Nov. 8, 1966 H. J. CHALL 3,283,999

TRANSFER MECHANISM FOR A CALCULATING MACHINE

Filed Aug. 24, 1964 4 Sheets-Sheet 1

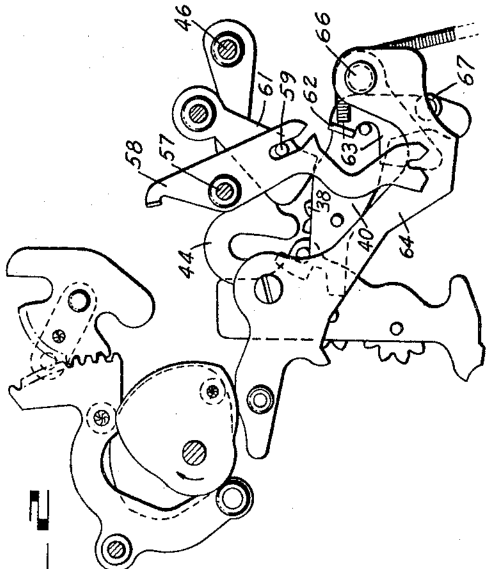

FIG_2

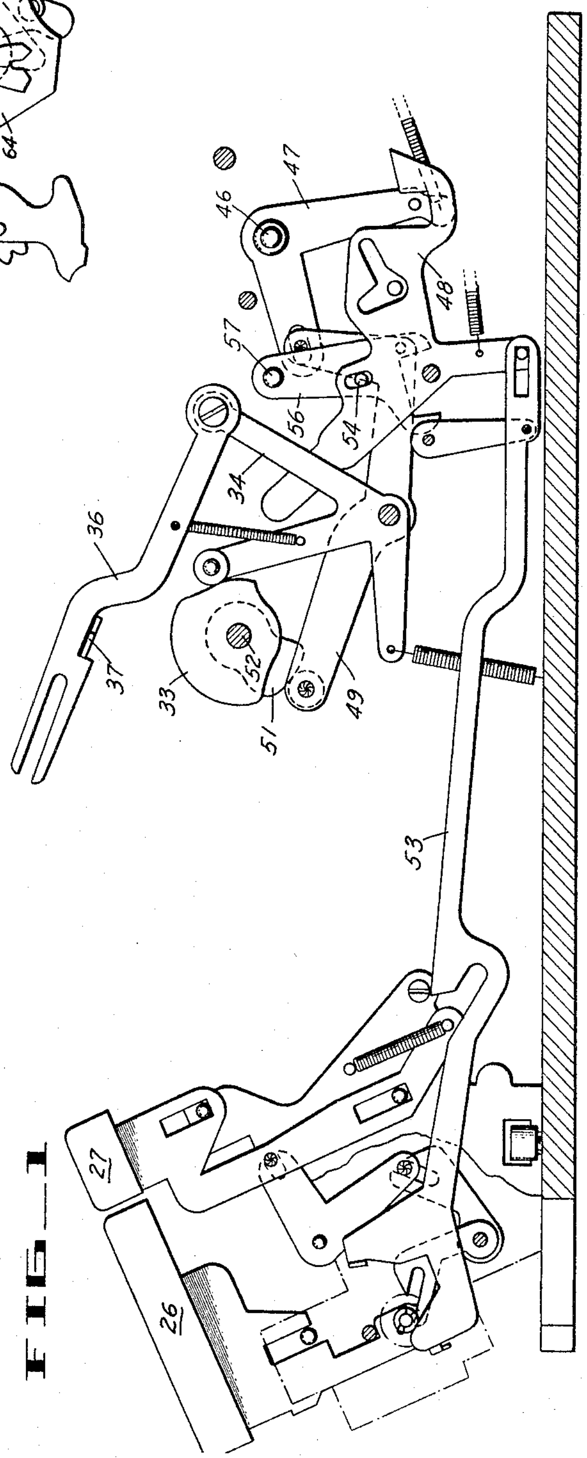

FIG_1

TRANSFER MECHANISM FOR A CALCULATING MACHINE

