of this present work. TO DO: Put a copy of the Gallica digitization in the noncommercial use only archive.

This journal issue has been digitized at least three times by Google. The digitization of the New York Public Library copy (Google Books ID: 910oAAAAYAAJ) is also available via The Hathi Trust at `https://babel.hathitrust.org/cgi/pt?id=nyp.33433078280439` However, its plate of the Physionotrace is so incomplete that it is not useful. The digitization of the University of Minnesota copy (Google Books ID: BvohAQAAMAAJ) is also available via The Hathi Trust at `https://babel.hathitrust.org/cgi/pt?id=umn.319510019208664` Its digitization of the plate is better, but it is cropped and omits one of the diagrams of the sighting device. Both of these digitizations are in the public domain.

The digitization by Google of the New York Public Library copy has an almost complete version of the plate, but it is still incomplete. It may or may not be in the public domain, depending upon the current status as you read this of the US court case Bridgeman Art Library v. Corel Corp., 36 F. Supp. 2d 191 (S.D.N.Y. 1999), because the Michigan copy is actually a 1971 facsimile reprint edition. At the time of writing it is available via The Hathis Trust at `https://babel.hathitrust.org/cgi/pt?id=mdp.39015051453291`

The fact that it takes a full page of notes in small print to establish the identity of a freely usable version of a two century old image of one of the most important precursors to photography is a sad comment on the decline of our civilization despite our fancy new technology.

{Cost 1986} Cost, Patricia Knittel. *The Contributions of Linn Boyd Benton and Morris Fuller Benton to the Technology of Typesetting and Typeface Design.* Thesis. Rochester Institute of Technology. 1986-05-01. Accessed from: RIT Digital Institutional Repository `https://repository.rit.edu/cgi/viewcontent.cgi?article=4915&context=theses`

{Cost 2011} Cost, Patricia. *The Bentons: How an American Father and Son Changed the Printing Industry.* Rochester, NY: RIT Cary Graphic Arts Press.

{Cromer 1925} Cromer, Gabriel. "Le Secret du Physionotrace: la curieuse «Machine à dessiner» de G. L. Chrétien." [article dated March 1922] In *Le Vieux Papier: Bulletin de la Société Archéologique, Historique & Artistique.*[3] Tome XVI, Fascicule No. 112 (October 1925): 477–484. Paris: [By the society Le Vieux Papier], 1925.

Volume 16 of *Le Vieux Papier* has been digitized by Google from the University of Michigan copy. Google Books ID J43gAAAAMAAJ at `https://books.google.com/books?id=J43gAAAAMAAJ`

{Cromer 1926} Cromer, Gabriel. "Quelques documents sur le Physionotrace." [Presented to the Society

[3]This journal frequently is miscataloged under its subtitle (or description) "Bulletin de la Société Archéologique, Historique & Artistique." The correct name of the journal is *Le Vieux Papier* (that is, "Old Paper"). It is still published by the Société «Le Vieux Papier»: `https://www.levieuxpapier-asso.org/`

1925-12-15.] In *Le Vieux Papier: Bulletin de la Société Archéologique, Historique & Artistique.* Tome XVI, Fascicule No. 113 (April 1925): 541–545. Paris: [By the society Le Vieux Papier], 1926.

Volume 16 of *Le Vieux Papier* has been digitized by Google from the University of Michigan copy. Google Books ID J43gAAAAMAAJ at `https://books.google.com/books?id=J43gAAAAMAAJ`

{Cromer 1928} Cromer, Gabriel. "Nouvelles précisions, nouveaux documents sur le Physionotrace." [Presented to the Society on 1928-02-17.] In *Le Vieux Papier: Bulletin de la Société Archéologique, Historique & Artistique.* Tome XVII, Fascicule No. 118 (October 1928): 289–316 and four plates. Paris: [By the society Le Vieux Papier], 1928.

Volume 17 of *Le Vieux Papier* has been digitized by Google from the University of Michigan copy. Google Books ID t43gAAAAMAAJ at `https://books.google.com/books?id=t43gAAAAMAAJ`

{DeVinne 1895} DeVinne, Theodore Low, ed. "Type-founding." Article in *Johson's Universal Cyclopædia.* "New Edition," Vol. 8 (1895): 324–326. NY: D. Appleton & Company and A. J. Johnson Company, 1895.

This has been digitized by Google from the Princeton University copy:
`https://books.google.com/books?id=zVTgXVXe8vEC`

Local copy of that digitization: `archive-pd-ccby/johnsons-universal-cyclopaedia-vol-8-1895-google-yDVOAAAAYAAJ-princeton.pdf`

{DeVinne 1900} DeVinne, Theodore Low. *The Practice of Typography: Plain Printing Types.* NY: The Century Company, 1900

The first edition (copyright 1899, published 1900) has been digitized by Google from Harvard copy.
`https://books.google.com/books?id=R4-DjphIpLMC`

A better (than Google) digitization has been done by the Internet Archive of a University of California copy of the 1900 first edition. Available via the Internet Archive at:
`https://archive.org/details/practiceoftypogr00devirich/`

Here is a local copy of the PDF presentation of the UC digitization:
`archive-pd-ccby/devinne-1900-practice-of-typography-plain-printing-types-uc-archive-org-practiceoftypogr00devirich.pdf`

A better (than Google) digitization has been done by the University of Toronto, of their copy of the 1902 second edition. Available via the Internet Archive at:
`https://archive.org/details/practiceoftyppla00deviuoft/`

Here is a local copy of the PDF presentation of the Toronto digitization:
`archive-pd-ccby/devinne-1900-2ed-1902-practice-of-typography-plain-printing-types-toronto-archive-org-practiceoftyppla00deviuoft.pdf`

{Dingler 1863} Schmidt, Robert. "Beschreibung eines von dem Mechaniker H. Hofer construirten Ellipsographen." ["Description of an Ellipsograph constructed by the mechanic H. Hofer."] In *Polytechnisches Journal* ["Dingler's Polytechnisches Journal."] Vol. 167 (1863). Third book, article 34, p. 166–169 and Plate III. Augsburg: J. G. Cotta, 1863.

A digitization of this volume is online at the Saxon State and University Library Dresden digital collection at: `http://digital.slub-dresden.de/id30153534Z`. It is in the public domain

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{DGZ 1925-11-15} Essigke, M. "Eine neue Graviermaschine." In *Deutsche Graveur-Zeitung und Stempel-Zeitung.* Vol. 50, No. 22 (1925-11-15): 465–466.

This has been digitized by Google from the New York Public Library copy. https://books.google.com/books?id=zVTgXVXe8vEC Here is a local copy: archive-pd-ccby/deutsche-graveur-und-stempel-zeiting-49year-1924-google-zVTgXVXe8vEC-nypl.pdf The article of interest begins on PDF page image 861.

{Dohren 1780} Döhren, Jacob von. *Beschreibung eines sehr einfachen zur Verjüngung der Schattenrisse dienenden Storchschnabels, den sich jeder Liebhaber selbst verfertigen kann* [Description of a very simple pantograph (storchschnabel) used to remake silhouettes, which any enthusiast can make themselves.] Münster, Prince-Bishopric Münster [Holy Roman Empire]: DöhrenPhilipp Heinrich Perrenon, 1780.

This has been digitized by the Getty Research Institute from their copy and is available via the Internet Archive at: https://archive.org/details/beschreibungeine00dohr

{Duensing [n.d.]} Duensing, Paul Hayden. *Homespun: A Typographic Novelty by Andrew W. Dunker.* No location [Kalamazoo, MI?]: The Private Press and Typefoundry of Paul Hayden Duensing, [n.d.; not before 1999].

{Eckman 1960} Echman, James. "The Inland Type Foundry, 1894–1911." In *Printing and Graphic Arts.* Vol. 8. (1961): 31–52. Lunenburg, VT: The Stinehour Press, 1960.

{Eckman 1961} Eckman, James. "The Great Western Type Foundry of Barnhart Brothers and Spindler, 1869-1933." In *Printing and Graphic Arts.* Vol. 9. (1961): 1–32. Lunenburg, VT: The Stinehour Press, 1961.

{Eckman 1965} Eckman, Dr. James. *The Heritage of the Printer.* Volume 1. Philadelphia: North American Publishing Co., 1965.

{Edouart 1835} Edouart, Augustin-Amant-Constant-Fidèle. *A Treatise on Silhouette Likenesses.* London: Longman and Company, 1835.

This has been digitized by the Getty Research Institute from their copy and is available via the Internet Archive at: https://archive.org/details/gri_33125008682912/

{Eliot 2009} Eliot, Simon and Jonathan Rose, Eds. *A Companion to the History of the Book.* Chichester, West Sussex, UK: Wiley-Blackwell, 2009

{Elliott 1943} *Catalogue and Price List, Sixth Edition, of B. K. Elliott Co.* Pittsburgh, PA: B. K. Elliott Co., n.d. [1943].

This catalogue itself is undated. However, it contains (slipped in a pocket inside the back cover) a price list for this catalgue edition which is dated March 1943. The Universal Drafting Machine which is illustrated here from this catalogue, item 613402, had a wartime capped price of $75.00. Using a cost-of-living based calculation from `https://www.measuringworth.com/calculators/uscompare/` this works out to $1,360 in 2024 dollars. Good instruments were never cheap.

{Essigke 1925} Essigke, M. “Eine neue Graviermaschine.” In *Deutsche Graveur-Zeitung und Stempel-Zeitung.* Vol. 50, No. 22 (1925-11-15): 465–566.

Google digitization of the NYPL copy: `https://books.google.com/books?id=zVTgXVXe8vEC`

Local copy of the entire volume: `deutsche-graveur-und-stempel-zeiting-49year-1924-google-zVTgXVXe8vEC-nypl.pdf`

Local copy of the article, extracted: `archive-pd-ccby/deutsche-graveur-und-stempel-zeiting-49year-1924-google-zVTgXVXe8vEC-nypl-EXTRACT-michael-kampf-pantograph.pdf`

{Faraday 1831} Faraday, Michael. “Experimental Researches in Electricity [— First Series].” [§1 On the Induction of Electric Currents. §2 On the Evolution of Electricity from Magnetism. §3 On a New Electrical Condition of Matter. §4 On Arago’s Magnetic Phenomena.] Read 1831-11-24. *Philosophical Transations of the Royal Society of London.* Vol. 122, Part 1 (1832): 125–162. London: Richard Taylor, 1832.

The Wellcome Library’s digitization of their copy is online at The Internet Archive at: `https://archive.org/details/s3id13528680/`

{Faraday 1833a} Faraday, Michael. “Experimental Researches in Electricity — Third Series.” [§7. Identity of Electricities Derived from Different Sources. §8. Relation by Measure of Common and Voltaic Electricity.] Read 1833-01-10 and 1833-01-17. *Philosophical Transations of the Royal Society of London.* Vol. 123, Part 1 (1833): 23–54. London: Richard Taylor, 1833.

