

YDL

# TYPOGRAPHICAL PRINTING - SURFACES

THE TECHNOLOGY AND MECHANISM OF  
THEIR PRODUCTION

BY

LUCIEN ALPHONSE LEGROS

MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS  
MEMBER OF THE INSTITUTION OF MECHANICAL ENGINEERS  
MEMBER OF THE INSTITUTION OF ELECTRICAL ENGINEERS  
PAST-PRESIDENT OF THE INSTITUTION OF AUTOMOBILE ENGINEERS

AND

JOHN CAMERON GRANT

AUTHOR OF "A YEAR OF LIFE"; "THE PRICE OF THE BISHOP"; "PEABIE PICTURES"  
"BITS OF BRAZIL"; "TORRIBA: A PRINCESS OF THE AMORAYES"; ETC. ETC.

Extract of Chapter XXVIII  
Composing, Line-Justifying, and Distributing  
Machines  
(Primarily the Paige Compositor)

LONGMANS, GREEN, AND CO.  
39 PATERNOSTER ROW, LONDON  
FOURTH AVENUE & 30TH STREET, NEW YORK  
BOMBAY, CALCUTTA, AND MADRAS

1916

*All rights reserved*

## CHAPTER XXVIII.

### COMPOSING, LINE-JUSTIFYING, AND DISTRIBUTING MACHINES.

*"The application was filed in 1867 and was pending eight years, mainly owing to the work of examination by the Patent Office. One of the examiners died while the case was pending, another died insane, while the patent attorney who originally prepared the case also died in an insane asylum."*

John S. Thompson. *History of Composing Machines.*

*Brevier condensed sans serif italic (Stephenson, Blake & Co.).*

Two very interesting patents, machines constructed under which were capable of performing the entire cycle of operations of composing, line-justifying, and distributing, were that taken out by C. W. Felt in America in 1860 (and in England in 1861), and that of J. W. Paige taken out in America in 1895. In many respects the earlier patent is the more remarkable for its curious anticipation of much that has followed. The Paige patent is perhaps, as far as size is concerned, the most voluminous ever taken out in the history of inventions.

*The Felt composing, line-justifying, and distributing machine.*—Felt's machine, fig. 354, is remarkable for containing, among other things, the earliest complete scheme for the use of a perforated record strip, though this method of control had been suggested at least a decade earlier; and he describes and illustrates a machine for producing this strip as a subsidiary part of his invention. Not only is the perforated record strip intended to be used alternatively as a method of composing, but also for effecting the distributing of the type when used in the reverse direction. The difficulty which would arise in the distribution of matter in which corrections had been made was apparently overlooked by this very thorough and capable inventor. The bell or indicator now long familiar on type-writers and other composing machines, is mentioned in this patent as the means of indicating when the line is nearly filled. The problem of conveying a large supply of type to any channel that required it is provided for by arranging the type in a spiral line or column wound on a drum by means of a flexible band. This is only one of many original and remarkable ideas proposed by this inventor.

The drawings of the Felt machine are extremely lucid and complete, and provide for effecting the various operations described in a direct and workmanlike manner. The machine, though not complicated when compared with some of the elaborate machines of the present day, was, however,

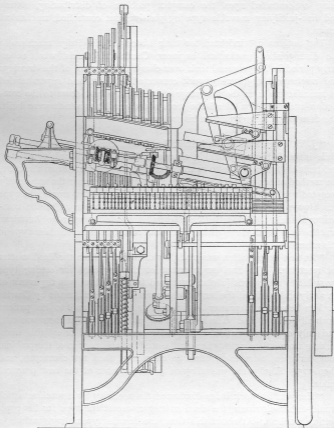


FIG. 354.—Felt composing, line-justifying, and distributing machine.  
General arrangement.

evidently much in advance of the period at which it was designed, when, it must be remembered, manufacturing operations could not be performed so cheaply as at present, and for this reason mainly, the authors believe, the machine failed to attain commercial realization.

*The Paige typesetter, or composing, line-justifying, and distributing machine.*—The history of the Paige typesetting machine, which in its final form was named the Paige compositor after the inventor and patentee, is an interesting story of inventive and constructional evolution, several minds being concentrated upon the complex problem of distributing, setting and line-justifying movable type by positive, but controlled, mechanical action.

The authors are indebted for their history of the Paige machine to the distinguished mechanical engineer, Charles E. Davis, who, at an early period in its progress, took over charge and control of the drawings and mechanical engineering work connected with it, and superintended its manufacture from the first stage of its development, down to the completion and operation of all the models and machines which were built. The description here given is in his own words.

