CLASS 5 CALCULATOR MACHINES

Instruction Book

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BURROUGHS ADDING MACHINE COMPANY

DETROIT, MICHIGAN

APPLICATION

KEYBOARD

ACCUMULATION

POWER

INDEX OF MECHANISMS

KEYBOARD

ACCUMULATION

POWER

(*Continued*)

Decimals are multiplied in the same manner as whole numbers. By means of the pointers on the case in front of the dials wheels, the decimal places in both factors are pointed off from the right.

Division is accomplished by repeated subtraction. The answer is a record of the number of subtract operations made.

Cipher Method of Division

The dividend, or amount to be divided, is entered in the machine beginning at the left of the keyboard in the column second to the last.

The divisor is set up on the small figures on the keys with one less in the unit value. In addition to the divisor keys, hold a small cipher in the column to the left.

Problem: 5778 ÷ 18

Beginning at the left of the amount to be divided, determine the number of digits required to contain the divisor. In this instance, two digits are required (57).

Hold the small figures, 017 which is one less than 018, over the 57, depress the keys, until the remainder becomes less than the divisor. In this problem, three subtractions are required. The remainder (3) is smaller than the divisor (18). The number of subtractions (3) is shown on the dial wheel at the left.

Bring down the next figure (7) to the right by moving the divisor one place to the right, repeat the subtract operations until the remainder again becomes less than the divisor. The remainder (1) is smaller than the divisor (18). The number of subtractions (2) is shown on the dial to the right of the one showing the previous number of subtractions, or (32).

Bring down the next figure (8) to the right by again moving the divisor to the right, repeat the subtract operations until the remainder again becomes less than the divisor. In this operation the remainder is reduced to zero after one subtraction.

The dials to the left show the answer is 321.

Example:

Hand Method	Machine Method
321	321
18)5778	18)5778
54	18
37	39
36	18
18	21
18	18
	37
	18
	19
	18
	18
	18

Pointing Off

To point off, place a decimal pointer in the same place as the point occurs in the dividend. Because of the small cipher that is held to the left of the divisor keys, move the decimal pointer one place to the left, then point off as follows:

When the divisor contains whole numbers with or without decimals, move the pointer one place to the left for each whole number in the divisor. In the problem, 5778 divided by 18, the pointer will be moved two more places to the left, three in all.

When the divisor does not contain whole numbers, move the pointer one place to the right for each cipher between the decimal point and the first figure of value.

When the divisor contains neither whole numbers nor preceding ciphers, the pointer is not moved.

(Plate 2) Continued

only one key in a column. The combined clearance between the key interlocks in any column allows only one keystem to pass between them.

Compression springs AO hold the keys in the upper position and limit the keystems against the top slot in the partition plate. This insures that the keystems will clear the key interlocks and the compound lever.

Adjustments

The degree of freedom of the keystems and the adding sector affects the key action. To check the keystem for being free, hold the sector forward and depress each key. The keystem will usually become free by twisting it, or slightly weaving it forward or backward.

The sector should lie parallel with the partition plate with minimum side play.

Adjustment: Swing bell-crank AK sideways.

To test the sector for being free, tilt the machine on its front end. The sector should drop of its own weight with spring AJ unhooked. Do not attempt to change the tension of sector spring AJ, as it has been carefully tested for the required tension at the Factory. If the spring tension is doubtful, replace the spring.

When a key is held depressed, index bar AM should limit firmly against the keystem, and compound lever AN should have slight up and down play. If either of the two conditions mentioned vary, it indicates curved link AP is bent. Do not attempt to bend the curved link, replace the sector instead. This test is applied to insure full movement of the sector.

Removal of Keystems and Keyboard Plate

Remove all key buttons.

Remove the screws holding the keyboard plate to the side frames. Partially lift the keyboard plate, moving it to the right (care must be exercised not to move the keystems out of their slots in the partition plates), then lift the keyboard plate clear of the machine. The individual keystems may be readily removed.

When replacing the keyboard plate, see that all keystems are in alignment and to the right, then place the keyboard in position starting with No. 9 keystems, taking care not to work the keyboard over too far to the left, thus avoiding any chance of the keystems getting out of place. It may be necessary to reach under the keyboard plate with a spring hook to guide the keystems into position.

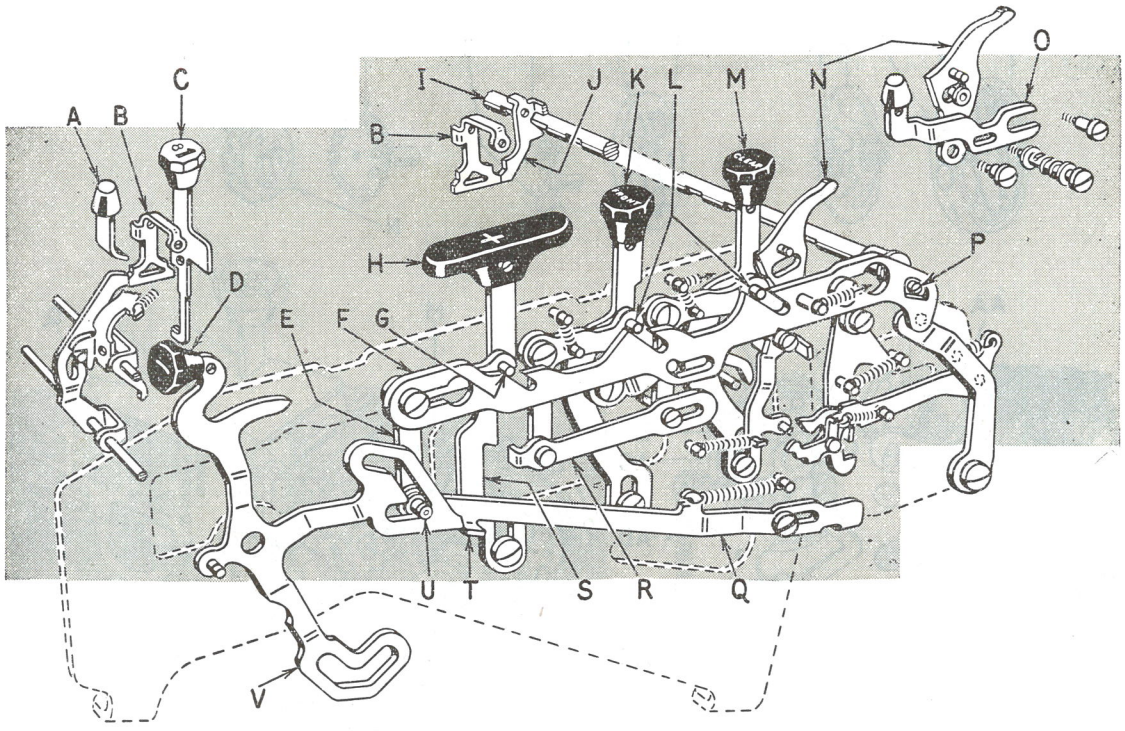
The keyboard plate is then secured to the side frames.

Removal of Key Interlocks

To remove key interlocks A1, first remove the adding sector. Use a follow up shaft; key interlocks can be removed through the bottom of the machine. The rear key interlocks, however, can be removed from the rear of the machine. To facilitate their removal depress a No. 9 key and turn the key interlock to the left.

When replacing key interlocks, see that they are all in line with one another at the point where keystems contact.

KEYBOARD INTERLOCKS (Plate 5)



Keyboard Interlocks (Plate 5)

The keyboard interlocks are arranged to permit the operation of the clearing keys K or M, transfer bar H, subtract key D, or the adding keys C.

The subtract key operates the transfer bar, but the transfer bar depression is independent of the subtract key. The clearing key operates the front clear key, but the front clearing key depression is independent of the clear key.

Except for the two conditions mentioned, when one of the above keys are depressed, the other keys are blocked.