The Wellcome Library’s digitization of their copy is online at The Internet Archive at: `https://archive.org/details/s3id13528690/`

{Faraday 1833b} Faraday, Michael. “Experimental Researches in Electricity — Fifth Series.” [§11. On Electro-chemical Decomposition.] Received 1833-06-18, read 1833-06-20. *Philosophical Transations of the Royal Society of London.* Vol. 123, Part 2 (1833): 675–710 London: Richard Taylor, 1833.

The Wellcome Library’s digitization of their copy is online at The Internet Archive at: `https://archive.org/details/s3id13528690/`

On p. 703 he records the electrodeposition of silver.

{Faraday 1834} Faraday, Michael. “Experimental Researches in Electricity — Seventh Series.” [§11. On Electro-chemical Decomposition, Continued.] Received 1834-01-09, read 1834-01-23, 1834-02-06, and 1834-02-13. *Philosophical Transations of the Royal Society of London.* Vol. 124, Part 1 (1834): 77–122, Plate I. London: Richard Taylor, 1833.

The Wellcome Library’s digitization of their copy is online at The Internet Archive at: `https://archive.org/details/s3id13528700/`

On p. 104 he records the electrodeposition of tin.

{Faraday 1839–1855} Faraday, Michael. *Experimental Researches in Electricity.* 3 Vols. London: Taylor & Francis, 1839, 1844, & 1855. Reprinted: London: Bernard Quaritch, 1878, 1878, [probably] 1882.

The Wellcome Library digitizations of their holdings of the Quaritch reprint are online at The Internet Archive at:

https://archive.org/details/b21497916/

https://archive.org/details/b21497928/

ihttps://archive.org/details/b21498453/

{Filmer 1859} Filmer, William. "Electro-Metallurgy." *The Printer.* Vol. 1, [number unknown] (1858–1859): [pages unknown].

I have not seen the original publication of this article in *The Printer.* The citation here is derived from {Silver 1974}, p. 100 and from Silver's comment that it appeared nineteen years after Mapes' articles in *The American Repertory*. It must, therefore, have appeared in an 1859 issue of *The Printer*. It was, however, reprinted in Ringwalt's *American Encyclopædia of Printing* {Ringwalt 1871}, pp. 121–122.

{Filmer 1872} Filmer, William. "An American Art: The Electrotype. — Its Application to Printing Purposes." *The Overland Monthly.* Vol. 8, No. 6. (June 1872): San Francisco, CA: John Carmany, 1872.

Filmer's name is not cited in the article as it appears, but his authorship is confirmed in the Index volume to *The Overland Monthly* for 1872.

Digitized by The Internet Archive from an unidentified microfilm and online at: https://archive.org/details/sim_overland-monthly-and-out-west-magazine_1872-06_8_6/

Here is a local copy of the PDF presentation from that digitization: archive-pd-ccby/sim_overland-monthly-and-out-west-magazine_1872-06_8_6.pdf

{[Filmer] 1900} "Death of One of the First Electrotypers." [Obituary] *The Inland Printer.* Vol. 25, No. 2 (May 1900): 253–254.

A digitization by the Smithsonian Institution of their copy of this volume (which is incomplete) is online at The Internet Archive at: https://archive.org/details/inlandprinter251900chic/

Here is a local copy of the PDF presentation of this digitization: archive-pd-ccby/inland-printer-v025-n2-1900-05-inlandprinter251900chic-has-filmer-obituary-pp253-254.pdf

{Fromageot 1908} Fromageot, Paul. "Notice sur Gilles-Louis Chrétien, Inventeur du Physionotrace." In *Bulletin de la Société de l'Histoire de l'Art Français.* Volume of 1908. [Presented at the session of 1908-03-06.] Paris: Jean Schemit, 1908: 42–43.

See {Courboin 1908} for the availability of digital versions of this. This entire journal issue was in the public domain until the implementation in US law of the Uruguay round of the GATT in 1996. It re-entered the public domain in the USA in (1908 + 96) = 2004. Paul Hector Fromageot's dates are 1837–1914 (see: https://www.myheritage.com/names/paul_fromageot), so this article entered the public domain in Europe and elsewhere in (1914 + 75 + 1) = 1990. However, the use of some digitizations of this journal are restricted by license terms, not copyright law. See the bibliographic entry for {Courboin 1908} for more information.

{GB 1548 of 1854 Wiberg} British patent No. 1548 of 1854. "Improvements in the construction, setting up, and distribution of types for printing." See the CircuitousRoot Notebook on "Wiberg's Unit-Set Type: 1854" for a reprint of the abridged specification of this patent: `https://circuitousroot.com/artifice/letters/press/noncastcomp/unit-set-type/wiberg-1854/index.html`

{GB 11,894 of 1885 Benton} Benton, Linn Boyd. 1885. "Improvement in Machines for Cutting Punches and the like." UK Patent No. 11,894 of A.D. 1885. Filed by Alfred Julius Boult for Linn Boyd Benton. Specification dated October 6, 1885.

This is the GB patent filing equivalent to Benton's US patent 332,990, filed 1884.

{[Goodson 1900]} "The Goodson Graphotype — The Coming Automatic Compositor." In *The Inland Printer.* Vol. 26, No. 1 (October 1900): 158–159.

This volume has been digitized by the Smithsonian Institution Library and is available via the Internet Archive at: `https://archive.org/details/inlandprint2619001901chic`

Here is a local copy of the PDF presentation of this digitization: `archive-pd-ccby/inland-printer-v026-1900-10-to-1901-03-smithsonian-archive-org-inlandprint2619001901chic.pdf`

Here is a local copy of this article, extracted: `archive-pd-ccby/inland-printer-v026-1900-10-to-1901-03-smithsonian-archive-org-inlandprint2619001901chic-v026-n01-1900-10-pp158-159-goodson-graphotype.pdf`

{Gorton 1959} *Tracer-Controlled Pantograph Engraving Machines.* Racine, WI: George Gorton Machine Co., 1959.

This has been scanned by Keith Rucker and is available on the Vintage Machinery website at: `http://vintagemachinery.org/pubs/detail.aspx?id=28476` The publication date cited is from the metadata for Rucker's scan.

Local copy of Rucker's scan: `archive-pd-ccby/gorton-tracer-controlled-pantograph-engraving-machines-1580-L-vintagemachinery-org-28476.pdf`

{Gress 1924} E.G.G. [Edmund Geiger Gress] "Sketches and Impressions of an American Printer." In *The American Printer.* Vol. 78, No. 10 (May 20, 1924): 36–40. NY: Oswald Publishing Co., 1924.

Digitized by Google from the University of Michigan copy: `https://books.google.com/books?id=_gMhAQAAMAAJ`

Here is a local copy of that digitization of the entire volume: `archive-pd-ccby/american-printer-v078-1924-jan-jun-google-_gMhAQAAMAAJ-mich.pdf`

Here is a local copy of just Gress' article, extracted: `archive-pd-ccby/american-printer-v078-1924-jan-jun-google-_gMhAQAAMAAJ-mich-EXTRACT-v078-n10-pp036-040-gress-sketches.pdf`

{Gress 1932} E.G.G. [Edmund Geiger Gress] "E. G. G.'s Observations." In *The American Printer.* Vol. 94, No. 5 (May 1932): 52–53.

This column is of interest here because it reprints a letter from Nicholas J. Werner to Gress on the cutting of various typefaces.

Here is a PDF of a photocopy of these two pages:
american-printer-v094-1932-05-pp52-53-gress-nicolas-werner.pdf

{Gustafson 1933–1934} Gustafson, David. “Who’s Who in Printing in the United States and Canada.” In *American Printing Industry Bulletin.* No. 3 (1933) and No. 4 (1934). Pittsburgh, PA: [By the author], 1933–1934.

{Harwerth 1924} [Klingspor Type Foundry] Illus. by Willi Harwerth. *1924 Klingspor Kalender*. Offenbach am Main, Germany: Gebr. Klingspor, 1923.

{Hallock 1844} “Type, and Stereotype Plates. / [Exhibit No.] 573. Homan Hallock, Boston. Six Pages of Oriental Types.” *The Fourth Exhibition of the Massachusetts Charitable Mechanic Association at Quincy Hall, in the City of Boston, September 16, 1844.* Boston: By Crocker and Brewster for the Association.

The bulk of this volume consists of “Reports of the Judges” of the exhibition. Each exhibited entry was assigned a number. The section of interest here is that for ‘Printing, Printing Materials, &c.” and, within that, “Type, and Stereotype Plates.” Entry 573, on Homan Hallock, spans pages 131–134.

This has been digitized several times. One good digitization, by the Tisch Library of Tufts University, is available via the Internet Archive at
https://archive.org/details/exhibitionfairof00mass/ It combines the reports of several of these annual exhibitions, beginning with the first in 1837. In this digitization, the report of the fourth exhibition begins on PDF page image 459 and the entry on Hallock is on PDF page images 589–592. Here is a local copy of the PDF version of that digitization:
archive-pd-ccby/exhibitionfairof00mass.pdf

{Hallock 1865} Calhoun, S. H., with note by Homan Hallock. “Arabic Translations of the Bible.” *Bible Society Record, Containing Correspondence, Receipts, Etc., of the American Bible Society.* Vol. X, No. 12 (December 1865): 177–178.

Google digitization of the New York Public Library copy containing vols. 9 (1864) and 10 (1865):
https://books.google.com/books?id=wqRVAAAAYAAJ

Local copy of this volume: archive-pd-ccby/bible-society-record-vols-09-10-1864-1865-google-wqRVAAAAYAAJ-nypl.pdf The section on Hallock is on PDF images 376–377.

{Hallock 1866a} Hallock, Homan. “Arabic Type and the Bible.” In the *Bible Society Record, Containing Correspondence, Receipts, Etc., of the American Bible Society.* Vol. XI, No. 1 (January 1866): 4–5.

Google digitization of the New York Public Library copy:
https://books.google.com/books?id=6aBVAAAAAYAAJ

Local copy of these pages, extracted:
archive-pd-ccby/bible-society-record-v11-n01-1866-06-google-6aBVAAAAAYAAJ-nypl-homan-hallock-pantograph-used-in-hand-punchcutting.pdf

Local copy of the entire NYPL/Google volume: archive-pd-ccby/bible-society-record-v11-12-1866-google-6aBVAAAAAYAAJ-nypl.pdf

{Hallock 1866b} “Syria — Arabic Bible.” In the *Forty-First Annual Report of the American Tract Society.* May 9, 1866. New York: American Tract Society, 1866.

The report on the production of an Arabic Bible in Syria, part of a section of reports on "Foreign and Pagan Lands," appears on page 145–146. It is in essence a brief summary of {Hallock 1866a}.

