

Jan. 8, 1935.

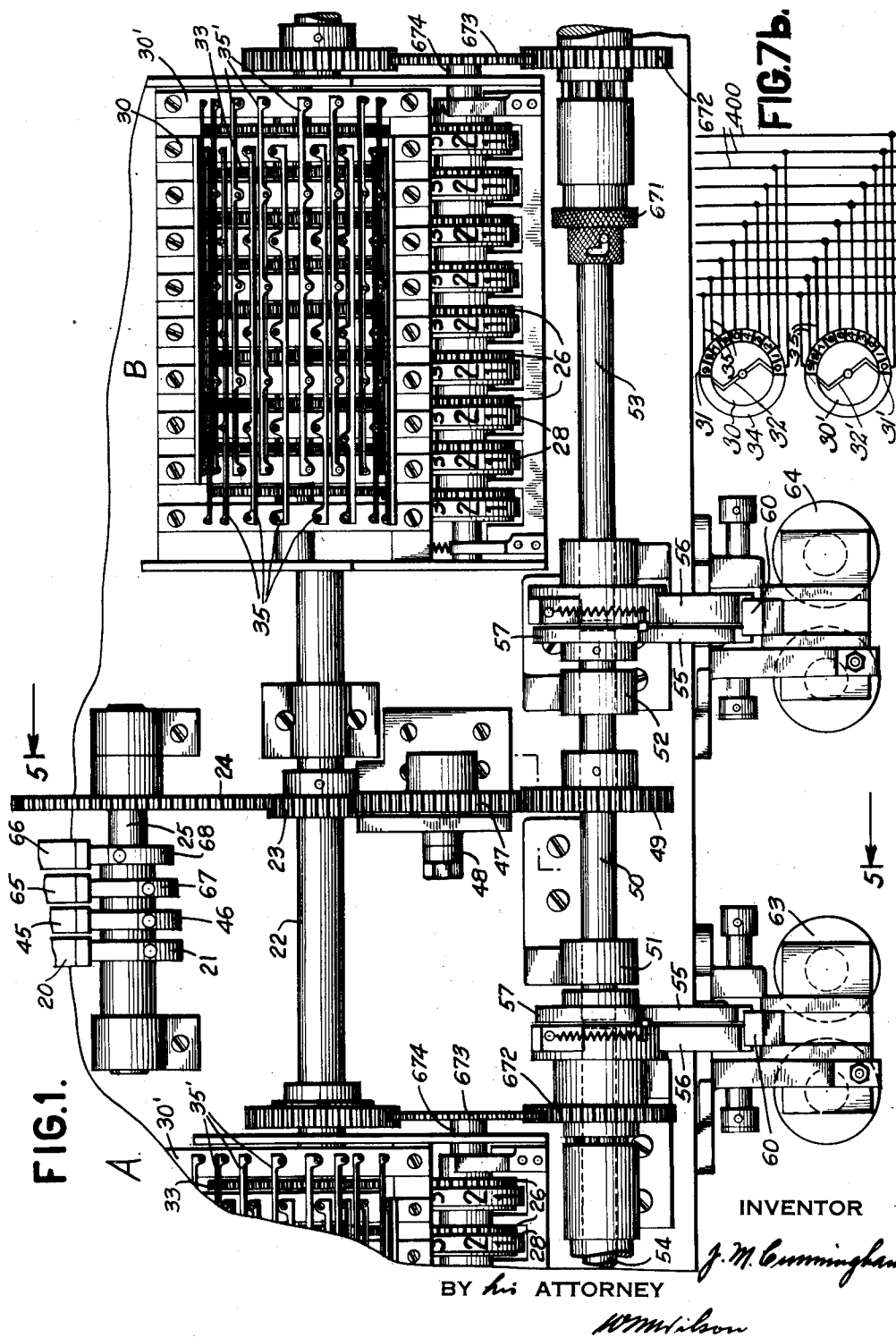
J. M. CUNNINGHAM

1,987,326

TABULATING MACHINE

Filed May 6, 1933

5 Sheets-Sheet 1



Jan. 8, 1935.

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TABULATING MACHINE

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FIG.2.

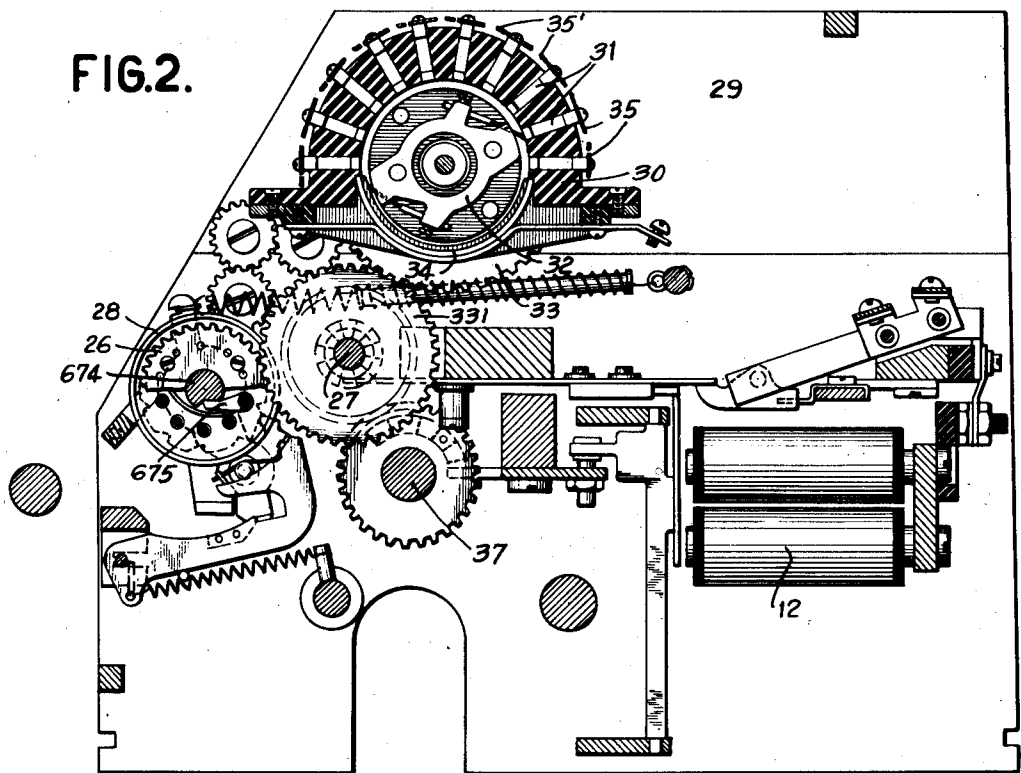
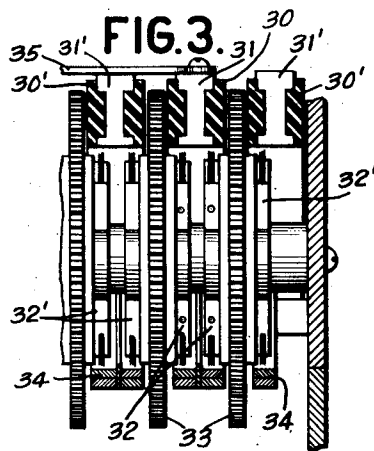
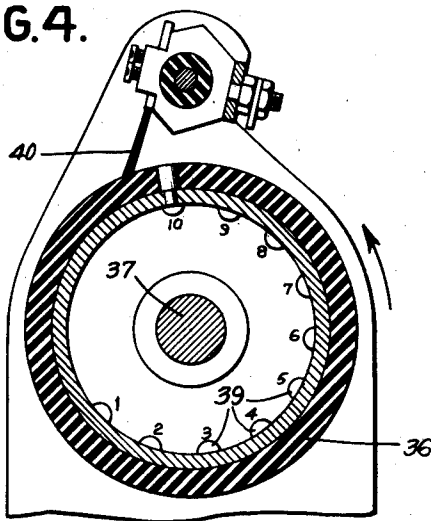


