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## **Latest Developments in the Burroughs' System of Book-keeping and Accounting.**

### **Development of the Accounting Machine.**

BY R. L. BURD.

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On behalf of the Burroughs Adding Machine Company, I desire to thank the Institute for the privilege of addressing you this evening on the subject of the Adding and Listing Machine as we know it to-day.

The idea of a commercial machine to add and list figures was original with William Seward Burroughs. The idea occurred to Mr. Burroughs when he was a bank clerk in Auburn, New York, and on account of poor health was ordered by his physicians to give up close, confining work. Believing that it was largely this work which had ruined his health, Mr. Burroughs set about devising a machine which would do the routine work of the clerk; and the rest of his life was devoted solely to this object.

In 1882 he went to St. Louis and began to put his ideas into definite shape, a task which occupied him constantly until he finally developed a practical model in 1889.

Like many inventors, Burroughs did not have money to carry on his experiments, and at an early stage in the development of the machine was obliged to hunt for capital. In this he was met by constant disappointment, as many people looked with suspicion upon a man who was so foolish as to think that he could make a machine do the work of the human brain, and as a result he was often considered somewhat out of his mind.

The very first models which Burroughs made are not in existence at the present time. The first one of which we have any definite record was very crude and had to be abandoned after tests had proven that it was not capable of doing the work required. It

is notable, however, that even in his early models, Mr. Burroughs included many of the essential features of the machine as it is built to-day, and it is a wonderful comment on his ability that after twenty-five years of practical tests it has been found that the original principles, as laid down by Burroughs, cannot be improved upon—and, in fact, have never even been approached by those who have spent years in the study of this subject since the time of Burroughs.

Mr. Burroughs' first aim was to produce a machine that would record figures on paper and would give a correct total of the amounts that were printed, without depending in any way upon human agency, except for the operation of the keyboard. The greatest trouble which he experienced was in getting his printing mechanism to work in exact unison with the totalling mechanism, and eventually he solved this problem by making the two mechanisms integral. This is the famous Burroughs Pivotal Principle. The entire mechanism for printing and adding amounts is mounted on one bar—a bar for each column of figures. The sector teeth, which perform the addition, are placed at one end of the bar, and the type, which perform the printing, at the other end. These bars swing on a central shaft or pivot, and the operation of the machine, therefore, is performed by a simple rocking or "see-saw" motion of these bars.

Other features which Burroughs devised to accomplish the work he had in mind are Locked Keyboard, which prevents the operator from depressing more than one key in any one column without first pressing a correction key; the locked adding mechanism, which keeps the total wheels positively locked at all times, insuring that only those amounts which are depressed in the keyboard shall be printed and added; the hammer printing mechanism, by which the type are fired against the paper, one at a time, doing away with vibration and jar. One essential principle which Burroughs at first overlooked, was the device to control the operation of the machine and guard it against rough treatment on the part of the operator. The necessity for this device was not discovered until the first machines were placed upon the market and subjected to the final test of commercial use.

It was in 1889 that the first machine was placed in the hands of the public, and its development at that time represented an expenditure of more than \$300,000. Mr. Burroughs considered the

machine perfect in every respect, because, in operating it himself, it responded perfectly and seemed to have no faults. The machines placed upon the market, however, being in the hands of inexperienced operators, soon gave trouble, and Burroughs found it necessary to visit the different users of the machine, when he discovered that there was a great difference between the machine when operated with his own hands and by careless and unskilled operators.

This was perhaps one of the worst disappointments in all the long series of disappointments which Burroughs experienced in his work. He had reached his triumph as the inventor of the first commercial machine to do this work, and here he was confronted by the failure of the machine, due not to any fault of the



Burroughs sector bar, carrying adding teeth at one end and printing types at the other. The operation of the machine is performed by the rocking, or "see saw" motion of these bars one for each vertical row of keys. When the adding mechanism descends a certain number of notches, the printing mechanism must rise an equal distance, so that whatever is added must be printed.

machine itself, but to the fact that it was impossible to train all of the people who might be called upon to use it.