Google digitization of several volumes of these reports, including this one: `https://books.google.com/books?id=H2JBAQAAMAAJ`

Local copy of the same: `archive-pd-ccby/american-tract-society-annual-report-38-1863-google-H2JBAQAAMAAJ-minn.pdf`

{[Hawkins 1803 (1804)]} "Specification of the Patent granted to John Isaac Hawkins, of Bordenton, in the United States of America; now residing in Lisle-street, in the County of Middlesex; for new Machinery and Methods for Writing, Painting, Drawing, Ruling Lines and other Things, and for applying Parts of that Aforesaid Machinery to other Purposes. Dated September 24, 1803." In *The Repertory of Arts, Manufactures, and Agriculture.* Second Series, No. 23 (April 1, 1804): 327–340, Plate XII. Collected in the *Repertory*…, Volume IV, Second Series (London: For J. Wyatt, Repertory-Office, 1806).

This has been digitized several times. Unfortunately, each of the digitizers failed to unfold the plate and, consequently, our knowledge of Hawkins' actual patent invention is severely compromised.

The digitization by the Münchener DigitisierungsZentrum is available at: `https://www.digitale-sammlungen.de/en/view/bsb10305622` It is generally of high quality, but the plate is unopened. This is unusual for German digitizations, and their digital rights statement implies the presence of an unidentified commercial party, so this may not have been done by them. The licensing asserted for this digitization restrict it to noncommercial use, which is incompatible with the broader attribution-only (CC BY) license used here.

The digitization by Google of the Oxford University copy, Google Books ID 6EkEAAAAQAAJ, is of lower quality and also fails to unfold the plate. The view of the plate, though, does show slightly more of the figure (figure 17?) depicting the silhouette application of Hawkins' machine. Public domain.

The digitization by Google of the Österreichische Nationalbibliothek copy is available at the ONB at: `https://viewer.onb.ac.at/10A2B707/` It fails to unfold the plate in yet another way (which reveals more of figures 19 and 21). The ONB presentation is restricted by license to noncommercial use only.

Various other digitizations, all by Google, are similarly flawed. See {Bedini 1984} for the only currently known full reproduction of the plate from Hawkins' 1804 English patent.

{Hawkins 1807} Hawkins, John Isaac. "Observations on Mr. Schmalcalder's Patent for a Machine for Tracing and Cutting Out Profiles." In *The Repertory of Arts, Manufactures, and Agriculture.* Second Series, No. LX (May 1807): 459–462.

This has been digitized by Google from a University of Michigan copy. Google ID: z9k0AAAAMAAJ.

{Hennequin 1926–1927} Hennequin, René. *Edme Quenedey des Riceys (Aube): Portraitiste au Physionotrace (1756–1830).* Troyes: J. L. Paton, 1926–1927.

Part 1, covering Quenedey's life, was published in 1926. Part 2, paginated consecutively with Part 1 and covering his work, was published in 1927.

Digitized by the "Gallica" digital library of the Bibliothèque nationale de France at: `https://gallica.bnf.fr/ark:/12148/bpt6k97716477/f176.item`

{[Hofer 1864 1118]} "Maschinen für engl. Siegel." [Advertisement] In *Illustrirte Zeitung*. Vol. 43, Whole No. 1118 (1864-12-03): p. 399.

This has been digitized by an unidentified source in Russia and is online at `https://opac.nekrasovka.ru/books/NEWSPAPERS/GUR/IZG/1864/IZG_1864_1118.pdf`

{[Hofer 1865 ARP]}*Amts-Blat der Königlichen Regierung zu Potsdam under der Stadt Berlin.* For 1865. Potsdam, Kingdom of Prussia, 1865.

Digitized by Google from the Bavarian State Library copy: `https://books.google.com/books?id=fCE_AAAAcAAJ` Here is a local copy: `amtsblatt-der-regierung-in-potsdam-1865-google-fCE_AAAAcAAJ-bavarian-state-library.pdf` The volume contains several independently paginated sections, and it doesn't help that pp. 75 and 76 of the section in question are in the wrong order here. The entry for Hermann Hofer is on PDF page image 176, which is p. 75. of Stück 7, 17 Februar 1865.

{[Hofer 1877 AB]} *Berliner Adreßbuch: für das Jahr 1877.* Berlin, Germany: Societät der Berliner Bürger-Zeitung, 1877.

The entry for Hofer is on p. 187.

Digitized by Google from the Bavarian State Library copy: `https://books.google.com/books?id=wqRVAAAAYAAJ` Here is a local copy: `archive-pd-ccby/berliner-adressbuch-1877-google-OsN448FPN0oC-bavarian-state-library-HOFER-on-p197.pdf`

{[Hofer 1879-12-27]} Martens, A. "Die wissenschaftlichen Instrumente auf der Berliner Gewerbeausstellung von 1879." ["The scientific instruments at the Berlin Trade Exhibition of 1879"] In *Wochenschrift des Vereines Deutscher Ingenieure.* Jahrgang 1879, No. 52: p. 487. Berlin: Published by the Association, 1879.

{Hopkins 1976} Hopkins, Richard L. *Origin of the American Point System for Printers' Type Measurement.* Terra Alta, WV: Hill & Dale Press, 1976.

Rich reset and reprinted this book in a slipcased edition in 1989. The contents of both editions are the same.

{Horgan 1938} Horgan, Stephen H. "The Old Maestro Leaves." [Obituary for Henry Lewis Bullen.] In *The Inland Printer.* Vol. 101, No. 2 (May 1938): 33–35.

{*Inland Printer* 1884} [Untitled trade notice.] *The Inland Printer.* Vol. 1, No. 10 (July 1884): 21.

The image reprinted here was scanned by DMM from the University of Wisconsin's copy. This rare volume has since been digitized by The Smithsonian Institution's Library from their copy. It is available via the Internet Archive at: `https://archive.org/details/inlandprinte118831884chic`

Here is a local copy of the PDF presentation of the Smithsonian's digitization: `inland-printer-v001-1883-1884-smithsonian-via-archive-org-inlandprinte118831884chic.pdf`

{*Inland Printer* 1886} [Multiple items.] *The Inland Printer.* Vol. 3 (October 1885 – September 1886).

Three items in this volume are of interest here:

An announcement of Bledsoe's "Self-Spacing Type." (Vol. 3, No. 8 (May 1886): 473.)

Benton's rebuttal of this. (Vol. 3, No. 11 (August 1886): 716–717.)

A brief account of a visit to the Northwestern Type Foundry. (Vol. 3, No. 12 (September 1886): 789.)

An incomplete original copy of this volume (which nonetheless contains all of the material cited here) has been digitized by the Smithsonian and is available at the Internet Archive: `https://archive.org/details/inlandprinte318851886chic/`

Here is a local copy of the PDF presentation of that digitization: `archive-pd-ccby/inland-printer-v003-1885-10-to-1886-09-smithsonian-archive-org-inlandprinte318851886chic-INCOMPLETE.pdf`

A poorer digitization of a more complete copy, from the University of Minnesota, has been done by Google and is available at: `https://books.google.com/books?id=em0eAQAAMAAJ`

Here is a local copy of that digitization: `archive-pd-ccby/inland-printer-v003-1885-10-to-1886-09-google-em0eAQAAMAAJ-minn.pdf`

{*Inland Printer* 1925} "Two Men Whose Work Greatly Benefits All Typographers." In *The Inland Printer.* Vol. 76, No. 3 (December 1925): 453.

This issue has also been digitized by the Internet Archive from microfilm and is available at: `https://archive.org/details/sim_american-printer_1925-12_76_3/`

Here is a local copy of the PDF presentation of that digitization: `archive-pd-ccby/inland-printer-v076n3-1925-12-sim_american-printer_1925-12_76_3.pdf`

{Jackson 1911} Jackson, Emily Nevill. *The History of Silhouettes.* London: The Connoisseur, 1911.

This has been digitized at least twice: by the University of Toronto (available via the Internet Archive at: `https://archive.org/details/historyofsilhoue00jackuoft`) and by the University of California (available via the Internet Archive at: `https://archive.org/details/historyofsilhoue00jack`)

{Jacobi 1840} Jacobi, Dr. M[oritz] H[ermann] von. *Die Galvanoplastik, oder das Verfahren cohärentes Kupfer in Platten oder nach sonst gegebenen Formen, unmittelbar aus Kupferauflösungen, auf galvanischem Wege zu produciren.* St. Petersburg, Russia: Eggerrs et. Co., 1840.

A fine digitization of this is online on the ETH's e-rara digital library at: `https://doi.org/10.3931/e-rara-59157`

(The Google digitization of the Harvard University copy, Google Books ID gCANAAAAYAAJ, does not have its plate folded out and is of very limited use. Additionally, the version now served by Google is corrupt; a version captured previously by The Internet Archive is ok, but its plate is still useless.)

{Jacobi 1841} Jacobi, Dr. M[oritz] H[ermann] von. Trans. William Sturgeon. *Galvanoplastik; or the process of cohering copper into plates, or other given forms, by means of Galvanic Action on copper solutions.* Manchester, UK: Josiah Leicester, 1841.

A digitization of the State Library of Pennsylvania's copy is online at The Internet Archive at: `https://archive.org/details/galvanoplastikor00jaco/`

Here is a local copy of the PDF presentation from that digitization: `archive-pd-ccby/galvanoplastikor00jaco.pdf`

{Japanese Visit 1872} *Diary of the Japanese Visit to Philadelphia in 1872.* Philadelphia, PA: Henry B. Ashmead, 1872.

Google digitization of the Univ. of Illinois (ex-Harvard) copy: https://books.google.com/books?id=TC5HAQAAMAAJ. Local copy: archive-pd-ccby/diary-of-the-japanese-visit-to-philadelphia-1872-google-TC5HAQAAMAAJ-illinois-ex-harvard.pdf

{JBSVF 1879-06-25} *Journal für Buchdruckerkunst, Schriftgiesserei und die Verwandten Fächer.* Vol. 46, No. 25 (1879-06-25). Braunschweig, Germany: Joh. Heinr. Meyer, 1879.

Google digitization of the Deutsches Museum copy: https://books.google.com/books?id=5rbxfePxr-IC Here is a local copy of the entire volume: journal-fur-buchdruckerkunst-schriftgiesserei-und-die-verwandten-facher-vol046-1879-google-5rbxfePxr-IC-deutsches-museum.pdf The report on Hofer's Matrizen-Bohrmaschine is in the "correspondenz" section, on column 490 (PDF page image 263).

{Johnson 2014} Johnson, Brian. "American Arabic." In *Alma Mater Newsletter.* No. 17: 18–20. Istanbul: Health and Education Foundation, 2014.

This is a newsletter of the Sağlık ve Eğitim Vakfı (Health and Education Foundation) in Turkey. It is undated, but an examination of the PDF internals reveals a creation date of 2014-11-23. A copy of it is online on the website of the Digital Library for International Research at http://www.dlir.org/archive/archive/files/56c4983f83800ee60d93afdd30d24335.pdf

{Kahan 2000} Kahan, Basil. *Ottmar Mergenthaler: The Man and His Machine.* New Castle, DE: Oak Knoll Press.

{Kaup 1909} Kaup, W. J. "Modern Automatic Type Making Methods." *American Machinist.* Vol. 32 (Dec. 16): 1042-1046.

