(Plate 11-1) Continued

Depression of prorating control key F rocks actuating arm J through spring M. The stud in the forward end of actuating arm J, operating in a slot in the rear portion of hook D, moves the forward end of hook D to couple with the head of screw E. Forward movement of cancelling shaft assembly C rocks bell crank assembly N, and moves roll P in the forward end of assembly N down the cam slot in bail assembly R. This cam slot is shaped so that the detent fingers of bail assembly A are engaged with gears B during the early part of the movement of cancelling mechanism C.

The opening of the spring joint between detent finger bail assembly A and bail assembly R serves to rotate gears B rearward slightly to permit pawl N (Plate 6) to reset behind the correct lug of ratchet gear J (Plate 6).

Carry arms Q are spring jointed to permit normal operation of cancelling shaft assembly C.

FULL CANCELLATION OF ALL DIAL WHEELS in the front register with prorating control key F latched is permitted when front clear key I is depressed. The bottom of key I contacts the rear end of actuating arm J to disengage hook D from screw E.

Tests and Adjustments

1. To ensure proper entry of non-cancelling detents on bail A into tooth spaces of dial wheels—

With prorating control key F latched depressed and cancelling mechanism C starting forward, the detents on bail A should enter centrally into tooth spaces of gears B on the dial wheels in columns 1, 2 and 3.

To adjust, raise or lower detents of bail A. Check lateral alignment of detents with gear teeth B.

2. To ensure complete engagement of hook D with the large screw head E in cancelling mechanism C—

With the direct subtract lever latched (to expose the head of screw E) slowly depress prorating control key F and check hook D to have approximately equal clearance on either side of screw head E.

To adjust, bend the rear vertical stock of assembly N forward or rearward.

position, and should be lowered to engage stud U fully and without bind when key Q is fully depressed.

To adjust, bend the forward arm of cam lever P.

2. Link BG should clear stud U in normal position and should be lowered to engage stud U fully and without bind when either key L, bar G, or the subtract bar (Z, Plate 9) is depressed.

To adjust, bend the rear arm of bell-crank BE.

3. Stud U should swing lever S on each clearing operation with sufficient movement to assure the release of latch AA by pass-by pawl BD.

To adjust, bend the lower fingers of lever S.

(*Plate 20*) *Continued*

overloaded circuit in approximately twenty seconds. Too low a value fusetron is likely to open the circuit during the normal machine operation. Too high a value fusetron lessens the motor protection against burning out.

Resistance Coil

Resistance coil J performs a twofold function. It prolongs the life of the governor contact points and it also reduces radio interference set up by the motor. These two functions are accomplished in conjunction with the condenser. The resistance coil consists of several turns of a special alloy wire wound on a procelain spool. The size of the wire and the number of turns are determined by the ohmic value of the resistance coil required. The wire on the spool is insulated with glass so that it will withstand high heat values.

Resistance Coil Value

If a resistance coil of too high a value is used, it would result in excessive arcing at the governor contact points, and it likely would increase radio interference. If the value of the resistance coil is too low, the motor speed would increase, as too much current is passing through the coil and by-passing the governor.

Radio Filter

Radio filter N to a degree, short circuits the interference voltage set up by the motor and dissipates it into the motor frame. This filter consists of two separate units within the same container, thus it has a twofold function. One unit serves as a condenser to reduce as much as possible, radio interference, and the other unit protects the pitting and burning of the governor contact points. This is accomplished by making the condenser a specific way in conjunction with the electric circuit required. Each unit of the radio filter may be composed of several interwound condensers, depending upon the capacity required.

Split Field Construction Motor

The motor circuit is arranged to electrically place a field coil on each side of the brushes and switch contact points to obtain the split field motor construction. By placing the brushes and switch points between the field coils in this manner, the field coils serve as choke coils in retarding radio interference voltage as set up by the motor. The current passes successively through the one field coil, brushes, armature, switch contact points, governor contact points, the remaining field coil, and back through the line.

In motors without the split field coils, the circuit changes. The current passes successively through the governor contact points, switch points, two field coils, brushes, armature, and back through the line.

Condenser Unit in Radio Filter

The condenser unit in radio filter N prolongs the life of the contact points. It reduces the pitting and burning of the contact points by absorbing the spark of arcing when the points separate. The condenser is composed of strips of tinfoil, separated by strips of tissue paper, wound together in a flat coil and impregnated with wax. It is sealed in radio filter N and it has the ability to store up electric energy, thereby reducing the extent of the arcing.

As the contact points of the governor start to separate, the arc that is set up is of extremely high heat, sufficient, if allowed to continue, to melt the contact points and weld them together. Any welding action across the contacts prevents them from separating and results in excessive motor speed. The condenser's ability to absorb this arc almost as soon as it occurs, by storing up this electrical energy, prevents burning the contact points.

Protecting the contacts from overheating is made possible through the resistance coil. While the governor contact points are open, part of the energy is absorbed and stored in the condenser, and part of it is dissipated in the form of heat through the resistance coil. The condenser would be completely discharged through the resistance coil if the governor contact points were left open long enough. The discharging of the condenser also takes place when the contact points are closed. A certain amount of current flows through the resistance coil even when the governor contact points are separated.

Condenser Test

A defective condenser is apt to cause continuous running of the motor, excessive arcing at the governor contact points, possible shock from being grounded or excessive radio interference.

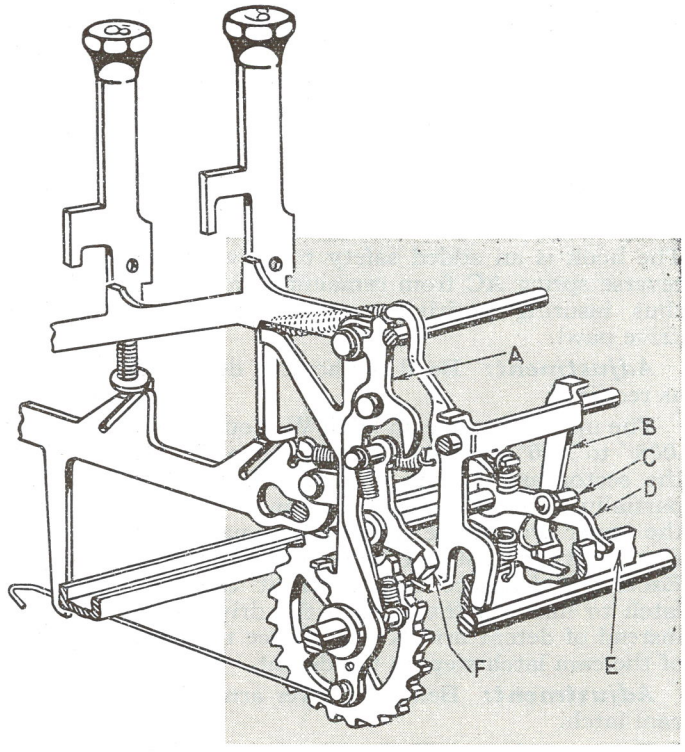
To test the condenser, observe the extent of the arcing at the governor contact points while the machine is operating, then remove one condenser lead wire from the contact points and again note the extent of the arcing. If the arcing becomes more pronounced after removal of the condenser lead wire, the condenser is effective. However, if the extent of the arcing remains the same before and after the removal of the lead wire, the condenser is defective.

