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EVOLUTION IN DESIGN, MANUFACTURE, AND USES OF TYPEWRITING MACHINES.

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ABOUT the year 1867 Mr Thomas Hall had the distinction of having invented and constructed a writing machine embodying the type bar principle, which, though crude, contained most of the essentials of the successful writing machines of to-day. But it seems that he abandoned that plan of construction and devoted his energies to a machine which was finally marketed about the year 1880, known as the Hall typewriter, its construction consisting of what is known as the pantograph principle, all of the type being placed on a soft rubber pad about square in outline, so that by the moving of a stylus the proper character is brought under a recess in the plate which lies just above it, permitting this elastic type carrier to act with the proper type through the recess and with the aid of a pushing member. It was strictly a one hand machine, so far as effective work was concerned, the other hand serving as a controlling medium, and, taking into consideration this handicap, the machine served in some cases very well for that period.

The first machine introduced and which could be classed as highly practical was the Remington typewriter, possessing the now well-known type bar principle, which was first introduced about the year 1873. This machine was mainly invented by a man named Sholes, who was a printer by trade. Through the assistance of an ingenious workman, Mr. Sholes having no mechanical training, he was enabled to build a crude model machine. This proved to possess the more essential principles necessary to the class of typewriter which could best be constructed at that period. The results of his efforts were recognized as of particular merit by two gentlemen, Messrs. Densmore and Yost, long since deceased. They purchased his patents and were finally successful in interesting the Remington Company, at Ilion, N. Y., a concern which was extensively engaged in

the constructing of fire arms during the Civil War period, a class of work requiring a high degree of mechanical skill for that time.

However, the original model (which was very largely constructed from wood) was used as a masterpiece, and from it, through the skill at the command of the Remington concern, was produced a machine which would write acceptably to those having the matter in hand.

The next important problem which confronted the promoters was to establish a market and it has been related that, at first, in no particular instance could a business man be found who would believe that its introduction in the office would be a practical undertaking. They therefore adopted the policy of lending a machine to each of several hundred business houses, presumably with the hope that some would find time to practice upon them, and with the full belief that it would develop in the minds of not a few that a saving of time as against hand writing was possible.

In this their judgment proved correct, it having been reported by many that the use of the machine was not only a saving of labor in correspondence, but that it also proved of great value in the reading of letters received. It goes without saying that the more progressive of these managements quite readily adopted the typewriter thereafter.

Sufficient years have elapsed since these earliest efforts to enable those who have had many and varied dealings with the subject to judge why certain ideas in construction then prevailed. It can well be said that, at that time, to create a mechanical instrument which would possess all of the movements necessary to the writing of letters and to build it economically, could be rated as a considerable undertaking, even though certain sacrifices as regarded the user were allowed in order to favor the problem from a manufacturing viewpoint; and it is my opinion that the blind, under-strike machine, as constructed during its earlier stages, represented, and necessarily so, one of the simplest forms which could have been introduced into a factory as a manufacturing proposition and at the same time possessed elements of fair speed and durability.

In this early machine the type bars were suspended in a circle, each and all so arranged as to strike upwardly to a common centre. The key levers represented levers of the second order,

simply extending from the key button, rearward, and hinged at the back of the machine. There were wire connections between each bar and its companion lever, which were fitted with a so-called turn-buckle. This turn-buckle rendered it an easy task to establish a proper distance between the two members, the type bar and the key lever, irrespective of the position at each engaging point, as the type bars, when inactive, rested upon a central ring or nest which served to arrest their movement when returning from the printing point. The spread of keyboard and lever system, as against the diameter of type bar suspension ring, was also worthy of note. These turn-buckles, furthermore, served the purpose, under adjustment to compensate for angularity of connection as well as to place each key button at its proper elevation, so as to afford an accurate level for all throughout each bank of keys.

