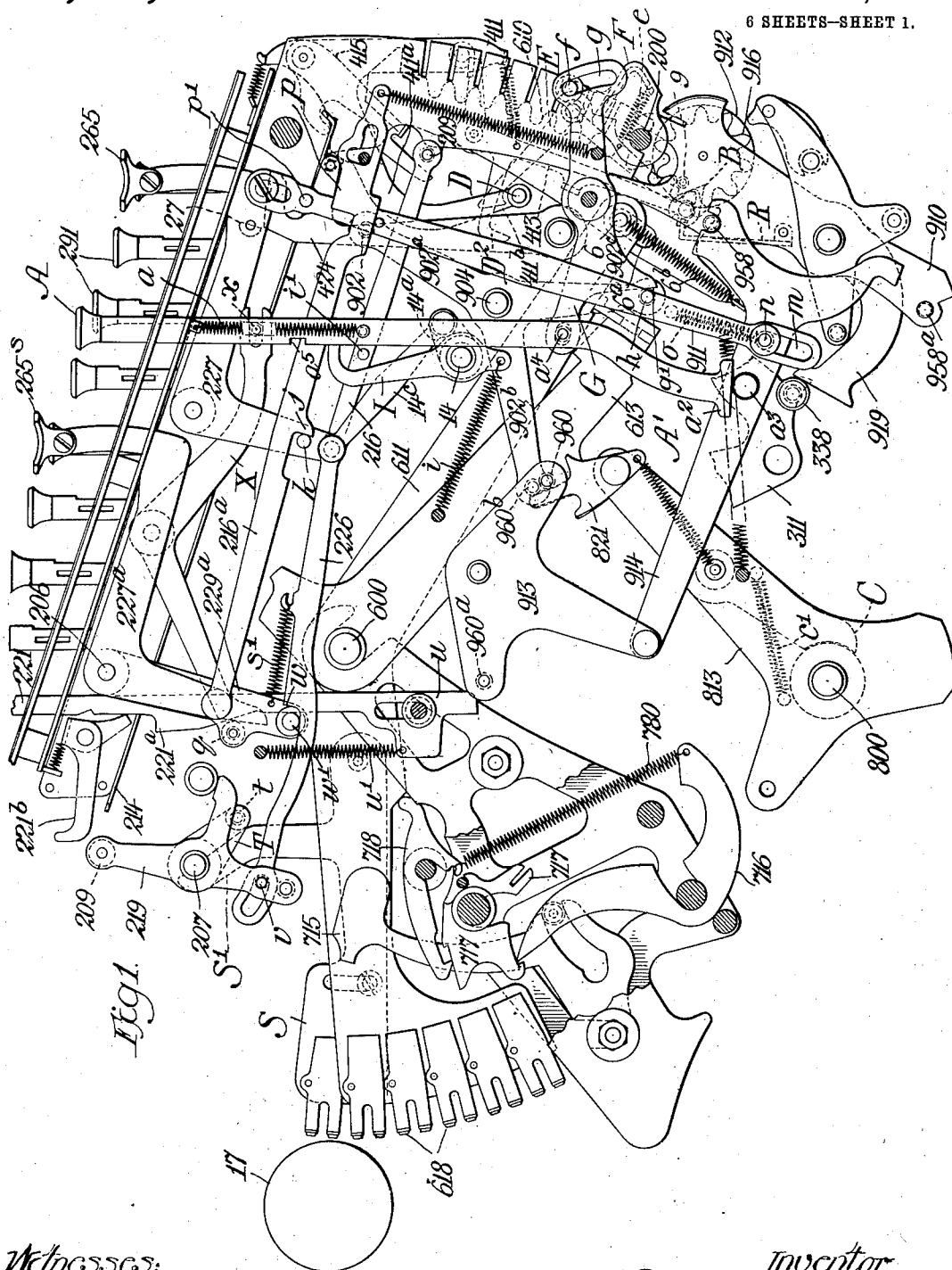


J. G. VINCENT.
 ADDING AND SUBTRACTING MACHINE.
 APPLICATION FILED APR. 6, 1908.

1,028,161.

Patented June 4, 1912.

6 SHEETS—SHEET 1.

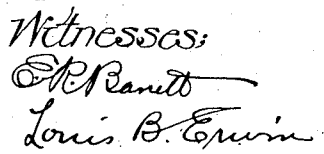


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6 SHEETS—SHEET 2.



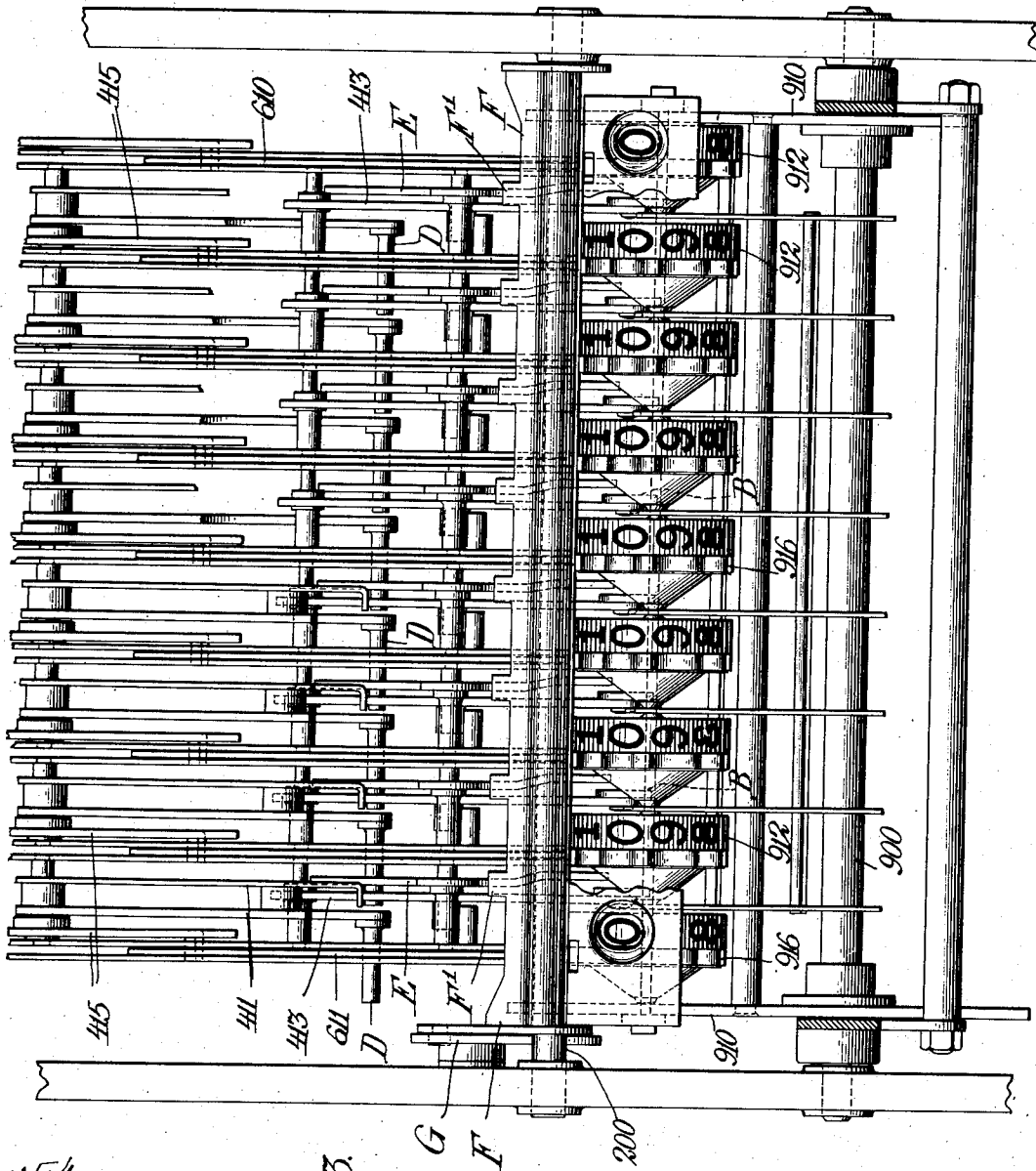
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6 SHEETS—SHEET 3.



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Fig. 3.