“ J. W. Paige lived in Rochester, New York, and early in the seventies, while interested in the oil-fields, conceived the idea of a simple typesetter, and built his first machine to handle agate ( $5\frac{1}{2}$ -point) type: From the start, the method of handling the type, edge upon edge, as against the universally accepted method of side upon side, was adopted: in other words, the type was always in the order of hand-composition, the same as in the compositor's stick. [Evidently this statement can only refer to American practice as several of the earlier European machines handled their type in this manner.]

“ At first no provision was made for distributing from the dead matter for resetting. The final arrangement of the keyboard for setting type by syllables and words [a plan conceived from the first] was the result of an analytical study of the language, covering all subjects, made by Charles G. Van Schuyver, a printer in the employ of Paige, and to his patient work all praise is due. The keyboard was so arranged that there was one, and only one, combination available for setting a word or syllable when reading from left to right. During the study of this portion of the problem four variations were tried; first 89 characters, then 141 characters, and then 115. Finally 109 was adopted as the number of the best practical value.

“ Early in his work Paige discovered the necessity for a machine which would either distribute the dead matter or recast the type for his typesetting machine. At about this time, the Shanks typesetting machine, a very rapid power-actuated typesetting machine, was invented in England. Paige secured the American rights for this and imported two of these machines for use in connexion with his typesetter.

“ While Mr. Paige was working in Rochester, many others were studying the problem, notably J. M. Farnham, of Hartford, Conn., where the manufacture of the Farnham typesetter was in progress, a gravity machine with converging channels using type side upon side. The Farnham

Typesetter Company was also developing the Thompson distributor with a view to its use for supplying the Farnham machine by distribution of dead matter.

"About 1877, Dr. George F. Hawley, President of the Farnham Typesetter Company, entered into a contract with Paige to use his typesetter and the Thompson distributor.

"The Farnham Typesetter Company had their own works in the building of the Colt's Firearms Company, which were in charge of E. S. Pierce, as mechanical engineer and superintendent. A few months after the contract had been made with Paige, he produced a plan for a combined typesetting and distributing machine; it was decided to build a machine upon the new lines, and to abandon the separate machines. The new machine was planned upon the lines of the Paige, and used the Thompson principle for forwarding the type for distribution to the common type-case to avoid the necessity of transference. The work progressed rather slowly, and not until about the close of 1878, was it possible to show anything tangible; six characters were distributed from a temporary channel into the main type-case, and were set from the same case, thus demonstrating the possibility of the combined type-case.

"It was shortly prior to this period, Pierce having resigned, that the services of Charles E. Davis were secured by those interested in the matter.

"Soon after the test of the principle of the combined machine, various defects in the plan of the mechanism developed, and it was necessary in order to accomplish successfully the desired results to redesign the machine, using only such parts of the mechanism as could be made to meet the required conditions, and it was at this time that the plan was adopted, and never departed from, of working always to figures on fully-dimensioned drawings.

"Some months after the completion of the test referred to, Samuel L. Clemens, better known as Mark Twain, first became interested in the machine through the purchase of stock in the Farnham Typesetter Company, at the solicitation of Dwight Buell. It would be fruitless and tedious history to detail all the delays that followed due to limited capital and other causes. During the period which elapsed up to the time when the first combined machine was completed and used as a composing machine handling brevier type, operated by two men, one at the keyboard, and the other to justify the type, Dr. Geo. F. Hawley, William L. Matson, William Hammersley, Samuel Coit, William Gaylord, and many others were identified with the enterprise. It was a difficult task to interest new capital, for at this time no one believed it possible to line-justify automatically and mechanically a line of movable type. Delay occurred until Paige conceived the idea of a printing-telegraph, operated by his combined keyboard, to be used either with Morse or roman characters, as a quick means of raising money to enable the composing machine to be proceeded with.

Several of these printing-telegraph machines were built, Samuel Coit being largely instrumental in furnishing the money, and Clemens being also called in to assist in the matter.

"It was while following the telegraph instrument that Clemens renewed his interest in the composing machine, and quite a number of his MSS. were set up on the machine. While the work on the telegraph instrument was in progress, Charles R. North, a skilled mechanic in the employ of Paige, invented an automatic justifier to work in combination with the Paige machine. After this matter had been presented to Clemens and a detailed estimate made at his request by experts from the Pratt and Whitney Company, covering the cost of building the first combined machine and its subsequent manufacture, he decided to undertake the responsibility for the construction of a new machine, combining North's Justifier with the Paige Typesetter and Distributor; for this purpose he deposited the first royalties received by him from the publication of his wonderfully successful book 'Huckleberry Finn.'

"With Whitmore as Clemens's financial representative work was commenced with Carl Grohmann, Chas. I. Earle and others as assistants in the engineering department; drawings were furnished to the Pratt and Whitney Company, and the machine was built at their works in Flower Street, Hartford, Conn., George A. Bates acting as their foreman.