It will be seen that, aside from the question of affording a proper and accurate jointage or hinge for each type bar, so as to insure truth of movement to the printing point, the rest of the type bar and key lever system required no great degree of exacting workmanship; and that in order to lend these important advantages to their manufacture, one of the most essential qualities from the user's standpoint—visibility—was sacrificed. The rest of the mechanism simply afforded the usual means of controlling the paper, both as to longitudinal movement and proper graduating between lines, coupled with the simplest provision for inking the type. As speed competitions between instruments was then unknown, and as the operators of these machines were, in the main, moderate in their speed of writing, refinements in detail as associated with the carriage movement were not then of a pressing nature, in order to secure commercial success.

The success of this first practical writing machine during the few years which followed naturally stimulated invention, and it was but natural that other plans of construction should develop, and of course each inventor had his own notions as to the foundation principles.

A machine known as the Caligraph was one of the next to appear, the main novelty in construction being that each type bar carried but one type as against two in its predecessor, but this step doubled the number of type bars, key levers, and key buttons. Yet to offset this seeming disadvantage with the keyboard, there

was no need for a shift key in the using of capital letters. However, it seems that certain patents then still in force compelled other deviations. The lever system was extended forward and considerably beyond the keyboard, at which forward point the key levers were fulcrumed, thereby providing a lever of the third order, which principle of lever, as applied, compelled a greater variation in key depression with each key bank in order to drive the type bar to the printing point. The means for propelling the carriage longitudinally was also of a different nature, yet the carriage proper was somewhat simplified due to the absence of the shift movement. This make of machine was afterward sold in considerable numbers for a term of years. Yet as a great majority of users favored the single shift key principle, the Caligraph machine afterward became less popular and is now no longer manufactured.

Another machine which appeared soon afterward was a type wheel machine known as the Hammond typewriter, invented by Mr. James B. Hammond, who undertook the task about the year 1876, and the machine was introduced in the market, I believe, about the year 1884. This machine met with considerable success, having certain unique advantages in its adaptability to the employment of characters common to various languages, as it was provided with an interchangeable type wheel system, thereby enabling its users to quickly shift from one class of correspondence to another. I understand it is received with particular favor in the Latin countries.

As a rule, the unusual accomplishments attending any given case, that is, an arrangement which is *too* universal, are effected through sacrifice of some sort, and against the type wheel style of construction it has been claimed that the machines operate more slowly, due to the added weight of the active printing parts; for instead of acting upon an individual type bar, as with the other class of machine, a member carrying all characters is involved under this plan of construction and the added weight must necessarily retard the speed of the action.

It will be noted that prior to the year 1890 three distinct classes of machines had been developed and extensively used, and it can truly be said that very much the greater number sold of the three was that incorporating the type bar idea and with a single shift keyboard, each bar carrying two type—upper and lower case. This most popular construction, however, still

lacked a vital quality, namely, visibility, and as the typewriter business was rapidly increasing in volume it was but natural that inventors should try to overcome this defect and so endeavor to reduce the improvement broadly to commercial practice.

In this undertaking many minds were at work, the earlier attempts being largely confined to the so-called top-strike principle, which construction, due to the law of gravitation, placed the type bars at a great disadvantage in their return movement, and furthermore introduced many complications difficult to deal with in factory practice. It fell to the lot of an inventor named Franz Wagner, a German by birth, to present a foundation plan of the construction for a visible writing machine and, with the aid of other able minds, this developed into what afterward became known as the Underwood visible typewriter. This machine incorporated a front-strike principle of type bar, and was first introduced into the market in a very limited way in the year 1896.

