THE BURROUGHS ADDING AND LISTING-MACHINE.

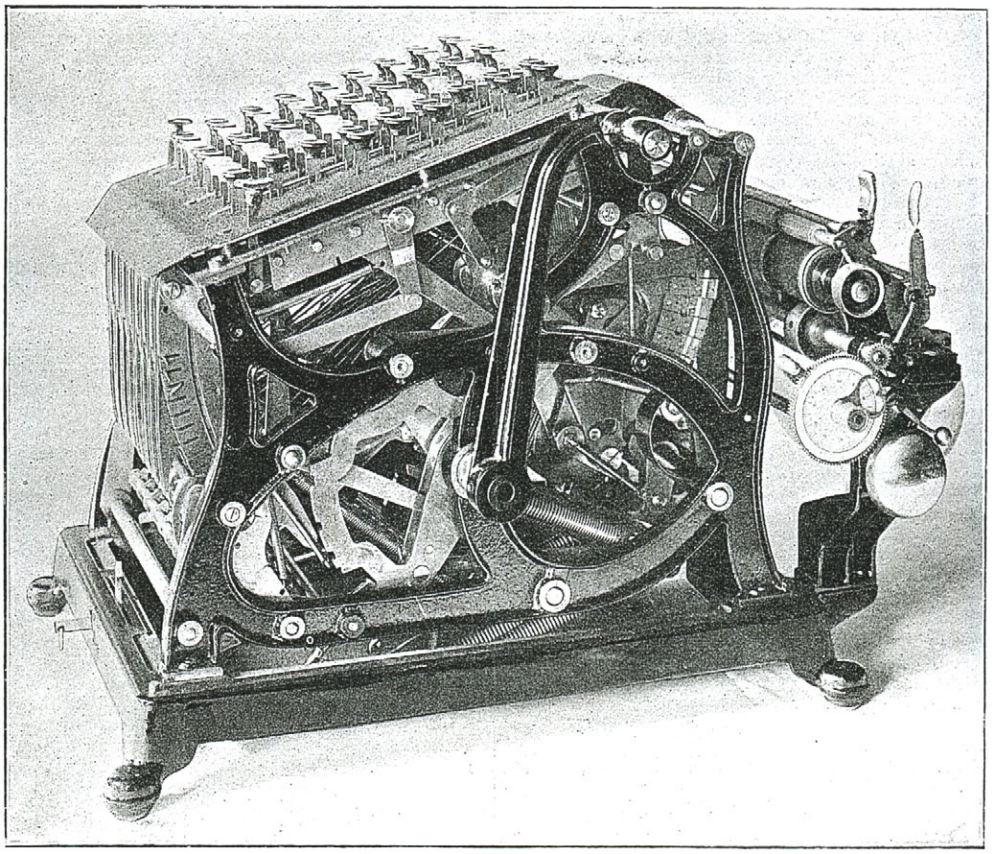
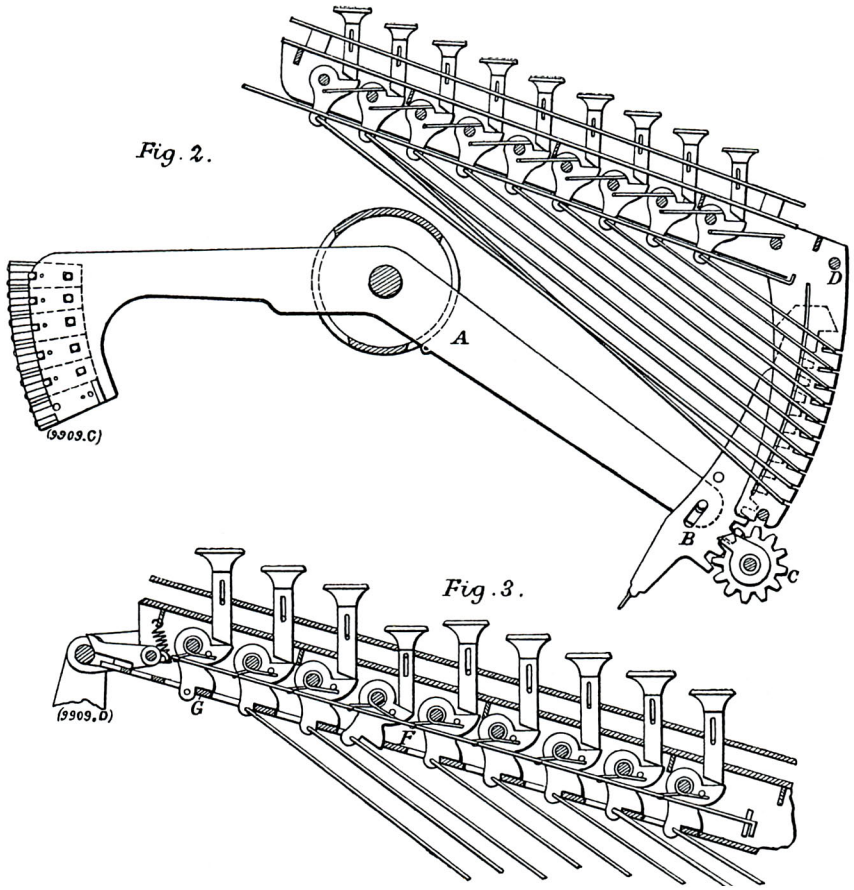