An occasional heavy flash at the contact points does not prove that the condenser is defective, as this may be the result of dirty contact points or the normal discharge of accumulated voltage.

DRIVE PAWL DETENT, EARLY (Plate 19)

Drive Pawl Detent, Early (Plate 19)

In machines with this type of detent B construction, the restoring key stroke is slightly longer than the later models which have the compound leverage detent. The key must be allowed to restore almost to normal prior to the next key depression, thus the key action is not quite as fast or as responsive. Because of this difference in construction, the drive pawl and detent adjustments differ in amounts of clearance as compared to the later construction, however, the manner of applying them remains the same.



Adjustments

There should be .010″ to .015″ clearance between the edge of drive pawl F and the horizontal shelf of detent B with keys depressed.

There should be minimum clearance between the upper end of detent B and arm A.

Cam latch D should have .015″ clearance over tie strip E.

Stud C in the drive pawl should have .010″ to .012″ clearance over cam latch D.

Care of the Motor

All of the motors (with the exception of the latest Type 5C, which have ball bearings) have oilite bearings that require an occasional drop of machine oil, Kit 131. To oil the bearings, screws AW, Plate 22 of Symbol List, are removed and a drop of oil placed in the screw holes, and the screws replaced.

Lack of oil causes the armatures to become sluggish in the bearings, overheating and breaking down the insulation which results in a burnt out armature.

Carbon dust accumulating within the motor also weakens the insulation resistance, and in some instances may result in electric shocks.

The dust should be removed at frequent intervals.

There should be .015″ separation between the governor contact points, and it must not exceed this amount.

A greater separation of the contact points results in an uneven motor action.

The surface of the commutator should be occasionally refinished with a fine grade of sandpaper.

Type 5C Motor (Plate 20)

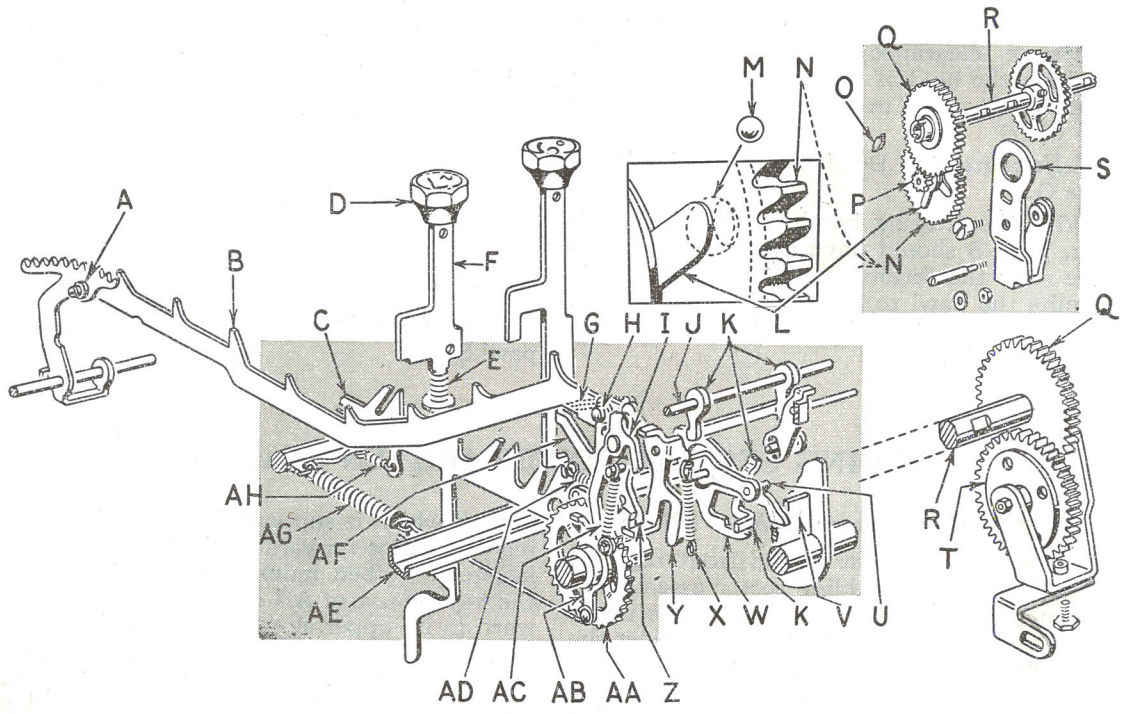
The motor furnishes the power to operate the machine. Various styles of motors have been used, starting with the enclosed type, to the present open type illustrated on this plate. The present Type 5C motor is 5⅛″ in length. It has fusetron A, resistance coil J, and radio filter N. It is constructed with split fields, one portion of which is electrically placed on each side of brushes K, governor I, commutator L, and switch F.

The present motor has ball bearings for the armature shaft while the early motor of this same type has oilite bearings. When ordering replacement armatures, it is necessary to specify the armature bearings required as outlined on Plate 27 of the Symbol Book.

Governor

Governor I controls the speed of the motor. This is accomplished by the centrifugal force exerted by two contact arms H against the tension of spring G. These contacts parallel each other and are normally closed. When the motor picks up speed, the centrifugal force of the contact arms becomes greater than the tension of the control spring, causing the contact points to separate and the motor to slow down. The lower motor speed reduces the centrifugal force of the contact arms, permitting the control spring to close

ADDING SECTOR, POWER DRIVEN (Plate 18) Continued



Motor Switch and Gear Drive

The rearward movement of slide C by the keystem rocks bail AE which permits the switch contact points to close, starting the motor.

The motor power is transmitted to the driving wheels through the pinion gear on the armature shaft, intermediate gear N and its pinion which is meshed with gear Q. Gear Q is connected to drive shaft R by a slot fitting over a pin in the drive shaft.

Intermediate gear N has a friction clutch which permits the motor to run if the machine locks. This type of construction eliminates the drive pin shearing if a lock occurred. The machine is driven through the clutch assembly by means of four ball bearings which are held in the pockets of disc T, by the arms on spring washer L. Spring washer L is held over the ball bearings by a small arm with a formed ear which extends into a hole of the intermediate gear.