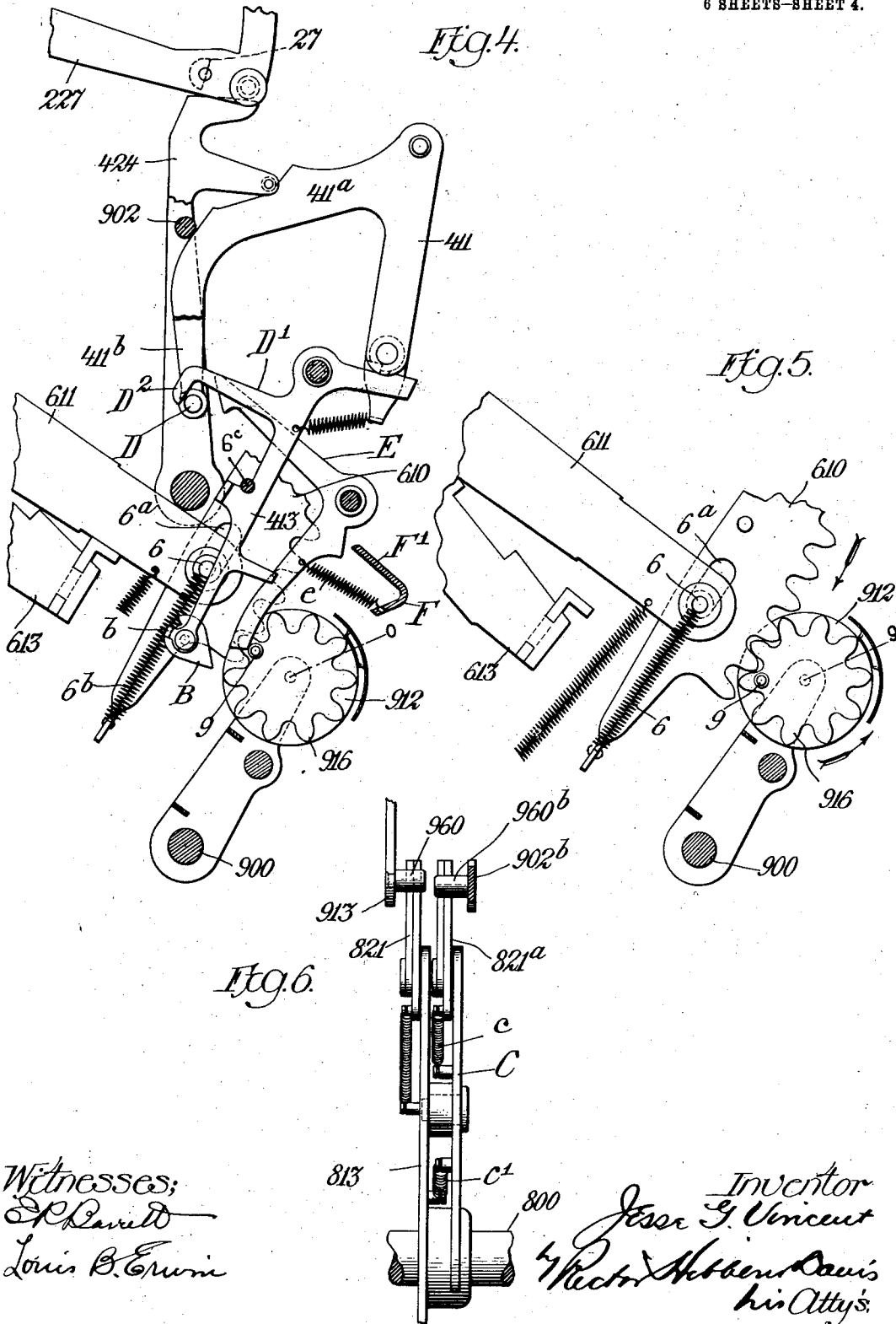
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6 SHEETS—SHEET 4.

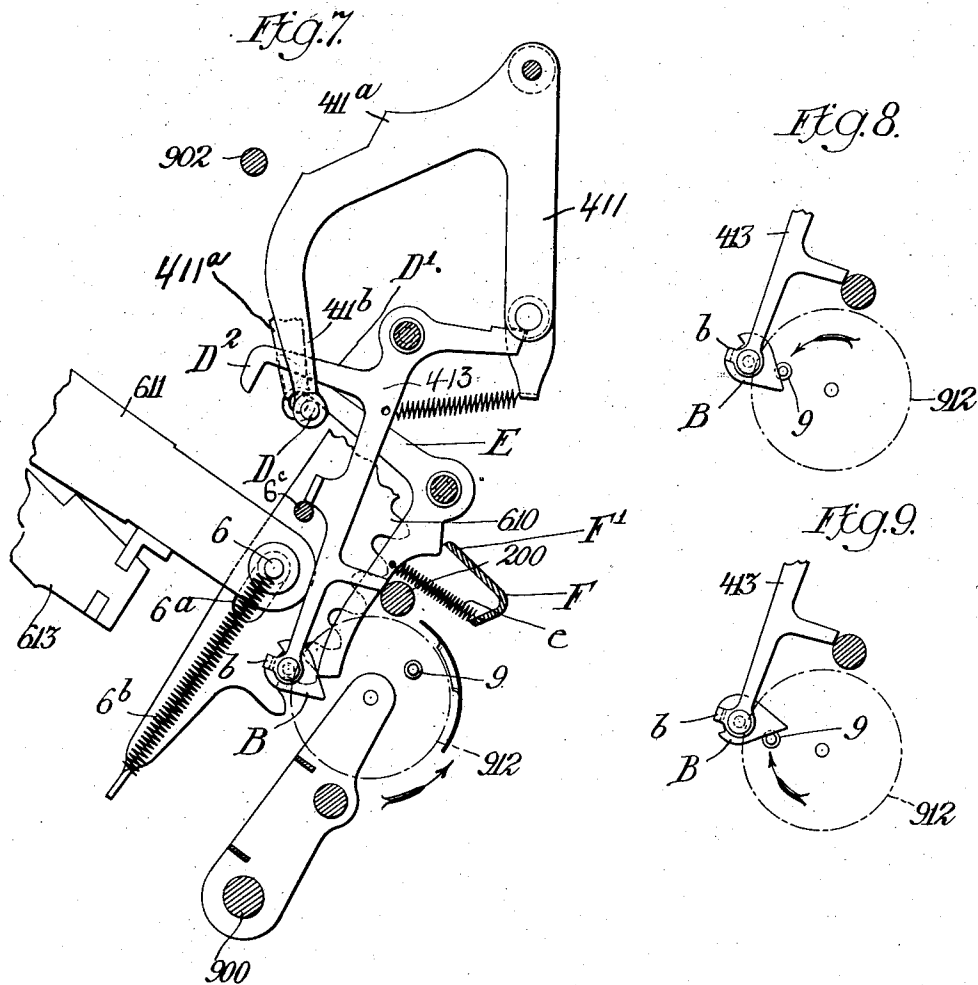


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6 SHEETS--SHEET 5.



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6 SHEETS—SHEET 6.

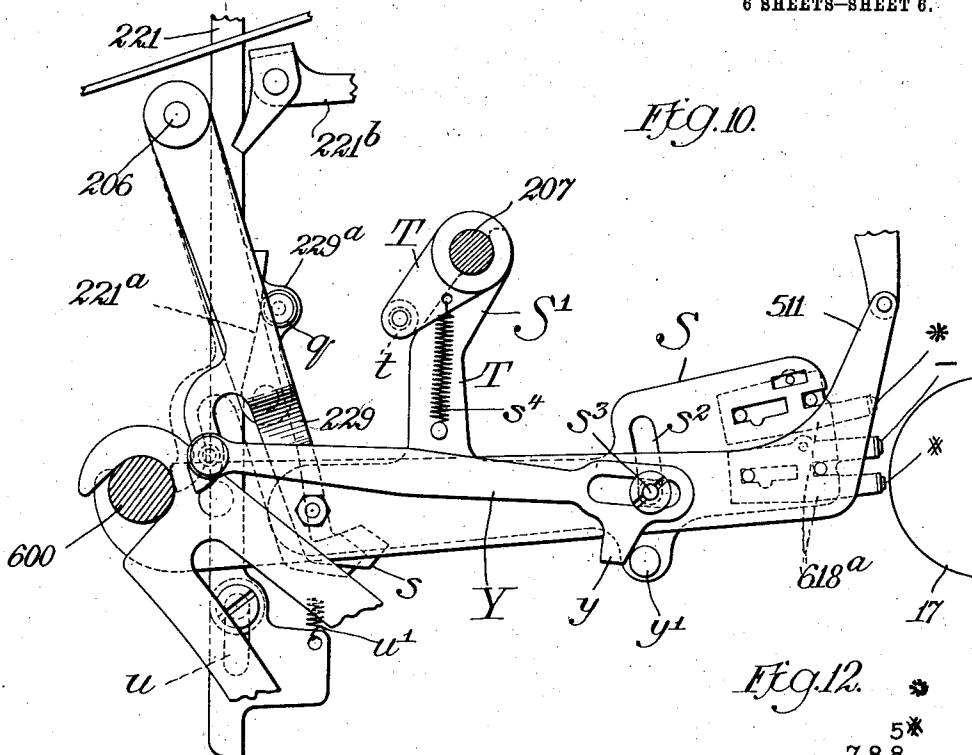


Fig. 10.