FIG.4.



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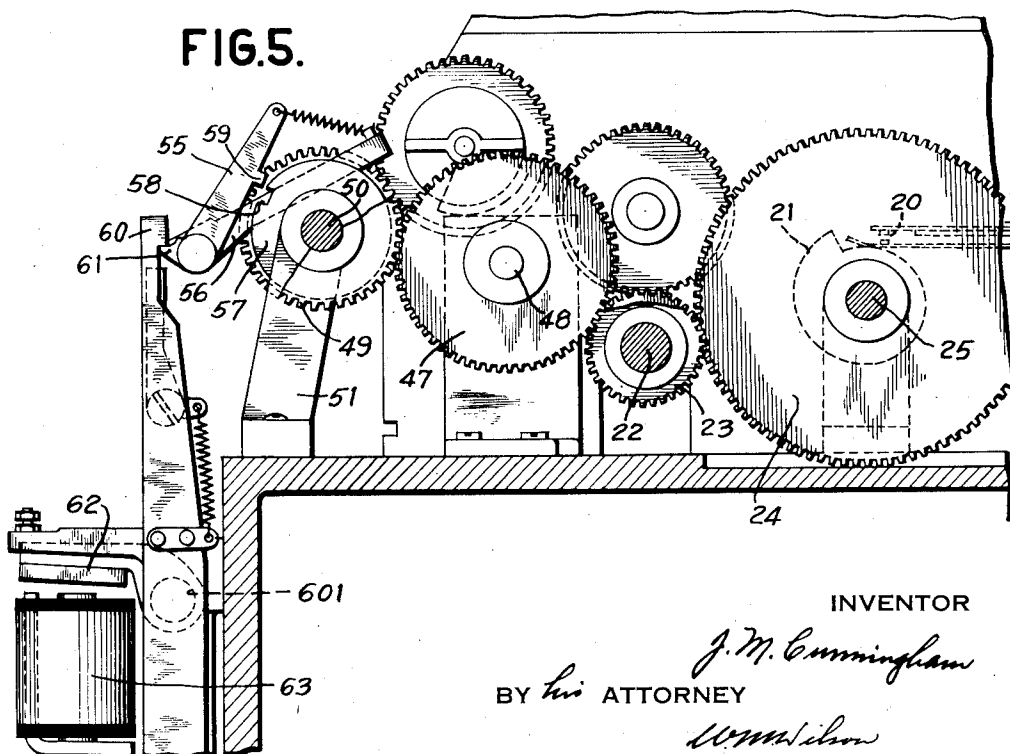
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FIG. 6.

AMOUNT	INVERTER A	INVERTER B	COUNTER C CREDIT BALANCE	COUNTER D DEBIT BALANCE
+ 9430	9430			
+ 671		671	9430	9999056'0
-10234	10234		671	99999329
+70629		70629	99989766	10234
- 1110	1110		70629	99929371
- 899		899	9999888'0	1110
			99999101	899
			68487	99931513

FIG. 5.



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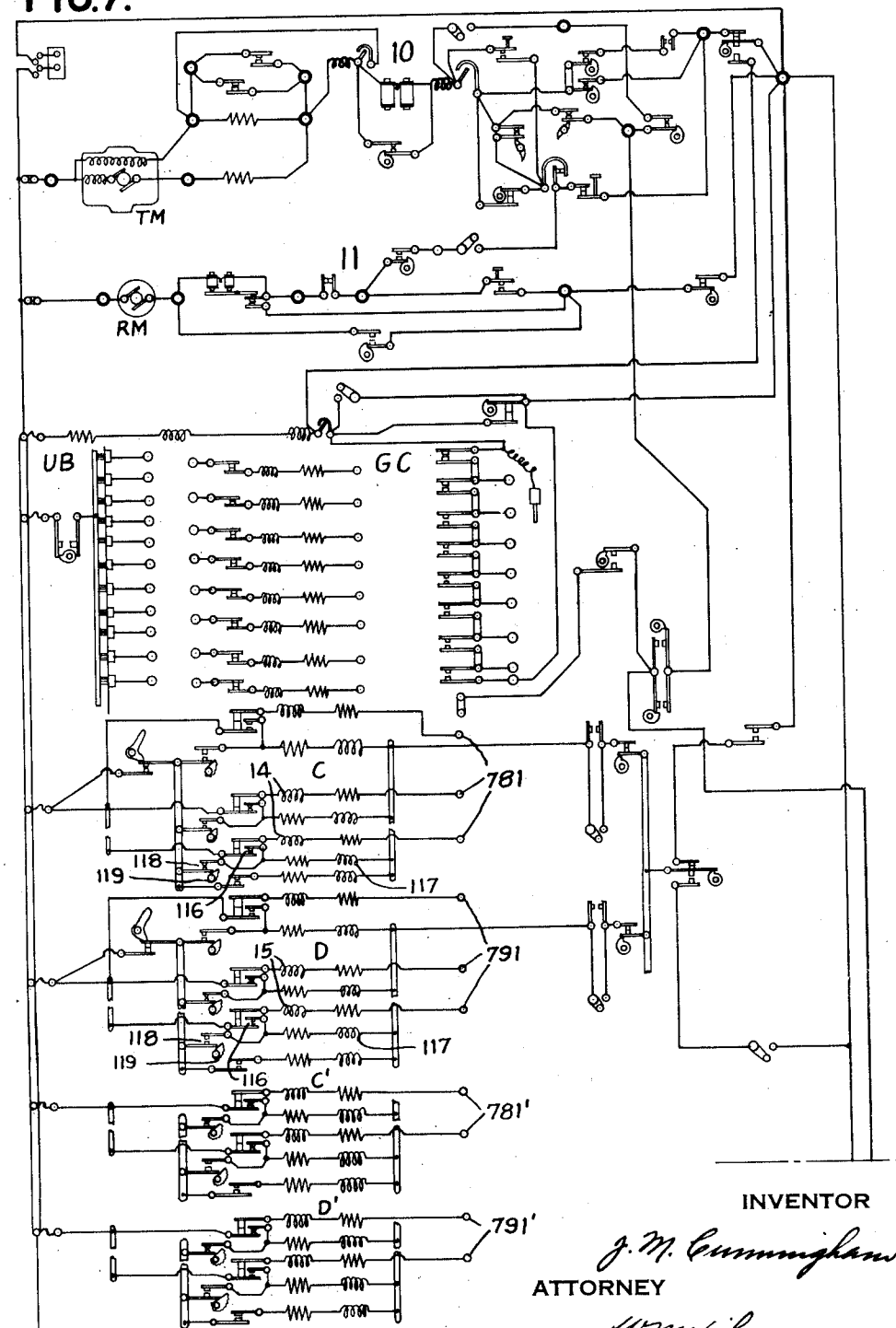
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FIG. 7.