This volume of *American Machinist* as digitized by Google from the Princeton Univ. copy is at: https://babel.hathitrust.org/cgi/pt?id=njp:32101048918864

This article, extracted from the Google digitization of the Princeton copy, is reprinted on the CircuitousRoot Notebook of "General Literature On Making Printing Matrices and Types." http://www.CircuitousRoot.com/artifice/letters/typemaking/literature/general/index.html

Here is a local copy of that extract: archive-pd-ccby/american-machinist-v032pt2-1909-hathi-njp-32101048918864-kaup-modern-automatic-type-making-methods.pdf

{Kelly 1883 CP} [Kelly, W. J.] "Copper Alloy Type Metal." In *The Chicago Printer.* Vol. 1, No. 1 (April 1883): 29.

This contains a reprint of Kelly's article about the Central Type Foundry which first appeared in *The American Model Printer*.

Digitized by Goole from the University of Chicago copy: https://books.google.com/books?id=cR0xAQAAMAAJ

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{Kelly 1883 H} [Kelly, W. J.] “A Few More Novelties.” In *Hailing’s Circular.* Vol. 2, No. 13 (Spring 1883): 4.

This contains a reprint of Kelly’s article about the Central Type Foundry which first appeared in *The American Model Printer*.

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Here is a local copy of just this number, extracted: `archive-pd-ccby/hailings-circular-v02-google-C7ZbAAAAQAAJ-oxford-extract-v2n13-spring-1883.pdf`

{Kemp 1990} Kemp, Martin. *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat.* New Haven, CT: Yale University Press, 1990.

{Klingspor 2007} “Ludwig & Mayer.” In the “Archiv der internationalen Schriftdesigner / International Type Designer Archive” of the Klingspor Museum, Offenbach. `https://www.klingspor-museum.de/Schriftgiessereien.html` Accessed 2025-10-16.

This document is undated, but the PDF internals reveal a creation and last modificaiton date of 2007-10-24. The document itself is at `https://www.klingspor-museum.de/KlingsporKuenstler/Schriftgiessereien/LundM/Ludwig_Mayer.pdf`

{Koch 1931} Koch, Rudolf. *Vom Stempelschneiden. Gutenberg-Jahrbuch.* (1931): 290-292. Mainz, DE: A. Ruppel, 1931.

This is an earlier version of the article which appeared in English as “On Punch-Cutting” in *The Colophon* {Koch, Kredel 1932}. The original German article has only one illustration.

{Koch, Kredel 1932} Koch, Rudolf and Fritz Kredel. With Warren Chappell. “On Punch-Cutting & Wood-Cutting.” *The Colophon.* [Series 1] Part 10. NY: The Colophon Ltd. [The Pynson Printers], 1932.

These are two separate articles combined under a single title: “Punch-Cutting” by Koch (four pages) and “Wood-Cutting” by Kredel (two pages). *The Colophon* was a quarterly journal composed of individual submissions by various authors and presses, each printed separately by their contributors before they were bound together in one volume. It has no overall pagination; this article has no internal pagination.

This article appeared earlier, in German, as *Vom Stempelschneiden* in the *Gutenberg-Jahrbuch* {Koch 1931} In the English language version the single illustration from the original is split into two and two additional illustrations appear.

{Koch 1933} Koch, Paul. Illus. Fritz Kredel. “The Making of Printing Types.” *The Dolphin: A Journal of the Making of Books.* Vol. 1 (1933): 24–57. NY: The Limited Editions Club [Macy’s], 1933.

{Langbein 1891} Langbein, George. Trans. and additions by William T. Brannt. *A Complete Treatise on the Electro-deposition of Metals.* Philadelphia, PA: Henry Carey Baird & Co., 1891.

The Library of Congress digitization of their copy is online at The Internet Archive at: `archive-pd-ccby/https://archive.org/details/completetreatise06lang/`

Here is a local copy of the PDF presentation from that digitization: `archive-pd-ccby/langbein-1891-a-complete-treatise-on-the-electro-deposition-of-metals-loc-archive-org-completetreatise06lang`

{Lanston 1942} *Parts Price List: Montype-Thompson Type-Caster.* Effective, March 11, 1941 (Revised April 2, 1942). Philadelphia, PA: Lanston Monotype Machine Company, 1942.

This has been reprinted in the CircuitousRoot Notebook “Thompson Typecaster Source Material: An Anthology” at `https://www.circuitousroot.com/artifice/letters/press/noncomptype/casters/thompson/anthology/index.html` Thanks are due to Sky Shipley of Skyline Type Foundry `https://www.skylinetype.com` for making this material available.

Here is a copy as uploaded to the Internet Archive: `https://archive.org/details/MonotypeThompsonTypeCasterPartsPriceList1942`

Here is a local copy as a PDF: `archive-pd-ccby/archive-pd-ccby/monotype-thompson-typecaster-parts-list-1942-25pct-of-1200dpi.pdf`

{Lavater 1776} Lavater, Johann Caspar. *Physiognomische Fragmente zur Beförderung der Menschenkenntnisze und Menschenlie* [Physiognomic fragments for the advancement of knowledge and love of human nature]. Zweyter Versuch [Volume 2, text volume]. Leipzig, Electorate of Saxony and Winterthur, Switzerland: Weidmanns Erben and Heinrich Steiner, 1776.

This has been digitized by the library of the ETH, Zürich, and is available via the e-rara.ch digital platform at: `https://www.e-rara.ch/zut/ch18/content/titleinfo/295255`. Public domain.

{Legros & Grant 1916} Legros, Lucien Alphonse and John Cameron Grant. *Typographical Printing Surfaces.* London: Longman, Green and Co., 1916

See the CircuitousRoot Notebook “General Literature On Making Printing Matrices and Types” for two reprints: `https://www.circuitousroot.com/artifice/letters/press/typemaking/literature/general/index.html#legros-grant`

{Lockwood 1894} *American Dictionary of Printing and Bookmaking.* NY: Howard Lockwood & Co., 1894.

{Lohf 1980} Lohf, Kenneth A., ed. 1980. *The History of Printing from Its Beginnings to 1930: The Subject Catalogue of the American Type founders Company Library in the Columbia University Libraries.* Four Volumes. Millwood, NY: Kraus International Publications.

The main title of this book is misleading. It is not a history, but is simply a photographic reprint of the index cards comprising the catalog of the American Type Founders Library, eighteen to a page, ordered within subject categories. These catalog cards were created by Henry Lewis Bullen, librarian of the ATF Library. Lohf, a rare book librarian at Columbia University, has added a useful introduction.

{Loy 1898-02 No. 1} Loy, William E. “Designers and Engravers of Type” [No. 1 in the series]. *The Inland Printer.* Vol. 20, No. 5 (1898-02), p. 621.

{Loy 1898-12 No. 11} Loy, William E. “Gustav F. Schroeder.” No. 11 in the series “Designers and Engravers of Type.” *The Inland Printer.* Vol. 22, No. 3 (1898-12), p. 338.

{Loy 1899-04 No. 15} Loy, William E. “Edwin C. Ruthven.” No. 15 in the series “Designers and Engravers of Type.” *The Inland Printer.* Vol. 23, No. 1 (1899-04), p. 64.

{Loy 1899-08 No. 19} Loy, William E. “Nicholas J. Werner” No. 19 in the series “Designers and Engravers of Type.” *The Inland Printer.* Vol. 23, No. 5 (1899-08), p. 595.

{Loy 1899-12 No. 23} Loy, William E. “Charles Henry Beeler [Jr.]” No. 23 in the series “Designers and Engravers of Type.” *The Inland Printer.* Vol. 24, No. 3 (1899-12), p. 417.

This series of articles by Loy has been collected in the CircuitousRoot Notebook “‘Designers and Engravers of Type’: William E. Loy” at `https://www.CircuitousRoot.com/artifice/letters/press/typemaking/literature/general/loy/index.html`.

The versions collected in the Notebook mentioned above were done some years ago, from low-quality Google scans. These volumes of *The Inland Printer* have been digitized more recently by the Smithsonian Institution Library at a higher quality level (though still far from perfect).

Smithsonian digitization of Vol. 22, at the Internet Archive:
`https://archive.org/details/inlandprint2218981899chic/`

Local copy of this digitization: `archive-pd-ccby/inland-printer-v022-1898-08-to-1899-03-smithsonian-archive-org-inlandprint2218981899chic.pdf`

Smithsonian digitization of Vol. 23, at the Internet Archive:
`https://archive.org/details/inlandprinter231899chic/`

Local copy of this digitization: `archive-pd-ccby/inland-printer-v023-1899-04-to-1899-09-smithsonian-archive-org-inlandprinter231899chic.pdf`

Smithsonian digitization of Vol. 24, at the Internet Archive:
`https://archive.org/details/inlandprint2418991900chic`

Local copy of this digitization: `archive-pd-ccby/inland-printer-v024-1899-10-to-1900-03-smithsonian-archive-org-inlandprint2418991900chic.pdf`

However, it is worthwhile to acquire a copy of the Saxe/Johnston edition of these articles, to which Steve Saxe added specimens of most of the types mentioned: {Loy, Saxe, & Johston 2009}.

{Loy, Saxe, & Johnston 2009} Loy, William E., and Stephen O. Saxe and Alastair M. Johnston, eds. *Nineteenth-Century American Designers and Engravers of Type.* New Castle, DE: Oak Knoll Press, 2009.

This book collects the 28 articles by Loy which appeared in *The Inland Printer* under the series title “Designers and Engravers of Type.” from 1898 to 1900. To these, Saxe has added specimens of most of the types mentioned by Loy, from his own collection. The late Steve Saxe gathered a notable collection of type specimen books; these are now at the Cary Graphic Arts Collection of the Rochester Institute of Technology.

{MacMillan 2018} MacMillan, David M. “The Pantograph Demythologized.” (Set of slides accompanying a presentation of the same title at the 2018 American Typecasting Fellowship Conference held at M&H Typpe Foundry in San Francisco.) Mineral Point, WI: CircuitousRoot, 2018.

This set of slides is online on the CircuitousRoot notebook “Pantographs (Mostly for Typographical Work” at `https://www.CircuitousRoot.com/artifice/letters/pantocut/index.html` It is presented there in both a short version (about 50 slides) and a long version (over 120 slides). During the presentation I actually spoke to about 30 of the slides. References here will be to the page numbers of the long version (which are off by 1 from the PDF image numbers).

{MacMillan 2023} MacMillan, David M. *A Census of Benton and Related Pantographic Engraving Machines.* Revision 13. Mineral Point, WI: CircuitousRoot, 2023.

This is online on the CircuitousRoot Notebook on “The Benton Pantographs”. This document is subject to revision; please see this canonical distribution location for the current edition: `https://CircuitousRoot.com/artifice/letters/pantocut/benton/index.html`

{Mallison 1976} Mallison, David Walker. *Henry Lewis Bullen and the Typographic Library and Museum of The American Type Founders Company.* A dissertation submitted for the degree of Doctor of Library Science, School of Library Service, Columbia University, 1976.