Filed Aug. 24, 1964

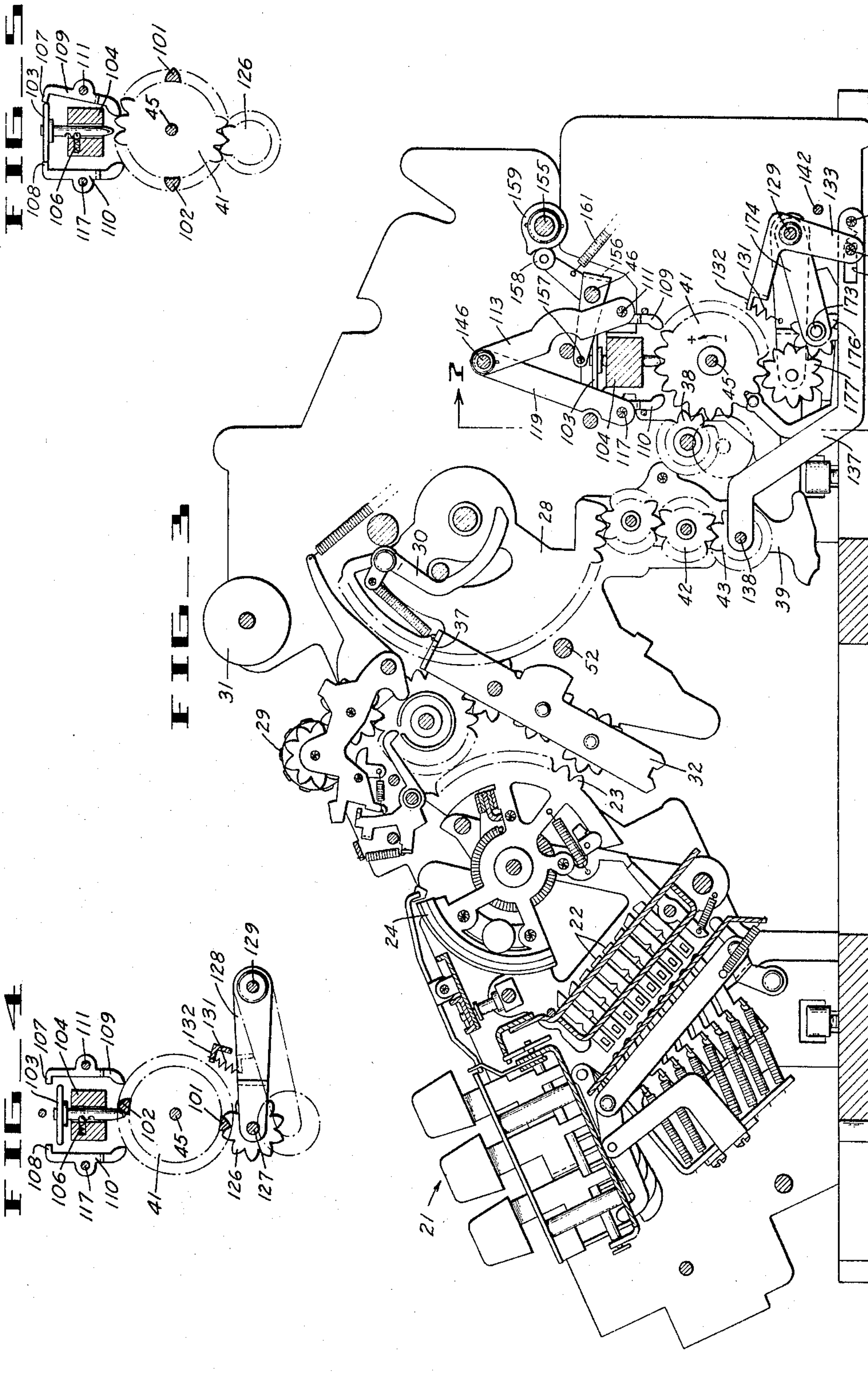

FIG. 5

FIG. 3

FIG. 4

TRANSFER MECHANISM FOR A CALCULATING MACHINE

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FIG. 7

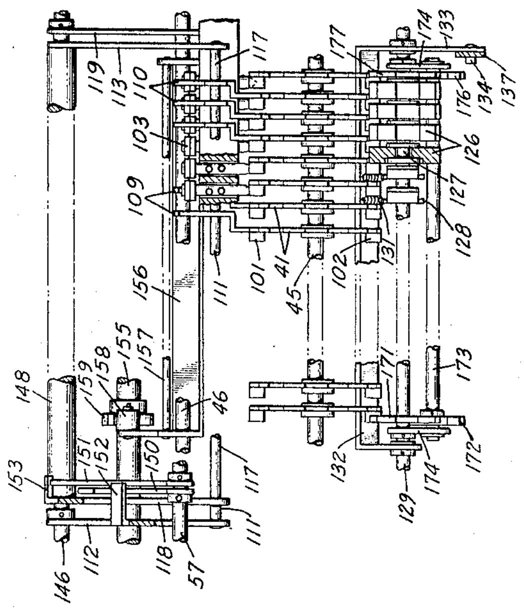
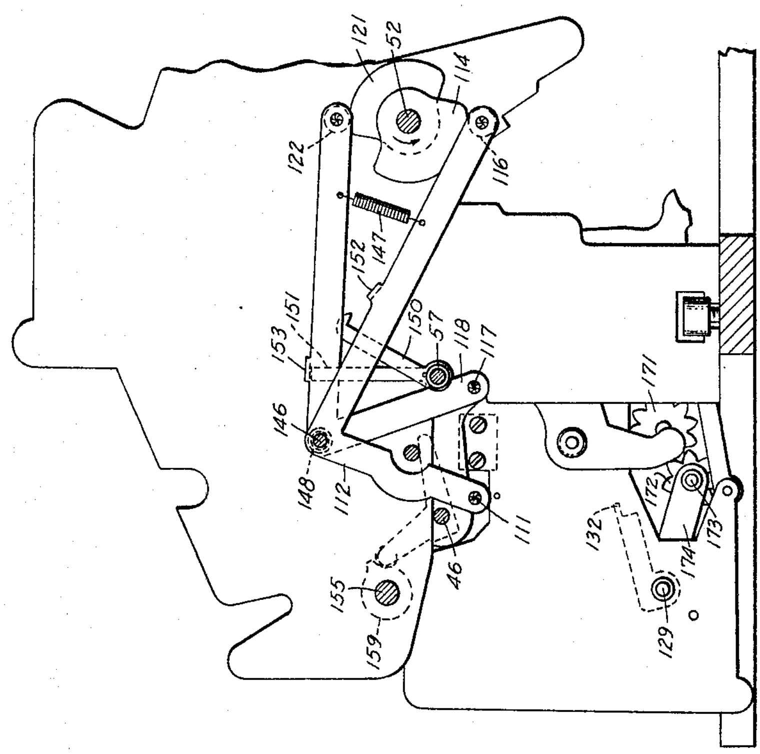