He wrestled with this problem for a long time, and his final solution was the Burroughs Controlling Device, which consists of an automatic governor located centrally in the machine, absolutely controlling its functions and safeguarding the mechanism against rough usage of any kind.

The machines that had been sent out for public trial were now recalled, and as they were received, one at a time, at the old Boyer machine shop, where Burroughs built his first machine, Mr. Burroughs took them in hand and stored them away in a small room in the work shop. When all had been returned and replaced by machines containing the controlling device, the inventor quietly

went to this room one day, without telling anyone his intentions, opened a rear window and tossed all the machines, one by one, out into the paved court yard, where they were heaped up in an unrecognizable mass of material. He then went to the shop and called Mr. Boyer out into the back yard, saying, "I have something to show you." Pointing to the pile of scrap iron, which was all that remained of his early work, he said: "There, I have got rid of all my troubles." This instance only shows the love for accuracy which Burroughs had, and which is shown to-day in his machine. So painstaking was he in all his work that even his drawings were made upon metal plates in order to gain absolute accuracy.

After the controlling device had been placed in the machine and its efficiency established beyond a doubt, the success of the company was assured, and 1,000 machines were built and sold between the years 1891 and 1895. Perhaps the best demonstration of the thoroughness of Burroughs' work is shown by the fact that some of these very first machines are still in use to-day and are perfectly accurate in every way.

The constant increase in the demand for the Burroughs machine is shown by the fact that while it took four years to sell the first 1,000 machines, the sales for the year 1907 alone were 13,314 machines, and there are over 65,000 in use at the present day.

In 1904 the first factory, which was built in St. Louis, for the manufacture of the machine was outgrown, and the American Arithmometer Company, as it was known at that time, moved to Detroit, where a new factory was built providing sixty per cent. more floor space than the former one. The name of the company was also changed at this time to the "Burroughs Adding Machine Company." In addition to moving the machinery and equipment, the company moved its skilled employes, their families and furniture, from St. Louis to Detroit. This factory in Detroit is located on a beautiful, broad, shaded boulevard, and is a model for cleanliness, light, modern appointments and completeness. At the present time the company are planning a building for office use alone which will give them a continuous frontage on the boulevard of two city blocks, with a total floor space in factory and offices of over five acres.

In order to meet the constantly enlarging demands of business,

it is necessary to maintain an Inventions Department, comprising over 100 skilled men—inventors, designers, draughtsmen, and experimental mechanics—who are working constantly bringing out new ideas and enlarging the scope of the machine. It seems remarkable, when we stop to think, that this corps of inventors, including the best minds in the adding machine art, that the fundamental principles contained in Mr. Burroughs' experimental machines, still command the admiration of the best mechanical engineers of to-day.

The pivotal principle is, of course, responsible for much of the success and prestige of the Burroughs machine. This is readily understood, as the friction in the pivotal bearings is very slight, whereas the sliding, dragging, metal-to-metal bearing surface used in most types of machines involves a constant sliding back and forth, which, of course, discharges oil from the bearings in a short time. It is said by those who were acquainted with Mr. Burroughs when he began his work, that he tried a sliding principle at the start, but could not secure accuracy, and found that his results could only be accomplished by using the pivotal principle.

The type bar, or sector, on the Burroughs machine carries the type figures from "naught" to "nine" on its rear end, and the adding rack on its forward end. The machine is constructed so that this bar moves at a high rate of speed with little friction, and to make this possible its weight is supported by the bearing on the center shaft, the bar being perfectly balanced. This not only secures ease of operation, but allows a movement of two or three inches at the ends, with a bearing movement of but  $3/32$  of an inch, in handling the largest amounts.

The entire machine is constructed on this pivotal principle, and every moving part works on a pivotal bearing and swings in the arc of a circle.