The advantages of the front-strike principle in visible writing machines may be set forth as follows: The type bar moves downward from the printing point after printing, thus affording a quick return to the bar, particularly with a provision on the Underwood of the so-called banking ring. Against this banking ring each type bar collides about midway in its length in printing, thereby affording a quick reacting movement, lending speed to the machine by aiding in the prevention of type bar collisions, this banking ring also helps to quickly separate the type from the paper after the imprint is made and thus prevents a blur, as with a speedy up-to-date machine the carriage movement starts simultaneously with the contact of the type. While it is true that in starting the type bar in action toward the printing point it immediately begins with an upward movement, yet this seeming disadvantage is very cleverly overcome by means of a cam action associated with the bar, whereby the greatest leverage is had in starting the bar into motion; the cam movement so favoring the motion thereafter as to lend an accelerated action, giving quickness of movement as a whole and yet an easy starting action under finger pressure at the key lever. The front-strike idea also places the printing-point at the best position and favorable to the operator. It also makes possible in the construction of the machine a proper position for parts such as would otherwise detract from this valued quality.

That the perfecting of a front-strike visible machine, such as was introduced as far back as the year 1896, was a great step of progress, can best be judged by the number of similar machines incorporating this principle which have since been introduced by several of the most prominent of the older makers of typewriters.

The building of typewriters, cash registers, adding machines, sewing machines, small fire arms, bicycles, etc., comes within the scope of what is known as manufacturing on the interchangeable part plan, the sewing machine presumably being one of the first inventions wherein this system was applied in a broad sense. This system was developed almost wholly in New England, and principally in the State of Connecticut, as was also the case with the sewing machine itself. Associated with this system of manufacture are several machines, which were necessarily perfected to give the plan completeness and economy of method. While this group of machines is at present extensively used throughout the civilized world, giving wonderful productive power, New England contributed: the milling machine, punch press, drop hammer, high speed sensitive drilling machinery, and the profiling machine, the latter so largely used in fire arm manufacture on irregular forms of the compounded type.

Coupled with the above as manufacturing machines, followed the special tools, such as jigs for the establishing of holes with interchangeable accuracy, punches and dies of endless variety for the shaping of sheet metals, and milling machine cutters with their many irregular forms.

The earlier typewriter, when introduced, lacked many of the manufacturing advantages common to-day, as the art of manufacturing on the interchangeable plan began substantially with the sewing machine and has been developed almost wholly within the lifetime of many now living. Very many of the instruments which have to do with interchangeable accuracy have been developed since the typewriter reached the state of common use, and it will therefore be understood why certain designs prevailed. With few exceptions precision work, owing to the nature of earlier typewriter designs, was not necessary, for, barring the jointage of the type bar in order to preserve its truth in printing, there was little required in accurate workmanship throughout the system of type bars, key levers, and connecting parts; the key levers, for example, consisting merely of plain straight bars

of wood. Therefore, perhaps, two reasons can be assigned for the appearance to start with of a machine devoid of the visible writing quality: first, because a construction yielding visibility would have proved a too difficult task to the inventor at that time; second, had such a machine, even as represented in the most up-to-date pattern of to-day, been then presented in model form, the incompleteness in manufacturing methods and practice of that period would have rendered impossible the task of its practical manufacture. Among the earlier machines the Hammond displayed certain unusual attainments in advanced workmanship, as the fashioning of steel dies or moulds for their hard rubber type wheels represented a rare accomplishment for that period.

In the way of raw materials as applied to instrument building, the progress made in the manufacture of steel in its various forms has been very great, and as similar gains have also been made in the production of other raw material, so likewise have the manufacturers of special and complete mechanisms followed in the train of mechanical progress. For instance, should a typewriter factory cease to harden all of such parts, as is the practice of to-day, and yet do all else equally well, its product would be practically valueless to the using public, although but a few years ago very few of the parts received such treatment. The result is a greatly increased life and substantial value commercially.

Assuming, therefore, that proper advancement has been made mechanically since the introduction of the typewriter, the "Factory" and its workings may be briefly considered. The plant of the Underwood Typewriter Company embodies the most modern ideas of factory management and may properly serve as a model for the general consideration of the subject.