"A grave error was made at this point which caused trouble later on; many parts of the first combined machine were used in the construction of the new machine, with the result that when the machine was completed and in operation it contained features which prevented its use as a model upon which to base a plant for manufacturing. The machine as built at the Pratt and Whitney works, was, however, a successful machine in its operation, and demonstrated the possibilities of distributing movable type dead matter, and simultaneously setting, line-justifying, and assembling in column-form live matter on a single, power-driven, positive-action machine, operated by one man.

"It was when this result had been achieved that Clemens said one day: 'We only need one more thing, a phonograph on the distributor to yell, "Where in H—— is the printer's devil, I want more type."' The late Dr. Thurston, the eminent mechanical engineer, said when he saw the machine in operation: 'This is thought crystallized;' and it was Theodore De Vinne of the Century Company who said, when somebody compared the Paige compositor to the Jacquard loom: 'True, but the Paige compositor unravels any old fabric, and from it reweaves any new design which the imagination of man can conceive.'

"Upon the completion of the Paige compositor at the works of the Pratt and Whitney Company, all the leading newspapers and publishing houses expressed their confidence in the project, and were ready to contract for its use. It was at this stage that George S. Mallory and Marshall H. Mallory undertook to finance the enterprise. The capital required was, however,

large and the reason the Paige compositor was never manufactured in quantity was due to the fact that at this time Paige, who controlled the patents, refused to part with a sufficient interest to induce other capitalists to invest the large amount required to conduct the business successfully, and was not attributable to any mechanical failure or defect in the machine. In this way three years were lost. It was during these three years that Philip T. Dodge assumed control of the Mergenthaler Linotype Company, and by a very successfully drawn contract with the newspapers and publishing houses, practically secured control of their composing rooms, and placed the Mergenthaler Company in a position to set the price at which the Paige machine could be marketed.

" Finally, in 1892, Ward, Frink, and Kneval of New York formed the Compositor Company, and contracted with the Webster Manufacturing Company, of Chicago, to build the machines, and the first compositor and the enterprise were moved from Hartford to Chicago in that year. An addition to the Webster factory was built, and a force of draughtsmen and mechanics employed to redesign and build a model machine.

" Again there were delays owing to the lack of funds, and although every effort was put forth to complete the machine in time for exhibition at the World's Fair, it was not ready, and late in the fall of 1893 work was stopped. Once more Clemens came into the breach, and through his influence Henry H. Rogers became interested, and the Regius Company was formed, a concern which subsequently became the Paige Compositor Company. Work was resumed and the machine carried to completion. When the Compositor Company went to Chicago, Mr. Scott, manager of the "Chicago Herald," agreed to test the machine on the "Herald." In September, 1894, the compositor was erected in the "Herald" office, and although it had not been tested on dead matter from which stereotype matrices had been made, a sixty days' run was started on copy taken from the 'hook.' For this test neither machinery nor repair tools were allowed to be erected. Any work that required to be done had to be taken to the company's works two and a half miles away. During this test two or three radical changes were necessary, but even in the face of this handicap the Paige compositor, with all delays counted against it, delivered more corrected live matter to the imposing stone, ready for the formes, per operator employed, than any one of the thirty-two Linotype machines which were in operation in the same composing department, although the latter had had several years' use on newspaper work. This record may fairly claim never to have been equalled by any composing machine on its maiden trial; moreover, the composition which the compositor turned out was, in artistic merit, equal to the finest book-work ever set by hand.

" The Paige compositor has been pronounced by competent engineers to be the foremost example of cam mechanism ever produced in the United States, if not in the whole world, and to have performed by positive mechanical devices the largest amount of brain labour ever undertaken.

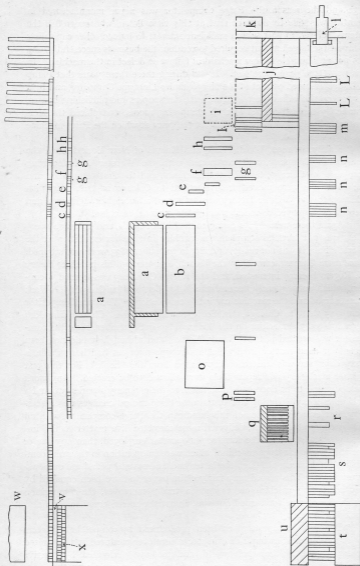


FIG. 355.—Paige composing, line-justifying, and distributing machine; diagram of operations.

The upper view: front elevation at  $25^{\circ}$  to the vertical, showing assembly.