Jan. 8, 1935.

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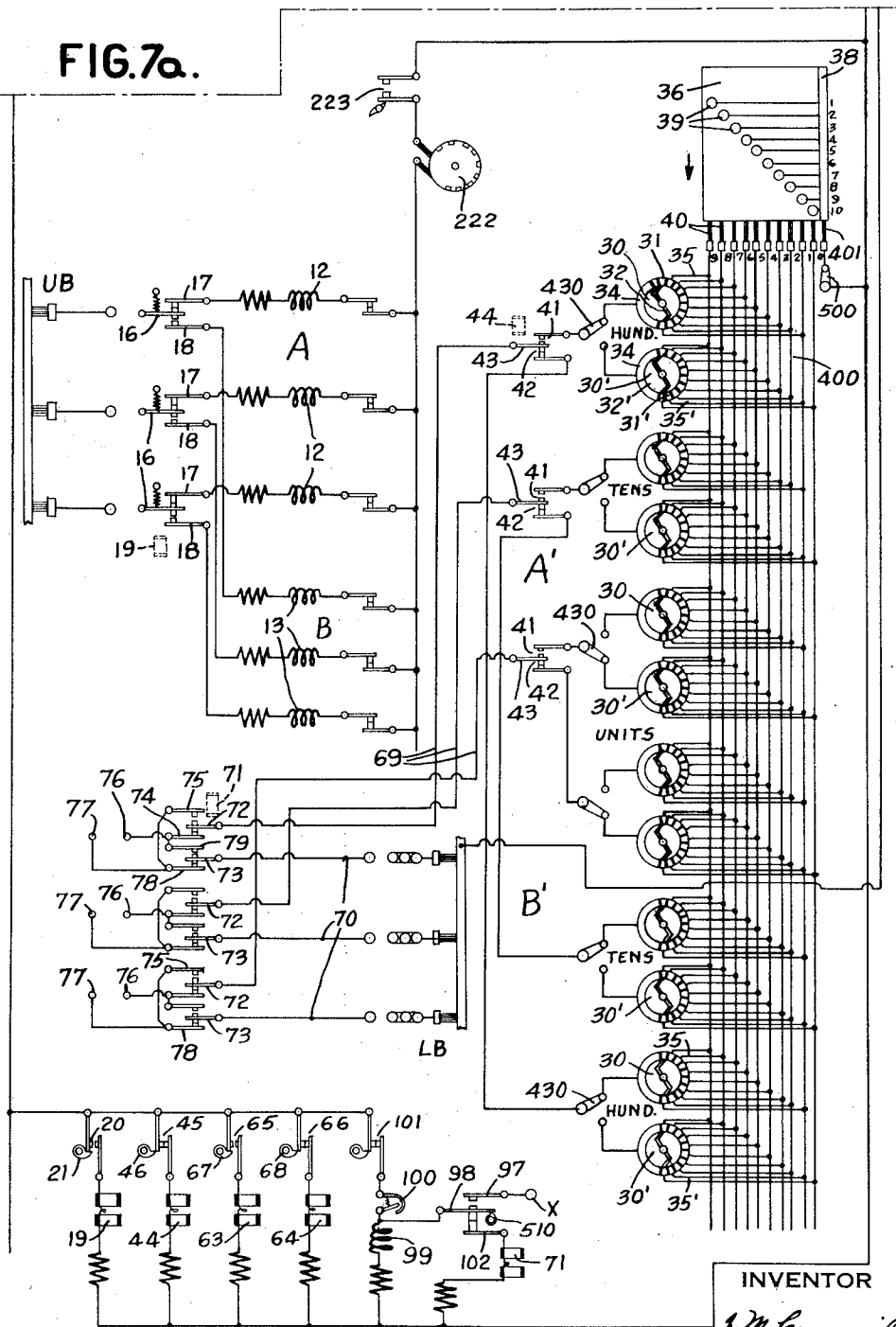
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TABULATING MACHINE

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FIG. 7a.



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1,987,326

TABULATING MACHINE

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Application May 6, 1933, Serial No. 669,640

9 Claims. (Cl. 235—92)

This invention relates generally to improvements in subtracting mechanism and more particularly to means for splitting inverting or complement entering devices so that any order of said devices may be adjusted to invert to tens complements and act as a units order.

The present case discloses an improvement on the devices set forth in application Serial No. 499,279, filed December 1, 1930 by G. F. Daly. In that case, each inverter counter comprises a plurality of settable commutator devices, one for each order. All the commutator devices are adapted to invert to nines complements, there being an elusive unit entry device associated with the units order so that the complement is filled out. In the present case, two commutator devices are associated with each inverter counter order; one to invert to nines complements and the other to invert to tens complements. A switch may be set to select one of the commutators or disconnect both. The use of an elusive unit entry device is obviated. Such construction adapts any order of the inverter counter to act as a units order. Thus, the inverter may be split so that instead of using the emitted complementary impulses to control one accumulator, two or more accumulators may be made effective in subtraction under control of one split inverter counter.

An object of the invention is to provide means for splitting an inverting device into two or more sections at any denominational order position, the right hand order of each section being conditioned to act as a units order in the operation of the device.

A feature of the invention is the universal split arrangement whereby a choice may be had of the kind of a complement to which a negative number may be changed in accumulating on one or more of the orders of an accumulator. A switch in each order of the inverter may be set to condition the order to perform in one of three ways; namely, to invert to nines complements, to open and disable the operation of the related order of the inverter and thus split the inverter, or to invert to tens complements thus making a units order of the order on the side of a split section of the inverter.