In the operation of an extensive plant of this class, there is necessarily much applied system which includes many distinct branches of labor. Apart from those relating to production, it has been found necessary to establish an Experimental Department in which is employed a corps of trained technical men whose duty it is to find solutions to the many technical problems that arise in the course of manufacture and to devise and apply novel features or improvements demanded by the consistent growth of the art. The maintenance of a depart-

ment of this kind, though it takes no part in the operations of manufacture, has amply proved its value by its influence in effecting economies in manufacture and improving the product.

When a large plant is operating to its full capacity great care is necessary in the purchase of material, machinery and tools, that each is of the proper character and quality and delivered at the proper time. This service demands of the Purchasing Division very close contact with the workings of the factory as well as an accurate and extended knowledge of the resources of available supply houses, as it is necessary to know what firms are best qualified to supply material in accordance with the factory's needs.

The division termed the Ways and Means Department, includes a designing department especially devoted to the consideration of problems of factory equipment and the machine shop applied to the building of special tools and special machinery and to their upkeep.

A standard design of the finished product, therefore, having been adopted and assuming that raw materials, manufacturing machinery, tools, fixtures, etc., are furnished, the next division is devoted to the manufacture of parts. Such instruments as typewriters are composed of an aggregation of distinct devices each performing a separate function and each, in itself, representing groups of parts. It is, therefore, found to be most practicable to subdivide the manufacture departmentally in group form, each department building a substantially separate group of parts. In addition to these, assembling, aligning and final inspection departments are provided.

There must be not only a perfect understanding of the requirements of each department but a harmonious co-operation between them. Indeed the productive capacity of the various departments must be so co-ordinated that at no step in the successive operations is any undue haste necessary to avoid congestion which might effect quality. In a well administered organization the rate of output of each department is so well adjusted that, for weeks in advance, the number of finished typewriters may be accurately predetermined.

The factory of the Underwood Company is one of the largest typewriter plants extant in point of floor space and number of operatives employed. Its buildings are nearly all new and of

modern mill construction. It contains about 347,500 square feet of floor space and employs nearly 2,000 operatives. Lighting and other features conducing to comfort and a resulting greater efficiency have received most careful study. Separate dining rooms for the men and women employed are maintained by the Company where a mid-day lunch may be obtained at cost. An emergency hospital is another provision for the welfare of the employees available without cost where first aid is given and wounds may be periodically dressed. A Mutual Beneficial Association is maintained by the men with the co-operation of the Company who contribute an amount equivalent to that subscribed by the members.

In harmony with the Company's endeavor to stimulate the efficiency of its men, as well as to promote their welfare, a merit-system is applied throughout the works. The leader of each department keeps a careful record of the accomplishments and progress of his operatives with a view to voluntarily affording each a fair and just compensation. These are reported and acted upon monthly. A premium system is also employed which avoids some of the defects of the commonly known piece work system. The plan of studying the welfare of the personell has proved most profitable in leading to almost uniform content and in raising the standard of efficiency of the workmen.

The subject of efficient leadership throughout the factory is a very important one, as, in this case, it involves the selection and directing of a large corps of men, each being chosen from a careful consideration of those requisite cardinal qualities,—honesty, disposition and natural ability and adaptability. It is only a close adherence to this mode of selection that will insure what may be classed as "team work" in its true sense. The so-called "team work" is the key-note to success in furnishing a product that will insure public good will, without which the growth of the project and demand for its product is not possible.

In the uses to which typewriters have been placed, there has been the same degree of advancement as in the improvement of the machine and the methods employed in its manufacture, and this has been particularly true during the last five or six years. Prior to that time, our company, which should afford a good comparison for trade wants, made but two widths of typewriter carriages, 10 in. and 14 in. respectively, the 14 in. alone represent-

ing the machine for special purposes. In response to increasing demands they are now made in seven widths, from 10 in. to 26 in.

Coupled with this great variety of widths of typewriters, there have been designed, step by step, numerous attachments to be applied to any width of carriage and for some particular class of work, such as did not apply to typewriting machines of the past. These may be enumerated as follows:

A so-called condensed billing attachment, which is meeting with so many and varied requirements with large business houses in general.