The lower view: plan at  $25^{\circ}$  to the horizontal.



## EXPLANATORY STATEMENT.

The types were guided on the feet and always under a light tension from the top; all the wearing parts were made easily interchangeable and readily replaceable.

The machine was built with parts parallel to or at right angles with the plane of the table, and when this was placed on the feet the whole of the upper part of the machine was inclined  $25^{\circ}$ , so that the type channels leaned backwards  $25^{\circ}$  from the vertical and the tables sloped downwards to the back at  $25^{\circ}$  to the horizontal. This ensured that the type remained on their feet, that the heaviest pressure was towards the face of the type, and that the columns in the channels were prevented from buckling forward.

## REFERENCES.

- a Dead matter; two or three columns of matter assembled in the distributor galley.  
 b Type line moved forward.  
 c Type separated.  
 d Type registered from the foot.  
 e Broken type removed.  
 f Wide type selected.  
 g Spaces selected and forwarded to the left.  
 h Type forwarded to the right.  
 i Pie-box.  
 j Support for type-case.  
 k Type-case and channels.  
 l Regular pie-box for odd characters not nicked.  
 m Elastic collector.  
 L Composed type moved forward.
- m Words measured and spaces determined.  
 n Words kept separated and forwarded to the left.  
 o Space-selecting plates.  
 p Space registered by backward and forward movement from the foot.  
 q Space-case or magazine.  
 r Spaces inserted between words.  
 s Line formed and forwarded to the live-matter galley.  
 t Leads inserted in live galley. 1, 2, or 3 leads could be inserted before the line was pressed down into the galley.  
 u Live-matter galley.  
 v Room left for leads below supporting shelf and above live matter.  
 w Depressing plunger.  
 x Live matter.

It will be noted that the types were moved forward to the right and registered for distribution before being received in the magazine, whereas the spaces moved, after selection, to the left until received in their magazine. The characters, after being composed, moved to the left, but at a higher level than the distribution level, and the words, as moved to the left, were kept separated until the space of separation was filled by the proper selected spaces, after which the words with the selected spaces completed their travel to the left with the live matter.

The spaces went through the same operation of separating, registering, removal of broken spaces, selection for distribution, and forwarding to their magazine channels as did the type, though the movement of the spaces was made in the direction opposite to that of the type.

" Some conception of the problem may be had if we follow the various operations required to deliver a finished column of live matter.

" After coming from the forme the dead matter was made up in the galleys for distribution. These galleys were inserted in the machine without a stop, and the top line was raised and advanced towards the front of the machine for the separation of the individual types. The type were then separated from the line by a mechanism, which handled them as though of equal width, though they were of every width and arrangement required in composition. When separated the type were raised a short distance, and a series of tests was automatically made to remove wide type, broken or cracked type, dirt or foreign matter of any kind, and to pass along into the distributing mechanism only such type as were perfect for resetting. Distribution was made possible by a series of nicks. Here again the greatest care was necessary so that no two different type had the same nicks, and that it was not possible for a type which had been broken in any way to cause a wrong distribution. All quads and spaces were so nicked that if reversed they would still distribute correctly. The selecting mechanism was so arranged that it would detect two type that might become stuck together in stereotyping ; if they reached the body of the machine they were thrown out, and the distribution was automatically stopped until these type were removed. Whenever any particular magazine channel became full, the feed stopped automatically until the type had been set out of that channel, or until any excess of sorts in that channel had been removed by special pincers provided for that purpose. During the whole of the operation of distributing, the movement of the type progressed towards the right, and of the justifying spaces towards the left of the machine, and of both forward towards the operator, fig. 355.

" When the type in process of distribution was moved forward into the plane of the common type-case, a lifting mechanism removed the type from the end of the forwarding plunger, and lifted and placed it upon a supporting shelf at the bottom of the channel from which the type was taken in composing, so that it was possible in the machine to distribute a type into the magazine and set the same type out of the magazine during the same revolution of the cam-shaft. This distribution continued until any one channel became filled up by the insertion of some 200 characters, when a weight carried on top of the column of type in the channel came into contact with the mechanism which stopped the feed of the machine. The operator at the keyboard could set out syllables and words into a race in which a collector operated for transferring the type set to the line of composition. During composition the movement of the type was again towards the front of the machine, but the subsequent movements were towards the left instead of towards the right. At this point the operation of the automatic justification of the type commenced, the mechanical problem which the machine solved, being as follows : after adjustment to a predetermined length of line of composition, the machine automatically