The invention is illustrated in connection with a machine having inverter counters into which a number is entered after being read off a perforated record. In the inverter the number is inverted to a complement before it is added in one of a pair of balance accumulators. The subtracting operation is performed by the addition of the inverted number or complement in the

balance accumulator of the class opposite to the class of the original number. For example, the complement of a debit item is added on a credit accumulator.

At times it is desirable to have more than one pair of balance accumulators to handle problems in subtraction. The present invention provides an arrangement whereby a single inverter counter may be split into groups of orders, the right hand order of each group becoming a units order adapted to invert numbers to tens complements instead of nines complements. Each group of inverter orders may be connected to a separate balance accumulator and thus the capacity of the machine is expanded for subtraction operation.

An object of the invention is to provide devices for accumulating a plurality of balances by the simultaneous addition of a plurality of true numbers and complements.

Another feature of the improvement in electric subtraction devices is the dual wiring of commutators in an inverter counter, thus giving the choice of inversion to nines complements or the tens complements on any order of the counter. The inverter is provided with two brush structures on each differentially adjusted inverter counter wheel. The brushes are positioned relative to two associated commutator rings connected differently to an impulse emitter. The segments on one commutator ring are connected to the bars of the emitter to receive timed impulses arranged to actuate an accumulator with additions of the nines complement of the number set up on the inverter. The segments on the other commutator are connected to the emitter bars in a slightly different fashion. These segments are connected to the bars to direct timed impulses through the accumulator so that the tens complement of the number set up in the inverter is added therein.

The invention is shown as applied to an electrical tabulator of the type shown in the patent to G. F. Daly and R. E. Page, No. 1,762,145, June 10, 1930.

Two separate counters in the machine are used merely as means for alternately storing and inverting readings of numbers read off perforated cards passing through the tabulator. The amount alternately entered into one or the other of these counters is always a true amount read directly from a card under the upper card sensing brushes. The number read from a counter is always the complement of the number read into the counter. These counters are named inverter counters.

The complement read from an inverter counter is accumulated on another counter which is one of a pair of accumulators. The other counter of the pair does not receive the complement but receives the true amount from a reading of the card when it is under the lower brushes. These paired counters are called balance counters or accumulators, all true positive amounts going into the credit balance counter and all true negative amounts going into the debit balance counter. In this pair of balance counters the complemental figures from the inverter counters are received so that the complements of all true positive amounts are entered into the counter which is accumulating the true negative amounts, and the complements of all true negative amounts are entered into the counter which is accumulating the true positive amounts. Briefly, one of the balance counters accumulates all true positive items, plus the complements of all true negative items; and the other balance counter accumulates all true negative items, plus the complements of all true positive items. This means that if the total of the true positive amounts exceeds the total of the true negative amounts, a true number or credit balance will appear in the first balance counter and the complement of the balance will appear in the second balance counter.

Conversely, if the total of the true negative amounts entered in the counters exceeds the sum of the true positive amounts which are entered in the counters, the second balance counter will show a true negative amount and its complement will appear in the first balance counter.

While one inverter counter is receiving the results of reading a card under the upper brushes, the complement of the number standing on the other previously operated inverter counter is being transferred to the credit or debit balance counter. The inverter counter from which the complement is being transferred is reset simultaneously with the transferal thus conditioning it for the reception of a number on the next card cycle. A complement may be read off one or the other of the inverter counters during each card cycle.

The devices for selecting which balance counter is to receive the complement and which balance counter the true number, are controlled by a special perforation in a debit card. When a card without the special perforation (i. e., a credit card) passes through the machine, the true number is added on the credit balance counter while the nines complement of the number is added on the debit balance counter. When a debit card passes through the machine, the true negative amount is added on the debit balance counter and the complement is added on the credit balance counter.

From the foregoing it may be gathered that the inverter counters are controlled in an invariable cyclic manner to receive numbers and be reset; while on the other hand the balance counters are controlled selectively to receive a true number or a complement of that number according to whether the amount is a debit or a credit item.

At any point in the operation of the machine a reading of the wheels on one of the inverter counters will reveal the number which is about to be entered into one of the balance counters. A reading of the balance counters will disclose the true credit or debit balance on one counter and the complement of the balance on the other counter. A printed record of both the true balance and the complement may be obtained, or if desired only

the true balance may be printed, the printing devices related to the wheels showing complemental numbers being disabled.

In order to obtain a complemental or inverted transferal of the number standing on an inverter counter, each counter wheel of the inverter is located between two commutators having a series of segments one for each figure indication on the wheel. Brushes may be geared to the counter wheel so that they always rest on the commutator segment corresponding to the digit reading of the wheel. Each of these brushes may be selectively connected to one or the other of related counter magnets in the balance counters to throw in the counter wheel operating clutch at the proper time during the rotation of the counter shaft. An impulse emitting device is coordinated with ten separate lines which are allotted to the ten decimal figures and connected to related commutator segments. The emitter is arranged to supply impulses to these lines at a point in the machine operation corresponding to the complement of the figure value which they represent.

Thus, one brush senses the nines complement commutator which is connected so that the "8" line, for example, receives an impulse timed to energize the connected balance counter magnets so that the counter wheels receive one step of movement, the "7" line receives an impulse timed to enable the clutches to turn the balance counter wheels through two spaces, and so on.

All the nines complement commutator segments corresponding to the "8" position of the inverter counter wheels are connected to the "8" line from the emitter, all the "7" segments are likewise connected with the "7" line, and so on. Thus it will be understood that the higher order balance counter magnets connected to the inverter counter wheels which stand at "8" will receive an impulse for adding a unit, all those connected with wheels that stand at "7" will receive an impulse for adding two units, and so on. The other brush on the inverter wheel cooperates with the tens complement commutator the segments of which are connected to the emitter lines so that a brush at the "8" position is connected to the "7" line and receives an impulse timed to energize the connected units order balance counter magnet so that the counter wheel receives two steps of movement, the brush at "7" receives an impulse timed so that the counter wheel receives three steps of movement, and so on. With this arrangement, it is apparent that the units order balance counter magnets connected to the inverter counter wheels which stand at "9" will receive an impulse for adding a unit, or if standing at "8" will receive an impulse for adding two units. Thus, a single emitter and a single set of ten lines serves to control nines and tens complemental entries.

Other objects, uses and advantages of the present invention will be hereinafter pointed out in the specification and claims and shown in the drawings, which show by way of illustration what is now considered to be a preferred embodiment of the invention.

Fig. 1 is a plan view showing one complete inverter counter and a portion of the other inverter counter. The counter resetting devices and the cams for energizing the reset magnets are also shown in this figure.

Fig. 2 is a vertical section through the inverter counter section of the tabulator showing the relationship of the commutators to the inverter counter wheels.