Fig. 1.

On this and the opposite page we give illustrations of an extremely efficient adding-machine, which is very extensively used in banks and clearing-houses both in this country and abroad. The machine is of American origin, but is manufactured at Nottingham by the Burroughs Adding and Registering-Machine Company, Limited, from whose works the whole of the large Continental demand is met, as well as the needs of the British market. The machine is intended to print down a column of figures, such as £ *s.* *d.*, and then almost automatically to print at the bottom of this column the sum total, thus relieving the

clerk of all the labour of addition. In principle the machine is quite simple, the apparent complication visible in Fig. 1 being due, in the first place, to the repetition of similar parts, inseparable from a machine of this kind; and, secondly, to the provision of various details, designed to make impossible the improper working of the machine by a careless or indifferent operator.



Each essential element of the machine consists of lever A (Fig. 2) pivoted near the middle, carrying at the one end a set of figures from 0 to 9, held in slides by springs, whilst the other end is attached to a segmental rack B, with which a number-wheel C can be thrown in or out of gear. The upper end of this rack is arranged to move between a couple of guide-plates D. It

will be seen that a curved slot is cut in these guide-plates which is concentric with the point of oscillation of the lever A. Into this slot fits a projection from the top of the rack B, and as the other end of this rack is secured to the lever A, any possible motion up and down between its guide plates is a true circular motion about the pivot of A. A number of slots are, it will be seen, cut in the right-hand edge of the guide-plates D, and in these slots lie the ends of a number of wires, as shown. If a key is depressed, the corresponding wire moves to the left, and its bent-in end is pulled to the bottom of its slot, in which position it catches the projection shown at the top of the sector B, and thus limits its possible downward movement. With the rack thus arrested the other end of the lever A is raised, so that, of the different figures it carries, that corresponding to the key depressed on the keyboard is in position for printing. This printing is effected by the release of a small spring-actuated hammer, which, striking the right-hand end of the type-block, which, as already stated, slides in a slot in A, and is normally held back by a spring, drives it forward against the type-ribbon and paper.

The same effort which produces the downward movement of the rack throws out of gear with it the number-wheel C, which therefore undergoes no rotation during this downward motion. After the operation of printing is effected, however, the rack is raised again to its topmost position; but prior to being permitted to take this upward movement, the wheel C is thrown into gear with it, and hence, by the time the rack is restored to its original position, this wheel will have been turned through a number of teeth, equal to the number of the key originally depressed. If the series of operations just described is repeated, a second figure will be printed on the paper, and the number-wheel fed forward

an additional number of teeth. Hence, if a set of these wheels is arranged in series, with suitable provision for “carrying” from one wheel to the next, as in an ordinary engine-counter, the wheels will show at any time the total of all the figures successively printed on the paper; and by suitable means this total can, moreover, be printed on the paper below the column of separate items.