When a lock up occurs, the intermediate gear continues to revolve with the motor, the tension of the spring washer is overcome, forcing the ball bearings out of the pockets in disc T.

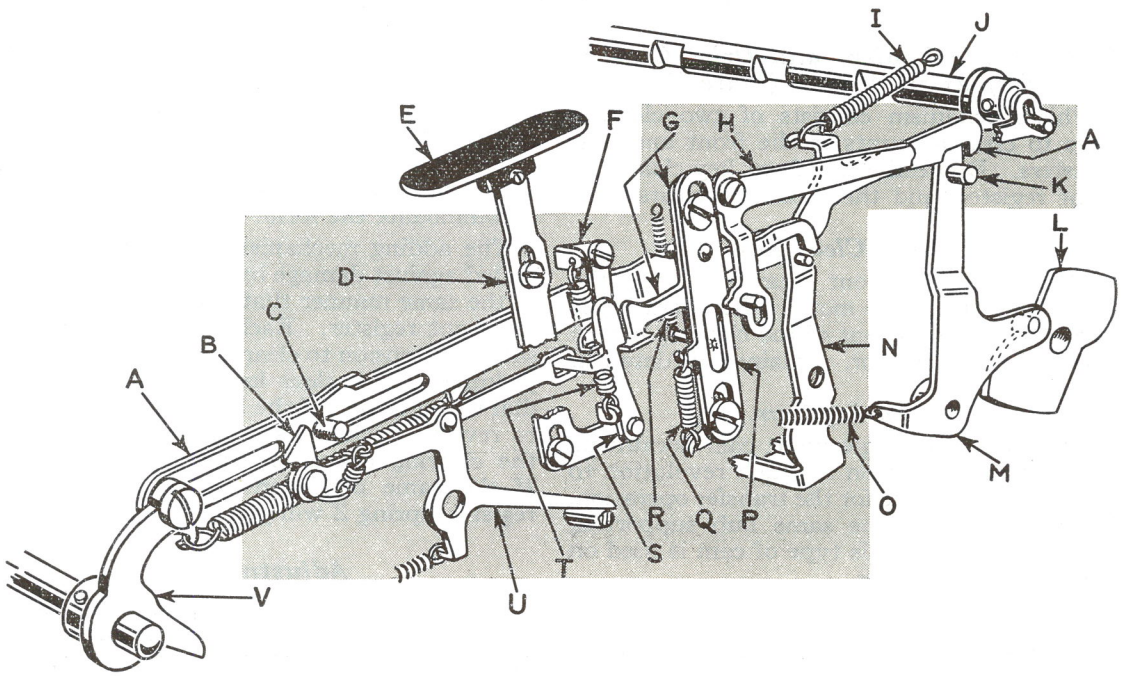
Adjustments

Booster arm AF should have about .010″ play on the step of index bar B. Make the test by holding index bar B in the normal position and move arm AB forward. Excessive clearance is apt to cause a premature disengagement of drive pawl Z from the driving wheel and result in underaddition. It may also cause a partial disengagement or reverse of the drive pawl. If this takes place, the drive pawl would re-engage the drive wheel and repeat the addition or it may disengage immediately without any addition taking place. Insufficient clearance may prevent the complete restoring of the sector as the booster arm cannot reset on the step of the index bar.

Adjustment: Bend the booster arm as required.

The shelf on detent Y should clear the nose of drive pawl Z by about .040″ when an adding key is depressed. This clearance should be the same from all adding keys and use Kit 43⅛ to hold the drive pawl normal when making the test. If a certain key in any column does not have the required throw of the detent, it indicates the keystem is bent. This clearance insures that the drive pawl has ample clearance to fall into the drive wheel teeth prior to the keystem limiting on the partition plate. Excessive clearance of the detent shelf on the nose of the drive pawl

CLEARING MECHANISM, EARLY ELECTRIC CALCULATOR (Plate 17)



Clearing Mechanism, Early Electric Calculator (Plate 17)

This mechanism clears the amounts on the dial wheels when the clearing bar E is depressed. The parts are of early design without the clutch assembly. Clearing cam L is a two point cam connected directly to the drive shaft and is in continuous motion with the motor.

When the clearing cam is in motion, clearing arm M oscillates with it and since they do not have a fixed position to stop, the stud in clearing arm M may stop forward of the pocket in link A. Slides P and G are spring connected to permit latching the clearing bar down regardless of the relative position between the stud in arm M and the pocket in link A.

Clearing Operation

Depressing the clearing bar, pawl S lowers slide G, which carries a stud contacting on clearing link A, lowering its pocket over the stud in arm M. The clearing bar and slide G are latched down by pawl F.

The revolving of the clearing cam L oscillating arm M, drives clearing link A forward to rock shaft assembly V to clear the dial wheels. The forward stroke of the clearing link parallels the results as secured when the clearing handle is drawn forward.

On the return stroke of the clearing link under tension of spring I, stud C contacts passby pawl B to rock bell-crank U. Bell-crank U rocks pawl S which releases latch F from the shelf of slide G, to permit the clearing bar mechanism to restore to normal.

Motor Switch

The rearward arm of slide G moving downward, contacts a stud in bail N, closing the motor switch to start the motor and revolve the clearing cam L.

Keyboard Interlock

A stud in slide G extending into the slot of bell-crank H and through the rearward slot, rocks shaft J, which blocks the adding key depression through the key locks.

Adjustments

When clearing bar E is latched in the first step of detent F, the adding key depression should be blocked. The keyboard lock is obtained from the stud in slide G entering the vertical part of the slot in bell-crank H.

Adjustment: Bend the horizontal arm of bell-crank H.

When the clearing bar is completely depressed, the second step of detent F should

(Plate 15) Continued

Motor Operation

When slide C is moved forward by the depression of the clearing bar, it lowers arm AB which contacts a stud in bail Z, swinging it rearward. A finger on the bail closes the switch points to start the motor. Slide C is latched forward by pawl J, to hold the clearing bar depressed and insure power for the clearing operation.

The forward movement of link B carries passby pawl I over stud H in pawl J, and on the return stroke when pawl J is released, the transfer bar and slide C restore to normal. When pawl J is rocked rearward, its stud engages hook W which holds the pawl momentarily to permit slide C time to move forward.

As arm AB moves upward, springs AA restore bail Z to normal, separating the switch points to stop the motor.