Fig. 3 is a sectional detail view of a few inverter counter wheels showing the dual brush construction and commutator segment arrangement.

Fig. 4 is a sectional detail view of the emitting device for initiating the timed operating impulses.

Fig. 5 is a section taken along the line 5—5 in Fig. 1, showing an end view of the resetting and cam operating gearing.

Fig. 6 is a chart showing the various entries and the method by which the machine arrives at the net balance of those entries.

Figs. 7 and 7a taken together constitute a wiring diagram of the machine.

Fig. 7b is an enlarged section of the wiring diagram showing two related inverter commutators.

The wiring diagram in Fig. 7 is substantially the same as that shown in the patent to Daly and Page, previously referred to. During adding operations the machine is driven by a tabulating motor TM controlled by a group of cam and relay controlled circuits indicated at 10. It is driven during total taking operations by a reset motor RM controlled by a group of circuits, contacts and relays designated generally at 11. When the tabulating motor TM is in operation it feeds the usual perforated tabulating cards, bearing differentially arranged index points representing digits; first, beneath the upper analyzing brushes UB and exactly one machine cycle later beneath the lower analyzing brushes LB (Fig. 7a). By means of the group control mechanism indicated generally at GC (Fig. 7), groups of cards, as represented by the same data entry in certain selected columns, may be operated upon separately, the items of each group being accumulated and the result of the accumulation secured before the machine begins operation on the following card group.

As the perforated cards pass the upper brushes their index points instantaneously close circuits through the proper upper analyzing brushes UB to energize inverter counter magnets 12 or 13 (Fig. 7a). When the cards pass the lower brushes LB the selected balance counter magnets 14 or 15 (Fig. 7) are energized.

As usual, the timed energizations of these magnets control mechanism for entering the data corresponding to the card reading on the counter wheels. In Fig. 2 is shown the counter structure A used for adjusting wheels 28 and 33 under control of magnet 12 in the usual manner. The structures of all the counters are similar to the structure shown. When any balance counter magnet 14 or 15 is energized it causes contacts 116 to close, energizing a printer magnet 117 to select the type corresponding to the entered data for printing. In this fashion the accumulated items may be listed. A total may be printed to record the amount standing on any balance counter by means of impulses through magnets 117 timed by the closing of contacts 118 under control of the stepped cams 119 on the counter wheels.

As the card is leaving the upper brushes, a special perforation provided for the purpose controls the machine according to whether the item on that card is a debit or credit, and the machine acts in accordance with the control to distribute the items in appropriate form to the proper balance accumulators.

For the purpose mentioned, four counters are required. For clarity of description these particular counters will be referred to as inverter

A (Figs. 1 and 7a), inverter B, credit balance counter C (Fig. 7) and debit balance counter D. The first two counters are used for inverting the items presented. The third counter is used for obtaining a credit balance if it shows a true positive total, and the fourth counter for a debit balance if it shows a true negative total. Other balance counters C' and D' may be provided.

It will be noted that one inverter counter is receiving an item from the upper brushes at the same time that the setting of the other inverter counter is used in transmitting the complement of the preceding item to a balance counter. The reason for the provision of two inverter counters is so that one counter may be receiving and setting up one item while the setting of the other counter is used in transmitting the complement of the previous item to a balance counter. If inverter A is used for one card, inverter B is used for the next card, alternately, regardless of whether the card presents a debit or credit item.

As a credit card passes through the machine the item standing thereon is inserted at its face value in an inverter counter during one card cycle and during the next card cycle the item is added at its face value in the credit balance counter and its complement is added in the debit balance counter. Conversely, if a debit card passes through the machine, the item standing thereon is entered at its face value in an inverter counter during one card cycle and during the next card cycle the face value of the item on the card is added in the debit balance counter and its complement is added in the credit balance counter.

With reference to complements, it will be noted that the complement of a number is arrived at in this invention in the following manner: The complement of an item, composed as they are in the present examples of eight or less digits, is the difference between 100,000,000 and that number. A convenient method of obtaining this complement is to let each digit of the number (including zeros to the left of the highest significant figure) be subtracted from "nine" except the right hand digit which is subtracted from "ten". This is a convenient and infallible method of obtaining the complement of a number of several digits. In the example shown in Fig. 6 the first credit item 9430 is added in the credit balance counter as a true number and added in the debit balance counter as a complement. This is done by adding 99,990,560 plus 10 to form a true complement as described above. The next item which is a credit figure of 671 is added in the counters in the same fashion. The first debit item 10234 is added as a true number in the debit balance counter and its complement is added as 99,989,766 into the credit balance counter in the manner previously described. The other debit and credit amounts are treated in the same way as the examples noted.

The two right hand columns on the chart in Fig. 6 show how the examples given would normally be printed on a record sheet showing the individual debit and credit items, the complements of these items, the net balance which happens to be a credit balance, and the true complement of the net balance.

Turning now to the manner in which the amounts are entered into the inverter counters, it is noted in Fig. 7a that plug wire connections may be made from the upper brushes UB to a series of contacts 16. In the position shown, the contacts 16 close circuits through upper contacts 17, thus directing the impulses from the

upper brushes to energize counter magnets 12 in inverter A and thereby entering an amount in this counter and positioning the associated commutator arms 32. A series of lower contacts 18 are connected to the counter magnets 13 in inverter B so that when the contacts 16 are lowered, closing the circuit between the upper brushes and magnets 13, an amount is entered in counter B. The contacts are lowered on alternate card cycles by means of a magnet 19. This magnet is energized alternately by means of a pair of contacts 20 that are opened and closed by a cam 21.

The devices for rotating cam 21 are shown in Fig. 5. There it is noted that drive shaft 22 has a pinion 23 meshing with a gear 24 mounted on the shaft 25 to which cam 21 is attached. The ratio of the gearing is such that shaft 25 is turned one-half a revolution per card cycle, thus enabling cam 21 to close contacts 20 during one card cycle and allow the contacts to open during the next card cycle.

An impulse distributor 222 (Fig. 7a) is located between the counters A and B, and the right side of the line. This distributor controls the current so that an impulse is allowed to run from the line only when a hole in the card is under a brush. Contacts 223 are closed when a card is under the upper brushes.

Referring now to Figs. 1 and 2, the inverter counter wheels comprise gears 26 driven from a shaft 27 under control of the counter magnets 12 as previously stated. As usual, indicating wheels 28 are provided and fixed to the counter wheels so that the data entered may be visually indicated on the counter wheels.