{Mapes 1840 April} [Mapes, James J.] “Copies of Medals and Engravings by Galvanism.” *The American Repertory of Arts, Sciences, and Manufactures.* Vol. 1, No. 3 (April 1840): 201–202. NY: W. A. Cox, 1840.

The identification of the publisher is from {Silver 1974}: 85.

A digitization of a microfilm copy of this number of *The American Repertory*, from an unknown source, is online at The Internet Archive at: `https://archive.org/details/sim_american-repertory-of-arts-science-and-manufactures_1840-04_1_3`

Here is a local copy of the PDF presentation from that digitization: `archive-pd-ccby/sim_american-repertory-of-arts-science-and-manufactures_1840-04_1_3.pdf`

{Mapes 1840 May} See {Spencer & Mapes 1840}. The material in *The American Repertory* for this month consisted primarily of a reprint of Spencer’s article (with only a small contribution by Mapes).

{Mapes 1840 June} [Mapes, James J.] “Medals, &c. Formed, by Precipitating Copper from its Solutions, by Galvanism.” *The American Repertory of Arts, Sciences, and Manufactures.* Vol. 1, No. 4 (May 1840): 349–354. NY: W. A. Cox, 1840.

Mapes’ article also reprints a letter to the editor (Richard Taylor) of the *London and Edinburgh Philosophical Magazine* (April 1840).

The identification of the publisher is from {Silver 1974}: 85.

A digitization of a microfilm copy of this number of *The American Repertory*, from an unknown source, is online at The Internet Archive at: `https://archive.org/details/sim_american-repertory-of-arts-science-and-manufactures_1840-05_1_4`

Here is a local copy of the PDF presentation from that digitization: `archive-pd-ccby/sim_american-repertory-of-arts-science-and-manufactures_1840-05_1_4.pdf`

{Mapes 1840 July} [Mapes, James J.] “Electrotype Copies of Medals, Copper Plates, Types, &c. &c.” *The American Repertory of Arts, Sciences, and Manufactures.* Vol. 1, No. 6 (July 1840): 434–436. NY: W. A. Cox, 1840.

The identification of the publisher is from {Silver 1974}: 85.

A digitization of a microfilm copy of this number of *The American Repertory*, from an unknown source, is online at The Internet Archive at: `https://archive.org/details/sim_american-repertory-of-arts-science-and-manufactures_1840-07_1_6/` It does not include the two plates referred to in this article.

Here is a local copy of the PDF presentation from that digitization: `archive-pd-ccby/sim_american-repertory-of-arts-science-and-manufactures_1840-07_1_6.pdf`

{[Matrix 1981–2003]} *Type & Typography. Highlights from Matrix, the review for printers and bibliophiles.* Intro. John Randle and John D. Berry. West New York NJ: Mark Batty Publisher, LLC, 2003.

{McGrew 1986} McGrew, Mac. *American Metal Typefaces of the Twentieth Century.* Prliminary Edition. New Rochelle, NY: Myriade Press, Inc. 1986).

This is the first edition of {McGrew 1993}, privately circulated by McGrew in order to solicit additional information and contributions.

{McGrew 1993} McGrew, Mac. *American Metal Typefaces of the Twentieth Century.* Second Edition. New Castle, DE: Oak Knoll Books, 1993.

This second edition is the first widely distributed version of this book. The actual first edition of this book was the privately circulated "Preliminary Edition," {McGrew 1986}.

{McMillan 1890} McMillan, Walter G. *A Treatise on Electro-Metallurgy.* London: Charles Griffin & Company, 1890.

A digitization of a University of California copy is online at:
`https://archive.org/details/treatiseonelectr00mcmirich`

Here is a local copy of the PDF version of that presentation:
`archive-pd-ccby/treatiseonelectr00mcmirich.pdf`

{Mergenthaler 1961} *The Eighth Wonder.* Film, approx. 25 minutes. Brooklyn, NY: Mergenthaler Linotype Company, 1961.

This film is online on Doug Wilson's `https://printingfilms.com/` website.

{Middleton 1937} Middleton, R. Hunter. *Chicago Letter Founding.* Chicago: The Black Cat Press, 1937.

A scan of my copy of this is online at The Internet Archive:
`https://archive.org/details/MiddletonChicagoLetterFounding1937`

Here is a local PDF:
`archive-pd-ccby/middleton-chicago-letter-founding-0600dpijpg.pdf`

{Middleton 1938} Middleton, R. Hunter. *Making Printers' Typefaces.* Chicago: The Black Cat Press [Middleton's private press], 1938.

A scan of my copy of this is online at The Internet Archive:
`https://archive.org/details/MiddletonMakingPrintersTypefaces1938/`

Here is a local copy PDF:
`archive-pd-ccby/middleton-making-printers-typefaces-1938-0600dpijpg.pdf`

{Miles 1994} Miles, Ellen G. *Saint-Mémin and the Neoclassical Profile Portrait in America.* Washington, DC: National Portrait Gallery and the Smithsonian Institution Press, 1994.

{Monotype 1956} The Monotype Corporation Limited. *'Making Sure' At the Monotype Works: Type Faces In the Making.* Film. Peak Film Productions, 1956.

This film is online on Doug Wilson's `https://printingfilms.com/` website.

{Mosley 2015} Mosley, James. "Big Brass Matrices: A Mystery Resolved?" *Journal of the Printing Historical Society.* New Series, No. 23 (2015): 45–48.

{Mullen 2005} Mullen, Robert A. *Recasting a Craft: St. Louis Typefounders Respond to Industrialization.* Carbondale, IL: Southern Illinois University Press, 2005.

{Nelson et al. 2020} Nelson, Raymond Stanley, Stephen O. Saxe, David M. MacMillan, Richard L. Hopkins. Ed. Richard L. Hopkins. *Making Printers' Type.* Terra Alta, WV: Hill & Dale Private Press and Typefoundry, 2020.

The second chapter of this book is a reprint Steve Saxe's paper on the pivotal caster, patrix cutting/matrix electroforming, and the way in which they enabled 19th Century complex and ornamented types (see {Saxe 2013}). This paper had first been published by the Printing Historical Society in their journal ({Saxe 2016}), but somehow during this process an error was introduced in the description of the mechanism of the drag pin. Saxe corrected this error here, though he did not live to see this book go to press.

{Nemeth 2017} Nemeth, Titus. *Arabic Type-Making in the Machine Age.* Leiden, The Netherlands: Brill, 2017.

{Nimura 2016} Nimura, Janice P. *Daughters of the Samurai: A Journey from East to West and Back.* NY: W. W. Norton.

{Nordin 1881} Nordin, Joh. Gabr. *Handbok i Boktryckarekonsten.* Stockholm, P. A. Norstedt & Söners, 1881.

This has been digitized by Google from the NYPL copy. `https://books.google.com/books?id=5o5QAAAAYAAJ` Here is a local copy: `nordin-1881-handbok-i-boktryckarekonsten-google-5o5QAAAAYAAJ-nypl.pdf` A better digitization (though harder to download) has been done by Project Runeberg: `http://runeberg.org/download.pl?mode=3Dwork&work=3Dnjgboktr`

{[Otto 1892]} "Neue Reliefgraviermaschine." *Archiv für Buchdruckerkunst und Verwandte Geschäftsweige.* Vol. 29, part 2 (1892): 47.

Google digitization of the Princeton University copy: `https://books.google.com/books?id=5rbxfePxr-IC`

Local copy of this digitization: `archive-pd-ccby/archiv-fur-buchdruckerkunst-und-verwandte-geschaftszweige-v29-1892-google-5TYZAAAAYAAJ-princeton.pdf`

{Paskso 1894} [Pasko, Wesley Washington, ed.] *American Dictionary of Printing and Bookmaking.* NY: Howard Lockwood & Co., 1894.

Despite its importance, this book has yet to receive a high quality digitization. The Google Books digitization of the Stanford University copy may be the best presently available. It is available via the Internet Archive at https://archive.org/details/americandiction00paskgoog/

{Peale 1803} Peale, Charles Willson. "Description of the Physiognotrace." From *Founders Online,* National Archives, version of January 18, 2019, https://founders.archives.gov/documents/Jefferson/01-39-02-0352-0002. [Original source: *The Papers of Thomas Jefferson.* Vol. 39, 13 November 1802–3 March 1803. Ed. Barbara B. Oberg. (Princeton: Princeton University Press, 2012): pp. 408–409.] The image and the text of Peale's letter are in the public domain. The original digitization of this image is at the US Library of Congress Prints & Photographs Online Catalog, at: https://www.loc.gov/pictures/item/2006688560/ (though, curiously, only a low-resolution version displays there).

{Peale 1857} Peale, Rembrandt. "The Physiognotrace." In *The Crayon.* Vol. 4, Part 10 (October 1857): 307–308.

This has been digitized by Google from a University of Virginia copy and is available via the Hathi Trust at: https://catalog.hathitrust.org/Record/012201121, https://babel.hathitrust.org/cgi/pt?id=uva.x002023141

{Pellehn 1903} Pellehn, G. "Der Pantograph. Vom Urstorchschnabel zur modernen Zeichenmaschine: 1603–1903." In *Deutsche Mechaniker-Zeitun.* Parts 1 ("Theorie") and 2 ("Die Übertragung") appeared in No. 10 (1903-05-15): 85–90. Part 3 ("Der Storchschnabel des Zeichners und seine Entwickelung") began in No. 11 (1903-06-01): 93–95, continued in No. 12 (1904-06-15): 105–107, No. 13 (1903-07-01): 113–117, and No. 14 (1903-07-15): 125–129. This journal was published as a supplementary journal to the *Zeitschrift für Instrumentenkunde* and appeared together with the 23rd year (1903) of that journal. Berlin: Julius Springer, 1903.

Digitization of the entire 23rd year of the *Zeitschrift für Instrumentenkunde*, including the *Deutsche Mechaniker-Zeitun.* by Google from the Deutsches Museum copy: https://books.google.com/books?id=7hgzAQAAMAAJ

Local copy of Pellehn's article, extracted: archive-pd-ccby/zeitschrift-fur-instrumentenkunde-and-deutsche-mechaniker-zeitung-1903-google-7hgzAQAAMAAJ-chicago-EXTRACT-pellehn-der-pantograph.pdf

{*Printers' Circular* 1884} Menamin, R. S., ed. "Self-Spacing Type." *Printers' Circular and Stationers' and Publishers' Gazette.* Vol. 18, No. 12 (February 1884): 243.

Digitized by Google from a University of Califonia copy: https://books.google.com/books?id=Q9VBAQAAIAAJ

Here is a local copy of the entire volume from Google's digitization: archive-pd-ccby/printers-circular-v18-1883-03-to-1884-02-google-Q9VBAQAAIAAJ-uc.pdf

{Rayher 2025} Rayher, Ed. *The Benton Protocol: Theory and Practice for Matrix Engraving.* Northfield, MA: Swamp Press, 2025.

{Rehak 1993} Rehak, Theo. *Practical Typecasting.* New Castle, DE: Oak Knoll Books, 1993.