FIG. 6



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TRANSFER MECHANISM FOR A CALCULATING MACHINE

Filed Aug. 24, 1964 4 Sheets-Sheet 4

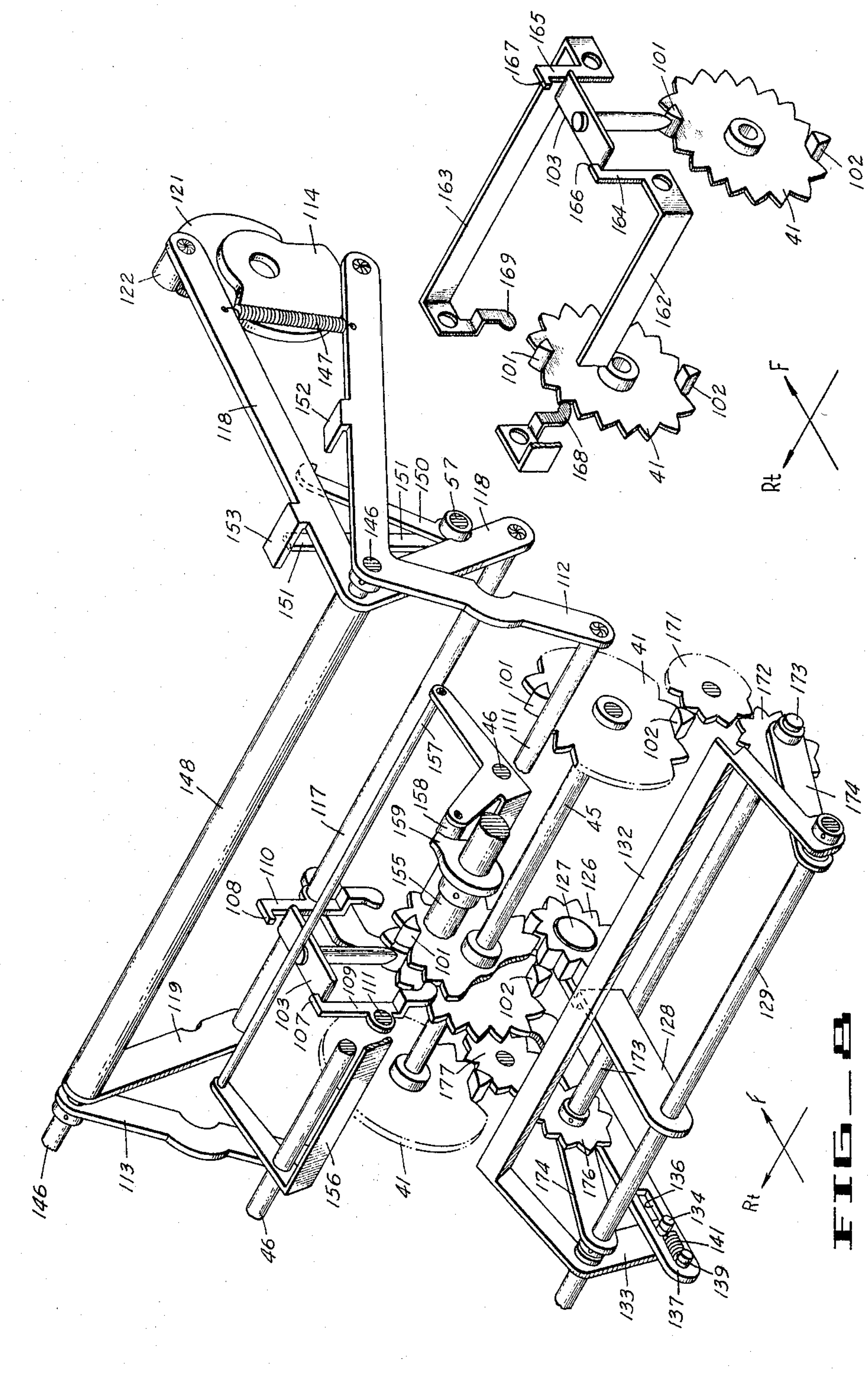

FIG. 9

FIG. 8

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3,283,999

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3,283,999

TRANSFER MECHANISM FOR A CALCULATING MACHINE

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Filed Aug. 24, 1964, Ser. No. 391,448

5 Claims. (Cl. 235—137)

This invention relates to simultaneous tens-transfer, or carry, mechanism for calculating machine accumulators.

Tens-transfer mechanisms are provided in calculating machines for transferring, or carrying, one unit into a register wheel of a higher order either additively when the wheel of the next lower order moves from "9" to "0," or subtractively when the wheel of the next lower order moves from "0" to "9." A carry resulting from "digitation," that is, from the addition or subtraction of the corresponding digits of two numbers, is called a "primary" tens-transfer. A carry resulting from another carry is called a "secondary" tens-transfer.

According to the present invention, each time a register wheel of the accumulator passes through its "9½" position, during the digitation operation of the calculating machine, an interponent is moved to an active position where it will remain until near the end of a machine cycle. Two opposing primary tens-transfer levers coact with the interponent, and one or the other, depending on the sign character of operation, is rocked to enter a unit in the next higher order register wheel. It may happen that rotation of the latter register wheel by the primary tens-transfer levers carries it through its "9½" position. In such a situation a transfer tooth on that register wheel drives a secondary tens-transfer gear which is yieldably urged into firm engagement with the register wheel for providing lost-motion-free connection to the next higher order register wheel for entering a unit therein. The secondary tens-transfer gear is brought into engagement with the register gear only during a tens-transfer phase that follows the digitation phase of the machine cycle.