Adjustments

Limit pawl V should have about 1/64″ hold on clutch member Q, when the notch in slide C latches on the formed ear of pawl J. Test the adjustment by slowly depressing the clearing bar. The object of this adjustment is to lock the keyboard prior to tripping the clutch. This same test is applied to both clear keys on the duplex subtractor.

Adjustment: Bend the forward ear on pawl J.

With clearing bar G held down and clutch member Q held in its normal position, limit pawl V should have 1/64″ clearance with the end of clutch member Q. This insures that the clutch will trip when the clearing bar is fully depressed. This same test is applied to both clear keys on the duplex subtractor.

Adjustment: Bend the formed ear on limit pawl V.

Pawl J must be swung rearward through passby pawl I to latch it in hook W on the return stroke of link B. Hold the clearing bar depressed to test. This adjustment should be considered in the following adjustment of hook W, as both have a bearing on the release of pawl J. The test is applied to both clear keys on the duplex subtractor.

Adjustment: Swing stud H by weaving pawl J.

Hook W should have a full hold on stud Y in pawl J. If hook W fails to hold pawl J, slide C will be relatched on pawl J, causing the motor to continue to run and the clearing bar to remain depressed. This test is applied to both clear keys on the duplex subtractor.

Adjustment: Bend the formed ear on W, and be very careful not to break off the ear, as this part is hardened.

Arm AB should have about 1/64″ clearance with the stud in bail Z to start the motor running prior to latching slide C by pawl J. This test is applied to both clear keys on the duplex subtractor.

Adjustment: Swing the arm of bail Z above its pivoting point.

When the switch is open, the contact points should be separated about 1/32″. This amount of clearance permits the motor to run prior to latching slide C when the clearing bar is depressed.

Adjustment: Bend the finger of bail Z.

When clutch member Q is resting on limit pawl V, the flat on drive pin S should clear the teeth of clutch gear P. When spring U draws clutch members Q and T together, drive pin S should have a full hold in the clutch gear. This adjustment is a matter of meshing the pinion on drive pin S with the teeth in clutch member Q.

When the subtract key is depressed, limit pawl V should have about 1/64″ clearance on clutch member Q. This adjustment parallels the adjustment on the clear keys.

Adjustment: Increase the offset in the subtract key bell-crank to increase the movement of slide C.

(Plate 13) Continued

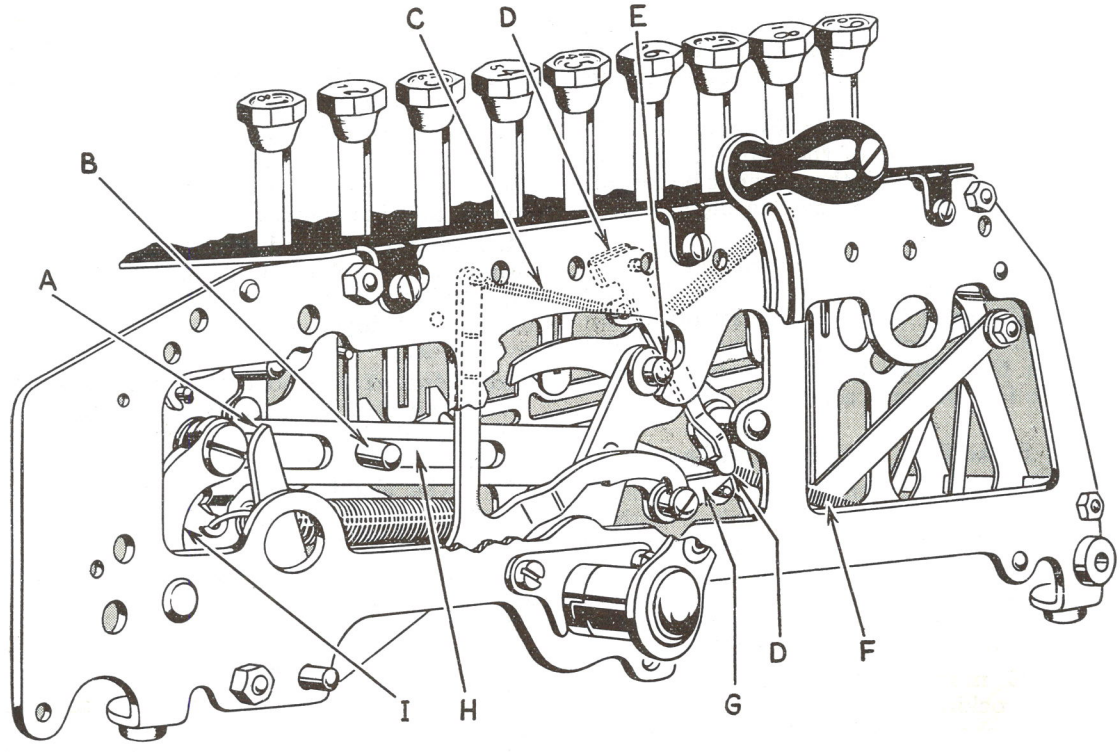
With the machine normal, the hook on arm P should have about 1/32″ clearance with each of the lugs on carry wheel M. Prior to bending arm P, be sure to check to see if the carry wheel is correctly meshed. When the clearing handle is forward, rocking shaft H, the hook on arm P should rotate the carry wheel and oscillating arm slightly rearward to remove the roll of carry arm J off the timer cam L. Test each lug on the carry wheel by repeating the carry operation in the same column, five times. Each carry advances the lug one space. If the carry wheel lug is located too high, the clearing handle will lock forward. If it is too low, the dial wheel may rebound, thus fail to clear.

Adjustment: Swing the hook of arm P.

When the clearing handle is forward, roller K should have a non-binding contact over the dwell on the foot of the carry arm J. Test the adjustment by holding the clearing handle forward and try each dial wheel for slight rearward rotating play. Make the test from each lug on the carry wheel by repeating the carry operation five times. If the carry arm foot is too tight on roller K, the clearing handle will lock forward. Excessive play at this point may result in the amount not clearing out of the dial wheel on a fast operation. Be sure to make this test over the entire dwell of the lower part of carry arm J.

Adjustment: Bend the lower part of the carry arm as required.

CLEARING HANDLE FULL STROKE MECHANISM (Plate 14)



Clearing Handle Full Stroke Mechanism (Plate 14)

When the clearing handle is pulled partially forward, full stroke lever A prevents it from restoring to normal until a complete forward stroke has been made to insure clearing the dial wheels.

On the clearing operation, if the dial wheel fails to revolve rearward, the handle will latch on the forward step in the full stroke lever. Rearward pressure on the clearing handle overcomes the tension of spring F, permitting hub assembly G to turn slightly to release the latch.