Through the gracious permission of Theo, this is now online at: https://CircuitousRoot.com/artifice/letters/press/typemaking/literature/general/index.html#rehak

{Reynolds 2021} Reynolds, Dan. "An independently-invented matrix-engraving machine: The 'Ludwig–Hofer pantograph.'" Website posting dated 10 September 2021. `https://www.typeoff.de/2021/09/ludwig-hofer-pantograph/` Accessed 2025-10-16.

{Ringwalt 1871} Ringwalt, J. Luther. *American Encyclopædia of Printing.* Philadelphia, PA: Menamin & Ringwalt and J. B. Lippincott & Co., 1871.

Despite its importance, it would seem that a good digitization of Ringwalt has not been done by any university library. A digitization by the Scientific and Technical Information Center (STIC) of the United States Patent and Trademark Office is the best available version. This is online at The Internet Archive: `https://archive.org/details/0069AMER`

Here is a local copy of the PDF presentation from that digitization: `archive-pd-ccby/ringwalt-1871-american-encyclopaedia-of-printing-uspto-archive-org-0069AMER.pdf`

{Rippey 1882} *United States Census and Business Manual.* Ninth Edition. [Copyright April 10, 1882] Cincinnati, OH: J. Rippey & Co.

{Rollins 1947} Rollins, Carl Purington. "American Type Designers and Their Work." [Materials to accompany an exhibition at The Lakeside Press Galleries of R. R. Donnelley & Sons Company, Chicago, Illinois: 1947–1948.]

Digitally reprinted in the CircuitousRoot Notebook on Rollins: `http://www.CircuitousRoot.com/artifice/letters/press/history-of-printing/heroic-age/rollins/index.html`

{Rollins 1948} Rollins, Carl Purington. "American Type Designers and Their Work." *Print.* Vol. 5, No. 4 (1948): 1-20.

This is a reprint of much of the material in Rollins' 1947 literature for the Lakeside/Donnelley exhibition.

Note that this article by Rollins is at the present time often being mis-cited as either "*Print,* No. 4," or "*Print,* Vol. 4, #1." Both of these citations are incorrect.

Digitally reprinted in the CircuitousRoot Notebook on Rollins: `http://www.CircuitousRoot.com/artifice/letters/press/history-of-printing/heroic-age/rollins/index.html`

{Rutherford 2009} Rutherford, Emma. *Silhouette: The Art of Shadow.* NY: Rizzoli, 2009. ISBN: 978-0-8478-3077-0 (hbk).

{Saxe 2013} Saxe, Stephen O. "The Bruce Pivotal Type Caster and Nineteenth-Century Typography." Unpublished manuscript dated 2013. PDF format. Acquired directly from Saxe and in the posession of the author.

This paper was first published in {Saxe 2016}, but somehow in the course of publication an error concerning the drag pin was introduced. It was republished, with this error corrected, as a chapter in {Nelson et al. 2020}

{Saxe 2016} Saxe, Stephen O. "The Bruce pivotal type caster and its influence on nineteenth-century typography." *Journal of the Printing Historical Society.* New Series, No. 24 (Summer 2016): 37–62 and illus. on front cover.

This is the first publication of {Saxe 2013}. Note that an error concerning the drag pin, not present in Saxe's 2013 version, was introduced into this publication. This error was corrected with the second publication of Saxe's paper as a chapter in {Nelson et al. 2020}.

{Schlesinger 1989} Schlesinger, Carl, ed. and Ottmar Mergenthaler. *The Biography of Ottmar Mergenthaler, Inventor of the Linotype.* New Castle, DE: Oak Knoll Series on the History of the Book.

{Schmalcalder 1806 (1807)} Schmalcalder, Charles. "Specification of the Patent Granted to Charles Schmalcalder, of Little Newport Street, in the Parish of Saint Ann's, Soho, in the County of Middlesex, Mathematical and Optical Instrument Maker; for a Dellineator, Copier, or Proportionometer, for the Use of Taking, or Tracing and Cutting Out, Profiles; and for Copying and Tracing Reversely Upon Copper, Brass, Hard Wood, Card Paper, Asses Skin, Ivory, and Glass, in any required Proportion, directly from Nature, Land-scapes, Prospects, or any Objects Standing, or Previously Placed Perpendicularly; as also Pictures, Drawings, Prints, Plans, Caricatures, and Public Characters." Dated December 22, 1806. In *The Repertory of Arts, Manufactures, and Agriculture.* Second Series, No. LVIII (March 1807): 241–244, Plate XI.

This has been digitized by Google from a University of Michigan copy. Google ID: z9k0AAAAMAAJ.

{Schraubstadter 1887} Schraubstadter, Carl, Jr. "Electrotype Matrices." In *The Inland Printer.* Vol. 4, No. 6 (March 1887): 382.

This volume of *The Inland Printer* has not, at the time of writing, received a good digitization. It has been digitized by the Internet Archive from microfilm (and confusingly mislabeled "american-printer"). Issue No. 6 is online at:
`https://archive.org/details/sim_american-printer_1887-03_4_6`

Here is a local copy of the PDF presentation from that digitization: `archive-pd-ccby/inland-printer-v004n06-1887-03-sim_american-printer_1887-03_4_6.pdf`

{Schraubstadter 1888} Schraubstadter, Carl, Jr. "The Amount of Relief in Printing Blocks." In *The Inland Printer.* Vol. 5, No. 12 (September 1888): 906–907.

This volume of *The Inland Printer* has not, at the time of writing, received a good digitization. It has been digitized by the Internet Archive from microfilm (and confusingly mislabeled "american-printer"). Issue No. 12 is online at:
`https://archive.org/details/sim_american-printer_1888-09_5_12`

Here is a local copy of the PDF presentation from that digitization:
`archive-pd-ccby/sim_american-printer_1888-09_5_12.pdf`

{Shaw 2005} Shaw, Gwendolyn DuBois. ""Moses Williams, Cutter of Profiles": Silhouettes and African American Identity in the Early Republic." *Proceedings of the American Philosophical Society.* Vol. 149, No. 1 (March 2005): 22–39. (Read 2003-11-14).

{Silver 1974} Silver, Rollo G. "Trans-Atlantic Crossing: The Beginning of Electrotyping in America." *Journal of the Printing Historical Society.* [First series] No. 10 (1974–5): 83-103.

{Skopeo 1896} Skopeo, of No. Six. "The Typefounder's Art." In *The Typographical Journal.* Vol. 9, No. 6 (1896-09-15): 211–214 and Vol. 9, No. 7 (1896-10-01): 253–256.

Part 2 of Volume 9 of this journal has been digitized by Google from a University of Califonia copy:
`https://books.google.com/books?id=T6EuAQAAIAAJ`

Here is a local copy of that digitization:
`archive-pd-ccby/typographical-journal-v009-1896pt2-google-T6EuAQAAIAAJ-uc.pdf`

Here is a local copy of Skopeo's article, extracted: archive-pd-ccby/typographical-journal-v009-1896pt2-google-uc-EXTRACT-v009-n06-1896-09-15-pp211-214-and-v009-n07-1896-10-01-pp254-256-skopeo-of-no-six-the-typefounders-art.pdf

{Smalin 1911} Smalin, Hermann. "Neuzeitliche Entwicklung der Schriftgieszerei." ["Modern Developments of the Typefoundry"] Pages 22–31 in *Festschrift zum 25 Jährigen Bestande des Klubs.* [Vienna]: [Presumably by the Club], 1911.

This is a commemorative volume (festschrift) celebrating the 25th anniversary of the Fachtechnischer Klub der Beamten und Faktoren der Kaiserlich-Königliche Hof- und Staats Druckerei ("Technical Club of Officials and [workers?] of Imperial and Royal Court and State Printing Office [of the Austro-Hungarian Empire]." The date of 1886, mistakenly given in some online sources as the date of publication, is the date of the founding of this club. The date of publication is the 25th anniversary of the club in 1911.

Google digitization of the Harvard University copy:
https://books.google.com/books?id=lgtKlTCCAAIC

{Soltis 2017} Soltis, Carol Eaton. *The Art of the Peales in the Philadelphia Museum of Art.* Philadelphia, PA: Philadelphia Museum of Art and New Haven, CT: Yale University Press, 2017.

ISBN 978-0-87633-277-1 (PMA) and 978-0-300-22936-3 (Yale).

{Spencer & Mapes 1840} Spencer, Thomas. "On the Mode of Producing Fac-simile Copies of Medals, &c. by the Agency of Voltaic Electricity." [with a note by James J. Mapes.] *The American Repertory of Arts, Sciences, and Manufactures.* Vol. 1, No. 4 (May 1840): 278–281. NY: W. A. Cox, 1840.

The identification of the publisher is from {Silver 1974}: 85.

This is a reprint of a letter by Spencer to the *London Journal and Repertory of Arts,* with an additional brief note by Mapes, editor of the *American Repertory*… claiming improvements on Spencer's method by Franklin Peale.

A digitization of a microfilm copy of this number of *The American Repertory*, from an unknown source, is online at The Internet Archive at: https://archive.org/details/sim_american-repertory-of-arts-science-and-manufactures_1840-05_1_4

Here is a local copy of the PDF presentation from that digitization: archive-pd-ccby/sim_american-repertory-of-arts-science-and-manufactures_1840-05_1_4.pdf

{Stephenson, Blake 1908} *Specimens of Point Line Type, Borders, Ornaments, Brass Rules.* Toronto: Stephenson, Blake & Co., 1908.

Scanned by the University of Toronto Library. Online at the Internet Archive at:
https://archive.org/details/specimensofpoint00step

Here is a local copy of the PDF version:
archive-pd-ccby/https://archive.org/details/specimensofpoint00step

The showing of Flemish Expanded used here was taken from the original JP2 scans in the IA distribution.

{Tracy 1986} Tracy, Walter. *Letters of Credit: A View of Type Design.* Boston: David R. Godine.

{Updike 1922} Updike, Daniel Berkeley. *Printing Types: Their History, Form, and Use, A Study in Survivals.* 2 vols. Cambridge: Harvard University Press, 1922.

This has been reprinted several times and digitized several times. Good digitizations may be found by searching the Internet Archive: `https://www.Archive.org`

{Urquhart 1881} Urquhart, J. W. *Elecro-Typing: A Practical Manual.* London: Crosby Lockwood and Co., 1881.

A California Digital Library digitization of the University of California's Bancroft Library's copy is online at The Internet Archive at:
`https://archive.org/details/electrotypingpra00urqurich/`

Here is a local copy of the PDF presentation from that digization:
`archive-pd-ccby/electrotypingpra00urqurich.pdf`

A California Digital Library digitization of the University of California at Irvine's copy is online at The Internet Archive at: `https://archive.org/details/electrotypingpra00urquiala/`

Here is a local copy of the PDF presentation from that digization:
`archive-pd-ccby/electrotypingpra00urquiala.pdf`

{US 4,130 Starr 1845} US patent 4,130, "Improvement in Preparing Matrices for Type by the Electrodeposition Process" [the title on the drawings is "Type Machine"]. Issued 1845-08-04 to Thomas W. Starr. Not assigned.