In order to provide a true "credit balance" print-out from the accumulator, a "fugitive-one" tens-transfer is similarly carried from the highest order register wheel to the lowest. It is, therefore, an object of my invention to provide an improved tens-transfer mechanism for the accumulator of a calculating machine.

Another object of the present invention is to provide a tens-transfer mechanism wherein all primary and secondary tens-transfers are effected simultaneously.

Another object of the present invention is to provide separate primary tens-transfer actuators for all register wheels operable simultaneously to effect a primary tens-transfer.

A further object of the present invention is to provide a separate secondary tens-transfer gear rockably engageable with each accumulator wheel.

Still another object of the invention is to provide yieldable means for firmly engaging the secondary tens-transfer gears with the accumulator wheels in lost-motion-free engagement to provide reliable simultaneous operation.

Further objects and advantages will become apparent from the following description of a preferred embodiment of the present invention, taken together with the accompanying drawings, in which:

FIG. 1 is a right elevational sectional view of a portion of the right-hand side of a machine embodying the present

invention, showing particular parts associated with the addition and subtraction control keys;

FIG. 2 is a fragmentary right elevational sectional view of certain mechanisms used for conditioning the machine for addition and subtraction into the accumulator;

FIG. 3 is a right elevational sectional view showing the keyboard, actuating and accumulating mechanisms;

FIGS. 4 and 5 are right elevational sectional views showing the primary and secondary tens-transfer mechanisms of the present invention;

FIG. 6 is a left elevational sectional view of a portion of the left-hand side of the machine showing the mechanism for controlling the operation of the primary tens-transfer levers;

FIG. 7 is a front elevational section taken along the plane indicated by the line **7—7** of FIG. 3 showing the arrangement of the simultaneous tens-transfer mechanism;

FIG. 8 is a perspective view taken from the upper left rear, showing the tens-transfer mechanism of the machine; and

FIG. 9 is a fragmentary perspective view of the simultaneous tens-transfer mechanism, taken from the upper left rear, and showing a primary end-around-carry means.

Only those parts of the complete calculating machine which are immediately concerned with the simultaneously-operable, primary and secondary, tens-transfer mechanisms constituting the subject matter of the present invention are shown in the accompanying drawings. The invention is embodied in a machine of the general construction shown and described in United States Patent No. 3,108,745, issued October 29, 1963.

Referring to FIG. 3, the present calculator includes a ten-key keyboard **21** on which numbers are entered one digit at a time, highest order digit first. As each digit is entered, a pin **22** is set and a selector sector **23**, including a check dial **24**, is released. The pins **22** and check dials **24** are part of a traveling selector which moves one order toward the left as each digit is entered. With a number in the selector, an addition key **26** (FIG. 1) or a subtraction key **27** may be depressed for causing the machine to cycle, and to transfer the number from the selector to an accumulator. In FIG. 3, an actuator includes a series of actuator sectors **28**, one for each order. Print wheels **29**, geared to the actuator, print the number on a paper strip carried by a roller **31**.

During an addition or a subtraction cycle, the actuator is connected to the selector by means of a gear pendant **32**. A cam **33** (FIG. 1) drives a bellcrank **34** for driving a link **36** rearward. A shoulder on this link overlies an ear **37** (FIG. 3) of the frame member of the pendant **32**.

Also, during an addition or a subtraction cycle, the actuator is connected to drive gear **38** of an accumulator by means of a rear gear pendant **39**. These drive gears **38** are in constant mesh with register wheels, or gears, **41** of the accumulator. During an additive entry, the drive gear **38** occupy their normal, upper position for engagement with central gears **42** of the rear pendant **39**, and during a subtractive entry, they occupy an alternative, lower position for engagement with the lowermost gears **43** of the pendant **39**.

The rear pendant **39** and the drive gears **38** are controlled by mechanism shown in FIGS. 1 and 2. The pendant **39** is moved by box cams **44** (FIG. 2) fixed to a shaft **46** controlled by a bellcrank **47** (FIG. 1). This bellcrank **47** is normaly blocked in its home position by a hook lever **48** (FIG. 1) but during addition and subtraction operations, it is unblocked, and is moved by a bellcrank **49** controlled by cam **51** on the main drive shaft **52**.

The addition key **26**, when depressed, moves a link **53** (FIG. 1) forward a short distance for swinging the hook lever **48** (clockwise in FIG. 1) through an angle sufficient for freeing the bellcrank **47**. Similarly, the subtraction key **27**, when depressed, moves the link **53** forward approximately twice as far as for an additive operation, and swings the hook lever **48** (clockwise) through a correspondingly greater angle. This motion of hook lever **48** also acts through a pin **54** (FIG. 1), a lever **56**, shaft **57**, a lever **58** (FIG. 2), pin **59** and a blocking lever **61**. During an additive operation the blocking lever **61** has no effect. During a substractive operation, the blocking lever **61** (FIG. 2) is swung rearward (to the right in this figure) far enough to overlie an ear **62** of a dog **63** carried by a lever **64**. As the machine cycle begins, the dog **63** is raised by the lever **64**. As the ear **62** intercepts the blocking lever **61**, the dog **63** swings (counter-clockwise in FIG. 2) about its journal **66** and in so doing, drives against a roller **67** of the frame **40** of the drive gears **38**, swinging it (counter-clockwise in FIG. 2) and the drive gears **38** to their lower, subtractive, position.

The foregoing structure and operation are shown and described in more detail in U.S. Patent No. 3,108,745, previously referred to.