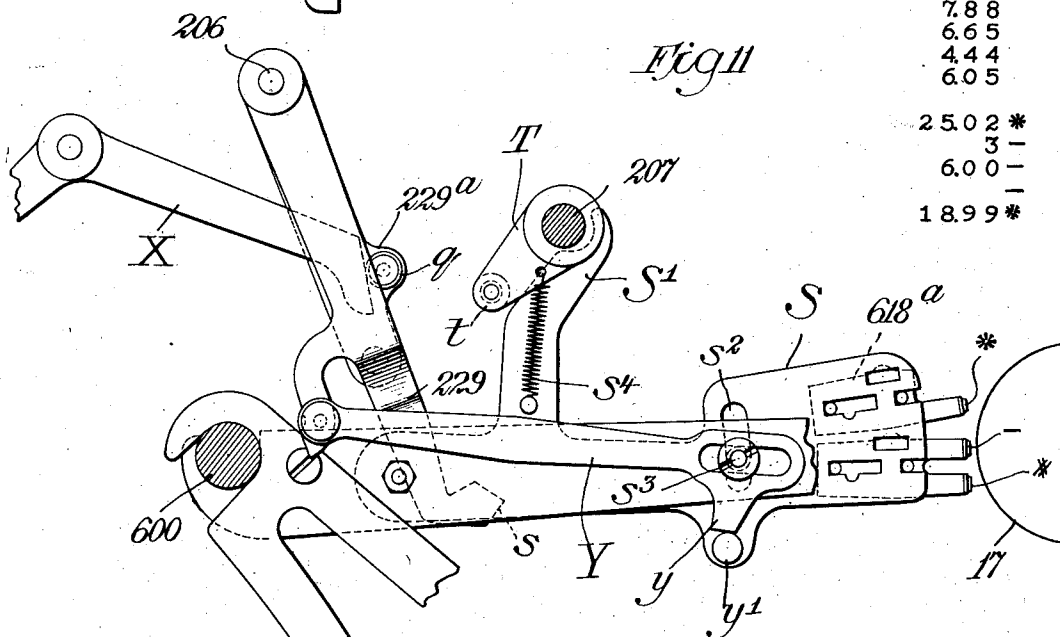


Fig. 11.

5*
 7.88
 6.65
 4.44
 6.05
 25.02*
 3—
 6.00—
 18.99*

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UNITED STATES PATENT OFFICE.

JESSE G. VINCENT, OF DETROIT, MICHIGAN, ASSIGNOR TO BURROUGHS ADDING MACHINE COMPANY, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

ADDING AND SUBTRACTING MACHINE.

1,028,161.

Specification of Letters Patent.

Patented June 4, 1912.

Application filed April 6, 1908. Serial No. 425,466.

To all whom it may concern:

Be it known that I, JESSE G. VINCENT, a citizen of the United States, residing at Detroit, in the county of Wayne and State of Michigan, have invented certain new and useful Improvements in Adding and Subtracting Machines, of which the following is a specification.

The present invention relates to that class of machines primarily organized to add or accumulate successive amounts, and also to print a list of such amounts and a total thereof whenever desired. It is common practice in the use of such machines to perform subtraction by adding to the subtrahend the complement of the minuend or vice versa, to which end the keys which regularly carry inscriptions to guide the user in addition are frequently inscribed also with complemental numerals.

The principal object of the present invention is to adapt a machine of the above class for use in direct subtraction as by the turning of register wheels in a direction opposite that in which such wheels turn when performing addition. Of course the mere reversal of direction in which such wheels rotate is no innovation of itself for it is commonly practised in machines of this class when taking totals or sub-totals but in such case there are no transfer movements of wheels in this reverse direction, whereas when the wheels are reversely rotated for purposes of subtraction provision must be made for transfer operations inasmuch as a wheel of lower order will frequently be required to borrow from the next adjacent wheel of higher order. The present invention therefore has particularly in view the adaptation of transfer mechanism such as employed in machines of this class to the new use of effecting the necessary borrowing when the machine is performing subtraction.

According to the present invention a machine primarily organized for performing addition can be so adapted to the performance of subtraction that by simply pressing a key or like manipulation the machine will, when operated in the usual manner as by touching amount keys and pulling a handle, subtract instead of add.

The invention is here shown as applied to an adding and listing machine of the well-known Burroughs type (See Burroughs Patents 504,963 and 505,078, September 12, 1893), in which type of machine transfer movements of register wheels are effected by excess movement of their actuating racks, such excess movement being effected through the medium of springs. By the present invention this same excess movement of racks is utilized to effect the necessary borrowing in the performance of subtraction and the transfer mechanism is so modified to this end that provision is not only made for the backward rotation one step of a wheel of higher order by reason of the next lower wheel being rotated backward past the zero point, but also for continued borrowing across the entire set of wheels if need be, such continued borrowing taking place in the same operation of the machine as the initial borrowing. Thus, for example, if the wheels all stood at zero and the one-cent key was depressed and the handle of the machine drawn forward and released, (the machine having of course been first properly prepared for performing subtraction as by depressing a special key) the units wheel will be turned one step backward and all the transfer devices will be tripped though at the conclusion of this operation the numeral 9 shows only on the units wheel, the other wheels still exhibiting ciphers. However, the racks will have all (except of course the units rack) partaken of the excess movement. So when the machine is again operated the higher wheels will all be turned backward one step by the taking up of such excess movement of racks. Of course if another subtrahend was set up on the keyboard before the second pull of the handle further subtraction would be done and perhaps further transfer tripping. Thus the same operation of the machine completes the borrowing prepared for in the previous operation and also effects subtraction and preparation for further borrowing, so that the modification of the transfer mechanism to serve for borrowing in subtraction, does not necessitate any more extended operation of the machine for subtraction than for addition, for, while in performing addition

transfer movements of higher wheels take place in the same operation as initial movement of a wheel or wheels, yet extra operation of the machine is required to restore or reset the transfer devices.

The invention also provides for the automatic restoration of the subtraction-setting devices by the act of preparing the machine for the taking of a total or sub-total as by depression of a total or sub-total key. Furthermore, provision is made for automatically characterizing the imprint of a subtrahend to distinguish it from added items and totals and in this connection the known feature of specially characterizing totals and sub-totals is preserved, as also if desired the feature of specially characterizing numbers not to be added or subtracted.

With the above and incidental objects in view the invention consists in certain novel features of construction and combinations of parts, the essential elements whereof are recited in the appended claims and a preferred form of embodiment of which is fully illustrated in the accompanying drawings and described in detail hereinafter.

Of said drawings Figure 1 represents in sectionalized left-side elevation a sufficient portion of a machine of the class indicated to illustrate the application of the present invention thereto, all the parts being shown at normal, that is to say with the subtraction devices not called into play but the machine in condition for performing its usual functions of adding and listing of items and printing of totals; Fig. 2 is a similar view on a larger scale and not extending to parts at the rear of the machine, the subtraction devices being here represented as set so that the machine is ready to do subtracting; Fig. 3 represents a front elevation of parts appearing in Fig. 2; Fig. 4 is a detail sectional elevation illustrating the relative positioning of parts when in a subtraction operation a transfer device has been tripped, also showing preparation for a continued or cross transfer; Fig. 5 is a somewhat similar view though not including illustration of so many parts, this latter figure illustrating the effect of initial movement of the handle in an operation of the machine next ensuing after the operation which would position the parts as indicated in Fig. 4; Fig. 6 is a section on the line 6-6 of Fig. 2; Fig. 7 is a view similar to Fig. 4, illustrating how continued borrowing is arrested when a wheel is reached from which borrowing can be done without such wheel being required to borrow; Figs. 8 and 9 are similar detail elevations illustrating how the transfer projection on a register wheel acts similarly to trip a transfer device whether the wheel is rotated in one direction or the other; Fig. 10 is a sectional right-side elevation of the special

printing devices, the same being illustrated as adjusted for the printing of a special sign to characterize an unadded and unsubtracted amount; Fig. 11 is a similar view but illustrates the changed relation of parts for the printing of the special character denoting a subtrahend; and Fig. 12 represents a sample of printing done by the machine.

Many of the parts shown in the drawings are practically the same as those illustrated and described in the above-mentioned patents but it will be desirable to specifically mention them and refer to their mode of operations inasmuch as this directly concerns the carrying out of the present invention. Referring first to Figs. 1 and 2, on a central rock shaft 600 there are loosely mounted side by side a series of levers 611 carrying segmental series of type-plates 618 at their rear ends and at their forward ends carrying studs 6 which occupy slots 6^a in segmental racks 610, the latter connected with said studs by springs 6^b which tend to move the racks independently of the levers the length of said slots. Such independent or excess movement of the racks is provided for transfer or carrying purposes, the racks being normally held down against the stress of said springs. Thus pivoted transfer pawls 413 normally overlies studs 6^c on said racks, the pawls being yieldingly held in normal position by springs 6^d which connect them with pivoted latches 411 normally held by said springs against the front ends of the forwardly-projecting arms of said pawls in the usual manner. Numbered wheels or dials 912 are arranged much as usual to display amount inscriptions at the front of the machine, said wheels carrying pinions 916 to engage the racks 610 respectively and each combined pinion and wheel carries a laterally-projecting stud 9, those of all the wheels except the one of highest order being adapted to displace the associated transfer pawl 413 as the wheels make complete rotations.