Result Key Function

Depressing clear key M clears the front and rear registers. Clearing key K marked "Front" clears the front register. Transfer bar H marked with a plus sign (+), clears the front register and transfers the amount to the rear register.

Subtract key D marked with a minus sign (—), clears the front register and subtracts the amount from the rear register.

Clearing Key Latch

Latch N blocks the clear key operation unless the latch is held down during the clear key depression. This is done to prevent the accidental clearing of both registers.

Latch N is disabled by moving the key button on slide O, rearward.

Transfer Bar Interlock

Depressing the transfer bar swings slide F forward through stud G, blocking the depression of clear keys K and M through studs L. The transfer bar also rocks bell-crank E to block the subtract key through roller U moving forward in the horizontal slot of keystem V.

The adding keys C and the subtract control keys A are blocked by slide F rocking shaft I through screw P, which moves arm J against keylocks B.

Clear Key and Subtract Key Interlock

The depression of either clear key or subtract key accomplishes the same interlocking effect as the transfer bar, since studs L and G are interconnected to slide F.

Transfer Bar and Clear Key Interlock

Simultaneous depression of the transfer bar or either clear key is blocked by slide R. When the clear key is depressed, slide R moves under a step in transfer bar keystem S. When the transfer bar key is depressed, slide R is blocked by the transfer bar keystem.

Subtract Key Interlock

The subtract key is blocked against depression when the clear keys move a formed ear T on slide Q under bell-crank V.

(Plate 6) Continued

gear C, the dial wheel is moved to add the amount.

Planetary Gearing

The planetary gearing consists of three gears, universe gear D, sun gear F, and a planet gear E. The universe gear is meshed with the ratchet gear from which it obtains its power. The sun gear on the carry wheel G is at the center of the universe gear and it rotates only when the carry gear is turned. The planet gear is carried by the universe gear and it is meshed with the sun gear and the internal gear on the dial wheel. The planet gear is the only means of transmitting the motion to the dial wheel.

In addition, the planet gear is carried around the stationary sun gear by the universe gear. In the carry operation, the sun gear itself rotates, which causes the planet gear to revolve on its own axis to register the carry on the dial wheel. This gear connection permits the simultaneous adding and carrying operation.

Control Gear

The control gear prevents an overthrow of the ratchet gear and dial wheel when the sector is suddenly stopped on the return stroke. This overthrow is due to the connection between the ratchet and pawl gears being a ratchet drive pawl. Pawl gear P, and the drive pawl carried by it are directly controlled by the sector movement because the pawl gear is meshed with the adding segment attached to the sector. When the sector stops, the pawl gear must stop, but the ratchet gear which is driven by the ratchet drive pawl may have sufficient momentum to continue rotating further than it was actually moved by the drive pawl. If the ratchet gear overthrows, it results in an overthrow of the dial wheel causing overaddition.

The control gear is in constant mesh with the ratchet gear, but in mesh with the pawl gear assembly only on the return stroke of the sector. This gear meshing arrangement is possibly due to the wide spaced teeth on the right side of the control gear. This enables the pawl gear assembly to rotate when the key is depressed without turning the control gear.

On the return stroke, the pawl gear drives the ratchet gear which in turn rotates the control gear, meshing it with the pawl gear assembly. Therefore, if the pawl gear stops, the control gear must stop and since the ratchet gear is in constant mesh with the control gear, it must also stop which eliminates the overthrow of the gears.

Carry Operation

The carry operation is performed through a train of gears, timer cam, and carry arm which impart the motion to the dial wheel through the planet gear. This train of gears are interconnected from one bank to another and are in ratio of ten to one. For example, when one dial wheel makes a complete revolution, the dial wheel in the next higher bank will make one-tenth of a revolution. A carry of this type is positive because it is geared.

As the dial wheel is rotated in the addition of an amount up to nine, carry arm roller AC is moving toward the peak of the timer cam on the dial wheel. When the dial wheel has made a complete revolution, roller AC drops off the high point of the timer cam. This movement rocks oscillating arm I and swings carry arm AE rearward through the tension of spring AD. Since the small pinion on the oscillating arm is meshed with the internal teeth of the carry wheel G, the forward motion of the oscillating arm moves the carry wheel. The carry wheel transmits the carry to the dial wheel through the sun and planet gears.

The carry arm segment gear AE is meshed with oscillating segment gear and through spring AD, the carry is completed in one quick operation as the roller in the carry arm drops off the dial wheel timer cam. This is done to provide reading alignment of the dial wheel figures at all times.

If the carry arm spring AD were disconnected, the carrying operation would still be correct, but it would result in gear crawl, destroying the dial wheel figure alignment.

Adjustments

Adding segment R should align centrally in the pawl gear assembly K.

Adjustment: Bend the adding segment sideways to align.

This insures side clearance with the disc of the pawl gear assembly and permits free action of the adding sector.

Pawl gear K should have about 1/64″ play in the teeth of adding sector R.

Adjustment: Carefully bend the front end of the adding segment R up or down as required.

This adjustment may affect the dial wheel aligning as it slightly changes the position of the ratchet gear.

Locate the forward edge of drive pawl N in alignment with an imaginary vertical line through the center of pawl gear hub.

Adjustment: This is secured by meshing the pawl gear in the adding segment with the

ACCUMULATION, REAR REGISTER (Plate 7)

Accumulation, Rear Register (Plate 7)

The rear register can be removed as follows:

Disconnect all of the transfer slides D (Plate 9) from sectors F.

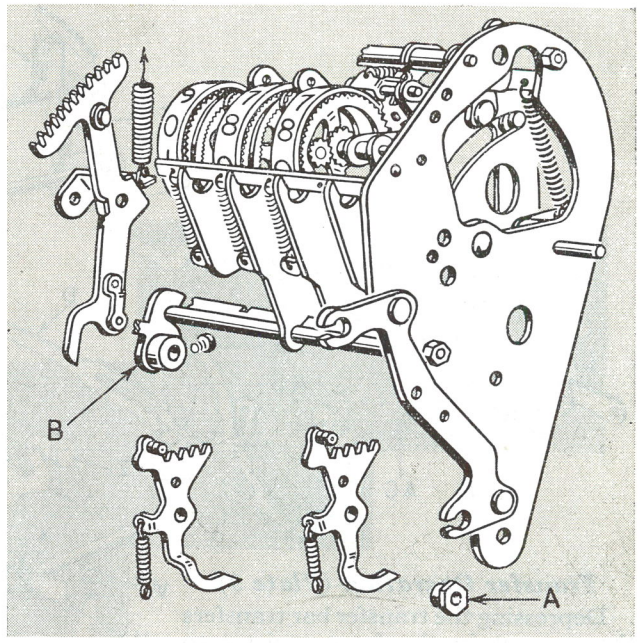
Remove arm R (Plate 9).

Remove clutch trip arm M (Plate 15).

Remove cancel arm S (Plate 16).

Remove shoulder nuts A which secure the rear register to the machine proper after which the section can be lifted off.

Brace B is used to prevent the rear register from sagging.



SUBTRACTION CONTROL KEY MECHANISM (Plate 8)

Depressing a subtraction control key adds a nine in that column as well as columns to the left. These keys are used to cancel the one produced in subtraction to the left of the problem, thus eliminating the need of depressing several number nine keys.

Function

When the subtraction control key is depressed, a projection on the keystem contacts stud K which rocks bail F. The rocking motion of bail F causes roller I to move slide G rearward, to start the motor and trip the drive pawl into the revolving gears to actuate the adding sector.