The accumulator in which the simultaneously-operated primary and secondary tens-transfer mechanisms of the present invention is employed is best shown in FIGS. 3, 7 and 8 and includes, in each numerical order, a twenty-tooth gear **41** rotatably and nonslidably mounted on a shaft **45**. The accumulator gear **41** represents twenty units. Thus, an entry, for example, of "2," causes the gear to rotate two tooth spaces. Integral with each gear **41** are two diametrically opposite, enlarged teeth **101** and **102** (FIGS. 4 and 8) which constitute tens-transfer cams. Rotation of the register gears during the digitation phase, through the "9½" position, causes one of these teeth **101** or **102** to cam a T-shaped interponent, or blocking member **103**, upward (FIG. 4). Each blocking member **103** is slidably mounted in a suitable aperture provided in a crossbar **104**. A spring ball detent **106** is provided in the crossbar **104** for holding the interponent **103** in either its lower, in active position (FIG. 4) or upper, active position (FIG. 5). Digitation can occur in all orders of the accumulator, and, therefore, there is an interponent **103** for each register gear **41**. In its upper position each interponent **103** is aligned with abutments **107** and **108** on pawls, or two-arm levers, **109** and **110** associated with the next higher order register gear (FIG. 8).

Pawls **109** function during additive operations. They are rockably mounted on an addition control rod **111** carried by bail arms **112** and **113** (FIG. 8) controlled by a cam **114**. During the tens-transfer phase of an addition operation, control rod **111** is moved forward (to the left in FIGS. 4 and 5) for actuating all pawls **109** simultaneously. In an order in which the interponent **103** has been raised, that interponent will stop the upper end of the pawls **109** (i.e., abutment **107**) so that the lower end is driven against the register wheel, as best shown in FIG. 5, of the next higher order (FIG. 8) for driving the wheel (counter-clockwise in FIG. 5) one tooth space for entering the primary tens-transfer unit therein.

Pawls **110** similarly function during subtractive entries. They are mounted on a subtractive control rod **117** (FIGS. 4 and 5) which is carried by bail arms **118** and **119** (FIG. 8) controlled by a cam **121**. Rod **117** carries the pawls **110** rearward (right in FIGS. 4 and 5) during the tens-transfer phase for entering tens-transfer units subtractively.

It will be apparent from the foregoing description that the primary tens-transfers in all orders are entered simultaneously.

It may happen that the entry of a primary tens-transfer will necessitate the entry of another, called a "secondary" tens-transfer, and the entry of that second transfer may necessitate the entry of still another, also called a "secondary" tens-transfer. A secondary tens-transfer will be required whenever an order stands at "9" for an additive entry (at "0" for subtractive entry) and a tens-transfer, either primary or secondary, is to be made into that order. For example, if the register stands at "299995" and a "5" is added, the digitation entry of the "5" will carry the lowest order to "0" and necessitate a primary tens-transfer into the second order, which will necessitate secondary tens-transfers into the third, fourth, fifth and sixth orders.

At each interval between adjacent register gears **41** (FIGS. 7 and 8) a broad-face secondary tens-transfer pinion **126** is rotatably mounted at **127** on a rockable arm **128** and aligned with both, one register gear **41** and the tens-transfer teeth **101**, **102** of the gear of the next lower order. Each of the rockable arms **128** is journalled on a shaft **129** and is urged upwardly by a spring **131**. During digitation, a control bail **132** depresses all of the arms **128** for holding the gears **126** clear of the register gears **41**. During the tens-transfer phase of each entry cycle, the bail **132** is held elevated so that the gears **126** rise into engagement with the register gears, as shown in FIGS. 4 and 5.

FIG. 8 shows a secondary tens-transfer gear **126** engaging the tens-transfer cam **102** of a register gear in the "0" position. It also engages the register gear of the next higher order. With the parts in this position, a tens-transfer, either primary or secondary, in the subtractive direction into the lower of these two register gears, will drive the cam **102** (counter-clockwise in FIG. 8), turning the secondary tens-transfer gear **126** which turns the second (higher) register gears. Each spring **131** maintains firm engagement between its secondary tens-transfer gear **126** and register gear **41**, and ensures that there is no lost mostion between the two gears. Uniformity of the register gears **41** then ensures little or no lost motion between each tens-transfer gear and the projecting tooth **101** or **102** of the next lower register gear. All of this provides a train of gears that are substantially free of lost motion from the register gear that originates the primary tens-transfer through all those that are required to receive secondary tens-transfers because of it (in the case of an additive entry, all immeditely successive register wheels standing at "9").

During rotation of the accumulator wheel in the additive direction (counter-clockwise in FIG. 4) for a secondary tens-transfer operation the interponent **103** may drive against the tip **107**, and if so, will simply rotate pawl **109** (clockwise in FIG. 4). Although rod **111** is moved forward, pawl **109** will be free to rotate because the next higher register wheel **41**, with which the lower tip of pawl **109** is aligned, will be rotating for effecting the secondary tens-transfer operation. Thus, in the previous example, the register wheels stand at "299990" after digitation, and as the tens-transfer phase begins, the pawl **109** responding to the first (lowest) order drives the register wheel of the second (next highest) order. The register wheel of the second order is standing at "9," as shown in FIG. 4. Therefore, its upper tens-transfer cam **102** passes under interponent **103** and drives it up against tip **107** of pawl **109** and thereby forces the lower end of pawl **109** toward the third order register wheel. But, at this time, the lower tens-transfer cam **101**, through pinion **126**, is driving the third order register wheel for entering the secondary tens-transfer therein. Therefore, the lower end of pawl **109** is free to idly follow the rotation of the wheel and not interfere with the rotation thereof by pinion **126**. The same operation is continued throughout the remaining orders, except the sixth order, which is not rotated through its tens-transfer position.