The racks are normally upheld by pivoted latches 415 of the usual form adapted to be severally displaced by depression of amount keys 291 through the medium of detent strips 214 and adapted to be collectively displaced by depression of the total key 265 or the sub-total key 265^a. The levers 611 are normally upheld on the forward side of the shaft 600 by the usual restoring frame or bail 613 which is secured to the rock shaft 600 and upon downward swinging of said frame without release of racks 610 the levers move the length of the slots 6^a which is sufficient to bring the zero types to the printing line opposite the platen 17. When amount keys have been depressed the levers move correspondingly to bring to the printing line types corresponding with the keys,

the latter setting stops as usual to limit the downward movement of the racks. When a total or sub-total is to be printed the racks move distances determined by the degree of rotation of wheels necessary to return them to zero and the types are set up to correspond.

The wheels and pinions 912 and 916 are as usual carried by a rocking frame 910, one side-plate of which has studs 958 and 958^a adapted to be engaged by the upper and lower branches respectively of a pitman 914 which is jointed at its rear end to a three-armed lever 913. The latter as usual carries studs 960 and 960^a adapted to be alternately acted upon by a wipe-plate or pawl 821 pivotally mounted on the upper end of an arm 813 which oscillates in every operation of the machine. The notched upper branch of the pitman is normally engaged with the upper stud 958 and at the outset of an operation of the machine the frame 910 will therefore be rocked to disengage the pinions from the racks. The pinions remain thus disengaged while the operating handle of the machine is drawn forward and the racks lowered. Then as the handle starts back the pinions are drawn into mesh with the racks to partake of the upward movements thereof. This is the ordinary adding operation in a Burroughs machine and when a total is desired a blank stroke of the handle is first taken to restore any racks which have moved up for transfer purposes and then either the key 265 or the key 265^a is depressed and the handle pulled. Depression of either of these keys lowers the pitman 914 disengaging its upper branch from the stud 958 and in case of depression of the key 265 permitting the lower branch of said pitman to engage the stud 958^a so that the pinions will be disengaged with the wheels at zero. At the conclusion of such an operation the pinions are reengaged with the racks through the action of a roller 338 on the usual full stroke sector 311 against the cam-edge of a rearwardly-projecting arm 919 of the rocking frame 910. When the sub-total key is depressed the pitman is prevented from engaging the stud 958^a so that the pinions will remain in engagement with the racks throughout the operation.

All of the above-described operations are well-known as those commonly occurring in a Burroughs adding and listing machine and no detailed discussion of them is necessary.

It will be seen that to provide for direct subtraction by reverse rotation of the wheels 912 under regulation of the amount keys the pinions 916 should remain in mesh with the racks as in the case of taking a total. Therefore in carrying out the present invention a key A is provided whose depression lowers the pitman 914 as does depression of the

total key 265, in fact to an even great extent for the lower branch of the pitman does not stop at the stud 958^a as when the total key is depressed but the angle of its lower edge is such that the final pressure applied to the key A causes the pitman to cam past said stud and take up the position at once which in the case of depression of the total key is not assumed until the handle starts on its backward or return stroke. The stem A' of the key A slides through the keyboard plates and is normally upheld by a spring α and at its lower end this stem is widened into a foot α^2 which engages a roller α^3 on the pitman 914. When the key is depressed said foot acting upon said roller forces the pitman down, disengaging its notched upper branch from the stud 958 and engaging its lower branch with the stud 958^a as shown in Fig. 2. It will therefore be seen that in an operation of the machine with this key depressed the pinions will remain engaged with the racks during the forward stroke of the operating handle and be disengaged therefrom during the return of said handle, the timing in this regard being the same as when the total key 265 is depressed.

As reverse rotation of the wheels 912 for subtraction purposes is to effect transfer tripping when borrowing becomes necessary the pawls 413 are modified to provide for their displacement by the projections 9 under rotation of wheels in either direction instead of only in a forward or adding direction as is ordinarily the case, such pawls heretofore constituting zero stops limiting backward rotation of the wheels. In the present instance as shown more clearly in Figs. 8 and 9 each of the pawls 413 carries at its lower end a pivoted cam nose B recessed in rear of the pivot to receive a laterally-turned lip b of the pawl, said nose having a double taper on the forward side of the pivot. The nose B is permitted to rock on its pivot a limited extent which provides for an easy camming action of the projection 9 against either the upper or the lower edge of the nose and displacement of the pawl under rotation of the wheel in either direction by reason of said projection wiping over the cam edge when one shoulder or the other of the recess of the nose comes to bear against the lip b .

The effect of displacing a transfer pawl in backward rotation of a wheel will of course be to relieve the rack of next higher order from restraint normally imposed upon it by such pawl but as the lever 611 associated with such rack will at such time have necessarily lowered, the rack cannot rise and of course it is not intended that independent upward movement of the rack under such circumstances shall turn the next higher wheel because that wheel must be turned backward, not forward. The rack

does not partake of the extra movement until the close of the operation of the machine the associated lever 611 is restored to normal and at such time the wheel is of course disengaged from the rack and consequently the latter rises without affecting the wheel. In the next subsequent operation, however, when the wheel is kept in mesh with the rack the latter having moved upward the length of its slot 6^a will be moved downward one step by the lever 611 and thus the wheel will be turned backward one step. Of course in such subsequent operation the wheel will turn farther backward if a key in its associated bank of amount keys has been depressed.

The detaining of a displaced transfer pawl is effected by the engagement therewith of the associated latch 411 which also serves to detain the pawl when displaced in an adding operation. It is of course essential in either case that the pawl be held displaced until the rack has had an opportunity to partake of its excess upward movement which cannot ensue until near the very close of the operation of the machine. The return to normal of any displaced transfer pawls requires the retraction of the latches 411. In the regular Burroughs machine this occurs just about as the operating handle reaches the forward end of its stroke which is early enough in the case of addition because there is no rotation of wheels until the handle starts back. However, in the case of subtraction the rotation of wheels accompanies the forward stroke of the operating handle. Consequently it becomes necessary to restore the transfer pawls at the outset of such stroke so that the pawls may be ready to be again tripped. A rocking bail is employed for retracting the latches as in the regular construction but it is quite differently controlled. The numeral 902 designates the cross-rod of this bail, which rod is arranged to act against rearwardly-projecting arms 411^a of the latches; the reference numeral 902^a designates one of the two side-pieces of the bail and the reference numeral 904 designates a rock shaft to which these side-pieces are secured. The left-hand side-piece is formed with a rearwardly and downwardly-extending branch 902^b (Fig. 2) having a laterally-projecting stud 960^b at its rear end. On the arm 813 there is pivoted intermediate its ends a bar C. (Fig. 6) the upper branch of which carries a wipe-pawl or plate 821^a similar in form to the plate 821 and similarly held central by a spring *c*. The lower branch of the bar C is drawn by a light spring *c*¹ into contact with the hub of the arm 813. The latch-restoring bail is normally drawn rearward by a heavier spring *c*² applied to a downwardly-extending branch 902^c of the side-piece 902^a. Normally the wipe-plate 821^a has its central

prong bearing against the stud 960^b as illustrated in Fig. 2, this wipe-pawl and the upper branch of the bar C constituting in effect a toggle joint normally broken. As the arm 813 swings rearward the forward shoulder of the said wipe-pawl strikes the said stud 960^b and fulcrums upon the same as the arm 813 continues to swing rearward straightening the toggle joint with the effect of lifting the bail arm 902^b and rocking the bail forward, thus restoring the latches. This occurs in the first part of the forward stroke of the operating handle and as soon as the arm 813 has traveled rearward far enough to take the toggle joint over the center it quickly breaks under the stress of the spring *c*², the spring *c*¹ yielding, and the bail may thus quickly recover leaving the latches free to again spring over any displaced transfer pawls. All of this occurs in that portion of the handle stroke which swings the restoring frame or bail 613 downward only far enough to permit the levers 611 following the length of the slots 6^a, and consequently before any movement of the racks takes place except such movements as effect borrowing resultant from transfer tripping in the previous operation. Hence in further movement of wheels resultant from depression of amount keys retripping of transfers may take place.

While the above described construction and mode of operation of parts provides for the borrowing from the next higher wheel by any one wheel which makes a complete backward rotation, it may of course occur that the borrowing must continue automatically as for example when one or more wheels, including that from which the initial borrowing is done, already stand at zero. In the performance of addition successive tripping of transfer pawls when continued carrying is required, will take place at a time when the racks may immediately partake of excess movement, as will be understood from the previous reference to the transfer operation in addition, but the same thing is not true when the machine is operating to perform subtraction, for as has already been explained, the borrowing movements of wheels cannot take place in the same operation of the machine that the direct subtraction movements thereof take place. It therefore becomes necessary to make further modification in the transfer construction to provide for continued borrowing. To this end the rearwardly extending branches of the latches 411 have downward extensions 411^b carrying at their lower extremities laterally projecting elongated studs D, which studs are designed to act against transfer pawls of next higher order, respectively, the pawls being formed for such purpose with rearwardly projecting arms D¹ having abutment lugs D² at their

rear ends, as illustrated in Figs. 1, 2, 4 and 7 of the drawings.