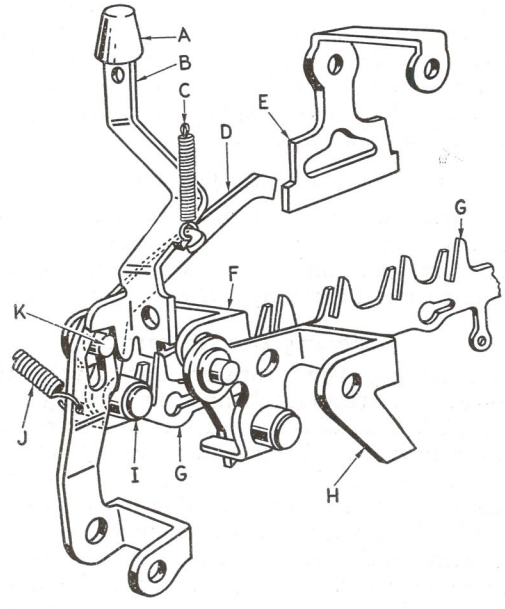
Bail F has a formed ear which overlaps the foot of the bail in the columns to the left. The overlapping of the bails is the means of imparting the movement from one bail to another toward the left.

Keyboard Blocking Bail

Keylock bail D has an L shaped slot fitting over stud K in bail F. The rocking motion of bail F swings the arm of bail D against keylock E to block the adding key depression in that column.

Adjustments

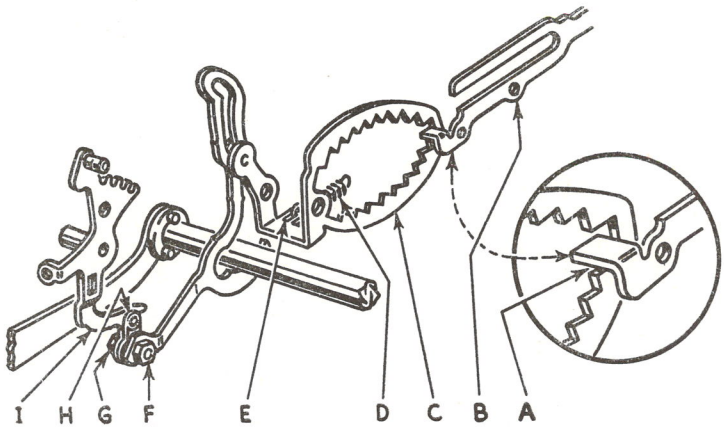
There should be minimum clearance between the formed ear on bail H and the foot of bail F. This is done to obtain equal movement for tripping the drive pawls in the drive wheels in all columns to the left of the depressed key.



Adjustment: Swing the formed ear of H. The keys should be free. Test by holding the right-hand key depressed and try the key in each column to the left.

Adjustment: Bend or twist the keystem. Bails H, F, D, and slide G should be tested for being free in each column. Hold the left-hand key depressed, and depress the key in the next column to the right. Repeat this operation across the keyboard.

TRANSFER INDEX RACKS—IMPROVED—DUPLEX SUBTRACTOR (Plate 9-1)



Transfer Index Racks—Improved—Duplex Subtractor (Plate 9-1)

Purpose

—To further assure proper limiting of the transfer links by the index racks when transferring amounts from the front register to the rear register.

Construction

Improved transfer index rack C may be identified by the elongated spring hole E.

Carry rack I includes auxiliary link H which makes the movement provided by eccentric screw G effective only from front to rear. This eliminates the tendency to increase or decrease the effective length of the lower arm of carry rack I by turning eccentric screw G.

Installation

The use of index rack C requires carry rack I having auxiliary link H.

Adjustment

With the machine clear, add 9 in the front register and disconnect the power. Depress the transfer bar and manually operate the machine to locate index rack C and transfer link B in transfer 9 position. There should be .030″ to .040″ clearance at point A between the lip of transfer link B and the step of index rack C.

To adjust, turn eccentric G.

Note: All other positions should be automatically equalized from this adjustment—if not, the index rack is off test and should be replaced.

Check other positions as follows:

a. Operate the machine to transfer 1 position. As the lip of transfer link B passes the transfer cipher step and moves to limit on the transfer 1 step, there should be .010″ to .015″ clearance between the flat surface of the lip and the horizontal surface of the transfer cipher step.

b. Operate the machine to locate index rack C in subtract 9 position. The lip of transfer link B should have flush hold on the subtract 9 step of index rack C.

Note: On the rightmost index rack, which has an extra step for the automatic one, the lip should have flush hold plus .010″ on the subtract 9 step.

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(Plate 9) Continued

Function

As amounts are added in the front register, timer cam A locates the step on the index rack C to a corresponding position through carry arm B and link AD. Depressing the subtract key rocks index bail AC, and through the index rack link, shifts the index rack step in alignment with the formed lip on transfer link D. Index bail AC is controlled by the lower slot in the subtract key lever.

The rearward slot in the subtract key lever rocks bell-crank M to lower the transfer bar, start the motor, and trip the clutch.

Check pawl V prevents striking the subtract key a sharp, hard blow, due to the pawl being controlled by light tension spring X. The time gained in slowing up the subtract key depression permits the previous machine operation to be completed prior to the subtract operation.

During the forward stroke of the machine operation as the transfer cam Q revolves, the transfer links limit against the complement steps of the index rack, and the adding sectors index the drive pawls in a corresponding tooth of the ratchet gears. During the return stroke, the transfer cam through the transfer bail restores the sectors to add the amount in the rear register. After the transfer links are restored, the amount in the front register is cleared. The operation described is the same as a transfer operation except that the transfer links limit on the complement steps of the index rack instead of the transfer steps.

Adjustments

Adding sectors F should have a non-binding contact on restoring bail E in the normal position. The object of this adjustment is to obtain equal movement for all adding sectors and retain as much as possible, the movement of eccentric S for adjustment.

Adjustment: Turn eccentric S to move the restoring bail up to the tight adding sectors, and then adjust the foot of the loose adding sectors parallel to those that are tight.

Always place the wide side of eccentric S upward to insure maximum clearance of transfer bail on the foot of the first sector which travels a greater distance due to automatic one.

To permit the index rack C to reset on the formed ear of transfer link D, slight clearance is necessary at the cipher position. This adjustment must be considered when adjusting eccentric S.

Transfer links D are factory tested for the correct length, and bending the links to change the length is not recommended. To determine the correct transfer link length, add fives in half the columns and nines in the other half of a clear front register. Manually turn the machine forward until the adding sectors with a nine limit in the slot of the upper register partition plate. The nine position is fixed by the partition plate slot and it permits pawl gear K to be turned until the control gear tooth space is about 1/16″ forward of the edge of the partition plate.

In the columns in which a five has been added, the pawl gear movement is limited by the steps of index racks C, and the tooth space of the pawl gears should be parallel with those columns having a nine. If any of the columns having a five are different, it indicates the transfer link is off test and it should be replaced. Repeat the test on each side of the keyboard by reversing the figures.

The dimension 1/16″ used in locating the pawl gear tooth space with the partition plate is only approximate. The important point is that all pawl gear teeth be parallel. We used the figure five as the amount to add on one side of the keyboard, this could be any figure except nine, in order to have the index rack limit the transfer bar.

The steps on index rack C should have about a flush hold with the formed ear on transfer link D. Make the test with one and nine on the dial wheel for the transfer steps and with cipher and nine on the subtract complement steps. This adjustment covers both the transfer and subtract steps, and it is a matter of equalizing the hold. The adjustment is quite limited and must be carefully checked to insure correct indexing of the transfer links on the transfer and subtract operations.

Adjustment: Swing the index rack up or down in the U form at the pivotal shaft.

The formed lip on link O should have about 1/64″ clearance with the lower end of rocker arm R. This clearance is necessary to permit the link to reset if the transfer bar or subtract key is held depressed during the machine operation. The lip on link O prevents the transfer bail operation on the clear key operation.

Adjustment: Bend the formed lip on link O.

Check pawl V should have just passing clearance with the formed lip on arm W on a slow depression of the subtract key. This adjustment plus the light tension of spring X, prevents the subtract operation from taking place if the key is struck a sharp blow.

Adjustment: Swing the ear on arm W toward or away from the check pawl.