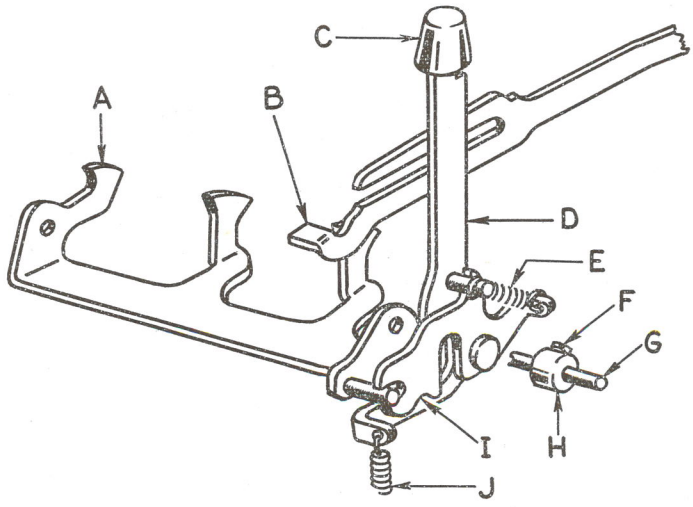
Function

As the clearing handle is drawn forward, full stroke lever A is pulled down over the square surface of hub assembly G, and detent D moves forward under tension of spring C. Near the end of the forward stroke, stud B raises full stroke lever A to permit detent D

DECIMAL NON-TRANSFER MECHANISM (EARLY) (Plate 12)

Decimal Non-transfer Mechanism (Early) (Plate 12)

When the decimal non-transfer key is latched down, it prevents transferring amounts in the first three columns in the front register to the rear register. This mechanism is in early duplex calculators which do not have the subtract key mechanism.



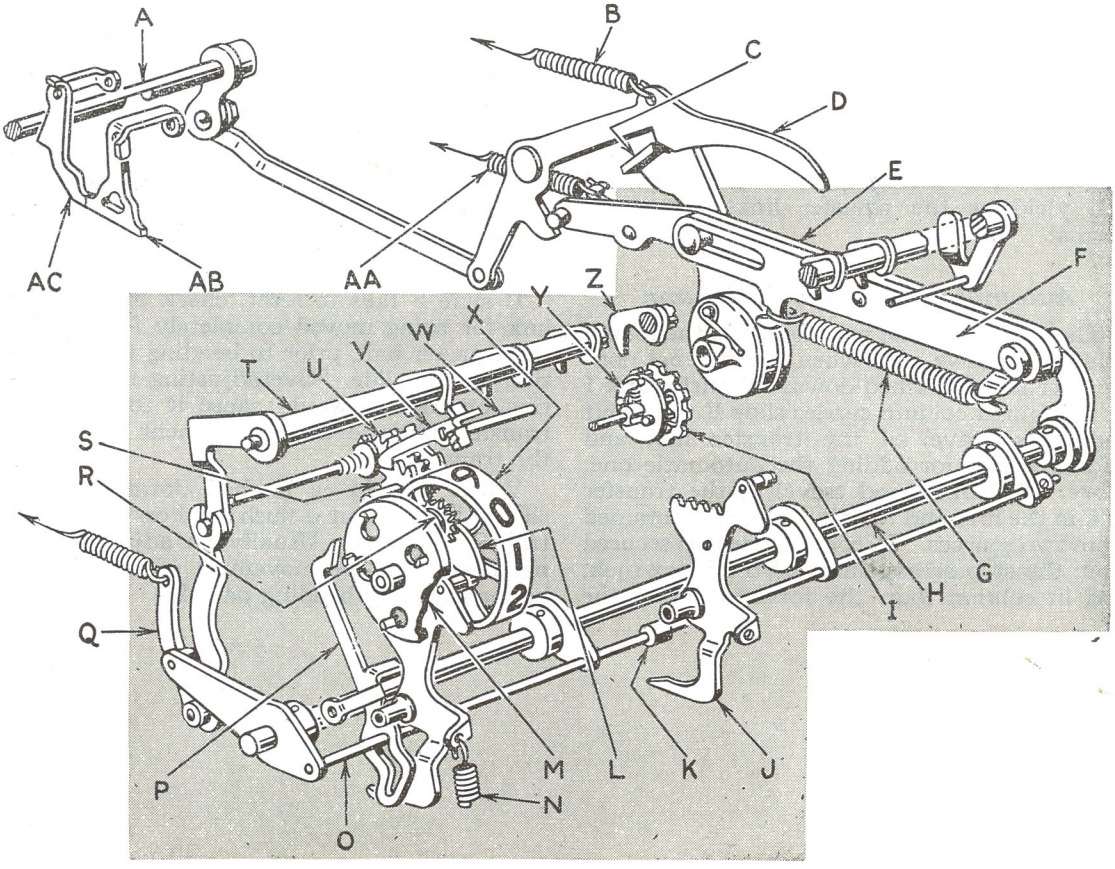
Function

The depression of decimal non-transfer key rocks bail A through rocker arm I, placing the projection of the bail in the path of transfer links B to block their rearward movement.

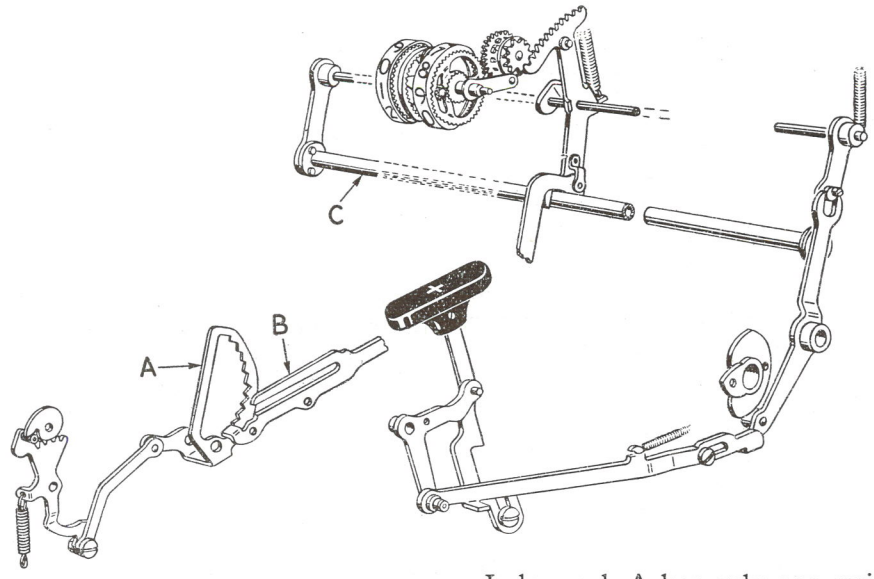
Adjustments

Bail A should have about a flush hold on the formed lip of the transfer link B, when key C is latched down. The design of the parts usually gives the amount of hold required, but to adjust for more or less hold, weave the stud in the bail. Be sure the three projections on the bail are parallel.