measured the words and syllables as set up by the operator, added the sum of these measurements together, subtracted the sum from the length of the line required, divided the remainder by the number of words less one, and automatically selected a space, or a combination of spaces, for insertion in the line which would justify the line within the limit of 0.005 inch. When a word had been composed and delivered to the line by a collecting mechanism in the type raceway, a key was touched which caused another mechanism to operate positively in harmony with the remainder of the machine, and to move the word forward a sufficient distance to allow another word to follow: no spaces were inserted in the line at this stage. This process continued until the indicator showed the operator that the line in process of composition had reached a length which would not permit of the setting of another syllable or word. The operator then touched a key known as the line-key, and mechanism was brought into operation to send each of the words forward in harmony with the other words previously set in the line in such way that when the first word in the line passed the justifying-case—which was a duplicate in principle of the regular type-case, but located some distance to the left—the points of this mechanism acted as an automatic key for inserting in place the space or spaces which would justify the line. When the last word of the line passed the case no space was inserted, and a mechanism was automatically brought into play for moving the completed line forward ready for insertion into the live-matter galley. At this stage provision was made for automatically inserting one, two, or three leads into the column of live matter, before the line of type, which had now been justified, was moved downward; by this means it was possible for the operator at the keyboard to set either solid, single, double, or treble leaded matter at his discretion into the live-matter column. This live matter was placed in galleys ready for removal to the proof galley, and from thence, after correction, to the imposing stone.

“One very important, in fact *the* most important element in connexion with this machine was what was termed the ‘time-lock;’ this was purely mechanical in construction, simple in formation, yet so designed that it was possible for the operator to finger the keyboard without regard to the beat of the machine while the positive mechanism of the machine would operate so as to perform all its various functions without interference one with the other, and without danger of knife-edge contacts or damage to the mechanisms. It is true that there were a large number of mechanisms in the machine, but the subject had been so carefully worked out and charted that even an operator who was not familiar with the machine, by simply looking at the degrees shown on the indicator dial, could, by reference to the chart, know exactly what mechanisms were in operation at that particular time, and so be able to locate accurately any difficulties that might have arisen, or which might have caused the machine to stop automatically; this it did whenever any undue strain was applied to any of the mechanisms.

“The speed of the machine shaft was 220 revolutions per minute. At

this speed it was possible to distribute approximately 7500 ems (15,000 ens) of solid matter per hour, and it was possible for an expert operator to set up and justify over 9000 ems (18,000 ens) per hour, and 12,000 ems (24,000 ens) on rush matter ; under these conditions, however, more frequent sorting of the case would be necessary, and provision was made for its easy accomplishment by the glass front of the case being spring-balanced, and so arranged that the removal of two screws, each turned one-half turn, would permit the case to be opened down to the bottom type.

" After the completion of the test at the offices of the " Chicago Herald," the matter of the continuation of the manufacture was thoroughly discussed, and a report was made on the mechanical reliability of the machine, which was favourable in every way. At one time the Mergenthaler Linotype Company had offered to exchange half-interests with the proprietors of the Paige machine, but Paige would not accept this offer. During the three years of delay the Mergenthaler Linotype Company had secured the field in such a way as to be able to fix the price of the Paige machine, and this caused the capitalists to come to the decision that money could be made faster in other channels than in the manufacture of the Paige machine. As a consequence, about two years later Philip T. Dodge purchased the patents and the two machines for the Mergenthaler Linotype Company, who loaned to the Cornell University the machine manufactured in Chicago and tested in the " Chicago Herald " office, and to the Columbia University, in New York, the machine manufactured in Hartford by the Pratt and Whitney Company, and at these universities they now are."

The Paige compositor, figs. 356 to 360, plates XLII to XLVI, used on the " Chicago Herald " test, was approximately eleven feet in length, three and one half feet wide, and six feet high. It weighed about 5000 pounds, and the power required was transmitted through a  $\frac{3}{4}$ -inch round belt to a grooved pulley 14 inches in diameter ; it consumed about  $\frac{1}{2}$  to  $\frac{3}{4}$  horse-power. It could be started and turned up to speed with one finger at a 7-inch leverage. It was specially designed for newspaper work, and used nonpareil type ; the distributing, setting, justifying, and leading mechanisms were adjustable to any width of column desired for newspaper or book work.

Various statements have been made in regard to the amount of money expended in the development of the Paige compositor.

According to C. E. Davis, who was closely associated with the matter and who examined the accounts, the total expenditure did not exceed one million dollars. Davis believes that about eight hundred thousand dollars represents the actual expenditure on the engineering, experimental, production and patent work for all of the Paige machines manufactured.

The authors subjoin another description of the Paige compositor for which they are indebted to the good offices of Philip T. Dodge, President of the Mergenthaler Linotype Company, who has had it abstracted

PLATE XLII.