The rocked tens-transfer pawl, as seen in FIG. 5, also provides an effective anti-overthrow device for each register wheel of the accumulator. Rocking of the pawls is stopped when the edge of a pawl abuts the crossbar **104**. At that time the lower tip of the pawl remains in the interdental tooth space of the register gear **41**. Because the trailing tooth of the rotated register gear cannot rotate past the lower tip of a pawl, any further rotation of the gear is prevented by the pawl. Thus, any inertia in the gear that would cause the gear to overthrow is stopped by the tip of the pawl.

Engagement with, and disengagement from, the secondary tens-transfer gear **126** by the accumulator gear **41** is controlled by the control bail **132** (FIGS. 3 and 8). For this purpose the right arm **133** of the bail **132** (FIGS. 3 and 8) extends downward from the shaft **129** and carries at its lower end a pin **134**. The pin **134** extends into a slot **136** provided in the rear end of a link **137**, which link **137** is connected at its forward end to the shaft **138** of the rear pendant **39** just inside of the right frame of the machine. Extending to the left from the link **137** is a stud **139** (FIG. 8) to which is connected one end of a spring **141**, having its other end connected to the pin **134**, whereby the spring ensures that the bail **132** will follow movement of the link **137**. The spring **141** urges the pin **134** into contact with the rear edge of the slot **136**. When the gear pendant **39** is in its normal position, shown in FIG. 3, link **137** holds the bail **132**, **133** in its clockwise position so that the springs **131** hold the tens-transfer gears **126** in firm engagement with the register gears **41**. This is the position required during the tens-transfer phase of the machine cycle. When the gear pendant **39** is swung rearward into engagement with the accumulator drive gears **38**, link **137** moves rearward and swings bail **132**, **133** counterclockwise for lowering the tens-transfer gears **126** clear of the register gears. This position is required during the digitation phase of positive and negative entries. The parts are also in this position during readout and re-entry in total and subtotal operations, so that gears **126** do not add to the mechanical load in those operations. This action is desirable because during readout, accuracy depends on the proper action of the spring-loaded sickle bars **30** in the actuator drive. In order to limit counter-clockwise movement of the bail **132**, as viewed in FIG. 3, and thereby counter-clockwise movement of the arms **128** for the secondary tens-transfer gears **126**, there is provided a stop **142** extending leftward from the right-hand frame of the machine, against which stop the downward extending leg **133** of bail **132** abuts upon counter-clockwise movement of the bail. Because of the pin-and-slot connection **134** and **136**, the spring **141** permits the link **137** to continue rearward movement upon rearward movement of the pendant **39**, but the pin **142** limits rearward movement of the bail leg **133** and thereby overthrow of the secondary tens-transfer gears **126**. Conversely, return of the rear pendant **39** to its normal position (FIG. 3) draws the link **137** forward to raise the bail **132** whereby each spring **131** will stretch and cause firm engagement of each tens-transfer gear **126** and accumulator gear **41**. It can be seen that stretching of springs **131** individually takes up lost motion between the secondary gears **126** and the accumulator gears **41**.

Referring now to FIGS. 6 and 8, there is seen a pair of tens-transfer drive cams **114** and **121** fixed to the main drive shaft **52** on the outside of the left side frame. One arm of a positive control bellcrank **112** carries a roller **116** riding on the cam **114**. The other arm of the bellcrank **112** extends downwardly from a quill shaft **146**, which shaft is suitably journalled in the machine frame and carries at its lower end, one end of the positive control rod **111** on which, as already mentioned, the positive tens-transfer levers **109** are journalled. The quill shaft **146** is rotatably journalled in a left side control frame (not shown) and in the right side frame of the machine. Near the right end of the quill shaft **146** is fastened an arm **113** (FIGS. 3 and 8) in transverse alignment with the downwardly extending arm of bellcrank **112** and has fastened at its lower end the right-hand end of the positive control rod **111**. A spring **147** urges the bellcrank **112** counter-clockwise in FIG. 8. It can be seen that the above construction of the rod **111**, bellcrank **112**, arm **113** and quill shaft **146** forms a bail which is rockable by the positive tens-transfer drive cam **114**. At about the mid-point of an additive entry cycle, cam **114** permits spring **147** to lift arm **112** for driving the addition control rod **111** forward for effecting the tens-transfers, as previously described.

A second, or negative, control bellcrank **118**, is fastened to the left end of a sleeve shaft **148**, as seen in FIGS. 6, 7, and 8. At the end of the forward extending arm of the negative control bellcrank **118** is fixed a roller **122** which is urged to ride the negative tens-transfer drive cam **121** by the spring **147**. The other arm of this bellcrank **118** extends downward from the sleeve **148** and has fastened at its lower end the negative control rod **117** on which rod are rockably mounted the negative primary tens-transfer drive levers **110**. The sleeve **148**, as mentioned above, extends transversely of the accumulator and has mounted at its right end a downward extending arm **119** (FIGS. 3 and 8), similar to the downward extending arm of bellcrank **118**, to which arm **119** is fastened the right end of the negative control rod **117**. During the first half of a subtraction operation the high portion of the cam **121** holds the negative tens-transfer levers **110** forward, or disengaged from the interponents **103**. At about the mid-point of the subtraction cycle, the cam **121** lets the spring **147** rock bail arm **118** (clockwise in FIG. 8) for driving the negative drive rod **117** rearward for effecting negative tens-transfers, as previously described.