Here is a local copy of the USPS digitization: `archive-pd-ccby/us-0004130-starr-1845.pdf`

{US 129,331 Gally 1872} US patent 129,331, "Improvement in Combined Stereotyping and Telegraphing Machines." Issued 1872-06-16 to Merritt Gally. Not assigned.

Here is a local copy of the USPS digitization: `us-0129331-gally-1872.pdf`

{US 129,725 Gally 1872} US patent 129,725, "Improvement in Combined Stereotyping and Telegraphing Machines." Issued 1872-06-23 to Merritt Gally. Not assigned.

Here is a local copy of the USPS digitization: `us-0129725-galley-1872.pdf`

{US 162,521 Benton 1875} US patent 162,521, "Improvement in Price-Tag Needles." Filed 1875-01-18. Issued 1875-04-27 to Linn Boyd Benton. Not assigned.

Here is a local copy of the USPS digitization:
`archive-pd-ccby/us-0162521-benton-1875-price-tag-needle.pdf`

{US 172,956 Benton 1876} US patent 172,956, "Improvement in the Manufacture of Floats." Filed 1875-11-27. Issued 1876-02-01 to Linn Boyd Benton. Not assigned.

Here is a local copy of the USPS digitization: `archive-pd-ccby/us-0172956-benton-1875-improvement-in-the-manufacture-of-floats.pdf`

{US 254,792 Benton 1882} US patent 254,792, "Mold for Casting Printers' Leads." Filed 1882-01-09. Issued 1882-03-14 to Linn Boyd Benton. Not assigned.

Here is a local copy of the USPS digitization:
`archive-pd-ccby/`us-0254792-benton-1882-mold-for-casting-printers-leads.pdf

{US 290,201 Benton 1883} US patent 290,201, "Printing-Type." Filed 1883-05-08. Issued 1883-12-18 to Linn Boyd Benton. Not assigned.

Here is a local copy of the USPS digitization: `archive-pd-ccby/us-0290201-benton-1883-self-spacing-type.pdf`

{US 313,224 Mergenthaler 1885} US patent 313,224, "Machine for Producing Printing-Bars." Filed 1884-08-30. Issued 1885-03-03 to Ottmar Mergenthaler. Assigned to the National Typographic Company.

Here is a local copy of the USPS digitization: `us-0313224-mergenthaler-1885.pdf`

{US 332,990 Benton 1884} US patent 332,990, "Punch-cutting Machine." Filed 1884-02-29 as application serial number 122,534 [it might be ,584; the USPTO scan is flawed]. Issued 1885-12-22 to Linn Boyd Benton. Assigned to Benton, Waldo & Co.

Cost, citing original correspondence between Benton's attorneys and the US patent office, says that this patent was initially issued as No. 327,855 on 1885-10-06 but that it was withdrawn due to a clerical error and reissued as 332,990 on December 22.

Generally it is best to cite patents by their date of issue. But in the case of Benton, date of invention is important. So the date for the citation here is 1884, the year of filing, not 1885, the year of issue.

Here is a local copy of the USPTO scan, as a PDF: `archive-pd-ccby/us-0332990-benton-1884-punch-cutting-machine.pdf`

{US 347,629 Mergenthaler 1886} US patent 347,629, "Machine for Producing Type-Bars." Filed 1885-10-23 as application serial number 181,169. Issued 1886-08-17 to Ottmar Mergenthaler. Assigned to the National Typographic Company.

Here is a local copy of the USPTO scan, as a PDF: `archive-pd-ccby/us-0347629-mergenthaler-1886.pdf`

{US 414,399 Goodson 1889} US patent 414,399, "Matrix-Making Machine." Filed 1887-12-28 as application serial number 259,257. Issued 1889-11-05 to George A. Goodson. Assigned to the Minneapolis Electro Matrix Company.

Here is a local copy of the USPTO scan, as a PDF: `archive-pd-ccby/us-0414399-goodson-1889.pdf`

{US 414,400 Goodson 1889} US patent 414,400, "Matrix-Making Machine." Filed 1888-03-20 as application serial number 267,795. Issued 1889-11-05 to George A. Goodson. Assigned to the Minneapolis Electro Matrix Company.

Here is a local copy of the USPTO scan, as a PDF: `archive-pd-ccby/us-0414400-goodson-1889.pdf`

{US 422,874 Benton 1888} US patent 422,874, "Tool-Grinder." Filed 1888-01-17 as application serial number 261,053. Issued 1890-03-04 to Linn Boyd Benton. Assigned to Benton, Waldo & Co.

Generally it is best to cite patents by their date of issue. But in the case of Benton, date of invention is important. So the date for the citation here is 1888, the year of filing, not 1890, the year of issue. It is interesting that this is four years after his 1884 (filing date) pantograhic engraving machine patent.

Here is a local copy of the USPTO scan, as a PDF:

archive-pd-ccby/us-0422874-benton-1888-tool-grinder.pdf

{US 614,845 Dedrick 1898} US patent 614,845, “Engraving-Machine.” Filed 1897-04-16 as application serial number 632,387. Issued 1898-11-29 to Nicholas Dedrick. Not assigned.

Here is a local copy of the USPTO scan, as a PDF:

archive-pd-ccby/us-0614845-dedrik-1898.pdf

{US 645,164 Dedrick 1900} US patent 645,164. “Engraving-Machine Table.” Filed 1899-01-16 as application serial number 702,323. Issued 1900-03-13 to Nicholas Dedrick. Not assigned.

Here is a local copy of the USPTO scan, as a PDF:

archive-pd-ccby/us-0645164-dedrick-1900.pdf

{US 645,165 Dedrick 1900} US patent 645,165. “Engraving-Machine Table.” Filed 1899-01-16 as application serial number 702,324. Issued 1900-03-13 to Nicholas Dedrick. Not assigned.

Here is a local copy of the USPTO scan, as a PDF:

archive-pd-ccby/us-0645165-dedrick-1900-tool-grinder.pdf

{US 774,030 Benton 1900} US patent 774,030, “Grinding-Machine.” Filed 1900-05-05 as application serial number 15,594. Issued 1904-11-01 to Linn Boyd Benton. Assigned to American Type Founders Company.

Generally it is best to cite patents by their date of issue. But in the case of Benton, date of invention is important. So the date for the citation here is 1900, the year of filing, not 1904, the year of issue. In the case of this cutter grinder patent, doing so reveals that it was filed in 1900, in the year after the patent for Benton’s Type 2 engraving machine was filed (1899).

Here is a local copy of the USPTO scan, as a PDF:

archive-pd-ccby/us-0774030-benton-1900-cutter-grinder.pdf

{US 790,172 Benton 1899} US patent 790,172, “Tracing Apparatus.” Filed 1899-07-21 as application serial number 724,584. Issued 1905-05-16 to Linn Boyd Benton. Assigned to American Type Founders Company.

Generally it is best to cite patents by their date of issue. But in the case of Benton, date of invention is important. So the date for the citation here is 1899, the year of filing, not 1905, the year of issue.

Here is a local copy of the USPTO scan, as a PDF:

archive-pd-ccby/us-0790172-benton-1905-tracing-apparatus-delineating.pdf

{US 809,548 Benton 1899} US patent 809,548, “Matrix and Punch Cutting Machine.” Filed 1899-02-17 as application serial number 705,785. Issued 1906-01-09 to Linn Boyd Benton. Assigend to American Type Founders Company.

Generally it is best to cite patents by their date of issue. But in the case of Benton, date of invention is important. So the date for the citation here is 1899, the year of filing, not 1906, the year of issue.

Here is a local copy of the USPTO scan, as a PDF:

archive-pd-ccby/us-0809548-benton-1899-matrix-and-punch-cutting-machine.pdf

{US 1,003,764 Little 1911} US patent 1,003,764, “Drafting Instrument”. Filed 1901-09-11 as application serial no. 75,004. Issued 1911-09-19 to Charles H. Little. Not assigned.

Here is a local copy of the USPTO scan, as a PDF:
archive-pd-ccby/us-1003764-little-1911-drafting-machine.pdf*

{US 1,081,758 Little 1913} US patent 1,081,758, "Drafting Instrument". Filed 1902-07-02 as application serial no. 114,115. Issued 1913-12-16 to Charles H. Little. Not assigned.

Here is a local copy of the USPTO scan, as a PDF:
archive-pd-ccby/us-1081758-little-1913-drafting-machine.pdf*

{US 2,128,611 Henkes 1938} US patent 2,128,611, "Engraving and Allied Machine". Filed 1935-07-27 as as application serial no. 33,611. Issued 1938-08-30 to Peter M. Henkes of Racine, WI. Assigned to the George Gorton Machine Company of Racine, WI.

Here is a local copy of the USPS digitization:
archive-pd-ccby/us-2128611-henkes-1938-gorton-ratiobar-pantograph.pdf

{US D12,123 St. John 1881} US design patent 12,123, filed 1880-12-14, "Design for Movable Types." Issued 1881-01-11 to James A. St. John.

Here is a local copy of the USPTO digitization:
archive-pd-ccby/us-d012123-1881-01-11-st-john-central-geometric.pd

{US D22,263 Schroeder 1893} US design patent 22,263, filed 1893-01-16 as application serial number 458,619, "Design for a Font of Printing-Type." Issued 1893-03-07 to Gustave [sic] F. Schroeder. Assigned to V. J. A. Rey, of San Francisco, Calif.

This is the design for DeVinne. Local copy of the USPTO digitization:
archive-pd-ccby/us-D022263-schroeder-1893-font-of-printing-type-devinne.pdf

{Van Krimpen 1950s, 1991} Van Krimpen, Jan. "On Preparing Designs for Monotype Faces so as to Prevent Arbitrary Encroachments from the Side of the Drawing Office on the Designer's Work and Intentions and Otherwise Inevitable Disappointments at the Designer's End." [Reprinted in] *Matrix*. No. 11 (1991): [xiv pages opposite p. 128.]

This essay is undated. It was also reprinted in {Matrix 1981-2003} (an anthology of material from *Matrix*). In the table of contents for this 2003 reprint, it is identified as having been written in the 1950s.

{Vivarez 1906} Vivarez, Henry. "Un précurseur de la photographie dans l'art du portrait à bon marché." In *Le Vieux Papier: Bulletin de la Société Archéologique, Historique & Artistique.*[4] Tome IV, Livraison 3, Fascicule No. 36 (1906-05-01): pp. 181–188, Tome IV, Livraison 4, Fascicule No. 37 (1906-07-01): pp. 288–296, Tome IV, Livraison 5, Fascicule No. 38 (1906-09-01): pp. 358–369, and Tome IV, Livraison 6, Fascicule No. 39 (1906-11-01): pp. 453–457. Paris: [By the society Le Vieux Papier], 1906.