CLEARING MECHANISM, HAND CALCULATOR (Plate 13)



TRANSFER MECHANISM WITHOUT SUBTRACT KEY (Plate 10)



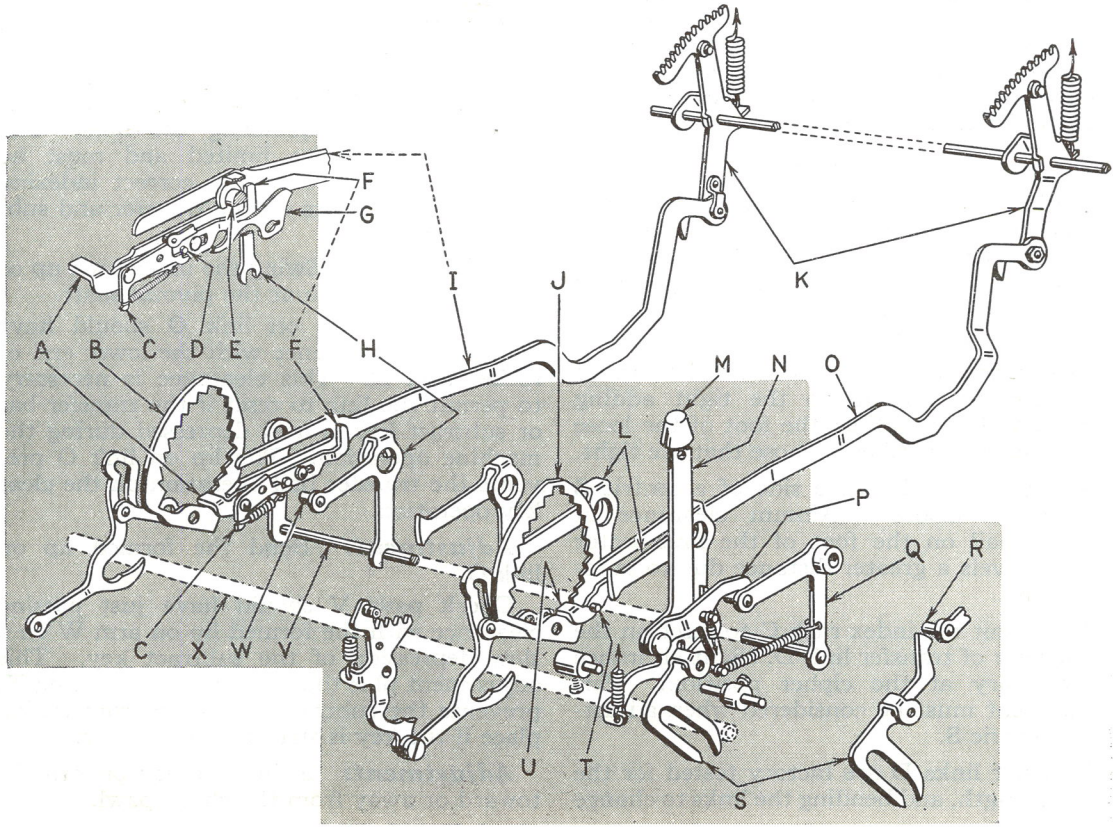
Transfer Mechanism Without Subtract Key (Plate 10)

This mechanism covers the transfer operation of the early style duplex calculator which did not have the subtract key.

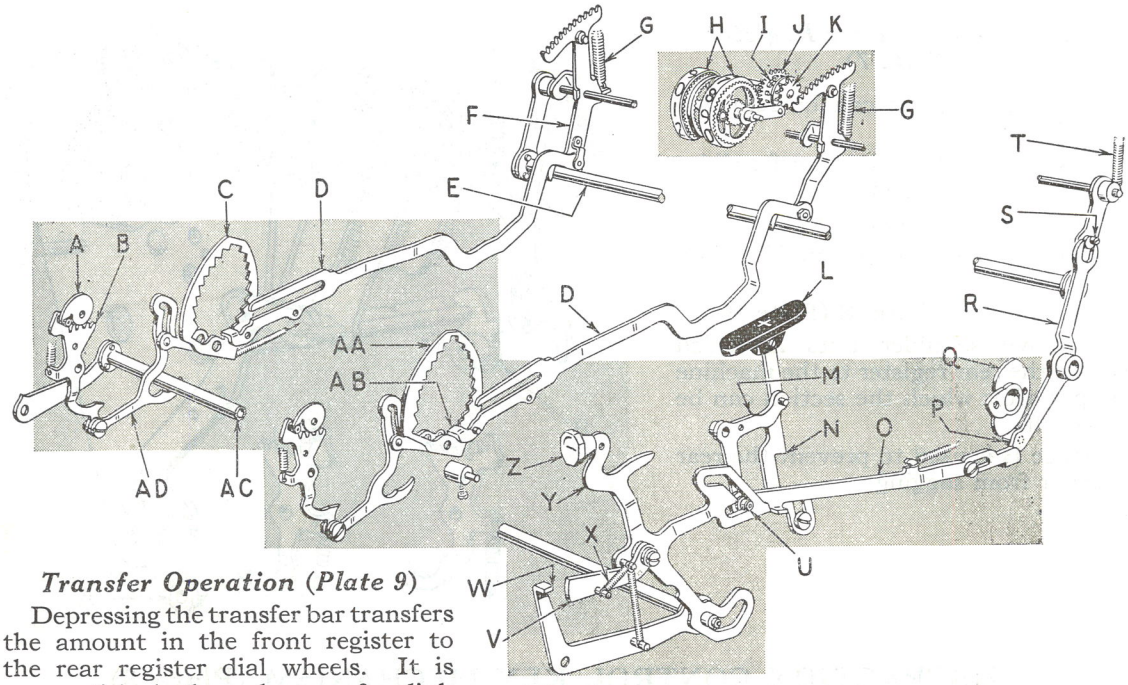
Index rack A has only one series of steps for the transfer links B to limit against on the transfer operation.

The function, tests and adjustments on this mechanism are the same as those required for the duplex subtractor calculator, Plate 9.

AUTOMATIC ONE, UNIT COLUMN (Plate 11)



TRANSFER OPERATION (Plate 9)



Transfer Operation (Plate 9)

Depressing the transfer bar transfers the amount in the front register to the rear register dial wheels. It is accomplished through transfer link D, and index rack C which has two series of steps. The lower index rack steps are used on the transfer operation and the upper steps are for subtraction. The steps are graduated from 0 to 9 and correspond with the figures on the front dial wheels.