The inverting mechanism indicated generally at 29 in the upper part of Fig. 2 consists of a commutator 30 provided with segments 31 corresponding in number and position to all the figure indicating positions of the counter wheel 28. In Fig. 3 it is seen that a brush structure 32 and another brush structure 32' are mounted on each gear 33 driven by the gear 331 (Fig. 2) which drives the counter wheel 28, so that the brush structures are angularly displaced according to the reading on the related counter wheel. The one brush structure 32 cooperates with the segments 31 in the nines complement commutator 30, and the other brush structure 32' cooperates with the segments 31' in the tens complement commutator 30'. Each structure carries two brushes, one of which engages the segments 31 or 31' and the other of which engages a common segmental conductor 34, the surface of which corresponds to the configuration of the commutator. It will be noted that wherever possible each commutator 30 or 30' has been placed to cooperate with two brush sets 32 or 32' to conserve space and simplify the structure. Similar structures on adjacent wheels are placed together to cooperate with a common series of segments in a commutator located between the wheels. Each group of segments 31 corresponding to the same figure on the nines complement commutators 30 are connected by a common conducting bar 35 (Figs. 1, 2 and 3) whereby all the "8" segments are in multiple, all the "7" segments in multiple, and so on. In the same way each group of segments 31' representing similar figures on the tens complement commutators 30' are connected by a bar 35'.

The device for emitting the timed impulses synchronized with the movement of the counter wheel clutches in the balance counters C and D is shown in Figs. 4 and 7a. This emitter consists

of an insulating shell 36 suitably mounted on the shaft 37 so that it rotates in synchronism with the counter clutch drive shaft 27.

Referring to the development in Fig. 7a, this emitter is provided with a continuous contact ring 38 and a plurality of contact spots 39, each of the latter being electrically connected to the ring 38. The spots 39 are displaced from each other both laterally and circumferentially, the circumferential spacing being such that each spot reaches a reading line formed by brushes 40 in time to energize the magnets for the balance counter clutches so that the clutches will engage and turn the balance wheels a corresponding amount. The lateral offset of the spots 39 permits each to cooperate with a separate brush 40. These brushes are electrically connected by a single set of ten lines 400 leading to the bars 35 and 35' connecting the common commutator segments as shown in Fig. 7a. A brush 401 contacting ring 38 is connected to a wire leading to the right side of the line.

It is noted in Fig. 7a that each of the lines 400 is numbered, a number being placed to the right of each line to identify it. The line at the extreme right is numbered 0; the second line from the right is numbered 1, and so on. The zero line is connected with all the segments 31', Fig. 7b, which are so placed in the tens complement commutators 30' that brush 32' will contact with them when the connected inverter wheel stands at zero. The "one" line is connected to all segments 31 contacted by brushes 30 when at zero, and segments 31' contacted by brushes 30' when at one. In the same way, each of the other lines 400 is connected with the related segments in the commutators 30 and 30'.

In the same figure it is also noted that each of the spots 39 may be identified by a number located at the right hand side of the emitter development and in line with the spot. The arrow shown at the left of the emitter development shows the direction of movement of the emitter past the line of brushes 40.

It is noted that the spot numbered 10 will be the first to pass under the line of brushes 40 and that this spot will contact with the brush 40 leading from the line 400 numbered 0. The "9" spot will be the second to approach the line of reading brushes and will make contact with the brush 40 extending from the line 400 numbered 1. The other spots 39 contact the related brushes 40 in successive order. From the above it may be gathered that the zero segments on the tens complement commutator 30' will be the first to receive an impulse from the emitter and said impulses are directed through the brush structures 32' to energize connected counter clutch magnets 14 or 15 in time to turn the related balance counter wheels through ten steps of movement.

In the same way the segments connected to the common line 400 numbered 1 will receive an impulse at a time enabling them to energize the connected counter magnets so that an amount of nine is added in the counter wheels. These connections are made by a nines complement inverter brush 32 at 0 or a tens complement brush 32' at 1, Fig. 7b. In the same way all the lines 400 receive an impulse which is so timed as to energize the balance counter wheel connected with the inverter devices of that bar so that the nines or tens complement of the number represented by inverter wheel having brush connections to the bar may be turned in the balance counter wheel.

Selectively connected to each set of two commutator rings 30 and 30' is a switch 430, Fig. 7a, wired in series with the control magnet 14 or 15, Fig. 7, through plug wires between sockets 791 or 781 and sockets 76 or 77, Fig. 7a, contacts 74 or 75 and wire 69 of the accumulator order in which the inverted amount is added. When the switch 430 is in a lowered position and connected to commutator 30', the number read out of the inverter will equal ten minus the number read in the inverter counter from the record card. When the switch 430 is set in the other upper position, the number read out of the inverter will equal nine minus the number read into the inverter counter.

By the adjustment of the switches the operator of the machine may adjust any order of the counter to invert to tens complements rather than nines complements. Thus any order may be made to act as a units order in a split section. If the switch is set between the two above mentioned positions, the related order of the inverter counter is disconnected from the accumulator control magnet, and the associated wheel in the balance accumulator is prevented from operating to add complements.

In Fig. 7a it is noted that the inverter commutator devices related to inverter A are shown at A' and the commutator devices for inverter B are located lower at B'. Wires from the commutators at A' carry impulses from the commutators to a series of upper contacts 41. The impulses from the commutators at B' are carried by wires to a series of contacts 42. A series of contact springs 43 are mounted in a manner enabling them to contact either with upper contacts 41 or lower 42. As shown in Fig. 7a they are positioned to close the circuits to the lower group of inverter commutators which are associated with the inverter counter wheels B. A magnet 44 is adapted to attract the contacts 43 so that they will close the circuit to the upper commutators which are associated with the inverter counter A. This magnet 44 is energized on alternate card cycles by a means which opens and closes a pair of contacts 45 under control of a cam 46. This cam 46 is mounted on the same shaft 25 that cam 21 is fixed to, cam 46 also receiving a half revolution on each card cycle. The directing of the complementary impulses from A' or B' into the proper balance counter will be described further on in this specification.

As explained hereinbefore, while the one inverter counter is receiving a true number from the upper brushes, the other inverter counter is acting as part of the mechanism for inverting a number which is directed into one of the balance counters and is simultaneously being reset. The description of the devices for resetting the inverter counters will now be taken up.