Automatic One, Unit Column (Plate 11)

The automatic one required on subtraction to produce a carry in the unit column is obtained from the index rack J. The complement steps on the index rack are arranged to include the automatic one and permit the adding sector and transfer link to travel one space further in the unit column. Because of adding the extra one, this index rack is different than those in the other columns. The slot in the partition plate in the rear register is lengthened to permit the extra travel of adding sector K.

Decimal Non-transfer Mechanism

Depressing decimal non-transfer key M prevents transferring amounts in the first three columns of the front register to the rear register. These amounts usually represent fractional parts of one, used in computation in the front register.

Function

When the key is depressed, arm P contacts the stud in bell-crank Q, rocking shaft V to lower arms L in the path of the studs in transfer links O. If the decimal non-transfer key is depressed while the transfer links are rearward, the spring connection on arm P will yield as the transfer links restore to normal.

Automatic One, Fourth Column

The automatic one mechanism in the fourth column is active only when the decimal non-transfer key is latched down. Transfer link I in the fourth column carries slide F to permit the extra travel of the transfer link and adding sector for adding the automatic one. ***Note:*** The increased travel of the transfer link in the first and fourth columns is obtained from two sources. In column one it is secured from the step arrangement of the index rack, and in column four, the forward ear of the transfer link is part of slide F which has slots to increase the length of the transfer link.

When slide F is latched by pawl C, the transfer link is the regular length which permits using a standard index rack in the fourth column.

Function

When the subtract key is depressed with the decimal non-transfer bar latched down, shaft V is moved slightly beyond its latched position by bell-crank S. This extra movement of shaft V causes stud W, in arm H, to lower pawl C off the stud in slide F. As the transfer link moves rearward, slide F moves forward to extend the length of the transfer link one space to add the automatic one.

As the transfer link moves forward to restore to normal, the vertical projection on slide F contacts stud E in the partition plate, to latch the slide by pawl C. The fourth column partition plate slot is longer to permit the extra travel of the adding sector as in column one.

Adjustments

Slide F on the automatic one transfer link in the fourth column, should reset on latch C with minimum clearance. The slots in slide F are just long enough to permit minimum reset clearance to insure that the transfer link is the regular length when the slide is latched.

Adjustment: Bend the projection on slide F.

If slide F fails to reset, check the transfer link for being moved completely forward by the transfer bail, prior to bending the projection on the slide. Overadjusting the projection on slide F would cause it to limit the transfer link's forward movement instead of the transfer bail.

When key M is latched down, arms L should have about a flush hold on studs T in transfer links O. Usually no adjustment is necessary, but the movement of shaft V can be increased by bending pawl P.

Clearing Mechanism, Hand Calculator (Plate 13)

This mechanism clears the amount on the dial wheels when the handle is pulled forward. The dial wheels are turned back to cipher to clear, instead of adding amounts to them to produce a carry as in a canceling operation.

Before the dial wheels can be turned backward, the control gear must be moved sideways, out of mesh with the pawl gear. Carry wheel hook P engages the lug on the carry wheel, drive pawl Y is disengaged from the ratchet gear tooth and check pawl V is raised clear of the ratchet gear. This preliminary work must be done at the beginning of the forward movement of the clearing handle.

Clearing Handle Operation

The adding and carrying mechanisms are protected against a sudden or harsh clearing handle operation by check pawl D and spring connection G between links E and F. If the clearing handle is struck a sharp blow, spring B does not have sufficient time to raise check pawl D clear of the formed lip on arm C. If the dial wheel or one of the connecting gears fails to turn backward, they cannot be forced, as spring G will yield if the clearing handle is brought forward.

When the clearing handle is pulled forward slowly, the dial wheels turn backward under tension of spring N on the carry arm. To insure positive action and retain the dial wheel in the cipher position, roller K contacts the foot of carry arm J.

Function, Forward Stroke

The forward movement of the clearing handle rocks arm C carrying link E with it which permits spring B to raise check pawl D clear of the formed lip on arm C. The link on check pawl D rocks shaft A which moves interlock AC forward, against key locks AB, to block the depression of the adding keys.

Link E moves link F forward through spring G rocking shaft assembly H, which in turn rocks shaft assembly T through the slot in arm Q. The rocking motion of shaft assembly T causes finger Z to disengage drive pawl Y from the ratchet gear tooth S and raise check pawl V clear of the ratchet gear. Shaft assembly T also cams the control gear shaft to the left to disengage the control gear from the pawl gear.

The downward movement of shaft O in the slot of arm P swings the upper hook over the lug on the carry wheel M, rotating it and oscillating arm R slightly rearward. This motion of the gears moves the roll in the carry arm J off the timer cam L to permit free revolving of the dial wheel and forward movement of the oscillating arm by the carry rack spring N. The continued downward motion of shaft O carries roller K against the foot of the carry arm, insuring that the dial wheel remains at cipher.

Return Stroke

Spring AA restores link E, rocking shaft assembly H rearward, which permits the parts shifted to the clearing position to restore to normal.

Adjustments

Check pawl D should have about 1/32″ clearance with the formed lip on arm C. Too little clearance at the above point would cause the formed lip on arm C to strike the step on the check pawl during a normal clearing handle operation. Excessive clearance would result in loss of the check pawl protection on a hard, sharp clearing handle operation. It may also permit an adding key depression with the clearing handle forward.

Adjustment: Bend arm D as required. This arm is quite difficult to bend, therefore, securely hold it in the bending operation.

Shaft T should have minimum end play between the side frames.

Adjustment: Bend the side frames.

Fingers Z on shaft T should be adjusted centrally between the pawl and ratchet gears, to insure the fingers will contact only on the drive pawls.

Adjustment: Bend the fingers sideways.

With the clearing handle normal, control gear U should be in full mesh with the pawl gear I, and have slight play with partition plate. The slight play in the control gear insures a free revolving gear, and full mesh between ratchet and pawl gears.

Adjustment: Bend the arms on shaft T to limit shaft W.

With the clearing handle forward, the control gear should move to the left to disengage it from pawl gear I. This is done to permit the control gear to revolve with the ratchet gear.

Adjustment: Bend the camming ends of the arms on shaft T.

With clearing handle forward, check pawl V should clear ratchet gear and there should be slight clearance between Z and the formed lip on the check pawl. The check pawl is raised to permit the ratchet gear to revolve freely with the dial wheel. If a bind is created between Z and V, the clearing handle would remain forward.

Adjustment: Bend the formed lip on the check pawl.

(Plate 14) Continued

to latch it in the upper position. When the clearing handle restores to normal, stud E releases detent D and the full stroke lever limits on the hub of assembly G.

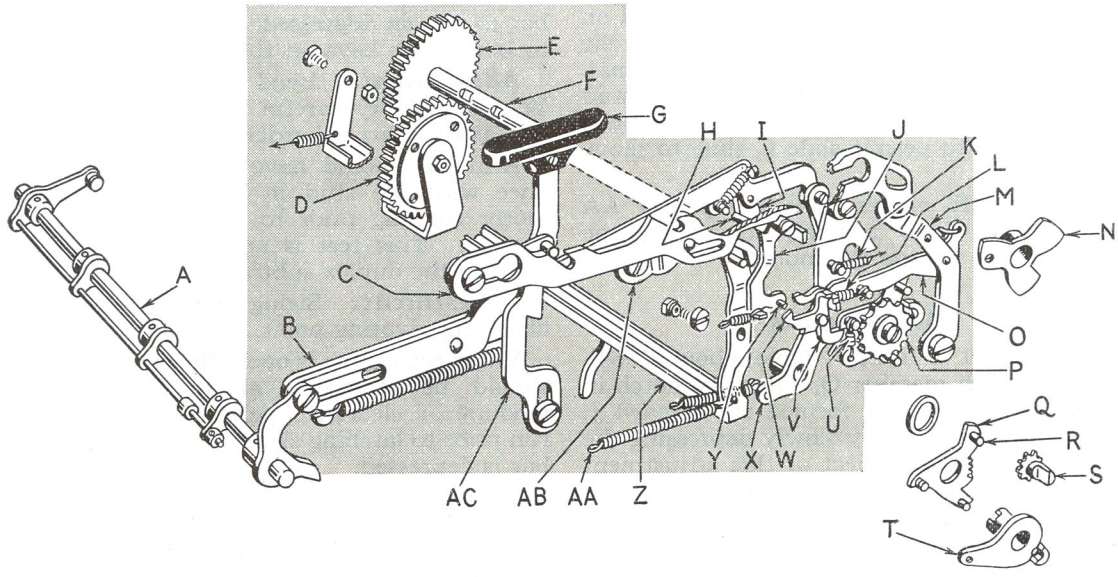
Adjustments

When full stroke lever A latches in the rearward step, the keyboard should be blocked. This prevents adding an amount while the dial wheel is being cleared. Check the adjustment of 1/32″ clearance between the check pawl D and formed ear on arm C, Plate 13.