Regarding the controlling device which I have mentioned: In addition to the oil actuated controller, we have two heavy springs which take up all vibration and jar imparted to the machine by means of the handle. In other words, the power applied to the handle is transmitted to the machine through these springs and the controlling device, so that no matter how hard or fast the handle may be pulled, the machine cannot go above the normal speed, and the sequence in which its functions are performed cannot be

disturbed or altered in any way. It will be seen that such perfect control is necessary in a machine which does the work of the Burroughs, for while a watch may vary two or three seconds in the course of a day without disturbing its owner, the Burroughs must not vary a single unit in its tireless daily grind of figures. Therefore, whether the machine is operated fast or slow, by an operator who pulls the handle evenly, or one who jerks it violently, the machine is bound to give the same results in each instance. Therefore, the life of the machine is not determined, or in any way shortened, by the manner of its operation.

Next, Mr. Burroughs realized that it was necessary to securely lock the adding wheels in the front of the machine at all times, and the safeguards thrown around this adding mechanism are perfect. As the handle is pulled forward preparatory to adding an amount, these adding wheels must move out to permit the adding sector to descend, and as the wheels move out they are locked between two teeth in front before they are unlocked in the rear from the teeth in this adding rack. By this you can see that no shock or jar could ever be great enough to disturb the figures on these wheels, which show the correct total at all times.

Next, Mr. Burroughs realized that vibration must be avoided if the machine was to perform its work perfectly and for a long time. Therefore, he did away with vibration in all parts of the machine. In addition to the shock absorbers which I have previously described, he carried out the same idea in the printing mechanism by causing the hammers which perform the printing to strike one at a time, instead of all at once. In the standard sized Burroughs machine there are nine of these hammers, and they fire one at a time, the effect being as though we were to fire a double-barreled shot-gun one barrel at a time instead of both together.

Another thing which Mr. Burroughs provided for was an absolutely interchangeable construction throughout the Burroughs machine. A part which becomes slightly worn after years of use can be replaced with a new one without hand work or special fitting, and this is possible, because Mr. Burroughs constructed the machine in such a way that every part is easily accessible and interchangeable. To maintain this interchangeability it is necessary to have very fine and accurate instruments, and thus the tool room at the Burroughs model factory is one of the best equipped in the

country and employs nearly 200 skilled mechanics, who are very busy turning out the various tools used in the manufacture of the machine.

The Burroughs machine is sometimes criticised on the ground that it contains so many parts, but the wonderful length of life of the machines in constant use proves conclusively that there are only enough parts to make a perfect machine for a long length of time. In this connection we might compare two watches, one made to sell for a dollar, the other a good Swiss or American made watch. In the good watch we have more parts, more springs, but we have accuracy and long life. In the other we have fewer parts, also a constant doubt as to the accuracy of the watch, and very short life. In the dollar-watch the number of parts has been reduced to bring the manufacturing cost within the required limit. This makes it necessary for each part to perform the work that should be borne by two or three, and in doing this that part is subjected to great wear, which soon destroys its accuracy.

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## Mechanical Accounting.

BY THOMAS M. JONES.

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When Mr. Burroughs was endeavoring to raise enough money to perfect his invention, the greatest inducement he had to offer to his prospective backers was that some day they might be able to sell as many as 8,000 machines to the banks in this country. At the present time there are over 65,000 Burroughs machines in use, and hardly one-third of these are used by banks. The first machines that were sold were fitted with a paper carriage to accommodate a roll of paper only. This, at that time, being the only style of paper desired by banks, whose use for the machine was simply making their balances. The first need for a paper carriage to accommodate wide sheets was made apparent by the needs of cotton dealers, who found that they could save a great deal of time by invoicing their cotton weights on the adding machine. Cotton weight sheets were so ruled as to accommodate the weights of one hundred bales. The wide paper carriage was