Index Limit Rack

As the front register dial wheel is rotated, the timer cam A lowers the index rack to a step corresponding to the figure on the dial wheel through carry arm B and link AD.

Indexing the Amount

Depressing the transfer bar starts the motor, trips the clutch and by rocking bell-crank M, slide O is moved forward to release rocker arm R. As transfer cam Q rotates, transfer bail E is rocked rearward through eccentric S and spring T. The motion of the transfer bail permits transfer link D to move rearward until they limit against the step of the index rack. Spring G rocks the upper sector and moves the transfer link rearward. The rocking movement of the adding sector rotates the pawl gear to index the drive pawl in the ratchet gear tooth corresponding to the amount on the front register dial wheel.

Adding the Amount

The transfer cam Q drives the transfer bail forward through rocker arm R. The bail contacts the foot of adding sector rotating the pawl and ratchet gears to add the amount in rear register dial wheels. As the adding sector is restored, the transfer link fastened to it is carried to normal. After transfer link is normal, the amount in the front register is cleared.

Subtract Operation

Depressing the subtract key subtracts the amount in the front register from the total of the rear register. The subtract mechanism functions in connection with the transfer mechanism, as the transfer bar is also depressed on the subtract key operation.

The subtract key depression finds the complement of the amount in the front register, transferring it, plus an automatic one, to the rear register. Index rack C has an upper series of steps graduated from 0 to 9 and this rack is shifted to the complement steps of the front register amount by the subtract key. Depressing the subtract key with both registers clear, adds a nine in each rear register dial wheel because the complement of cipher is nine. The nines are canceled to cipher by the automatic one.

Subtract Problem

3750	rear register total
825	front register total
9999999174	subtract complement, adds in rear register
1	automatic one, adds in rear register
0000002925	rear register total
0000000000	front register is clear

(Plate 6) Continued

sector normal. Test to see if finger AA contacts toward the top central portion of the drive pawl.

Drive pawl resetting test: Depress the five adding key twice to produce a carry. Clear the machine and see if the drive pawl has reset on the ratchet gear tooth in the column operated and the column receiving the carry.

A weak spring under drive pawl N would prevent the drive pawl from resetting in the tooth of the ratchet gear and result in the dial wheel figure in that column showing low. This would appear in the adding operation.

Dial Wheel Alignment

The top of the figures on the dial wheel should be 1 1/64″ to 1 1/32″ from shaft AB. Use the figure five as a gauge in measuring this distance.

The dial wheel figures can be moved 1/64″ at a time in either direction for each tooth of the universe gear. Changing the mesh of the universe and ratchet gears one tooth, results in different relation of the planet and sun gears. When the gears are remeshed, the sun gear will cause the planet gear to turn which imparts the movement to the dial wheel. The universe gear is turned in the direction the dial wheel figure should move to align.

If the mesh of the universe gear with the ratchet gear and the planet gear with the sun gear is not changed at the same time, the dial wheel figure will move considerably more than a 1/64″.

In the aligning operation, it is necessary to maintain the mesh between the oscillating gear H and dial gear A. If the mesh is changed, the carry gear lugs will move out of position and the dial wheel figure to the left will be out of position. It is also essential to avoid turning the dial wheel as it is installed. If the dial wheel is turned, the figures move a corresponding distance.

To remove any of the gear assemblies in a certain column of the registers, a follow up shaft is used to retain the alignment of the gears in the other columns. The method will be explained under "Dial Wheel Removal Only" after which, the same procedure should be applied in removing other gears or assemblies.

Dial Wheel Replacement

When replacing a dial wheel, two conditions must be considered, the dial wheel alignment and the position of the carry lugs.

Removing the Dial Wheel

Remove the shaft retaining plate, the spring anchor tie strip, and hook the carry arm springs in the notch of the partition plates. Operate the key in the column in which the dial wheel is to be removed until the planet gear is in an upward and forward position to permit easier removal. Measure the distance through the dial wheel to be removed, with a follow up shaft. Insert the follow up shaft to the measured distance, withdraw it sufficiently to permit removal of the dial wheel.

Installing Dial Wheel

Ciphers should be registered in the columns to the right and left of the dial wheel to be replaced. Turn the universe gear until the planet gear is near the figure five on the dial wheel to be installed. Hold it in this position as it is lowered and meshed with the ratchet gear. If the dial wheel figures are out of alignment, apply the aligning operation.

Carry Gear Assembly Alignment

The lugs on carry gear G should be located to clear the cam hook by about 1/32″. The two aligned teeth of pinion gears H on the oscillating arm I are meshed in the fourth tooth space of internal teeth of the carry gear. Include the tooth space opposite the carry gear lug in the count. One tooth of pinion gear H of the oscillating arm is chamfered for identification of the aligned teeth of the two pinion gears (illustration on Plate 6).

The aligned teeth of the pinion gears are placed between the cipher and nine figures on the dial wheel to correctly locate the carry gear lugs. If the aligned gear teeth are not located between cipher and nine, they can be correctly positioned as follows:

Place the planet gear in the dial wheel to the right toward the rear, registering any number except cipher. Lower the dial wheel just far enough to disengage the universe and ratchet gears. Hold the dial wheel and turn the pinion gear until the lug is in alignment with another carry wheel which is correctly aligned.

Removing Carry Gear Assembly

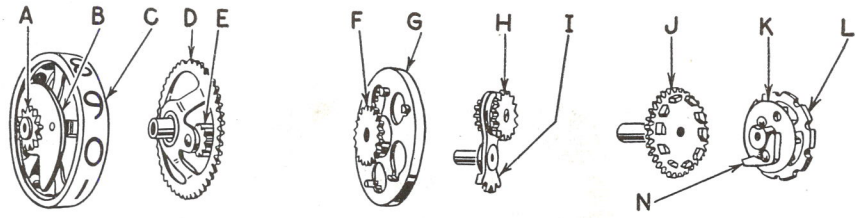
To remove carry gear assembly G and oscillating arm I, locate planet gear E on the bottom side of dial wheel to the left of the carry wheel to be removed. Repeatedly depress the adding keys to obtain this condition.