This latter operation is effected by depressing the totallising key, shown at the far side of the keyboard in Fig. 1, which is arranged so that no other key on the board can be depressed at the same time. The effect of the depressing of this key is to prevent the number-wheels C being thrown out of gear before the downward motion of the racks. These wheels are fitted with pawls, which prevent them being rotated backwards beyond the zero position. Thus, if in the totallising movement a wheel indicated 5, the rack in its descent would turn it back through five teeth, and would then be unable to descend further, just as if in the case previously described the wire corresponding to the number 5 key had been moved back in its slot. Hence the type end of the lever A will be in position to print the number 5, which was that on the counter. At the same time it will be seen that this counter-wheel C has been moved back to its zero position, and if moved out of gear before the racks are raised again, will read zero at the completion of the operation. Thus the taking of a total clears the machine, setting all the number-wheels to zero.

Whilst the essential principles of the machine are as just described, many safeguards are necessary to ensure its proper working. The latter involves on the part of the attendant two distinct operations. In the first place, the amount to be recorded

is “set” by depressing a key on the keyboard. By pulling back the handle shown to the side of the machine in Fig. 1, this sum is then printed on the paper at the back of the machine, and on the return stroke of this handle the number on the keyboard is transferred to the number-wheels, as just explained, and at the same time the keys depressed in setting the keyboard are released and return to their normal positions.

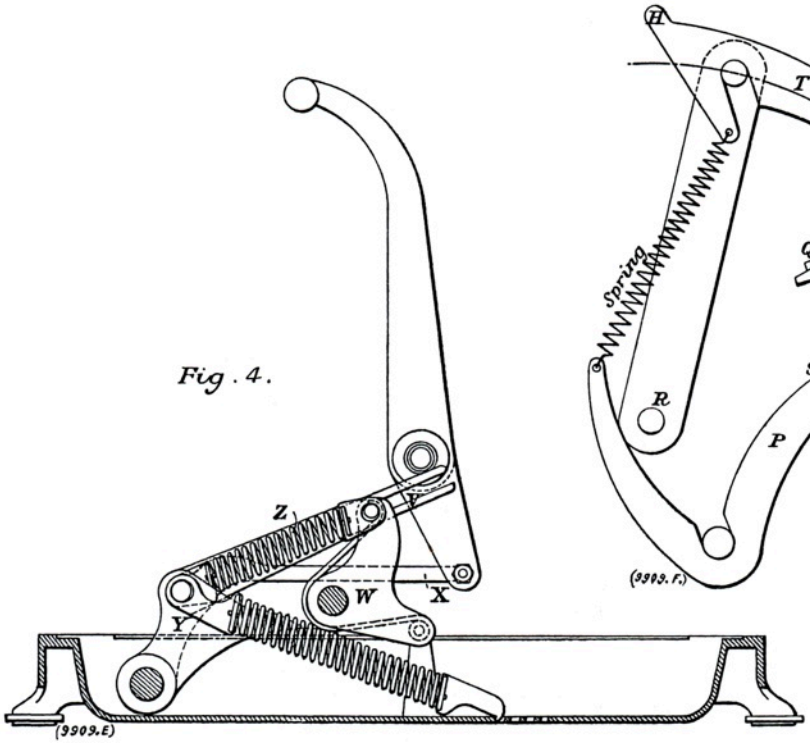
The depression of a key has three distinct results. In the first place it moves the corresponding stop-wire to the back of its slot, as already explained. Secondly, it locks every other key in the same column; and, thirdly, it withdraws a catch which would otherwise prevent the descent of its corresponding sector.