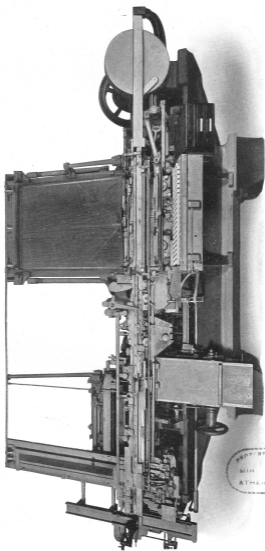


FIG. 356.—Frige composing, line-justifying, and distributing machine; general view.

PROPERTY OF THE  
MUSEUM OF  
ATHENS

To face page 346

PLATE XLIII.  
[To face plate XLIV.]

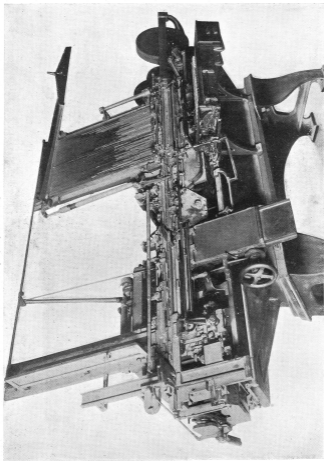


FIG. 357.—Poige machine; front view from left end.

PLATE XLIV.

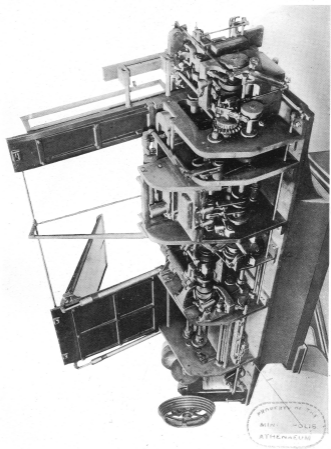


FIG. 358.—Perigo machine ; back view from left end.

To face plate XLIII.)

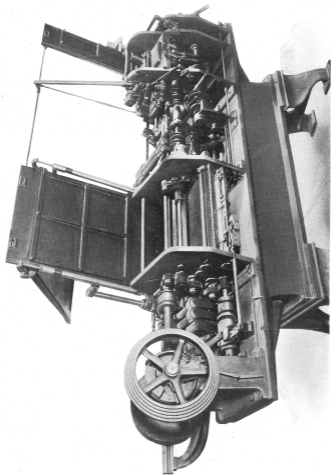


FIG. 359.—Ponige machine; back view from right end.





PROPERTY OF THE

MIN. HOLS

ATHENAEUM

PLATE XLVI.

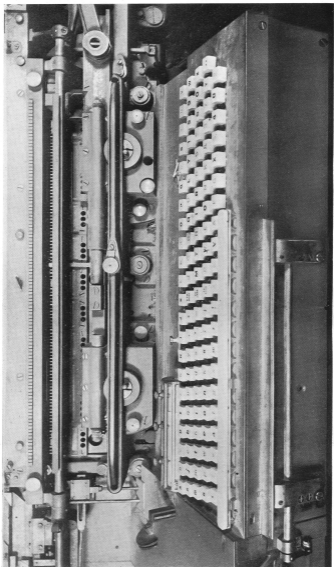


FIG. 360.—Peige keyboard.

for them from a contemporary official booklet. The Paige machine is of such interest both mechanically and typographically that the authors think any repetition which may occur is excusable, and that the more personal description of the engineer responsible for its construction is well supplemented by the more prosaic information contained in the official account published by the Connecticut Company.

"The Paige Compositor, using movable type and consequent perfect face, covers the whole problem in every detail, so that we claim for the machine, without fear of contradiction, that by no known method can a printing surface be produced which equals, or in fact approaches, in artistic merit, legibility, hair-line effects, perfection of justification, economy of space occupied by given amount of reading-matter, or speed and economy of composition, that produced by this machine.

"The Paige Compositor really performs the entire work of the 'compositor' at the 'case' automatically, for while the machine does require a person to touch the keys which the copy to be printed calls for, as in a typewriter, the machine sets the type itself automatically and harmoniously with the action of the other parts of the machine, which, as a whole, acts as follows: When the type has been printed from and is ready to be distributed it is called 'dead matter.' This 'dead matter,' in column or page form, is taken to a Paige Compositor in a galley, as it is called, placed in position in the machine while the machine is running, and then the Compositor works as follows: The machine separates one line from the top of the page or column, then separates each individual type from the line and puts it in position for the other operations of distribution. The machine then removes any type which may have been damaged in the press or stereotype, or turned bottom-side up, or end for end, by the hand compositor in correcting or otherwise, takes the spaces used in justifying out of the line, distributes them into a separate case or channels provided for them, and distributes the types which remain into another case or channels, putting the spaces and types into the bottom of their individual channels which are slightly inclined back from a vertical position. The types are then built up one on another from the bottom. On top of the type in each channel is placed a piece of metal, and, when any one of the channels of type reach up to a certain fixed line in the case, the piece of metal is brought in contact with a bar which stops the feed of type from the galley, preventing an overflow of the case, no matter how careless an operator may be. Whenever a type is called for by the person who is operating the machine, from the channel which stopped the feed, the feed is automatically started and the distribution is resumed.