With the clearing handle forward, full stroke lever A should have about 1/32″ reset clearance on detent D. This is to insure that the full stroke lever is inactive on the return stroke and until the next forward operation of the clearing handle.

Adjustment: Bend the vertical projection of full stroke lever.

CLEARING MECHANISM AND DRIVE CLUTCH, ELECTRIC CALCULATOR (Plate 15)



Clearing Mechanism and Drive Clutch, Electric Calculator (Plate 15)

This mechanism clears the amount on the dial wheels when clearing bar G is depressed. The clearing operation relative to the dial wheels is the same as on the hand calculator, but the power to accomplish the result is furnished by the motor instead of being manual.

When the clearing bar is partially depressed, the motor starts revolving drive clutch gear P, fastened to shaft F. Further depression of the clearing bar trips clutch drive pin S into the clutch gear connecting the clearing cam N with the revolving shaft F. As the clearing cam revolves, it drives link B forward through bell-crank X which rocks shaft assembly A to clear the dial wheels.

Clearing Cam

The three point clearing cam N permits three complete clearing operations to take place on one revolution of the clearing cam. The cam construction as explained, permits a rapid clearing operation, and it is used only on the electric calculator. The clearing cam has an oblong hole to couple it with the clutch member having a similar shaped hub.

Clutch Trip Mechanism

When the clearing bar is depressed, slide C carries link M and O forward, a projection on link O engages formed lip on clutch limit pawl V, swinging it forward to clear the end of clutch member Q. Spring U draws the clutch member down and its segment end rotates the pinion of drive pin S to engage clutch gear P.

Clutch member Q revolving with clutch gear P, causes stud R to raise link O, releasing clutch limit pawl V and permit it to restore under tension of spring K. As the clutch member Q engages limit pawl V, the drive pin is turned clear of the teeth in clutch gear P.

CLEARING MECHANISM AND DRIVE CLUTCH, DUPLEX SUBTRACTOR (Plate 16)

Clearing Mechanism and Drive Clutch, Duplex Subtractor (Plate 16)

This mechanism consists of two clearing keys to clear amounts in the front and rear registers. Depressing the front key clears the front register, and the clear key clears both registers.

Front Clear Key

Depressing the front clear key trips the clutch and starts the motor. Its operation is about the same as that of the clearing bar on the electric calculator, explained in detail in Plate 15.

Clearing Cam

This cam is a single point cam permitting one clearing operation for each revolution to allow sufficient time for the transfer operation. It is fastened to the same hub supporting transfer cam T. This type of cam is used on the duplex subtractor.

Clear Key

Depressing the clear key couples the rear register mechanism with the front register clearing mechanism. Shaft assembly P performs the same function in the rear register as shaft A in the front register, as the clearing operation in both registers is alike.

Coupling Function

When clear key I is depressed, it also depresses the front clear key through bell-crank E, link Y, and bell-crank C, which starts the motor and trips the clutch. Stud X in bell-crank E rocks arm D, lowering the hook of lever L over screw M. When the clearing transfer cam T revolves, it drives link B and lever L forward through lever U, rocking shafts A and P to clear both registers. The forward extension of coupling lever L moves under stud J to prevent it disengaging from stud M.

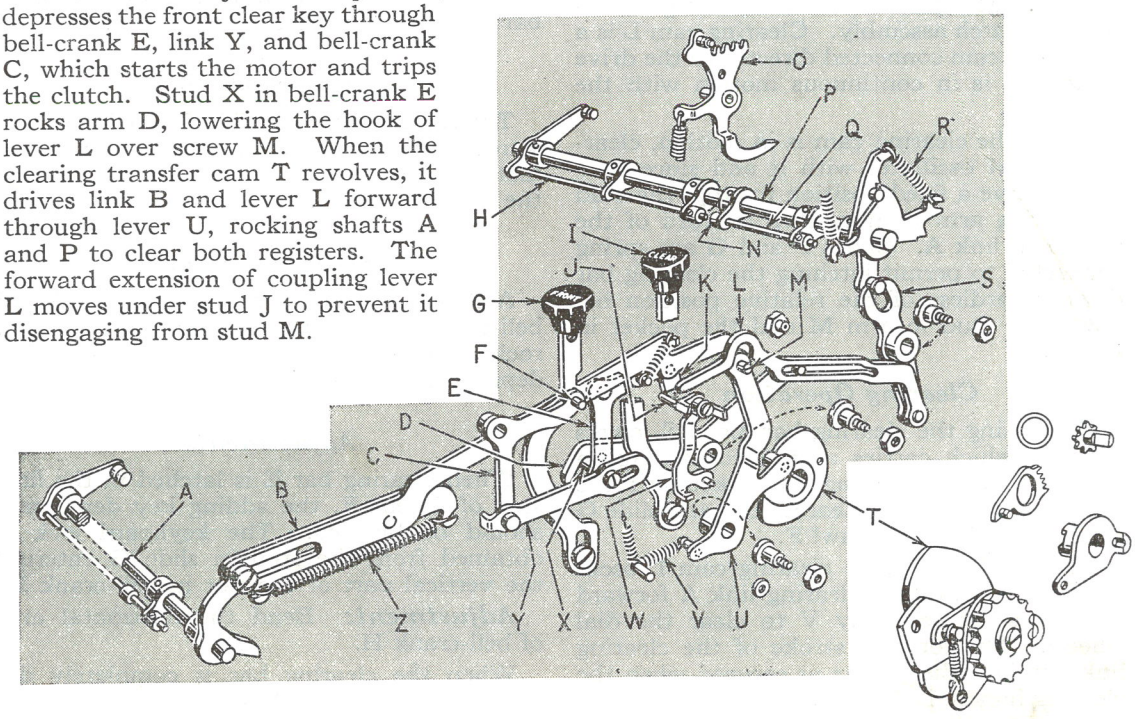
Assembly P has the two shafts H and Q split in the fourth column to permit the extra travel of the adding sector to add the automatic one. The third carry arm O is special since the form is toward right instead of the left, and the partition plate is cut off to accommodate the form.

The adding mechanism in the rear is protected against damage by spring connection R in the same manner that spring Z provides in the front register. Each spring should have sufficient tension to clear the registers without yielding on the clear key operation. If the dial wheel or one of the connecting gears fails to revolve backwards in the rear register on the clearing operation, spring R will yield. If the same condition occurs in the front register, spring Z will yield.

Adjustments

When the clear key is depressed, the hook of coupling link L should have a full hold on screw M. This insures that the coupling link is securely connected to lever U, to clear the rear register. The front register is cleared through link B rocking shaft assembly A in the same manner as on the clearing bar operation (Plate 15).

Adjustment: Bend the front end of rocker arm D.



(*Plate 17*) *Continued*

have about 1/64″ clearance on the formed ear of slide G. Make the test without power. Excessive clearance at this point would decrease the hold of the hook on link A over stud K and result in a partial clearing of the dial wheel.

Adjustment: Bend the formed ear on slide G.

With the clearing bar in the normal position, pawl S should have about 1/64″ clearance over the formed ear on slide G. This permits the pawl to have sufficient clearance to reset when the clearing bar restores to normal slowly.