The locking of every other key in the same column is effected by the device shown in Fig. 3. The tail of each, it will be seen, rests on the horizontal arm of a small bell-crank, the other end of which is connected to the stop-wire. As the key is depressed, the vertical leg of the bell-crank moves to the left, and carries with it a sliding-plate G, through a slot in which the lower arm of the bell-crank passes, as indicated at F (Fig. 3). In the position shown, key No. 6 being depressed, the sliding-plate G, moving to the left, has brought solid metal under the noses of each of the other bell-cranks; so that, as will be seen, it is impossible to depress any other key till the plate has been restored to its original position. This sliding-plate is constantly impelled to the right by a spring, and would fly back when the pressure on the key was removed, were it not locked by a pawl at its left-hand end. After an item has been printed, the final motion of the machine lifts this pawl, letting the plate slide back, in doing which it carries with it the depressed key, restoring this to its normal position. At its forward end, this plate, in being

moved back by the depression of a key, carries with it, by means of a projection, the stop which, as already stated, would otherwise prevent the downward motion of the sector.

This stop, when a figure has been set, is prevented from flying back by a pawl, and this pawl is released, bringing the stop into its normal position simultaneously with the release of the sliding plate at the end of an operation of the machine. In certain cases it is convenient to be able to repeat a number several times in succession, without resetting it. This is effected by depressing the special key, shown to the right of the keyboard in Fig. 1. The depression of this key prevents the pawls which hold the sliding-plate G, on the depression of a key, from being raised at the end of an operation of the machine, and consequently any depressed keys remain down. Provision of this nature is possible, since but very few of the various motions of the machine are positive in character, but are effected through the medium of springs. Summing up, it will be seen that the depression of a key has but three simple results. All further operations are effected by pulling back to the limit of its travel the side handle shown in Fig. 1, and letting it return of its own accord. The effect of pulling over this handle is to throw into tension a series of powerful springs in the base of the instruments; these springs acting then as driving power to the main shaft of the machine. The rate at which they succeed in effecting the different operations is governed by an oil dashpot, and hence sufficient time is ensured for all the successive operations of printing and totallising to be effected in due order. It is therefore impossible for a careless operator to damage the machine by seeing how fast he can “buzz it round.” The force operating the machine is quite independent of that which he

exerts on the handle, and cannot exceed the tension of the springs. A notched plate is, however, attached to the handle-spindle, and moving with it, ensures by engagement with pawls that the handle shall be pulled over to the limit of its travel every time, before being allowed to return. The handle, though it does no direct driving of the mechanism, does govern some of the movements made, since the possible motion of the spring-actuated driving-shaft cannot exceed that allowed by the motion of the handle, and the latter must therefore be carried to the end of its travel before the spring-driven shaft can effect its full travel. Moreover, if this handle is out of its normal position, it throws up a bar extending right across the machine, which locks all the keys, and prevents any being depressed until the handle is restored to its position of rest.