It will be understood that the studs D should not act upon the pawls except in cases where borrowing is to continue, which would mean that the wheel initially borrowed from would, as a result of such borrowing, pass the zero point. Hence the latches 411 are put under control of the wheels as follows: A series of latches E of bell crank form are independently pivoted in position to have their downwardly extending arms lie in the several paths of movement of the transfer projections 9 on the wheels and their upwardly and rearwardly extending arms in the paths of rearward movement of the studs D, respectively, such rearwardly extending arms being formed at the ends as catches to engage said studs. The result of this arrangement is that when any wheel comes to the zero position its stud 9 contacting with the depending arm of the associated latch E will displace the latter to clear the path of the stud D of the next lower latch 411. Consequently, if that latch is tripped by displacement of its associated transfer pawl, it may swing rearwardly a sufficient extent to displace the next higher pawl by the action of the stud D against the abutment lug D² of such pawl. The result is, therefore, that the rack belonging to the wheel of still higher order will be released from the restraint of the pawl and so the borrowing will properly continue. When a wheel is reached which is not standing at zero its latch E is, of course, occupying effective position which will prevent the full rearward swing of the next lower latch 411 and hence stop the borrowing, as illustrated in Fig. 7. In such case this next lower latch moves a limited extent sufficient to hold out the associated pawl, but being then arrested by the latch E, cannot move far enough to affect the next higher pawl, which will then only be displaced in the event of the associated wheel being turned far enough in addition to the borrowing movement to carry it past the zero point, but the next lower latch 411 plays no part in this because meantime it will have been restored to normal in the manner already explained and the tripping of the higher pawl will be simply a direct tripping by action of the transfer projection 9 against the nose of the pawl.

When the machine is operating to add, the latches E should be held displaced so as to prevent their lower ends from interfering with forward rotation of the wheels. Therefore, a comb plate F is pivotally mounted by suitable side arms on one of the cross rods 200 of the machine, said plate having a rearwardly projecting finger F¹ for each one of the latches E and so when the plate is rocked rearwardly all said

latches will be displaced. The lower arms of the latches are connected by springs *e* with a forward flange of said plate and when the latter is rocked outwardly these springs serve to hold the latches yieldingly downward and forward abutting the said cross rod 200, as illustrated in Fig. 7. The plate is controlled by a lever G, Fig. 2, pivoted intermediate its ends and having in its forwardly projecting arm a cam slot *g* embracing a stud *f* on the left hand side piece of the comb plate. The rearwardly projecting arm of said lever is slotted to embrace a stud *a*⁴ on the subtraction key A. It will be remembered that this key is normally upheld by the spring *a*, hence the lever is normally upheld as to its rearwardly extending arm and its forwardly extending arm normally depressed, as illustrated in Fig. 1, so that the stud *f* is at the upper end of the slot *g*, which is the end nearest the pivot of the lever. Consequently the comb plate is normally held rearward and the latches E maintained by it in non-effective position. Depression of the subtraction key rocks the lever and the resultant cam action of the inner edge of the slot *g* upon the stud *f* forces the comb plate forward, thus releasing the latches and drawing them yieldingly to effective position. Of course, if at such time any transfer projection 9 stands at the zero position the associated latch E will be prevented from assuming such position, but upon the turning backward of the wheel carrying such projection the latch will be drawn by its spring into effective position.

The disabling of latches E in the manner above described when the machine is performing addition, must not, of course, permit a latch 411 of lower order to trip a pawl 413 of higher order in the manner before described when discussing subtraction. This is provided for by altering the normal or rearward position of the latch-restoring bail when the machine is operating to add, as compared with the corresponding position of said bail when the machine is operating to subtract. Fig. 2 indicates by dotted lines the limit of rearward movement of the bail when the machine is adding and the full lines indicate the limit of such movement when the machine is subtracting. When the dotted line position is assumed the cross rod 902 constitutes a stop for limiting the rearward swing of the latches 411 and preventing their studs D from acting upon the abutment lugs D² of higher order pawls. When the full line position is assumed rearward swing of the latches is permitted sufficient to displace such pawls under conditions such as heretofore mentioned. Two different rearward positions of the bail are determined by the abutment of a stud *h* on the branch 902² of the left

hand side of the bail, against a cam edge g^1 of the rearwardly extending arm of the lever G. When the subtraction lever is elevated and this rearwardly extending arm of the lever correspondingly elevated the lower portion of said cam edge stands in front of said stud, such portion of such cam edge being further removed from the pivot of the lever and consequently acting to prevent the bail swinging as far back as when a higher portion of said cam edge nearer the pivot of the lever is directly in front of the stud h . Depression of the subtraction key brings such higher portion of the cam edge in front of the stud, as illustrated in Fig. 2 and consequently the bail may then take up a position farther rearward under actuation of its spring c^2 .

When depressed the subtraction key is held down by a pivoted locking arm I, Figs. 1 and 2, which is loosely mounted upon a rock shaft 14 and drawn toward the key by a spring i , the stem of the key having a square notch a^5 adapted to be entered by the curved and forwardly directed upper end of said locking arm, as illustrated in Fig. 2. The key will be indefinitely locked down as is of course desirable, inasmuch as repeated subtraction operations will often be in order and it would be inconvenient to have to operate this key each time. Preferably the release of the key is effected by depression of either the total or subtotal key. The total key 265 is as usual mounted upon the upper end of a bell crank lever 227 which, in company with an arm secured to the same rock shaft, operates the usual bail for connectively displacing the latches 415, said bail comprising a cross rod 209 and side pieces 216, one of which appears in Figs. 1 and 2. On this side piece of the bail there is a stud i^1 which, when the bail is drawn rearward by depression of the total key, operates upon the locking arm I to displace the same and release the subtraction key, the latter immediately rising under actuation of its springs a . Depression of the subtotal key 265^a has a like effect, said key surmounting a bell crank lever 227^a, to which is jointed a bar 216^a having a lug j to engage a stud k on the lever 227. It will be seen that through these connections depression of the subtotal key results in rocking the grand total key lever the same as depression of the grand total key.

The connections controlled by the total and subtotal keys are somewhat modified as compared with those ordinarily found in Burroughs machines, such modification being for the purpose of preventing depression of the subtraction key causing depression of the total key. The latter is, as usual, connected with a link 911, the latter slotted at its upper end to embrace a stud on the lever 227. Instead of being simply pivoted

at its lower end to the pitman 914, as is usually the case, this link at its lower end is longitudinally slotted, as shown at m , Figs. 1 and 2, to embrace a stud n on the pitman and a spring o connects said stud with the link. It will be seen that with this arrangement the pitman can be lowered independently of the link against the stress of the spring o , and this is what takes place when the subtraction key is depressed. At the same time depression of the total or subtotal key will cause lowering of the pitman as usual. The function of the upper slot of the link is as usual to permit lowering of the link and pitman independently of the total key for the purpose of producing an effective engagement of the lower branch of the pitman with the lower stud 958^a on the register frame. In the case of a subtotal such independent movement is prevented by the rearward movement of the bar 216^a which has a raised portion p to intercept a stud p^1 on the link.

The locking of the total and subtotal keys against depression after itemizing and until a blank stroke of the handle has been taken is important in connection with subtraction as well as in connection with addition. The means ordinarily employed for so locking out the total and subtotal keys after one or more items have been accumulated will also serve to lock out said keys after one or more items have been subtracted. While this is not essential in the case of simple borrowing, it is important when there has been continued borrowing. While in the case of simple borrowing the correct remainder would not appear on the number wheels or dials until a blank stroke of the operating handle had been taken, yet the printing of the correct remainder would take place, even though no blank stroke was taken prior to depressing the total or subtotal key. In the case of addition the racks must of course be restored to normal before the machine is operated to take a total, for otherwise the printed total would be one numeral short in any decimal place where a transfer should show. But in the case of subtraction the situation is reversed and the shortage in returning to zero is the desired thing. Consequently it would not be necessary to have a rack which had partaken of its transfer advance, restored to normal by a separate operation of the machine, but the depression of total or subtotal key would permit such rack to run down until the wheel came to the zero stop which, on account of the advanced position of the rack at the start, would not bring to the printing line the type corresponding with the numeral displayed on the wheel, but the type set up would be a unit less in value. Then, of course, at the conclusion of the operation in the case of a subtotal the numeral corre-

sponding with the lesser type would come to view instead of the numeral exhibited at the outset of the operation. However, in the case of continued borrowing, the correct remainder would not be printed because one or more of the wheels would have been standing at zero and consequently could not rotate backward at all, whereas they should move backward to the 9 position.