By reference to Figs. 1 and 5 it will be noted that the pinion 23 mounted on shaft 22 is in mesh with an idler gear 47 mounted on a stud 48. This gear is in mesh with another gear 49 mounted on a resetting stub shaft 50. As shown in Fig. 1, shaft 50 is supported in bearings 51 and 52 and has its ends abutting the ends of resetting shafts 53 and 54 associated with the inverter counters A and B. The three shafts 50, 53 and 54 are in axial alinement. Shaft 50 rotates during item entering operations of the tabulator, receiving one revolution per card cycle. The other two shafts 53 and 54 are alternately connected with shaft 50 in order to alternately reset the inverter counters A and B. The reset shafts 53 and 54 are alternately connected to the stub shaft 50 by

means of clutch pawls 55 which are mounted on frames 56, there being a frame 56 on the end of each reset shaft. Close to the ends of shafts 53, 54 are two disks 57 (Fig. 5) fast to shaft 50 and located at both ends of this shaft. Each disk 57 is provided with a notch 58 into which a finger 59 on pawl 55 may be engaged in order to connect one or the other of the shafts 53 or 54 with the resetting drive shaft 50. Each pawl 55 is normally held out of engagement with a resetting driving disk by an arm 60 the end of which engages a tail 61 on the pawl, thus lifting the pawl out of the path of the disk as the carrying frame 56 nears the home position. The pawls are alternately released by a counterclockwise movement of one or the other of the arms 60 about pivots 601. The release arms 60 are connected to armatures 62 that are displaced when one or the other of two magnets 63 and 64 are energized. From the plan view in Fig. 1 it may be noted that magnet 64 controls the connection of the resetting drive shaft to reset counter B, while magnet 63 controls the resetting of inverter counter A. The alternate energization of these magnets is brought about by operation of contacts 65 and 66 (see lower portion of Fig. 7a).

The contacts 65 and 66 are alternately opened and closed by means of cams 67 and 68. These cams are mounted on the shaft 25 which holds the cams 21 and 26. The cams 67 and 68 serve to open and close contacts 65 and 66 on alternate card cycles. While cam 68 is holding contacts 66 closed so that magnet 64 is energized and counter B reset, cam 67 allows contacts 65 to open thus preventing a resetting operation on inverter counter A.

Each of the shafts 53 and 54 is provided with a clutch 671 (Fig. 1) which serves to normally connect the shaft with a gear 672. This gear drives another gear 673 which is fixed on the end of a notched reset pickup shaft 674 (Fig. 2) in each of the inverter counters. The shaft 674 when turning cooperates with pawls 675, there being a pawl on each inverter wheel. The shaft in turning to reset rotates in the same direction that the wheels rotate in adding, so that the wheels that have remained in a position to indicate "0" are the first wheels to be picked up by the shaft as it turns. Wheels that stand at "1", having been moved one step in adding, are the ones that are the next to be picked up, and so on. As the wheels standing at zero have positioned brush structures 32 through which the first inverted or "10" impulse is directed, the resetting devices are timed to pick up such wheels first and the others in order, allowing each wheel to remain undisturbed while an impulse is directed through the associated brush structure. Thus it is possible to transmit inverted impulses through the inverter wheels in the same machine cycle during which they are reset, the orders through which the last inverted impulse is directed, being the last to be disturbed in resetting. The shaft 674 in turning lags behind long enough to insure the passage of an impulse through the commutators of the wheels before the pawls on the wheels are picked up by the shaft during resetting.

The manner in which cams 21, 46, 67 and 68 are mounted on shaft 25 may be noted in Fig. 1. There it may be seen that the cams are mounted in a compact formation on the shaft 25 driven by the large gear 24. The ends of contacts 20, 45, 65 and 66 are in parallel alignment above the cams.

The distribution of the complement and true

number to the balance counters will now be discussed. Amounts are entered into the balance counters C or D (Fig. 7) by means of the energization of counter magnets 14 or 15 with timed impulses through wires 69 (Fig. 7a) leading from the inverter devices or through wires 70 leading from the lower brushes LB which analyze cards.

These impulses are selectively distributed so that one counter will receive the complemental figure from the inverter devices while the other balance counter will receive the true amount directly from the card while it is under the lower brushes. This selective control is brought about by energizing a magnet 71 (Fig. 7a) which is adapted to attract a series of contacts 72 extending from the ends of the wires 69 reaching to the inverter mechanism and also a series of contacts 73 at the end of the wires 70 leading to the lower brushes. The contact 72 normally closes a circuit through a contact 74 when a credit item is being entered into the counters. However, if a debit item is presented, magnet 71 is energized under control of a special perforation in a debit card, as explained hereinafter, and contact 72 is urged upward (Fig. 7a) to close a circuit through a contact 75. Normally the complementary amount will be sent by means of impulses in the wire that terminates at plug socket 76. However, when a debit item is presented, the impulses will be switched into a line reaching out to sockets 77.

At the same time that the impulses for the complementary amount are being switched from one line to the other the impulses from the lower brushes are also being switched by means of the magnet 71. Normally the current from the lower brushes will flow from the contact 73 through contact 78 to the plug socket 77. This is at a time when the complementary amount may be taken by plugging in at 76. If the conditions are reversed by the presentation of a debit amount, the contacts 73 will be urged upward by the magnet 71 to close the circuits through contacts 79 leading to the plug sockets 76. From the above it may be gathered that the true amounts and the complementary amounts of items presented to the machine may be selectively entered into credit balance counter C or debit balance counter D according to whether the item is a debit or credit. If it is a credit item, the true amount is added in counter C and the complement is added in counter D. If the item is a debit, the true number will be added in counter D and the complement added in counter C.

The wiring between the plug-sockets 76 and 77, and the counters C and D insures the correct distribution of the complement and the true number. From the plug sockets 77 (Fig. 7a) plug wires extend to plug sockets 781 (Fig. 7) in credit balance counter C. The other sockets 76 have connections to the plug sockets 791 in counter D. From the position of the parts in Fig. 7a it is obvious that the item being handled is a credit; the impulses making up the inverted or complemental number going through wires 69 to sockets 76 and into the debit balance counter D, while the impulses for the true number are directed from the lower brushes to sockets 77 across to sockets 781 and into the credit balance counter C. Upon energization of magnet 71 the contacts 72 and 73 will be lifted and the true number of the debit item will go into counter D while the complement of the number is added on counter C.

The elusive unit entry is automatically taken care of by the setting of the switch levers 430

(Fig. 7a) associated with the units orders of the inverters so that a tens complement reading is effected. Then if a units order wheel is at zero, an amount of ten is entered and a unit is carried over to the higher orders by the regular transferring operation of the counter C or D.

Other balance counters C' and D' may be provided and the inverter counters may be split so that they control four balance counters instead of only two. The lowest pair of plug sockets 76, 77 (Fig. 7a) associated with the units order of the inverter, may be connected by plug wires to the sockets 781', 791' (Fig. 7) in extra counters C' and D'. Then what is shown as the tens orders of the inverters A', B', may be changed to units orders of a section of the inverters by lowering the associated switches 430 to connect the tens complement commutators 30' in the circuit. The associated plug sockets 76, 77 are connected to the units order sockets 781, 791 in balance counters C and D. The tens orders of counters C and D may be connected to the upper sockets 76, 77 in line with the hundreds section labelled "Hund." in Fig. 7a. The switches 430 in this replugged order remain as shown selecting the nines complement commutator.

With the parts connected as outlined, it is obvious that two debit or credit numbers may be entered simultaneously into the split inverter counter, and the complements of such numbers are formed therein and directed into a pair of balance counters at the same time that the corresponding couple of true numbers are entered into a related pair of balance counters. Thus a plurality of balances may be calculated at the same time with different parts of the same inverter counter.