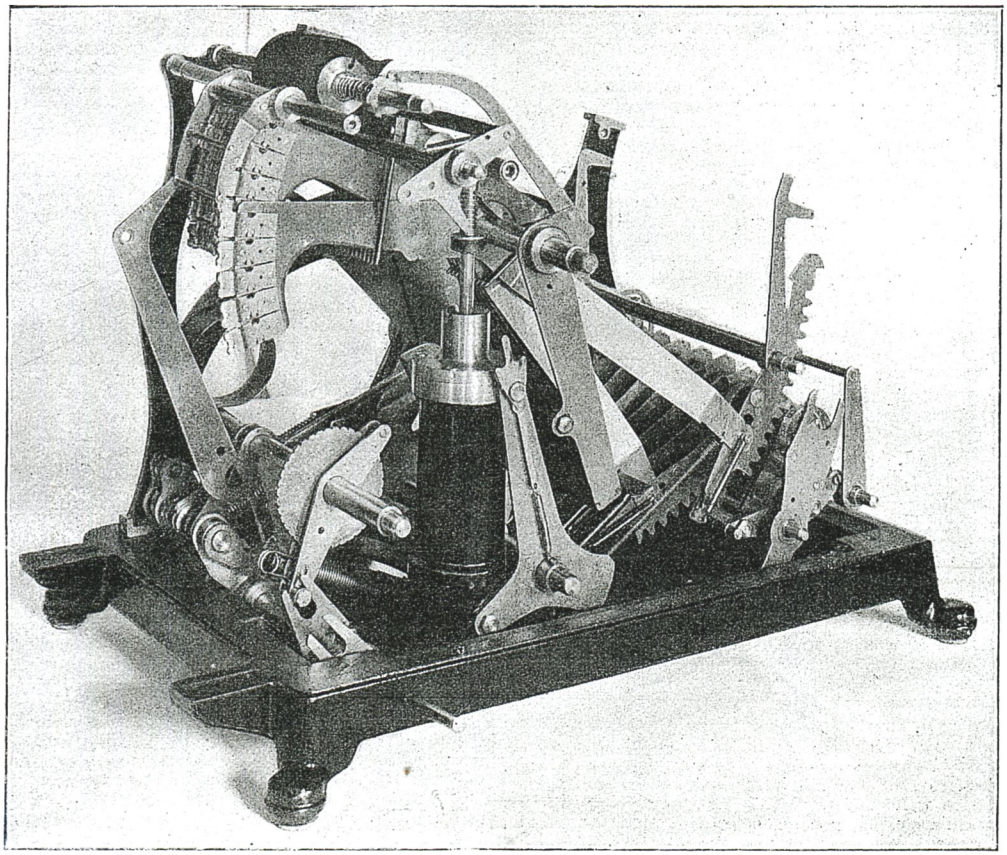


Fig. 5.

Referring to Fig. 4, it will be seen that the handle, by means of the link X, pushes over the lever Y. This lever is pulled towards the front of the machine by four strong springs hooked into the bottom plate, as indicated, and, by a set of springs, such as Z, pulls over, in its turn, the bell-crank W. It is this crank which really actuates almost the whole of the mechanism of the machine. It is coupled to Y by springs, as already stated, and moves to the left under the influence of these only. Its return stroke to the right is, however, made under the thrust of the fork V, which is pivoted to Y. Hence the driving power of the machine on its return stroke is provided by the springs connecting the lever Y with the base of the machine, and in the

forward stroke by the springs between Y and W. On both strokes, therefore, the machine is spring-driven. A dashpot, not shown in this figure, but clearly visible in Fig. 5, which represents the machine partially dismantled, controls the speed of the machine on both strokes.

We have already explained that in the operation of listing a series of items which are ultimately to be added up, the first action of the machine is, through suitable linkwork, to shift all the number-wheels clear of the descending racks. To this end the whole set are mounted on a frame extending right across the machine. This frame is itself mounted on pivots, so that it can be swung in or out from the racks. As soon as the handle has been moved over to the full extent of its travel it is automatically locked here, and prevented from returning until the operation of printing has been effected. On the return stroke of the machine the wheels are swung into gear with the racks which, in ascending, turn these wheels round through a number of teeth equal to the number of notches, past which the rack has been allowed to fall till brought up by the stop-wire. In order that these wheels shall always show the total sum registered by the machine, a “carrying device” is necessary from the wheel corresponding to the units place, to the tens place, and so on. This carrying device consists, in the first place, of a cam or long tooth – keyed to the number-wheel C, Fig. 2. This cam does not, as in an engine-counter, rotate directly the wheel next above it, but merely releases a stop, which, when no total is being carried, limits the rise of the succeeding rack. Hence, if a “carrying” operation is to be made from the units to the tens wheel, the cam on the former displaces a stop in the path of the tens rack, and, as a consequence, on the return stroke of the machine, the tens

rack rises beyond its normal position to a height equivalent to the pitch of its teeth. While the racks are rising (during the operation of listing) the number-wheels, as already stated, are in gear with the racks; hence, in the above case, the tens wheel rotates one tooth more than it otherwise would have done.

In the operation of totalling, it will be remembered that the relation of the number-wheels to the racks is reversed; that is to say, they remain in gear during the down stroke of the racks, and are thrown out of gear on the return. As the racks in totalling fall to a distance limited by the wheels rotating backwards to the zero position, it is essential that these racks shall be in normal position before a total is effected, and hence provision is made by which if any rack is in the high position due to its having "carried over" from one wheel to the next, a stop is thrown into action which makes it impossible to depress the totallising key at the left hand of the machine. By making an idle stroke of the machine the racks are restored to the normal position, and a total can be taken. This idle stroke of the machine, moreover, feeds forward the paper on which the items are listed, so that a space intervenes between the list of items and the total printed by the next movement of the handle. This space serves the useful purpose of distinguishing a total from one of the individual items, the column of items being always separated from the total by this space.