- 10 The means for locking out the total and subtotal keys comprises the familiar spring-drawn bail 424, the left side piece of which has a broadened upper end adapted to move under a stud 27 on the total key lever 227.
- 15 This takes place as usual by reason of the depression of amount keys, the detent strips 214 having downwardly turned portions to act against the cross-bar of said bail, but the bail is also under control of the transfer latches 411 and when any one of the same is displaced as a result of the tripping of the associated transfer pawl in an adding operation the bail is blocked by such latch against return to forward normal position.
- 25 Consequently the total key is locked against depression and of course the subtotal key likewise. As before explained, the rearward swing of the latches 411 as a result of initial borrowing is slight as compared with the rearward swing when continued borrowing is to take place. The movement of said latches for initial borrowing need not be sufficient to hold the bail 424 in position for locking out the total and subtotal keys, but obviously the rearward swing of latches for continued borrowing will result in blocking the bail and locking out the total and subtotal keys.

- As the transfer pawls cannot serve to limit backward rotation of the wheels as in a machine which simply adds, it becomes necessary to provide a separate zero stop device under control of the total and subtotal keys. In the present instance a comb plate R is pivoted to the sides of the register frame 910, as shown in Figs. 1 and 2, said plate having forwardly projecting fingers, one for each of the wheels and adapted when the plate is swung forward to enter the respective paths of the transfer projections 9 on said wheels. At its right hand end said plate has a rearwardly projecting arm r which is connected by an irregular-shaped link R^1 with a crank arm 14^a secured to the rock shaft 14 near its right hand end. Near its left hand end said rock shaft carries a similar crank arm 14^b connected by a link 14^c with the bell crank 227. It will be seen that through these connections depression of the total or subtotal key will result in rocking the said comb plate forward and projecting its fingers into the paths of the transfer projections 9, thus setting stops to limit the rearward turning of the wheels. The total key is as usual

normally upheld by a spring 7 and the comb plate thus normally retracted.

Passing now to the printing devices of the machine, the means for driving the type plates against the platen are of the usual character, the same comprising pivoted hammers 715 operated by levers 716, the latter driven by springs 780, but normally restrained by latches 717. Pawls 718 on an oscillating bail individually actuate the latches to release the hammers and are controlled by the type-carrying levers 611 in the ordinary way. To the right of the series of type-carrying levers there is located a special type-carrying arm S, Figs. 10 and 11, which is pivotally mounted at its rear end preferably on the right side piece of the usual ribbon frame 511. This arm carries type plates 618^a having as here shown three special character types, the lower one of which is formed to print the number sign (#) indicating an amount neither added nor subtracted, whereas the middle type is formed to print the minus sign (—) to indicate a subtracted amount or a subtrahend, and the upper type is formed to print a star (*) to indicate a total or subtotal. These type plates are driven against the platen in the same way that amount type plates are so driven, there being provided an extra set of impression devices, such as those already specified, but of course these extra impression devices do not come into play except when either the total, subtotal, subtraction, or elimination key is depressed. The pawl of this extra set of impression devices is disabled in a similar way to that in which pawls of the other sets of impression devices are disabled. Thus an arm 229 secured to a rock shaft 206 is formed at its lower end with an inclined or cam edge s for disabling the pawl, said arm being normally held back against the shaft 600 by a spring s^1 , Fig. 1, attached to an arm 229^a secured to the left hand end of said rock shaft 206.

The special type carrier is normally held in a position with the number sign type at the printing line, as indicated in Fig. 10, such carrier being upheld by a spring s^4 which connects it with a crank arm T secured to the rock shaft 207 of the usual key-restoring bail. The type carrier is limited in upward movement by the abutment against said rock shaft of an upstanding arm S^1 and is guided in its movements by an arc-shaped slot s^2 formed in it and engaged by a stud s^3 fastened in the side piece of the ribbon frame.

The reference numeral 221 designates the elimination key which slides vertically through the keyboard plates, Fig. 1, and is further guided by the engagement of a slot u in its lower portion with a stud on the left hand side piece of the main frame of

the machine, said key being normally upheld by a spring w^1 , and acting as usual to prevent engagement between the wipe pawl 821 and the rear stud 960^a of the three-armed lever 913 to prevent engagement of the pinions 916 and racks 610. The stem of the key is formed with a cam rise 221^a adapted when the key is depressed to act against a roller q on the arm 229^a, thus swinging said arm rearwardly. The accompanying rearward swing of the arm 229 removes the cam edge s from the path of the pawl 718 and thus permits the hammer to drive the number sign type against the platen. The elimination key is caught and held down by a pivoted spring-drawn detent 221^b which is displaced at the conclusion of an operation by the same bail which releases depressed amount keys. The said bail as usual comprises side pieces 219 and a cross rod 209 and the left side piece carries a stud v which is embraced by a slot in the rear end of a link 226 coupled at its forward end to the total key bell crank lever 227 as shown in Fig. 1. This link has a shoulder w at an intermediate point standing in front of a stud w^1 on the arm 229^a. Depression of the total or subtotal key thrusts the link 226 rearward causing its shoulder w to swing the arms 229 and 229^a rearward, thus permitting the pawl 718 to act, and the rocking of the key-releasing bail, by depression of either of said keys, causes the arm T to be swung down. The upright arm S¹ on the special type carrier has an inclined forward edge and a roller t on the crank arm T acting against such edge with a camming effect forces the type carrier downward, positioning the star type at the printing line. Thus the imprint of a total or subtotal will be characterized by the printing in association therewith of the star or asterisk. This special character may also be printed before starting a list to indicate that the machine was clear at such time, the star then appearing alone in the example shown in Fig. 12. In that same example the first imprint thereafter is of an unadded and unsubtracted number, and has the number sign (#) printed in association with it to so indicate.

The subtraction key stem carries a stud x , Fig. 1, which engages the bifurcated forward end of a lever X pivoted intermediate its ends just under the keyboard and formed at its rear extremity to act with a camming effect upon the roller q . Depression of the subtraction key thus has the effect of swinging the arms 229 and 229^a rearwardly so as to permit the special hammer to act and in this case said arms swing farther rearward than by depression of either the total, subtotal or elimination keys. The arm 229, Figs. 10 and 11, has pivotally connected with it the forward end of a thrust bar Y

which at its rear end is slotted to embrace the stud s^3 and is also formed with a cam lug y which, when the bar is thrust rearward by the depression of the subtraction key, acts with a camming effect upon a stud y^1 on the special type carrier, the latter thereby being forced downward to the middle position in which the minus type is at the printing line, as indicated in Fig. 11. Thus there will be printed in association with a subtrahend, a minus sign (—), as indicated in the example of work shown in Fig. 12, wherein the star indicates that the amount printed just above the first subtrahend is a subtotal. The last amount shown in said example is a reduced grand total or remainder.

While the construction here shown and described will be seen to be well adapted for thoroughly fulfilling the objects primarily stated, it is to be understood that the invention is not limited to this particular form of embodiment but may be otherwise carried out.

What is claimed is:

1. In a machine of the character described, the combination of differentially movable reciprocating racks, wheels movable into and out of engagement therewith, transfer mechanism for causing a complete rotation of any wheel in either direction to result in an increment of movement of the next adjacent wheel of higher order, and means for reversing the order of engagement and disengagement between wheels and racks to provide for movement of the wheels in either direction by the racks.

2. In a machine of the character described, the combination of differentially movable reciprocating racks, wheels movable into and out of engagement therewith, spring transfer mechanism for causing a complete rotation of any wheel in either direction to result in an increment of movement of the next adjacent wheel of higher order, and means for reversing the order of engagement and disengagement between wheels and racks to provide for movement of the wheels in either direction by the racks.

3. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, means normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks, and means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels by the racks in either direction, with provisions for causing complete rotation of any wheel in either direction to permit independent movement of the rack of the adjacent wheel of higher order for transfer purposes.

4. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers under spring-actuation, means normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks, and means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels by the racks in either direction, with provisions for causing complete rotation of any wheel in either direction to permit independent movement of the rack of the adjacent wheel of higher order for transfer purposes.

5. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, and means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks.

6. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers under spring-actuation, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, and means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks.

7. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, and latches for holding the pawls displaced until the rack carriers return home.

8. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers,

the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, and means for retracting the latches before the racks are advanced an increment of movement by their carriers.

9. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced, said latches adapted under control of the wheels to displace pawls of higher order.

10. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, and means controlled by the wheels when turned in one direction for restraining the latches from performance of their last-mentioned function except when the wheels are at zero.

11. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction,

means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, and latches for said pawl-latches to restrain the latter from performance of their last-mentioned function but displaced by the transfer projections on the wheels.

12. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches having elongated studs to act upon the pawls of higher order and displace the same, and latches to engage said studs and restrain the pawl-latches from displacing adjacent pawls but themselves displaced by the transfer projections on the wheels.

13. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, means controlled by the wheels when turned in one direction for restraining the latches from performance of their last-mentioned function except when the wheels are at zero, and means for disabling said restraining means altogether when the wheels are to be turned in the opposite direction.

14. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projec-

tions to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, latches for said pawl-latches to restrain the latter from performance of their last-mentioned function but, displaced by the transfer projections on the wheels, and means for displacing said pawl latches independently of the wheels when the latter are to be turned in the opposite or adding direction.

15. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches having elongated studs to act upon the pawls of higher order and displace the same, latches to engage said studs and restrain the pawl-latches from displacing adjacent pawls but themselves displaced by the transfer projections on the wheels, and means for displacing said pawl latches independently of the wheels when the latter are to be turned in the opposite or adding direction.

16. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, means controlled by the wheels when turned in one direction for restraining the latches from performance of their last-mentioned function except when the wheels are at zero, means for disabling said restraining means altogether when the wheels are to be turned in the opposite direction, and means for

then otherwise limiting movement of the pawl-latches to prevent displacement by them of pawls of higher order.

17. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, latches for said pawl-latches to restrain the latter from performance of their last-mentioned function but displaced by the transfer projections on the wheels, means for displacing said pawl latches independently of the wheels when the latter are to be turned in the opposite or adding direction, and means for then otherwise limiting movement of the pawl-latches to prevent displacement by them of pawls of higher order.

18. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, means controlled by the wheels when turned in one direction for restraining the latches from performance of their last-mentioned function except when the wheels are at zero, means for disabling said restraining means altogether when the wheels are to be turned in the opposite direction, and means for restoring the pawl-latches adjustable to limit movement thereof and prevent displacement thereby of pawls of higher order when the wheels are to be turned in the adding direction.

19. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of

racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, said latches adapted to displace pawls of higher order, latches for said pawl-latches to restrain the latter from performance of their last-mentioned function but displaced by the transfer projections on the wheels, means for displacing said pawl latches independently of the wheels when the latter are to be turned in the opposite or adding direction, and means for restoring the pawl-latches adjustable to limit movement thereof and prevent displacement thereby of pawls of higher order when the wheels are to be turned in the adding direction.

20. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, and a key for effecting this changed adjustment of said connections.

21. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, and means controlled by the wheels and the aforesaid key for re-

straining the latches from performance of their last-mentioned function except when the wheels are at zero.

22. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, normally disabled means for restraining the latches, and means operated by said key to enable said restraining means, the latter adapted to be again disabled by the transfer projections on the wheels.

23. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, latches for said pawl latches to restrain the latter from displacing pawls of higher order, and means normally disabling said restraining latches, but itself disabled by operation of said key, the restraining latches then assuming effective position but adapted to be displaced by the transfer-projections of the wheels.

24. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of

racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, latches for said pawl latches to restrain the latter from displacing pawls of higher order, means normally disabling said restraining latches, but itself disabled by operation of said key, the restraining latches then assuming effective position but adapted to be displaced by the transfer-projections of the wheels, and means for restoring the pawl-latches normally limiting movement thereof to prevent displacement of pawls of higher order but adjustable by said key to permit sufficient movement of the pawl-latches for such purpose.

25. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, pivoted latches adapted to restrain the pawl latches from displacing pawls of higher order, a movable comb-plate for holding said restraining latches normally displaced, and a cam-slotted lever engaging said comb-plate and engaged by said key whereby operation of the latter causes the comb-plate to withdraw and permit the restraining latches to assume effective position, said latches then adapted to be displaced by the transfer projections on the wheels.

26. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement

independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, normally disabled means for restraining the latches, means operated by said key to enable said restraining means, the latter adapted to be again disabled by the transfer projections on the wheels, a restoring bail for the pawl latches normally limiting movement thereof to prevent displacement of pawls of higher order, but adjustable by said key to permit sufficient movement for such purpose, and means for reciprocating the bail.

27. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, normally disabled means for restraining the latches, means operated by said key to enable said restraining means, the latter adapted to be again disabled by the transfer projections on the wheels, a restoring bail for the pawl latches normally limiting movement thereof to prevent displacement of pawls of higher order, a cam lever engaging said bail and engaged by said key whose operation thereby adjusts the bail to permit sufficient movement of the pawl latches to displace pawls of higher order, and means for reciprocating the bail.

28. In a machine of the character described, the combination of differentially

movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, pivoted latches adapted to restrain the pawl latches from displacing pawls of higher order, a movable comb-plate for holding said restraining latches normally displaced, a restoring bail for the pawl-latches normally limiting movement thereof to prevent displacement of pawls of higher order, a lever having a cam-slot engaging the said comb-plate and a cam edge engaging said bail, said lever engaged by said key whereby operation of the latter adjusts the bail to permit sufficient movement of the pawl-latches to displace pawls of higher order and causes the comb-plate to withdraw permitting the restraining latches to assume effective position subject to displacement by transfer projections of the wheels, and means for reciprocating the bail.

29. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, and means for retracting the latches before the racks are advanced an increment of movement by their carriers, said means comprising an oscillating bail to act on the latches, a vibrating arm and a wipe pawl on the latter to engage the pawl.

30. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls nor-

mally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, normally disabled means for restraining the latches, means operated by said key to enable said restraining means, the latter adapted to be again disabled by the transfer projections on the wheels, a restoring bail for the pawl latches normally limiting movement thereof to prevent displacement of pawls of higher order, but adjustable by said key to permit sufficient movement for such purpose, and means for reciprocating the bail, comprising a vibrating arm and a wipe-pawl thereon.

31. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, normally disabled means for restraining the latches, means operated by said key to enable said restraining means, the latter adapted to be again disabled by the transfer projections on the wheels, a restoring bail for the pawl latches normally limiting movement thereof to prevent displacement of pawls of higher order, a cam lever engaging said bail and engaged by said key whose operation thereby adjusts the bail to permit sufficient movement of the pawl latches to displace pawls of higher order, and means for reciprocating the bail comprising a vibrating arm and a wipe-pawl thereon.

32. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, connections for moving the wheels out of and into engagement with the racks and operating normally to keep the wheels and racks disengaged during advance of the racks and engaged during return of the racks but adjustable to effect reversal of this order of engagement and disengagement, a key for effecting this changed adjustment of said connections, latches for holding the pawls displaced until the rack-carriers return home, said latches adapted to displace pawls of higher order, pivoted latches adapted to restrain the pawl latches from displacing pawls of higher order, a movable comb-plate for holding said restraining latches normally displaced, a restoring bail for the pawl-latches normally limiting movement thereof to prevent displacement of pawls of higher order, a lever having a cam-slot engaging the said comb-plate and a cam edge engaging said bail, said lever engaged by said key whereby operation of the latter adjusts the bail to permit sufficient movement of the pawl-latches to displace pawls of higher order and causes the comb-plate to withdraw permitting the restraining latches to assume effective position subject to displacement by transfer projections of the wheels, and means for reciprocating the bail comprising a vibrating arm and a wipe-pawl thereon.

33. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, means for reversing the order of engagement and disengagement between racks and wheels to provide for movement of the wheels in either direction by the racks, latches for holding the pawls displaced until the rack carriers return home, and means for retracting the latches before the racks are advanced an increment of movement by their carriers, said means comprising a spring-drawn oscillatory bail to act on the latches, an oscillatory main driving arm, a spring-held toggle link pivotally mounted thereon and limited as to movement in one direction, and a wipe-pawl on said link

adapted to engage said bail and act upon the same in opposition to its spring.

34. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, a rocking frame carrying said wheels, a pitman branched to engage said frame above or below its rocking center and normally engaging the frame above such center, an intermittently vibrating lever jointed to said pitman for reciprocating it, and a depressible subtraction key for shifting said pitman to engage it with the rocking frame on the lower side of the latter's rocking center.

35. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, a rocking frame carrying said wheels, a pitman branched to engage said frame above or below its rocking center and normally engaging the frame above such center, an intermittently vibrating lever jointed to said pitman for reciprocating it, a depressible subtraction key for shifting said pitman to engage it with the rocking frame on the lower side of the latter's rocking center, a total key also adapted to disengage the pitman from the rocking frame on the upper side of such center, and a zero stop member for the wheels adapted to be rendered effective by operation of said total key.

36. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, a rocking frame carrying said wheels, a pitman branched to engage said frame above or below its rocking center and normally engaging the frame above such center, an intermittently vibrating lever jointed to said pitman for reciprocating it, a depressible subtraction key for shifting said pitman to engage it with the rocking frame on the lower side of the latter's rocking center, a

total key having a slot-and-pin-and-spring connection with said pitman and a zero stop member for the wheels adapted to be rendered effective by operation of said total key.

37. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, a rocking frame carrying said wheels, a pitman branched to engage said frame above or below its rocking center and normally engaging the frame above such center, an intermittently vibrating lever jointed to said pitman for reciprocating it, a depressible subtraction key for shifting said pitman to engage it with the rocking frame on the lower side of the latter's rocking center, a link having a slot-and-pin-and-spring connection with said pitman, a total key having a slot-and-pin connection with the link, and a zero stop member for the wheels adapted to be rendered effective by operation of said total key.

38. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, a rocking frame carrying said wheels, a pitman branched to engage said frame above or below its rocking center and normally engaging the frame above such center, an intermittently vibrating lever jointed to said pitman for reciprocating it, a depressible subtraction key for shifting said pitman to engage it with the rocking frame on the lower side of the latter's rocking center, a link having a slot-and-pin-and-spring connection with said pitman, a total key having a slot-and-pin connection with the link, a zero stop member for the wheels adapted to be rendered effective by operation of said total key, and a sub-total key adapted to operate said total key and limit the movement of said link.