The rearward arm on slide G should have about 1/32″ clearance on the stud in bail N when the clearing bar is normal. The motor should not run in the first step of detent F, but the switch points should be completely closed in the second step.

Adjustment: Bend rearward arm of slide G as required.

When stud C in link A contacts the high point on passby pawl B on the return stroke, pawl S should be moved forward with slight clearance on the formed ear on slide G. This clearance permits slide G to restore to normal.

Adjustment: Bend the formed finger of pawl S.

ADDING SECTOR, POWER DRIVEN (Plate 18)

Adding Sector, Power Driven (*Plate 18*)

To add the amount in the front register, index bar B of the adding sector assembly is driven forward by the motor until the upper projection of the index bar limits against the keystem of the depressed key. The index bar has eight upper projections corresponding to keys one to eight. The ninth key position is the forward end of the partition plate slot, and the rearward end of this slot is the normal limit for index bar B through stud A.

The motor power is imparted to the adding sector through drive pawl Z, which is tripped into revolving drive wheel AA when the key is depressed. The tension of spring AC holds the drive pawl in the revolving drive wheel. After the index bar limits against the keystem, arm AB continues to move forward in the slot which connects it to the index bar. At this time the hook of reverse arm I disengages the drive pawl and changes the pulling power of spring AC to hold it clear of the driving wheel.

Key Function

Depressing keystem F moves slide C and latch W rearward. The step on latch W contacts arm K of detent Y, swinging the detent clear of drive pawl Z. When the detent clears the nose of the drive pawl, spring AC pulls the drive pawl into the tooth of drive wheel AA. As the drive pawl swings downward, stud U contacts latch W, disengaging arm K, and latch W is held over the tie strip V to retain slide C rearward, holding the key depressed. When arm K is released from latch W, detent Y is restored to normal by spring X.

Sector Forward Stroke

The revolving drive wheel picks up drive pawl Z which is supported on arm AB, moving the sector forward against the depressed keystem. When index bar B limits against the keystem, arm AB continues to move forward in its upper slot, causing reverse arm I to rock on stud H to reverse the directional pull of spring AC. As reverse arm I is rocked, its rearward hook contacts a spring stud in the drive pawl, disengaging the pawl from the driving wheel.

Sector Return Stroke

When the drive pawl disengages from the drive wheel, latch W is released, permitting the key and the sector to restore to normal, and add the amount. Toward the end of the sector restoring movement, reverse arm I contacts against shaft J to change the directional pull of spring AC, and to seat the drive pawl on the shelf of detent Y.

Booster Arm

Assembly AB has a forward arm AF, called a booster arm. This arm is in alignment with a step on the underside of index bar B, and its purpose is to absorb the shock of the drive pawl engaging the revolving drive wheel and prevent a premature disengagement of the drive pawl.

It is effective only in starting the sector forward and after the index bar has moved about half way to the number one key position, the booster arm clears the step on the index bar.

Spring G holds the index bar B against the forward end of the slot in arm AB to insure retaining the clearance between the index bar step and the booster arm.

(*Plate 18*) *Continued*

reduces the lead of the step of latch W on the formed ear of detent arm K when the key restores to normal.

Adjustment: Bend arm K of the detent assembly as required.

The upper hook of detent Y should have minimum clearance on reverse arm I. Use Kit 43⅛ to hold the drive pawl normal while a key is depressed to observe the clearance. The hook is an added safety to prevent the reverse spring AC from remaining on center, thus insuring positive engagement of the drive pawl.

Adjustment: Bend the hook of detent Y as required.

The upper arm of cam latch W should have .008″ to .010″ clearance over tie strip V with the sector and detent normal and the key partially restored. This clearance permits the upper arm of the cam latch to pass over the tie strip and slide C to restore to normal. Excessive clearance would permit the cam latch to limit on the stud in the drive pawl instead of detent arm K and reduce the hold of the cam latch step on the detent.

Adjustment: Bend the lower arm of the cam latch.

Drive pawl stud U should have .022″ to .025″ clearance over the top of cam latch W in the normal position. This insures maximum hold of the cam latch over the tie strip V to hold the depressed key down while the drive pawl is in the drive wheel. The clearance also prevents the stud from limiting the upper movement of the cam latch. Excessive clearance is apt to cause an early key release and overaddition because the sector goes beyond the depressed key position.

Adjustment: Bend the drive pawl arm with the stud as required. In adjusting the drive pawl, the idea is to bend it in the form. To decrease the clearance, place a screw driver under the drive pawl supporting it on the drive wheel and the tie strip, then strike the drive pawl arm with the stud, a light downward blow. To increase the clearance, reverse the operation, support the stud in the drive pawl arm and drive downward on the drive pawl. Have the detent shelf rearward.

When the hook on reverse arm I contacts the spring anchor stud in the drive pawl, there should be about 1/32″ clearance visible in the slot of arm AB. This clearance permits the drive pawl to be disengaged from the drive wheel after the index bar limits against the depressed keystem. If there is no clearance at this point, the drive pawl could not disengage, causing the machine to lock.

Adjustment: Swing the spring stud in the drive pawl.

The driving wheel AA is located on the shaft with a flush hold on the drive pawl and with slight side clearance on arm AB.

Adjustment: The drive wheel hub has a set screw which fastens on a flat surface of shaft R.

Intermediate gear N should be meshed with the pinion gear on the motor shaft. The gear should run quiet with as much mesh as possible.

Adjustment: Swing bracket S in its slot as required.

Adding Sector Removal

Remove the case, base and motor.

Loosen up the driving wheels on the drive shaft.

Remove the screw holding the clutch gear on to the drive shaft, then remove the clutch unit, drive shaft and gears.

Remove the keystem latching-in slide.

Remove the drive pawl detent.

Disconnect the forward portion of the sector from the pawl gear by using a follow up shaft.

Remove the sector through the rear of the machine.

Adding Sector Installation

Place the sector in position, align the first tooth of the segment with the bottom of the pawl on the pawl gear after first ascertaining that the pawl gear itself is in position.

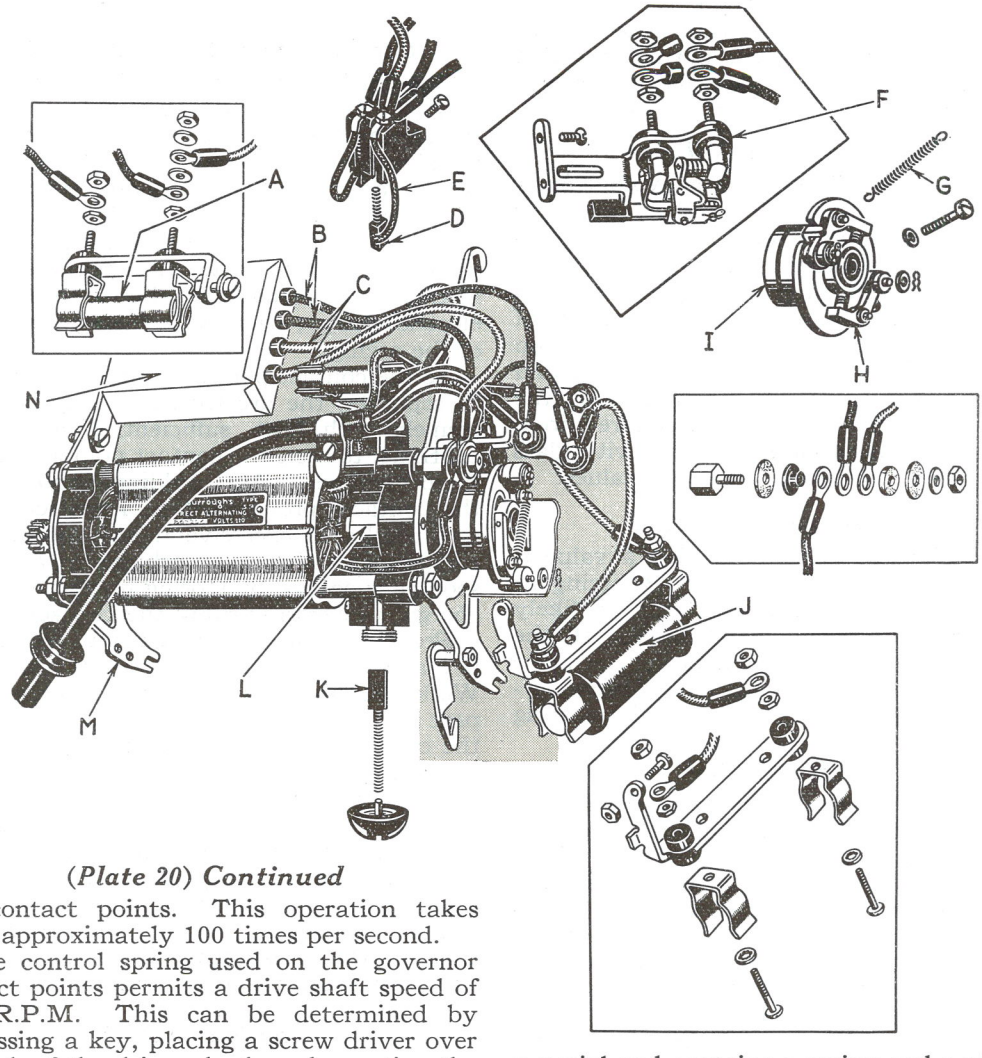
Install the keystem latching-in slide.