We have said that in "carrying over," the rack which effects the operation rises one tooth beyond its normal position. This is possible, because, as will be seen from Fig. 2, the rack is connected to the swinging beam A by a pin working in a slot. A spring tends to throw the rack up and bring the pin to the bottom of the slot. When no "carrying over" is to be effected, the beam

A, in moving back to its normal position, carries with it the rack B, but the latter is stopped in its upward movement by a catch before the beam A has completed its stroke. This the latter does in stretching the spring connecting it with B, and comes to rest finally with the pin at the top of the slot. If, on the other hand, the long tooth on the preceding wheel has removed the stop in the path of B, the latter moves with A till the latter has completed its stroke and comes to rest with the pin at the bottom of the slot, and, therefore, one pitch above its normal position. Each of the swinging beams A is connected on its right-hand side with a spring, pulling it downwards. A bar extending right across the machine prevents any one of the beams descending, until it has been swung out of the way by pulling the operating handle. When this bar has been swung clear, any one of the beams which may have been released by the depression of a key is pulled down by its spring till brought to rest by the stop-wire connected to tbe depressed key. On the return stroke of the machine, the bar, already mentioned, is swung up to its original position, carrying with it all the beams which have been displaced; and when these are home, they are locked there by a set of pawls, each of which is released only by depressing one of the corresponding keys.

The swinging beams A are bent in the horizontal plane, so that whilst their type ends are set at ⅛-in. centres, their other ends are ¾ in. apart. At its type end each beam has mounted on one side of it a set of five little blocks, which move in slots, and are held back towards the pivot of the beam by springs. Each block carries two types, the five giving all digits from 0 to 9, whilst a set of little hammers, spring-actuated, lie between each set of beams, and, if released, will drive forward the block in

front and print the corresponding character on the paper. The release gear for these hammers is shown diagrammatically in Fig. 6. There are a series of pawls T mounted side by side on a pin, which is carried by two links swinging about a centre R. If this link is swung forward, it can, it will be seen, catch a second pawl U, provided always that the forward end of T is allowed to fall behind the catch. If the main swinging lever A, Fig. 2, corresponding to T, is in its normal position – that is to say, if no one of its corresponding keys has been depressed – the tail H of the pawl T is prevented from rising by the underside of this lever, and as a consequence its forward end cannot catch hold of U. Hence, on the return stroke of the frame on which T is mounted, U remains unaffected, and the striker P, which drives the type-hammer by the roller S, remains in place, and consequently no printing is accomplished as far as that particular element of the machine is concerned.

If, on the other hand, a key has been depressed on the board in the row corresponding to the pawl T, the sector end of the corresponding lever falls, and its type-carrying end rises, so that the tail H of the pawl T is no longer kept from rising. The main lever having been brought into position by the fall of the sector against its stop-wire, as already explained, the further operation of the machine swings forward the frame on which is mounted the pawl T, which, as its tail can now rise, grabs U, and, on its return stroke carrying this with it, releases P, which, driven forward by its spring, strikes the hammer sharply against the back of the type-block, and the corresponding character is accordingly printed. The arrangement of pawls and levers P, U, and T is repeated for each place in the pounds, shillings, and pence column, the whole set being mounted side by side. As

stated above, the pawl U is, in general, never raised unless a key has been depressed in the corresponding column of the keyboard. If, however, it is desired to print the sum of 500*l*., say, then it is convenient that the zeros shall be printed automatically, without requiring to be set on the keyboard, for which, in fact, no provision is made. To effect this the tail Q of U for the hundreds column has a projection on its right-hand side, which extends over the tail of the U pawl for the tens column. If, then, the U pawl for the hundreds column is raised by its corresponding piece T, its tail Q pushes down the tail of the U pawl for the tens column, and thus releases the corresponding striker P. Similarly, the raising of the U pawl for the tens column releases also the striker for the units column; and thus, in the case taken, the sum 500*l*. will be printed, though only one key has been depressed on the keyboard.

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