39. In a machine of the character described, the combination of differentially movable reciprocating racks, wheels movable into and out of engagement therewith and normally disengaged therefrom during advance thereof and engaged therewith during the return of the racks, two means for reversing this order of engagement and dis-

engagement, one such means permitting unlimited successive rotation of the wheels by the racks in their advance movements, a zero stop member for the wheels operated by the other of said means, and transfer mechanism for causing a complete rotation of any wheel in either direction to result in an increment of movement of the next adjacent wheel of higher order.

40. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, means normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and normally disengaged therefrom during advance of the racks and engaged therewith during return of the racks, two means for reversing this order of engagement and disengagement, one such means permitting unlimited successive rotation of the wheels by the racks with provisions for causing complete rotation of any wheel to permit independent movement of the rack of the adjacent wheel of higher order for transfer purposes, and a zero stop member for the wheels, operated by the other one of said two means.

41. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, said wheels being normally disengaged from the racks during the latter's advance and engaged therewith during their return, two means for reversing this order of engagement and disengagement, one such means permitting unlimited successive rotation of the wheels, and a zero stop for the projections on the wheels, said stop operated by the other one of said two means.

42. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, said wheels being normally disengaged from the racks during the latter's advance and engaged therewith during their return, two means for reversing this order of engagement and disengagement, one such means permitting unlimited successive rotation of the wheels, and a rocking zero stop plate

with fingers to engage the wheel-projections respectively but normally withdrawn from the paths of said projections, said plate adapted to be rocked by the other of said two means.

43. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, said wheels being normally disengaged from the racks during the latter's advance and engaged therewith during their return, two means for reversing this order of engagement and disengagement, one such means permitting unlimited successive rotation of the wheels, a rocking zero stop plate with fingers to engage the wheel-projections respectively but normally withdrawn from the paths of said projections, and operating connections between the other of said two means and the said plate, said connections comprising a rock shaft and a link cranked to the same and jointed to the plate.

44. In a machine of the character described, the combination of differentially movable reciprocating racks, wheels movable into and out of engagement therewith and normally disengaged therefrom during advance thereof and engaged therewith during the return of the racks, two means for reversing this order of engagement and disengagement, one such means permitting unlimited successive rotation of the wheels by the racks in their advance movements, a zero stop member for the wheels operated by the other of said means, transfer mechanism for causing a complete rotation of any wheel in either direction to result in an increment of movement of the next adjacent wheel of higher order, and a lock for holding the first-specified means set, said lock adapted to be released by operation of the other means.

45. In a machine of the character described, the combination of differentially movable reciprocating racks, wheels movable into and out of engagement therewith and normally disengaged therefrom during advance thereof and engaged therewith during the return of the racks, two means for reversing this order of engagement and disengagement, one such means permitting unlimited successive rotation of the wheels by the racks in their advance movements, a zero stop member for the wheels operated by the other of said means, transfer mechanism for causing a complete rotation of any wheel in either direction to result in an increment of movement of the next ad-

jacent wheel of higher order, and means for locking the last-mentioned means against operation until such increment of movement has taken place.

5 46. In a machine of the character described, the combination of differentially movable reciprocating racks; wheels movable into and out of engagement therewith and normally disengaged therefrom during
10 advance thereof and engaged therewith during the return of the racks, a depressible subtraction key and connections for reversing this order of engagement and disengagement while permitting unlimited successive rota-
15 tion of the wheels, a spring-drawn locking detent for detaining said key when depressed, transfer mechanism for causing a complete rotation of any wheel in either direction to result in an increment of movement of the
20 next adjacent wheel of higher order, a second depressible key adapted to establish the same order of engagement and disengagement of wheels and racks as the first-mentioned key, said second or total key effecting
25 disengagement of the locking detent from the first key, and a zero stop member for the wheels operated by said total key.

47. In a machine of the character described, the combination of differentially
30 movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally preventing such independent movement of
35 racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, said wheels being normally disengaged from
40 the racks during the latter's advance and engaged therewith during their return, a depressible subtraction key and connections for reversing this order of engagement and disengagement while permitting unlimited
45 successive rotation of the wheels, a spring-drawn locking detent for detaining said key when depressed, latches for holding the pawls displaced until the rack-carriers return home, a second depressible key adapted to establish the same order of engagement
50 and disengagement of wheels and racks as the first-mentioned key, said second or total key effecting disengagement of the locking detent from the first or subtraction key, a zero stop member for the wheels, operated
55 by said total key, means controlled by the pawl-latches to prevent depression of said total key, and means for retracting the latches before the racks are advanced an increment of movement by their carriers.

60 48. In a machine of the character described, the combination of differentially movable reciprocating racks and carriers, the racks having an increment of movement independent of the carriers, pawls normally
65 preventing such independent movement of

racks, wheels movable into and out of engagement with the racks and having projections to displace said pawls upon complete rotation of wheels in either direction, said wheels being normally disengaged from
70 the racks during the latter's advance and engaged therewith during their return, a depressible subtraction key and connections for reversing this order of engagement and disengagement while permitting unlimited
75 successive rotation of the wheels, a spring-drawn locking detent for detaining said key when depressed, latches for holding the pawls displaced until the rack-carriers return home, a second depressible
80 key adapted to establish the same order of engagement and disengagement of wheels and racks as the first-mentioned key, said second or total key effecting disengagement of the locking detent from the first or
85 subtraction key, a zero stop member for the wheels, operated by said total key, a spring-held bail acting when displaced to lock said total key against depression and adapted to be held displaced by the pawl-latches, and
90 means for retracting said latches before the racks are advanced an increment of movement by their carriers.

49. In a machine of the character described, the combination of adding and subtracting mechanisms, amount printing
95 mechanism, a key controlling the subtraction mechanism, a special type-carrier having a type to designate a subtrahend, a printing hammer for said type, a latch restraining said hammer, a reciprocating pawl
100 for displacing said latch, a movable arm normally in the path of said pawl for disabling the same, means for shifting said arm by depression of said key, and means for
105 moving the type-carrier by said arm to set the subtrahend type.

50. In a machine of the character described, the combination with adding and subtracting mechanisms and amount and total printing mechanisms; of depressible
110 keys controlling the subtracting and total printing mechanisms; a movable special type-carrier having a type to designate a total and a type to designate a subtrahend, a printing hammer for said types, a latch restraining said hammer, a reciprocating
115 pawl for displacing said latch, a movable arm normally in the path of said pawl for disabling the same, means for shifting said
120 arm by depression of the total key sufficient to remove it from the path of the pawl, means for shifting said arm to a greater extent by depression of the subtraction key, means for moving the special type-carrier
125 by the extra shift of the arm to set the subtrahend type, and means for moving said carrier by the total key to set the total type.

51. In a machine of the character described, the combination with adding and
130

subtracting mechanisms and amount and total printing mechanisms; of depressible keys controlling the subtracting and total printing mechanisms, a movable special type-carrier spring-supported and having a type to designate a total and a type to designate a subtrahend, a printing hammer for said types, a latch restraining said hammer, a reciprocating pawl for displacing said latch, a rock shaft having an arm normally in the path of said pawl for disabling the same, a thrust-bar coupled to said arm and having a cam-lug for moving the special type-carrier against the stress of its spring, a second arm on said rock shaft, a cam lever acted upon by the subtraction key and acting upon said second arm, connections from the total key for acting upon said second arm to a less extent than said lever, a second rock shaft operated upon by said total key connections, and a crank arm on said second rock shaft acting upon the special type-carrier.

52. In a machine of the character described, the combination with wheels and their actuators, the wheels having transfer projections; of transfer mechanism including pawls having pivoted and beveled abutment pieces or feet limited as to pivotal movement and adapted to be encountered by the transfer projections of the wheels moving in either direction.

53. In an accounting machine, the combination with a register, reciprocating actuating devices for said register, and mechanism for engaging said register and actuating devices for movement in either direction

at will, of transfer devices for said register, and means actuated by said register for tripping said transfer devices when said register is moving in either direction.

54. In an accounting machine, the combination with a register having denominational elements, reciprocating actuating elements for said register, and mechanism for engaging said register elements and actuating elements for movement in either direction of reciprocation at will; of transfer devices controlled by said register elements and permitting said actuating racks to have an additional movement in a constant direction no matter which direction the register elements are moving.

55. In a machine of the character described, the combination with a totalizer including denominational elements, of reciprocating racks for actuating said elements in either direction, transfer pawls normally stopping said racks but displaceable to permit excess movement of said racks in a constant direction, latches for retaining said transfer pawls in displaced position, a subtraction key for changing the direction of movement during engagement of said racks and denominational elements, means operated by movement of a latch for causing displacement of the transfer pawl of next higher order, and devices, controlled by the subtraction key, for preventing such displacing movement of the latch.

JESSE G. VINCENT.

Witnesses:

FRANK PARKER DAVIS,
LOUIS B. ERWIN.