In order to prevent the additive tens-transfer levers **109** from driving into contact with the blocking members **103** during a subtraction cycle, and the subtraction tens-transfer levers **110** from driving into contact with the blocking members, there is provided a means for selectively blocking the operation of the bellcranks **112** and **118**. As seen in FIG. 6, a pair of blocking arms **150** and **151** are fixed to the add-subtract shaft **57** adjacent the left side of the left side frame of the machine. As was mentioned hereinbefore in connection with FIG. 1, the shaft **57** rotates about 7° (clockwise in FIG. 8) for an additive entry and about twice that angle for a subtractive entry. When shaft **57** is set for a subtraction, the arm **150** blocks an ear **152** on the bellcrank **112** for preventing that bellcrank from following the cam **114** and so prevents additive control rod **111** from operating. The bellcrank **112** is unblocked during an additive entry, when its operation is required, and also during nonentry operations, when it is permitted to operate idly. When shaft **57** is either at home, or set for an addition, arm **151** similarly blocks an ear **153** on bellcrank **118** for preventing operation of the subtraction control rod **117**. When shaft **57** is set for subtraction, lever **151** is clear of the ear **153**, so that the bellcrank **118** is free to operate.

The present machine is provided with a second, or rear, drive shaft **155**. (See shaft **110**, FIG. 2 in Patent No. 3,108,745, previously referred to.) Rotation of this rear drive shaft **155** is utilized in the present invention for restoring any actively positioned T-shaped interponent members **103** before digitation in a succeeding machine operation. For this purpose there is provided an interponent restore bail **156** journalled on shaft **46** (FIGS. 3, 7 and 8). Each arm of the bail extends forward from the shaft **46** and has secured therebetween a rod **157** overlying all of the blocking members **103**. The left arm of the restore bail **156** extends upward and rearward from the shaft **155** and carries at the end thereof a roller **158** riding a restore cam **159**. The restore bail **156** is biased by a spring **161** for maintaining the roller **158** in engagement with the restore cam **159**.

An end-around or "fugitive-one" transfer from the highest to the lowest orders of the accumulator is provided for enabling the present machine to read out true "credit balances." In FIG. 9 there is illustrated the primary "fugitive-one," carry mechanism. A pair of end-around-carry bails **162** and **163** are rockably mounted on the additive and subtractive control rods **111** and **117**, respectively. The two carry bails have at their high order end (right ends in FIG. 9) upstanding arms **164** and **165**, similar to the upper parts of the tens-transfer pawls **109** and **110**, previously mentioned, which arms are provided with abutments **166** and **167**, respectively, extending toward, and co-operating with, the horizontal bar of a T-shaped interponent **103** associated with the highest order accumulator gear **41**. The other end of each bail **162** and **163** (left ends in FIG. 9) is provided with downwardly extending offset legs **168** and **169**, similar to the lower part of pawls **109** and **110**, in alignment with the teeth of the lowest order accumulator gear. The operation of the pawls **164** and **165** of FIG. 9 is similar to the operation of the previously described pawls **109** and **110** of FIG. 9. For example, during additive operations, the movement of control rod **111** toward the accumulator gears causes the abutment **166** to contact the actively positioned interponent and rock the end-around-carry bail. Upon rocking of the bail, the tip of leg **168** is moved into engagement with a tooth of the lowest order accumulator gear and rotates the gear one tooth space.

In those machines in which digitation does not occur in the highest order of the accumulator, it is unnecessary to provide the machine with a primary end-around-carry mechanism, as described above. In this situation the highest order accumulator wheel acts as an overflow register gear and a true credit balance is obtained by means of a secondary end-around-carry device.

The secondary "fugitive-one," or end-around-carry, mechanism is shown in FIG. 8. Supported on a rockable arm (not shown), similar to arm **128**, is a transfer pinion **171** arranged to co-operate with the tens-transfer teeth **101**, **102** of the gear **41** in the highest order of the accumulator. This pinion **171** is similar to, but need be only about half as thick as the secondary tens-transfer pinion **126**, since it needs only to co-operate with the tens-transfer teeth **101**, **102** of the highest order accumulator gear **41**. In constant engagement with the pinion **171** is an idler gear **172** fixed to an end-around-carry shaft **173** extending transverse the accumulator. Shaft **173** is journalled at its ends in a pair of arms **174** fixed on shaft **129**. Pinned to the right end (left in FIG. 8) of shaft **173** is another idler gear **176**, also constantly meshing with a tens-transfer pinion **177** for completing the secondary end-around-carry mechanism. Pinion **177** is similarly journalled on a rockable arm similar to arm **128** (which arm is not shown in the drawing), and is engageable with the teeth of the lowest order accumulator gear. The pinion gear **177** is about half as thick as the adjacent gear **126**. It should be noted that rearward movement of link **137** will rotate shaft **129** (clockwise in FIG. 8) and disengage the two end-around-carry pinions **172** and **177** from their associated accumulator gears **41**.

If, during the tens-transfer phase of the machine operation the highest order accumulator gear is caused to rotate through its tens-transfer position because of either a primary or secondary tens-transfer into it from the next lower gear, the secondary tens-transfer therefrom will be carried to the lowest order accumulator gear.

Whether or not digitation takes place in the highest order accumulator gear, it is necessary to provide the present machine with a secondary end-around-carry mechanism.

Near the end of each machine cycle the high portion of the restore cam **159** drives the roller **158** forwardly to rock the restore bail **156** (counter-clockwise as viewed in FIG. 3). Consequently, the rod **157** moves down and forces any actively positioned T-shaped blocking member **103** back to its inactive position where the blocking member is retained by the detent **106**.