Install the drive gears, drive shaft and clutch unit. Place a .002″ feeler gauge between clutch dog actuator Q (Plate 15) and the machine side frame. Place the right-hand drive gear in position, placing the wheel against the hub in the partition plate, making sure that the screw seats on the flat spot on the drive shaft before tightening the screw; locate the remaining drive wheels in position.

Install the detent.

Install the motor, base and case.

TYPE 5C MOTOR (Plate 20)



(*Plate 20*) *Continued*

the contact points. This operation takes place approximately 100 times per second.

The control spring used on the governor contact points permits a drive shaft speed of 120 R.P.M. This can be determined by depressing a key, placing a screw driver over the hub of the drive wheels and counting the number of times the screw of the drive wheel contacts the screw driver. Control spring G is adjusted to obtain the correct drive shaft speed.

Governor brush D has a shunt wire E, which serves as a direct connection from the terminal to the brush. This prevents the burning and sticking of the brush in the holder, caused by the current jumping between the brush and the holder.

Fusetron

Fusetron A is a specially constructed fuse which permits a momentary overloading or stalling of the motor. If the resistance against the motor operation continues, the fusetron metal inside the tube will melt, breaking the circuit prior to the motor becoming hot enough to burn out.

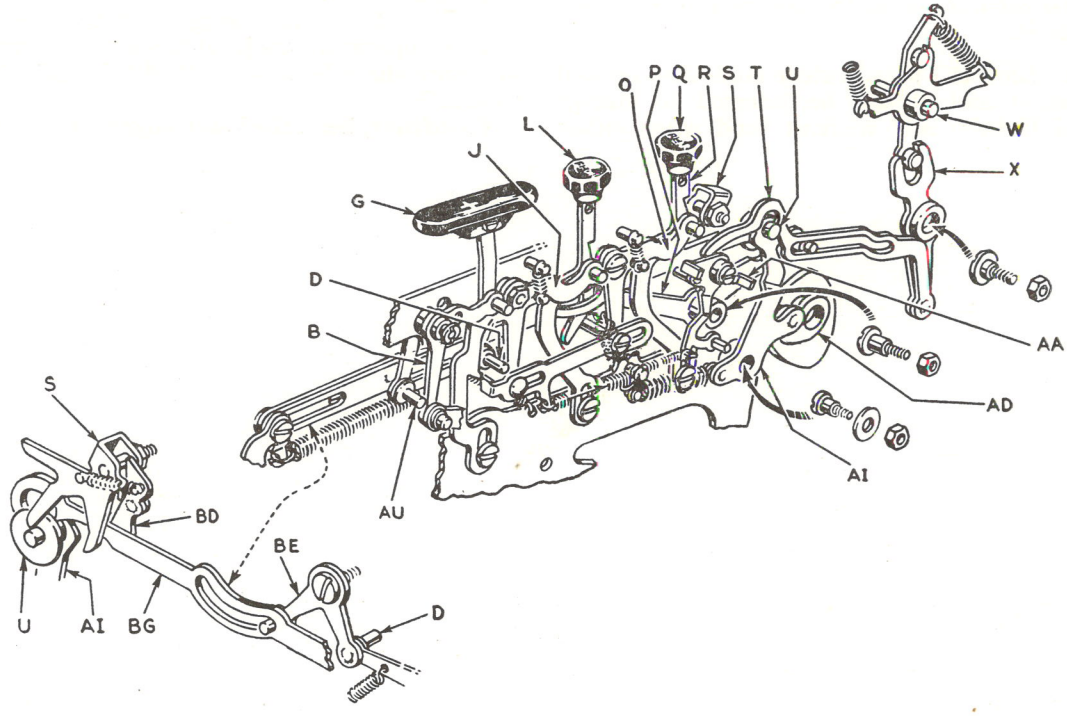
The fiber fusetron tube has an insulating material and contains a spring and a piece of metal soldered to the brass end pieces. It is rated in amperage determined by the motor voltage. The metal is of such size and composition that it will melt when the current passing through the fusetron, exceeds its rated value. For instance, if the load on the motor is increased because the motor cannot operate in a normal manner, the current factor in the motor is increased and consequently the metal in the fusetron melts to open the circuit. When this occurs, the fuestron has broken down and must be replaced.

A good fusetron can be determined by tapping it on an object and feeling the vibration of the spring on the inside. When no vibration is felt, it is an indication that the fusetron is burnt out or broken down.

Fusetron Value

The correct value of fusetron will open an

CLEARING MECHANISM, DUPLEX SUBTRACTOR—IMPROVED (Plate 16-1)



Clearing Mechanism, Duplex Subtractor —Improved (Plate 16-1)

Purpose

To permit independent clearing of both the front and rear registers.

Operation

Rear register clearing is indexed by the depression of key Q which rocks bellcrank O to swing its stud; and, by camming lever P, to lower link T which engages stud U in clearing drive lever AI. Also, depression of key Q, through the interlocking slide and the cam lever (C and AB, respectively, Plate 15) closes the switch points and trips the clutch causing the motor to oscillate lever AI through rotation of cam AD. Oscillation of lever AI, through lever X, operates the rear register clearing assembly W.

The purpose of latch AA is to hold the interlocking slide (C, Plate 15) forward; thus holding the clearing key depressed, locking other keys against depression, and retaining contact of the switch points.

Stud U, moving forward, contacts the front finger of lever S to raise pass-by pawl BD over the stud in latch AA. Latch AA is released as stud U, on its return movement, swings lever S rearward driving pawl BD downward. The upper finger of lever S serves as an overthrow limit for lever S as it is restored to normal.

Front register clearing is indexed by the depression of key L which rocks bellcrank J to contact stud D and rock bellcrank BE forward. Bellcrank BE lowers link BG to engage stud U in clearing drive lever AI. The forward movement of lever AI drives link BG to clear the front register.