"At the same time that the distribution is in process the person operating the machine is causing the part which sets the type to forward the letters called for in the copy into the line of composition. That is to say, the machine is so constructed that it distributes and sets type at the same time,

and a type can be put into and taken out of any of the channels during the same revolution of the machine.

" We next come to the justification ; and while this has been always considered impossible of mechanical accomplishment, its practicability will, we think, be clear to any one if considered on the mathematical side. Of course to make any number of things the same length one must start with some one length as a standard or unit. This unit can be made whatever length the work to be done requires, as, for instance, the width of any book, page, or newspaper column. With this length known, the problem is simply this : Take the length of any number of words which are to compose a line and subtract their sum from the unit or standard, and the remainder will be the length which is to be filled out by spaces to separate the words of the line. It is clear that the number of spaces would be one less than the number of words in any line as no space is needed at the end of the line. Hence, if we divide the remainder, found as above, by one less than the number of words, we shall have for the quotient the amount of space which, put between the words, will fill out the line and make it of standard length—or, in other words, justify the line.

" In the Paige Compositor the mathematical problem proposed above is automatically performed, and any one looking at the person operating the machine and following its automatic action incident thereto, would see type taken automatically from the case and assembled into column form or 'live' matter ; and the novel features which would fasten his attention and hold it to the end would come in order as follows :—

" Observing that the person operating the machine touched words instead of letters would bring out the fact that the keyboard was a study of the living language as in every day use in all the various avenues of life, and that the man who spent ten years of his life on its arrangement had placed every key in its most valuable position in relation to every other letter, so that all the keys which go to make up common words and syllables in constant use can be touched simultaneously, as one touches the chord on a piano, and maximum speed with minimum mental effort can be attained. It follows also that the type will be set out and delivered to the line of composition by words, letters, or syllables as called for.

" Turning now to the type which has been started on its journey to the column, he sees the machine take the length of the first word, record it and move the word out of the way of the second word, already on its way to join the first ; then it takes the length of the second and adds it to the first, and moves the two words out of the way of the third, and continues this operation until there is no room left in the standard line for more words to come in, which fact is indicated to the person operating the machine by an indicator placed in the direct line of vision and by a bell which sounds when he has reached a point in advance of the place where the longest word in the language which cannot be divided would go into the standard line. If the next word in the copy is so long that the indicator

shows it will not go into the line, then a key, called the 'line-key' is touched, and those parts of the machine are put into position which automatically accomplish the operations required to complete the justification of the line, and the parts connected with the operation of the keyboard are returned to their normal or first positions ready for the commencement of work on another line. The machine having now the sum of the lengths of the words which compose the line, the next operation is for the machine to subtract the sum of the lengths of the words of the line from the standard line and divide the remainder by one less than the number of words in the line, and to put into position for later action certain parts of the machine (which can be seen by the observer) which will at the proper time in the action of the machine cause to be inserted between the words which compose the line, and which words are separated for that purpose, one or more spaces of such a character as the quotient obtained by the above division may require to make the line of standard length. When the last word which was set in any given line has passed the case which contains the spaces used in filling out the line, then another part of the machine, which has been put in position by the touching of the 'line-key,' operates and takes the now completed line out to, and puts it down into, a 'galley' arranged to receive the 'live-matter' column. When this 'galley' or column is filled, the action of putting in the last line locks all the keys, so that the mind of the person at the keyboard is free from any thought other than that connected directly with operating the keyboard or the copy to be composed. In connection with the 'live-matter' column the machine is provided with means for inserting, between the lines composing the column, 'leads' for purposes of display or emphasis, this part being also controlled from the keyboard (as called for by the copy) by means of a switching lever at the volition of the operator. It also keeps a record of the number of lines composed by the machine, so that when the number of 'ems' which the standard line contains is known, the number of 'ems' set by the machine is found without taking duplicate proofs or any measurements whatever.

"It will thus be seen that the Paige Compositor has in its plan and fulfilment canvassed the whole problem and covered the entire work of composition. The machinery employed to do this work is of the most positive, substantial, and successful character known to mechanics, and is the result of twenty years and over of the most careful study—the strength, durability, accessibility, and simplicity of parts having been points which have always ruled in determining what should be used to accomplish the results desired. The machine in no way limits the operator, the speed of composition already obtained is from twelve to fifteen times that of the hand compositor.