To illustrate the operation of the present simultaneously operable primary and secondary tens-transfer mechanisms, an example of addition will now be described. Assume the amount "56839" is to be added to the amount "43229" already in the accumulator. Diagrammatically, this addition will appear as follows:

4 3 2 2 9	Augend (already in the accumulator)
5 6 8 3 9	Addend
9#9#0*5 8*	Register after digitation
1 0 0 0 6 8	Register after simultaneous and secondary tens-transfer operation (SUM)

* Tens-transfer out of this order moves interponent 103 to active position.

Transfer into this order, standing at "9" causes rotation of secondary gear 126.

During the digitation operation the register gear **41** of each of the first and third orders rotates through its "9½" position and the cam tooth **102** thereof forces the associated interponent **103** upward to its active position where the detent **106** will retain it until near the end of the cycle, at which time the restore rod **157** is operated to return all interponents to their inactive position. Subsequent to digitation, the additive drive rod **111** moves forward while the subtractive rod **117** remains unmoved because the addition-subtraction shaft **57** was rocked its smaller distance by the slight forward movement of the link **53** and the subtractive blocking arm **151** prevented the subtractive control bellcrank **118** from following cam **121**. Forward movement of rod **111** causes the tens-transfer levers **109** associated with the first and third ordinal interponents **103** to contact these actively set interponents and rock, as shown in FIG. 5. Rocking of these two tens-transfer levers causes the adjacent higher register gears, with which the tips of the levers are meshed (i.e., the second and fourth orders), to advance one step for effecting a primary tens-transfer therein simultaneously. Moreover, because the register gear of the fourth and fifth orders, which stood at "9" after digitation, rotates through its "9½" position, its transfer cam tooth **101** engages a tooth of the coordinal secondary tens-transfer gear **126** (see FIG. 4) and causes the register gear of the fifth and sixth orders, with which the secondary tens-transfer gear also meshes, to advance one step, thus performing the secondary tens-transfer operation into the fifth and sixth orders simultaneously with the primary tens-transfer into the second and fourth order register wheels.

From the foregoing description it will be evident to those skilled in the art that the novel tens-transfer mechanism of my invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are, therefore, intended to be embraced therein.

What is claimed is:

1. In a calculating machine comprising in combination:

ordinally arranged accomulator wheels;

means for entering values into said accumulator wheels;

an interponent for each of certain ones of said accumulator wheels, each interponent movable to an active position by the rotation of an accumulator wheel through its tens-transfer position;

an addition set of primary tens-transfer actuators, a subtraction set of primary tens-transfer actuators, at least one of said interponents in its active position enabling two of said primary tens-transfer actuators, one from each set;

control mechanism automatically operated by an additive condition of said value-entering means for effecting an operation of said addition primary tens-transfer actuators and by a subtractive condition of said value-entering means for effecting an operation of said subtraction primary tens-transfer actuators; and

a plurality of secondary tens-transfer actuators for said accumulator wheels, each said secondary actuator driven by the adjacent lower order accumulator wheel as that lower order wheel is rotated through its tens-transfer position in either direction by said primary tens-transfer actuator for entering the secondary tens-transfer simultaneously with the primary tens-transfer operation.

2. The combination of claim 1 wherein the interponent comprises a T-shaped member, the bar of the T providing centrifugally positioned abutments for the addition and subtraction primary tens-transfer actuators.

3. The combination of claim 2 including a primary end-around-carry device conditioned by the said T-shaped interponent associated with the highest order accumulator wheel for introducing a primary tens-transfer into the lowest order accumulator wheel.

4. In a calculating machine comprising in combination:

ordinally arranged accumulator wheels;

means for entering values into said accumulator wheels;

a plurality of interponents for said accumulator wheels, each interponent movable to an active position by the rotation of an accumulator wheel through its tens-transfer position; and

a plurality of simultaneously operable primary tens-transfer actuators for said accumulator wheels, each said primary actuator being conditioned by an actively positioned interponent to effect a primary tens-transfer into the adjacent higher order accumulator wheel;

the improvement comprising in combination a plurality of secondary tens-transfer actuators each having gear teeth engageable with one of said accumulator wheels, and each driven by the adjacent lower order order accumulator wheel through its tens-transfer position as a result of a primary tens-transfer operation therein, for entering the secondary tens-transfer simultaneously with the primary tens-transfer operation; and

means including resilient members urging said gear teeth of said secondary actuators radially into firm, lost-motion-free engagement with the gear teeth of said accumulator wheels, whereby to prevent lost motion between each said secondary tens-transfer actuators and its accumulator wheel.

5. In a calculating means having:

ordinally arranged accumulator gears;

means for entering values into said accumulator gears;

a plurality of simultaneously operable primary tens-transfer actuators for said accumulator gears; and

a plurality of secondary tens-transfer gears, each driven by the rotation of the adjacent lower order accumulator gear as that lower order gear is rotated through its tens-transfer position as a result of a primary tens-transfer therein to enter a secondary tens-transfer simultaneously with the primary tens-transfer operation;

the improvement comprising in combination separate rockable mounting means for each of said secondary tens-transfer gears, each of said rockable mounting means being biased to urge its gear radially into firm lost-motion-free engagement with the corresponding accumulator gear; and

control means operable in timed relationship to said value-entering means for engaging and disengaging said secondary tens-transfer gears with said accumulator gears, said control means being movable to a first position to block said rockable mounting means in inactive position with said secondary tens-transfer gears disengaged from said accumulator gears during digitation operations, and movable to a second position in which it leaves said rockable mounting means free for movement by their bias for moving said secondary tens-transfer gears into firm engagement with said accumulator gears during tens-transfer operations.

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