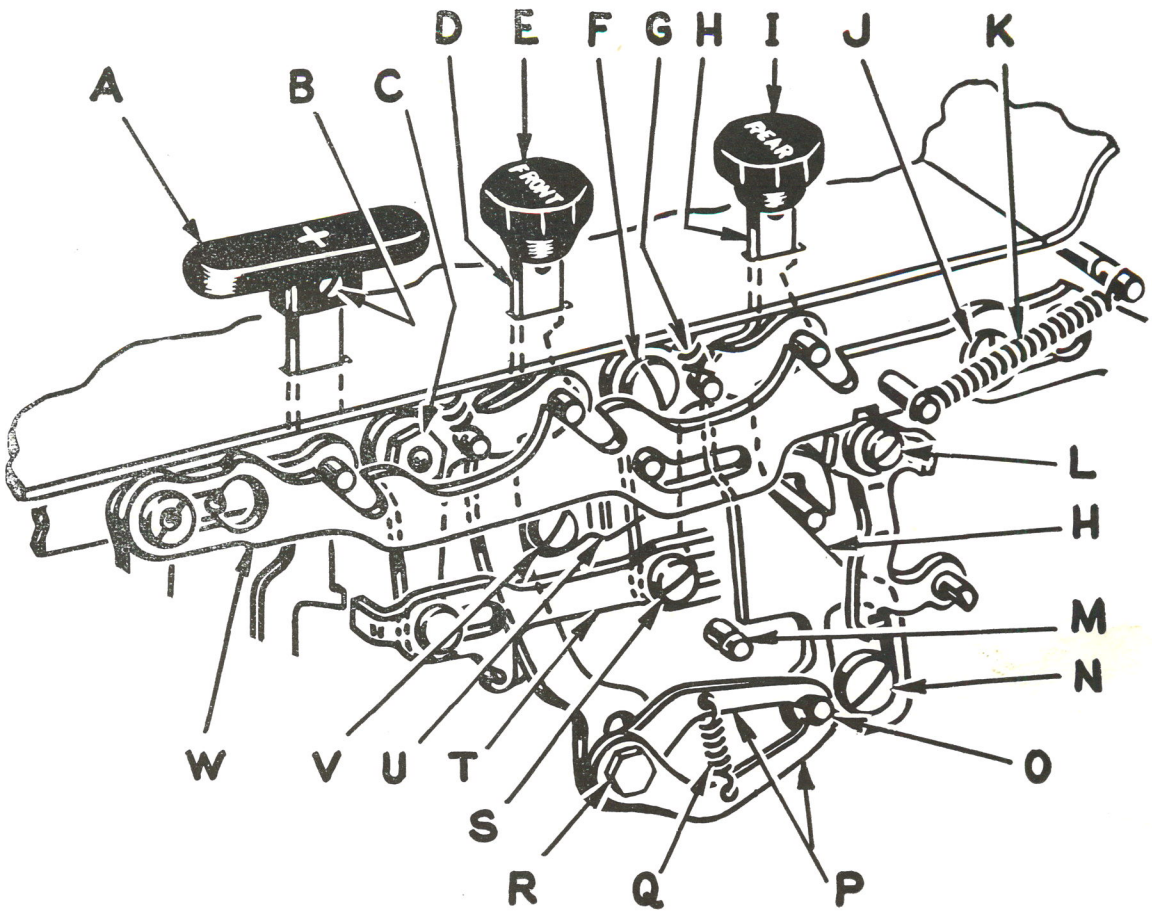
Simultaneous depression of keys L and Q engages both links T and BG with stud U to permit clearing both front and rear registers in one operation.

Transfer of amounts from the front to the rear register is indexed by the depression of bar G through bellcrank B and stud AU. Stud AU, through its connecting link, swings bellcrank BE to lower link BG. The transfer function is described in Plate 9.

Adjustment

1. Link T should clear stud U in normal

REAR CLEAR KEY LATCH, CLASS 5 DUPLEX (Plate 5-1)



Rear Clear Key Latch, Class 5 Duplex (Plate 5-1)

Purpose

To provide a means of preventing inadvertent clearing of the rear register.

Operation

Rear clear key H, when moved rearward, positions the pocket in the lower portion of the keystem over stud M, thereby preventing depression of the key. Key H is held in its forward or rearward position by interlocks P.

Adjustment

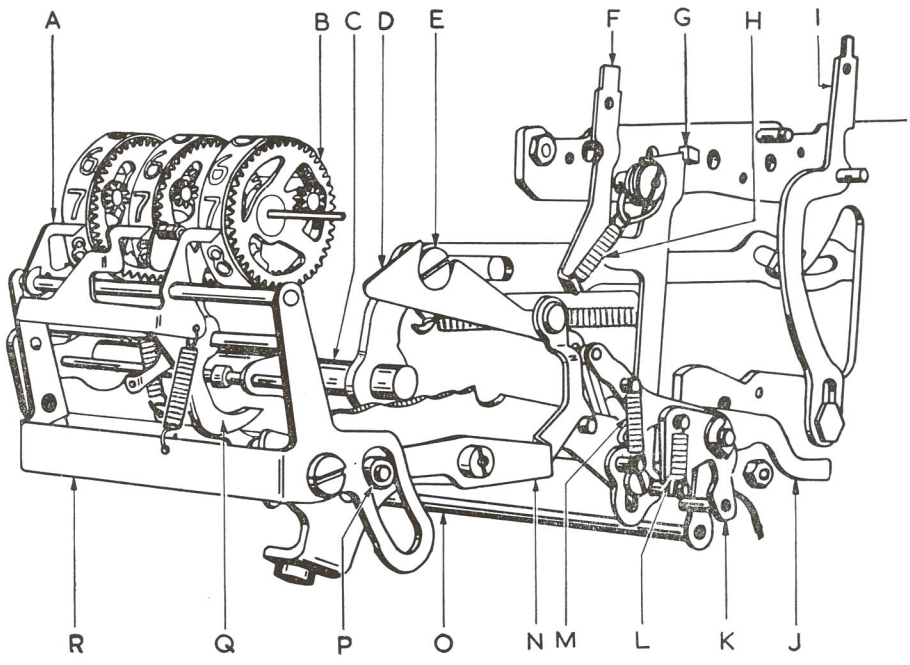
1. As key H is moved rearward, there should be sufficient clearance between the upper side of stud M and the upper edge of the pocket in the keystem to permit the edge of the pocket to pass over and have a full hold on the stud.

To adjust for clearance, remove stock from the upper edge of the pocket.

2. As key H is depressed in its forward position, there should be at least 1/64″ clearance between stud M and the forward edge of the keystem.

To adjust for more clearance, remove stock from the forward edge of the keystem.

PRORATING MECHANISM (Plate 11-1)



Prorating Mechanism (Plate 11-1)

In prorating, the amount to be prorated is multiplied successively by various percentages—the total of which equals 100 per cent. Due to fractions lost or gained when the calculations are individually corrected to the nearest unit, a total of the separate calculations may not exactly equal the amount prorated.

THE PURPOSE OF THE PRORATING FEATURE is to cause the total of these separate calculations to exactly equal the amount prorated. That is, the total of the products of separate multiplications with a constant multiplicand will exactly equal the product of the constant multiplicand times the total of the other factors. This is accomplished by retaining the amounts in columns 1, 2 and 3 (fractional amounts of the products) in the front register during transfer operations.

Operation

The Prorating Mechanism works in conjunction with the Decimal Non-transfer Mechanism (Plate 11). However, the Decimal Non-transfer Mechanism is still independent.

Key F indexes the Prorating Mechanism and is latched depressed by tension of spring H pulling a cutout in the keystem under square stud G.

When prorating control key F is depressed, the following functions are indexed:

1. Non-transfer of amounts on dial wheels in columns 1, 2 and 3 from front to rear register.

2. Non-cancellation of amounts on dial wheels in columns 1, 2 and 3.

NON-TRANSFER of amounts on dial wheels in columns 1, 2 and 3 from the front to the rear register is accomplished by indexing the Decimal Non-transfer Mechanism (Plate 11). Bail assembly O (same as V, Plate 11) is moved rearward by a stud in rocker arm K which is connected to prorating control key F by spring L.

NON-CANCELLATION of amounts on the dial wheels in columns 1, 2 and 3 is effected by engaging the detent fingers of bail assembly A with the teeth of gear B of the dial wheel assemblies during the initial movement of cancelling mechanism C.