"It may be stated in brief that the Paige Compositor does the entire work of composition; setting ordinary movable type with far greater speed, accuracy, and artistic effect, than has ever before been accomplished by

any method. It automatically distributes, and at the same time sets the type indicated by the operator, automatically spaces and justifies the matter, without mental effort on the part of the operator, places it in a galley ready for use on book or newspaper as desired, records the number of lines set, and leads the matter as and when required, and does all this by the employment of positive mechanism.

"The machine is not to be confounded with any other machine, as it is entirely unique in design, principle, and method of working.

"It is not a mere typesetting machine. It is a compositor in the truest sense of the word, as it performs simultaneously all the work of a human compositor."

Lest any wrong impression should be conveyed by the quotation at the head of this chapter, which refers to persons other than those who actually carried out the onerous work of preparing the Paige specifications, and lest it be thought that others had found the work too much for them, the authors wrote to David H. Fletcher of Chicago, the patent attorney who prepared the final specifications; his reply is of such interest that it is printed here *in extenso*.

Chicago. April 6th, 1913.

"I am in receipt of your favour of March 25th, 1913, in which you make inquiry as to my connection with the Paige Type-setting and Justifying Machine. I have never seen Mr. Thompson's History, but can readily imagine what was meant by the 'disastrous end' to which you refer. Fortunately, as you suggest, I am 'still alive,' although the words: 'sufficient unto the day is the evil thereof,' haunt me occasionally.

"I acted as Mr. Paige's attorney and took out his three patents, although the first two applications were filed by another—their apparent complications possibly having had something to do with the 'disastrous end.'

"The first application, although embodying a number of essential principles, was of minor importance. The second, which included the typesetting and distributing features, was, however, very elaborate. The patent issued thereon is known in the Patent Office as 'The Whale.' This harmless leviathan, in its original proportions, greatly exceeded its present size. Its author evidently became lost in the wilderness of appalling details. With a view of severing the Gordian knot, he drew his specification like the sermon of an old-fashioned clergyman, with corresponding mystifying results. As a beginning, the machine was, regardless of construction, function or operation, divided into three 'Grand Divisions.' Each division was in turn, divided into sub-divisions, and these again divided until the 'Sixteenth sub-sub-Division' was reached.

"Paradoxical as it may seem, this clarifying treatment tended only to confuse the mind of the Patent Office Examiner who held that there was a multiplicity of inventions and division was accordingly required. An

appeal was taken from the examiner's ruling. As an indication of the complications involved, it required thirty days for the Assistant Commissioner to read the specification in order to decide the question.

"It was at this stage that I was employed. The Office required a 'working model' which could not be furnished. A compromise was finally made by having the Examiner come to Chicago, where, for a month he studied the working machine. In the meantime, disregarding all previous work, I rewrote the entire specification, in which process I eliminated forty of the two hundred and six sheets of drawings originally deemed necessary to illustrate the anatomy of this wonderful creation. The revision was accepted without question.

"The justifying application filed by me, although not quite so voluminous in appearance, was in fact more complicated and subtle than the other. Every sheet of drawing was packed to the limit with detail; and, inasmuch as it was necessary to associate the operation of many detached mechanisms, some of which were in continuous operation while others were intermittent in varying degrees from minutes to months, the problem became somewhat involved.

"Eliminating the divisions and sub-divisions mentioned, the applications were accepted as embodying unitary inventions.

"You ask 'if this work produced no ill effects upon my mind.' Viewed from a purely human standpoint—yes; viewed from the standpoint that the universe is not a blunder and that man is here for some great purpose—no. This extraordinary creation was both a triumph and a tragedy. Notwithstanding all of the trying experiences and disappointments associated with it, it was in many ways uplifting, broadening, and inspiring. In judging of it as an invention, I have tried to dismiss prejudice and to measure its merits with those of the great inventors of the world, and, as an automatic device, considering the character of the varying problems solved by it, I am of the opinion that it is the greatest thing of the kind that has been accomplished in all of the ages. Commercial failure as it was, for reasons which need not be mentioned, it was an intellectual miracle and its relation to men, as indicating the creative power of mind, is a suggestive verification of the prophecy that 'they shall become as Gods.'

"If I have gone beyond the answer to your simple question, please treat it as 'off the record,' and disregard it. Trusting that I have not made myself tedious, and that I have shown no marked signs of that mental decay which would seem to be the natural corollary of the work in question, I remain, with best wishes for the success of your work.

"Yours sincerely,  
 "(Signed) D. H. FLETCHER."