Since any order of the inverter may be changed to read tens complements, the point of splitting may be anywhere along the counter. In fact, each order of the inverter could control a separate balance counter if small numbers are entered.

The devices described hereinafter are provided for controlling the selective energization of magnet 71 in order to properly distribute complements and true numbers.

The energization of magnet 71 is controlled by a special perforation which designates that the item on a card is a debit. As a debit card passes the upper brushes the item thereon will first be entered into an inverter counter to set up the shiftable commutator brushes of the counter to prepare for reading out the complement during the following cycle. After this, the special debit perforation passes a selected one of the upper brushes UB which has a plug wire connection to socket X (Fig. 7a) completing a circuit through contacts 97 and 98 which are closed instantaneously by cam 510 as the distinguishing perforation reaches the brush, and through relay 99 in parallel with the magnet 71, the energization of which shifts the switches 72 and 73 to their alternative position.

The circuit through magnet 71 is closed by contact 98 and contact 102 when contact 98 is released from momentary engagement with contact 97. When relay 99 is once energized, a stick circuit is prepared for it through its relay contacts 100 and cam contacts 101 which close just before the debit designating perforation reaches the controlling brush and remain closed until the zero index point on the following card has passed the brushes. The switch contacts 72 and 73 then remain shifted during the entire reading cycle in

which the debit card is under the lower brushes LB.

Therefore, a debit card as it passes the upper brushes will first position an inverter counter so that the complement may be read out in the following cycle, then shift the switches 72 and 73 to select the proper balance counter, and during the following cycle the true value of the item will be directed from the lower brushes into counter D and the tens complement will be entered into counter C.

If, however, the card passing the upper brushes does not have a special perforation punched in the control position, it is a credit card, the relay 99 remains deenergized, magnet 71 remains deenergized throughout the next succeeding card cycle, and contacts 72 and 73 will remain in the position shown in Fig. 7a. In this instance, the true value of the credit item will be entered into counter C from the lower brushes and the complement will be entered into counter D.

During total printing from the balance counters, a switch 500 (Fig. 7a) may be opened by the operator of the machine to break the circuit through the emitter.

The invention is disclosed by an illustration of the preferred embodiment. Many modifications in the mechanical and electrical details will readily occur to those skilled in the art and it is to be understood that the embodiment illustrated is not to be construed in a limiting sense as I intend to be limited only as indicated by the scope of the following claims:

1. In a machine of the class described, means for entering amounts, means for inverting said amounts comprising a pair of devices for each denominational order of the amount, one device being adapted to invert to nines complements and the other device being adapted to invert to tens complements, and an accumulating device under control of said inverting means for adding said complements.

2. In a machine of the class described, means for entering amounts, means for inverting said amounts comprising a pair of devices for each denominational order of the amount, one device being adapted to invert amounts to nines complements and the other device being adapted to invert amounts to tens complements, a selection means in each order for making either device effective or both devices ineffective, and accumulating devices under control of said inverting means for adding said complements.

3. In a machine of the class described, a counter having a plurality of denominational order elements each movable to different positions to represent the several digits, an accumulating mechanism, an emitter common to all the elements of the counter for emitting a group of impulses comprising a single impulse representative of each digit, means associated with each denominational order element for selecting from the group only that impulse representing the nines complement of the digit corresponding to the position of the element for controlling the accumulating mechanism, and other means associated with each order element for selecting only that impulse representing the tens complement of the digit corresponding to the element position for controlling the accumulating mechanism.

4. In a machine of the class described, means for simultaneously entering a plurality of multi-denominational amounts, means for securing a complementary reading of said amounts including a pair of inverting devices for each denomina-

tional order, one device being adapted to invert amounts to nines complements and the other device being adapted to invert amounts to tens complements, selection devices for making certain of said inverting devices effective, the tens complement devices in the units denomination orders and the nines complement devices in the other orders, and a plurality of accumulating devices for adding complements under control of said complement reading means and amounts under control of said entering means.

5. In a device of the class described, a counter wheel, a pair of commutators adjusted by said wheel, a switch for selecting one of said commutators, an emitter for directing an impulse through the selected commutator, said impulse being timed by the setting of said commutator to give an inverted reading of the standing of said wheel, and an accumulating device adjusted under control of said impulse.

6. In a device of the class described, a counter wheel, a pair of commutators adjusted by said wheel, an emitter for directing impulses through said commutators according to the setting of said wheel, the impulses being directed by one commutator to give a nines complement reading of the wheel, and by the other commutator to give a tens complement reading, a switch for selecting one of said commutators for effective control, and an accumulating device which is adjusted under control of impulses directed through said selected commutator.

7. In a perforated record controlled machine, record sensing devices, a pair of multi-denominational ordered counters, means for adjusting said counters alternately under control of said sensing devices, means for resetting said counters alternately, means for taking a nines complementary reading of certain orders of the counters and a tens complementary reading of other orders of the counters, the counters being read alternately, a plurality of balance accumulators, means for selectively adding the amount read by the sensing devices on certain accumulators and the complementary amounts read from one of said counters on other accumulators, and means for controlling the printing of the amounts entered into the accumulators and the net balances figured in the accumulators.

8. In a device of the class described, a plurality of counter wheels, a pair of commutators associated with each wheel, one for reading out nines complements and the other for tens complements, a brush cooperating with each commutator as adjusted by the related counter wheel, an emitting device for sending out timed impulses, wiring connections between said emitting device and said commutators, a series of accumulating wheels, clutches for actuating said wheels, and means for controlling said clutches by the impulses, the units order accumulating wheel being turned the tens complement of the amount on the related counter wheel and the higher order accumulator wheels being turned the nines complement of the amounts on the related counter wheels.

9. In a machine of the class described, a plurality of counter wheels, means for positioning said wheels differentially, commutating devices having contact segments connected to conducting bars which are common to all the wheels, a pair of brush devices for each wheel and adjusted by the wheel to contact with any of said segments, means for making either brush device effective, an impulse emitter for sending timed impulses

through the bars, the first impulse being sent through the bar and segments that are contacted by certain brushes on wheels in the "0" position, the second impulse being sent through the segments contacted by brushes of one set on wheels in the the "0" position or other brushes made effective with wheels in the "1" position, etc., to the tenth impulse which is directed through segments contacted by effective brushes on wheels in the "8" or "9" position, a plurality of accumu-

lator wheels, means for adjusting the wheels of the accumulators by the timed impulses, the first impulse controlling the adjustment of the accumulator wheels through ten steps of movement, the second impulse controlling the adjustment of the wheels through nine steps of movement, etc., the tenth impulse controlling the adjustment of the wheels through one step of movement.

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