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Local copy of this digitization:
archive-pd-ccby/le-vieux-papier-bulletin-de-la-societe-archaeologique-histori que-et-artistique-v4-1906-google-gzovAAAAMAAJ-nypl.pdf

[4]This journal frequently is miscataloged under its subtitle (or description) "Bulletin de la Société Archéologique, Historique & Artistique." The correct name of the journal is *Le Vieux Papier* (that is, "Old Paper"). It is still published by the Société «Le Vieux Papier»: https://www.levieuxpapier-asso.org/

Local copy of Vivarez' article extracted from this digitization: archive-pd-ccby/vivarez-1906-le-physionotrace-extracted-from-le-vieux-paper-vol-4-fasc-36-1906-05-01-fasc-37-1906-07-01-fasc-38-1906-09-01-fasc-39-1906-11-01-google-gzovAAAAMAAJ-nypl.pdf

A better digitization is available from the "Gallica" digital library of the Bibliothèque nationale de France at: https://gallica.bnf.fr/ark:/12148/bpt6k6558108x/f1.image (May), https://gallica.bnf.fr/ark:/12148/bpt6k6558109b/f1.image (July), https://gallica.bnf.fr/ark:/12148/bpt6k65581100/f1.image (September), and https://gallica.bnf.fr/ark:/12148/bpt6k6558111d/f1.image (November). Licensed for noncommercial use only.

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{Vogler 1810} "Physiognotrace or Silhouette Machine." Online collections database entry. Accession Number M-6. Old Salem Museum & Gardens / Museum of Southern Decorative Arts. https://www.oldsalem.org/item/collections/physiognotrace-or-silhouette-machine/1105/ Accessed 2026-02-19.

{Wahl 1883} Wahl, William H. *Galvanoplastic Manipulations: A Practical Guide for the Gold and Silver Electroplater and the Galvanoplastic Operator.* Philadelphia, PA: Henry Carey Baird, 1883.

Wahl's introductory history, though very brief, contains some things not found in similar volumes.

Digitized by Google from the New York Public Library copy. Google Books ID: eUgKAAAAIAAJ. Here is a local copy of the PDF presentation of that digitization: archive-pd-ccby/archive-pd-ccby/wahl-1883-galvanoplastic-manipulations-google-eUgKAAAAIAAJ-nypl.pdf

{Warde 1935} Warde, Beatrice L. "Cutting Types for the Machines: A Layman's Account." *The Dolphin.* No. 2 (1935): 60–70.

{Watts 1960} Watts, Stevens Lewis. *Henry Lewis Bullen, Printer: 18 September 1857 – 27 April 1938.* Wood engravings by John de Pol. Front Royal, VA: The Privateer Press, 1960.

"A tribute to the memory of Henry Lewis Bullen and his work. Spoken by one of his admirers at a meeting of The Society of Printers, [at] The Harvard Club of Boston, October 5, 1960."

{*Welthandel* 1878} "Hofer's Gravirmaschine." In *Der Welthandel: Monatschefte für Handel & Industrie, Länder- & Völkerkunde.* Tenth Year, First Volume (1878): 91. Stuttgart, Germany: Julius Maier, 1878.

The report of Hofer's pantograph is in the section "Revue der Entdeckungen und Erfindungen: Angewandte Physik und Technik" ["Review of discoveries and inventions: Applied Physics and Technology"].

Google digitization of the Bavarian State Library copy: https://books.google.com/books?id=IK-wNYXP9nQC

Local copy of this digitization: `archive-pd-ccby/der-welthandel-v10-1878-google-IK-wNYXP9nQC-bavarian-state-library.pdf`

{Wernicke 1909} Wernicke, Julius. "Neus aus der Schriftgiesserei." In *Klimsch's Jahrbuch.* Vol. 9 (1909). Frankfurt am Main: Klimsch & Co., 1909.

Google digitization of the entire volume from the University of Minnesota copy: `https://books.google.com/books?id=zVTgXVXe8vEC`

Local copy of Wernicke's article, extracted: `archive-pd-ccby/klimschs-jahrbuch-v09-1909-google-pskaAQAAMAAJ-minn-EXTRACT-wernicke.pdf`

{[Werner 1912]} "Printer, Punchcutter & Typefounder: An Interesting Career." In *The British and Colonial Printer and Stationer.* Vol. 71, No. 8, Whole No. 1769 (1912-08-22): 10.

Google digitization of volumes 70 and 71 from the University of Michigan copy: `https://books.google.com/books?id=CZ62gjuwZX4C`

Local copy of this digitization: `british-and-colonial-printer-and-stationer-vol-70-71-1912-google-CZ62gjuwZX4C-mich.pdf`

Local copy of the article on Werner, extracted: `archive-pd-ccby/british-and-colonial-printer-and-stationer-vol-70-71-1912-google-CZ62gjuwZX4C-mich-EXTRACT-v71-no8-whole-no1769-1912-08-22-p10-pdf607-werner.pdf`

{Werner 1924} Werner, Nicholas J. "A bold face type of years ago." Letter to the editor, dated 1924-07-10. In *The American Printer.* Vol. 79, No. 4 (August 20, 1924): 45.

Digitized by Google from the Indiana University copy: `https://books.google.com/books?id=R6mOkQbGiU8C`

Here is a local copy of this digitized volume: `archive-pd-ccby/american-printer-v079-1924-july-dec-google-R6mOkQbGiU8C-indiana.pdf`

Here is a local copy of just this letter, extracted: `archive-pd-ccby/american-printer-v079-1924-july-dec-google-R6mOkQbGiU8C-indiana-EXTRACT-v079-n04-1924-08-20-p045-werner.pdf`

{Werner 1927} Werner, Nicholas J. "Saint Louis' Place on the Typefounders' Map." *The Inland Printer.* Vol. 79, No. 5 (August, 1927): 764-766.

This has been reprinted in the CircuitousRoot Notebook "Nicholas J. Werner" at `https://CircuitousRoot.com/artifice/letters/press/typemaking/history/punch-patrix-matrix-makers/werner/index.html`

Here is a local copy (photographed by DMM from the University of Wisconsin copy): `archive-pd-ccby/inland-printer-vol-079-no-05-1927-08-werner-st-louis-place-on-the-type-founders-map.pdf`

This issue has also been digitized by the Internet Archive from microfilm. Note that this digitization's bibliographical identification is slightly misleading. In later years, *The Inland Printer* and *The American Printer* (which in turn had had several titles over the years) merged. The microfilm scan here identifies this as *The American Printer,* but it is in fact the *Inland*. Confusingly, Werner's 1924 letter in *The American Printer* was in volume 79, and his 1927 article in *The Inland Printer* was also in volume 79 of that publication.

{Werner 1931} Werner, Nicholas. J. "An Address by N. J. Werner of St. Louis." St. Louis: [St. Louis Club of Printing House Craftsmen], 1931.

This was reprinted under the title "St. Louis in Type-Founding History." {Werner 1941}.

This has been reprinted in the CircuitousRoot Notebook "Nicholas J. Werner" at `https://CircuitousRoot.com/artifice/letters/press/typemaking/history/punch-patrix-matrix-makers/werner/index.html` My thanks to Robert A. Mullen of Xanadu Press for kindly giving me a copy of his photocopy of the transcript of this address from the St. Louis Public Library. Here is a local copy: `archive-pd-ccby/werner-1931-an-address-st-louis-0600greyjpg.pdf`

More recently, this transcript has been published by the St. Louis Public Library in their Werner Typography Collection: `https://cdm17210.contentdm.oclc.org/digital/collection/werner/id/2026/rec/2` To their great credit, they have marked this "No copyright - United States, http://rightsstatements.org/vocab/NoC-US/1.0/"

Here is a local copy of their digitization: `archive-pd-ccby/werner-1931-an-address-st-louis-public-library-2026.pdf`

{Werner 1932} Werner, Nicholas J. "Wiebking Created Popular Faces in Chicago, Friend Discloses." *The Inland Printer.* Vol. 90, No. 2 (November 1932): 71-73.

This has been reprinted in the CircuitousRoot Notebook "Robert Wiebking" at `https://CircuitousRoot.com/artifice/letters/press/typemaking/history/punch-patrix-matrix-makers/wiebking-robert/index.html` Here is a local copy: `archive-pd-ccby/inland-printer-v090-n2-1932-11-0600grey-0071-werner-on-wiebking-0600greyjpg.pdf`

{Werner 1941} Werner, Nicholas J. "St. Louis in Type-Founding History." *Share Your Knowledge Review.* Vol. 22, No. 3 (January 1941): 21.

This is a reprint of {Werner 1931}.

This has been reprinted in the CircuitousRoot Notebook "Nicholas J. Werner" at `https://CircuitousRoot.com/artifice/letters/press/typemaking/history/punch-patrix-matrix-makers/werner/index.html` Here is a local copy (scanned by me from my own copy): `archive-pd-ccby/share-your-knowledge-review-v22n03-1941-01-werner-st-louis-in-type-founding-history.pdf`

{Wilkes 1990} Wilkes, Walter. *Das Schriftgießen: Von Stempelschnitt, Matrizenfertigung und Letterguss: eine Dokumentation von Walter Wilkes.* Darmstadt, Germany: Technische Hochschule Darmstadt. (Also Stuttgart, Germany: Hauswedell.)

{Williams 1913} Williams, Archibald. *Things to Make.* London: Thomas Nelson and Sons, n.d. [1913].

The book bears no date. The date given here (1913) is that guessed at by all relevant entries in Worldcat. Project Gutenberg asserts a date of 1918.

Revision History

Rev. 0, 2012–2023. The genesis of this project was my discovery around 2012 of the articles by Nicolas Werner from 1927 and 1931 which pointed out, for all to see, that Benton was not the first to use the pantograph in type making. Work on this project began in earnest with my presentation "The Pantograph Demythologized" at the 2018 American Typecasting Fellowship Conference in San Francisco. I managed an unreleased draft of some substance in 2019. Progress stalled until 2023 and then stalled again until late 2025.

Rev. 1, 2025-11-01. Restarted (again) 2025-10-14. Still very much unfinished, but over 200 pages. Realized the importance of Dan Reynolds' discoveries concerning Ludwing and Hofer. Circulated privately among a few typographical friends for review.

Rev. 2, 2026-04-09. Comments and corrections from several reviewers were very helpful. Extensive additions, including: patrix cutting, single-arm and silhouette pantographs, punch/patrix vs. matrix, removable spindles, Benton type 1 machines (and 1929 ATF Library photograph) recontextualizing Cost, Benton knowns and unknowns. Reorganized appendices: added sources for early typographic electroforming, moved Otto to the appendices. Many minor corrections throughout. Exceeded 300 pages, but still very incomplete. Circulated for another round of review.

The layout of this book was done
using the XeLaTeX derivative of
Prof. Knuth's TeX digital layout system.

Digital Lettering Faces

Latin text: TeX Gyre Schola.
Based on URW Century Schoolbook,
which in turn is based on
ATF's Century Schoolbook by M. F. Benton.

Latin display: Gillius ADF No. 2
from Arkandis Digital Foundry.
Based on Gill Sans.

Computer text: TeX Gyre Cursor.
Based on URW Nimbus Mono L,
which has roots in Kettler's Courier.