The tally strip device, which, in particular, has proved popular in department stores.

A decimal tabulator, which applies so well with insurance companies, banks, and with many other branches of work.

The universal card attachment, which facilitates the placing of a card to conform with the original printed matter contained thereon.

A label-writing attachment, adapted for the writing of labels in drug stores, as a label the size of an ordinary postage stamp can be placed under perfect control while writing.

An envelope and card inserting attachment.

A paper roll and paper knife attachment, particularly adaptable to railway work.

A typewriter-adding machine, the combination affording great advantage with certain classes of work such as is common with large manufacturers, department stores, banks, and some branches of insurance.

A back-spacing attachment, which facilitates the correcting of an error, particularly when quickly detected, as when using a visible writing machine.

Writing machines are also equipped with special type, such as would apply in the writing of life insurance policies, and also for check writing in non-erasable form.

A word regarding the growth of the typewriter business from its small beginnings may be interesting. It is estimated that in normal times about 300,000 high-grade typewriters are now produced yearly, representing a business of about \$30,000,000 annually. It is also true that the United States has produced nearly all of these machines from the first, Germany alone having made any progress in this direction and only in recent years.

It is also estimated that there are between 1,600,000 and 1,800,000 writing machines in daily use; lending tremendous earning power and commercial advantage as against the old-time practice of hand writing. In fact, the art of stenography, coupled with the use of the writing machine, has given such relief to men of high position as to add much toward the world's progress.

In treating a subject so broad in its scope, I have been compelled to gather data from several directions, and I feel particularly indebted to Mr. Lee S. Burrige, the proprietor of the Sun Typewriter Company, and also to the Providence Society of Mechanical Engineers for valued assistance.

BARK AFFECTS PENETRATION OF WOOD PRESERVATIVES.

The government has gone into the study of every phase of wood preservation, and as progress is made in new experiments important facts are brought to light which heretofore have been given little or no attention. One of the features in the work of wood preservation which has been neglected is the effect of patches of inner bark of wood in preventing proper penetration of preservatives.

Before timber is subjected to preservative treatment, it is customary to remove the bark. Unless this is done very thoroughly, however, patches of the inner bark will remain on the wood.

Until recently, it does not seem to have been realized that this bark presented a very effectual hindrance to the penetration of creosote. In conducting some tests on the treatment of pine in Louisiana and Alabama in 1907 and 1908, it was noticed by a representative of the Forest Service that very little or no creosote entered the wood through even the thinnest layer of adhering bark.

The same thing was discovered by the management of one of the large creosoting companies in the South, and steps were immediately taken to see that every particle of bark was removed from piling and other timbers. While it is probable that the bark of all species is not as resistant as that of pine, it is not known how the different species rank in this respect.

In the creosote treatment of timbers, it is rarely that the entire stick is penetrated by the preservative. The value of the treatment consists largely in the creating of an exterior antiseptic zone around the untreated interior portion. If this outer zone be broken, the value of the treatment is to a large extent lost.

In the case of piling, the effect of any small portion of untreated wood extending from the outer surface to the interior of the pile is especially injurious because of the manner in which teredos work. The teredo enters the wood when small, making but a tiny hole, perhaps no larger than a pinhead. As they grow, they increase the size of their borings, and if present in large numbers they will very quickly so riddle and weaken a pile that it will break off with a very slight strain. Access to the interior of a treated pile might readily be gained through small untreated portions of the outer surface of the wood, which, because of bark adhering at time of treatment, absorbed no preservative, with the result that all of the interior untreated portion would be riddled, leaving only the exterior creosoted shell sound. It is probable that many of the failures of creosoted piling are due to this cause.

With other forms of timber, the effect may not be so quickly seen or so disastrous, but in a similar manner decay may extend to the interior through any untreated portions communicating with the exterior.