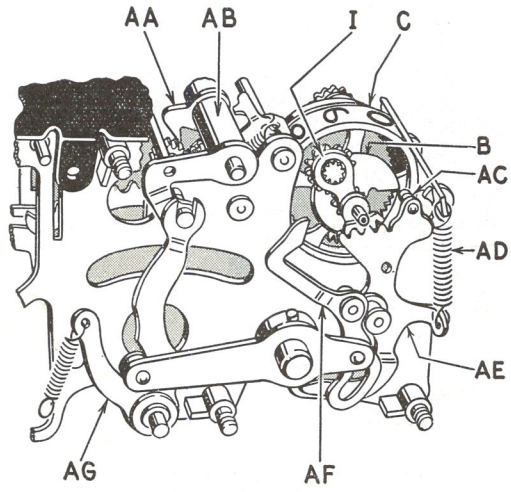
Installing Carry Gear Assembly

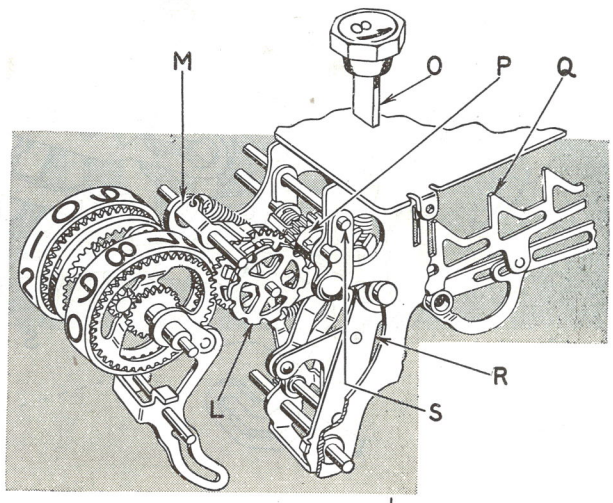
Mesh the first forward tooth of oscillating arm segment I in the first forward tooth space of carry arm AE as the carry gear is lowered into position.

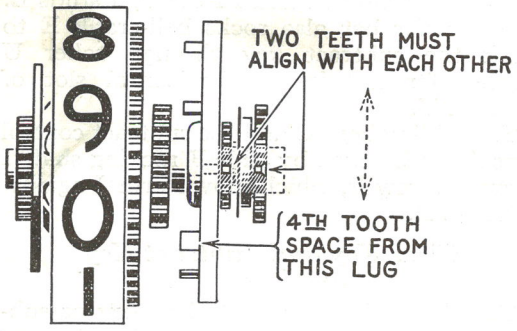
The dial wheel alignment in the column to the left of the carry wheel installed, will be lost. Refer to "Dial Wheel Alignment."

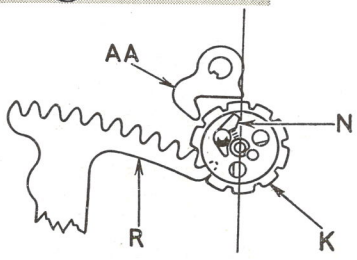
ACCUMULATION, FRONT REGISTER (Plate 6)











RELATIVE POSITION OF PAWL "N" IN CORRECT RELATION TO CANCEL FINGER "AA" AND SEGMENT "R".

Accumulation, Front Register (Plate 6)

The front register consists of a set of dial wheels and various gears to accumulate the amount corresponding to the key depressed.

The key depression drives the sector completely forward, expanding spring AJ, Plate 2, to furnish the power to revolve the dial wheels and various gears. This takes place when the adding key is released, allowing the sector to restore to normal.

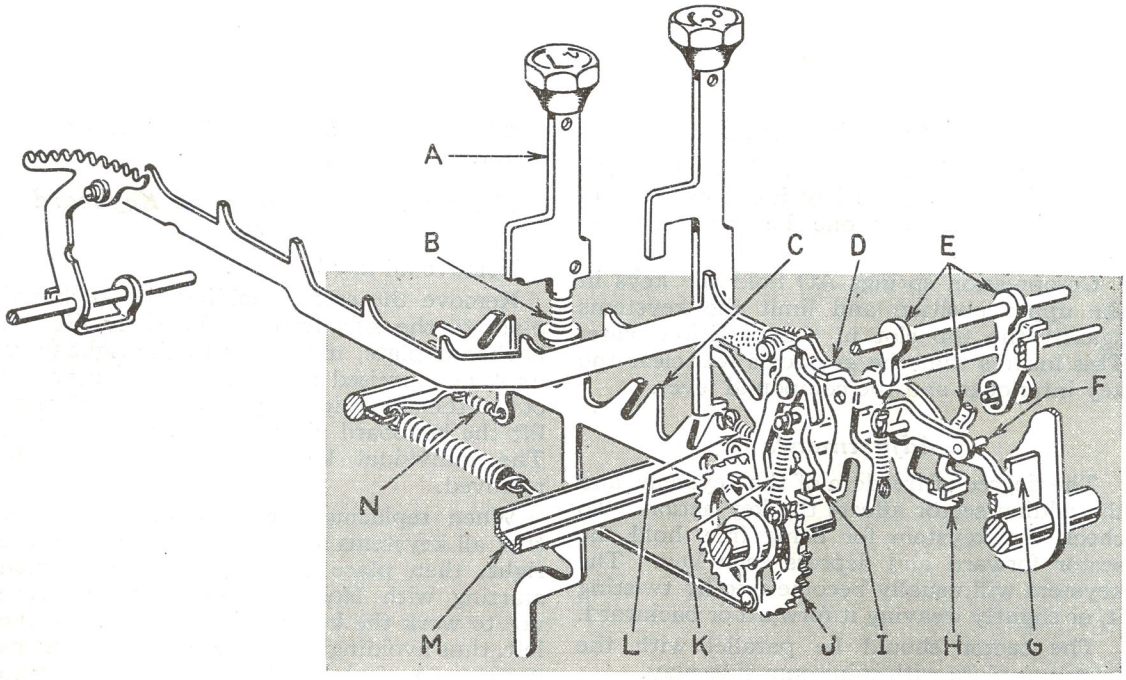
Sector Operation

Adding segment R is fastened to the front end of the sector and it is in constant mesh with pawl gear K, which carries the driving pawl N. The pawl gear is rotated and the drive pawl ratchets by the number of lugs on ratchet gear J to correspond to the depressed key. During the key depression, ratchet gear J is held stationary by detent M.

On the return stroke of the sector, the adding segment rotates the pawl gear, the drive pawl engages the lug of the ratchet gear, rotating it a corresponding amount. The ratchet gear rotates the universe gear D and through planet gear E, carried by the universe gear and meshed with the internal dial wheel

KEY ACTION, ELECTRIC (Plate 4)

(Plate 3 in Symbol Book only)



Key Action, Electric (Plate 4)

The purpose of the electric key action is to obtain a light and uniform key touch for the adding keys. The key action is fast and responsive, because the key stroke is short. This type of key stroke permits an early relatch of compound detent trip arm E on cam latch H, during the up stroke of the key, to insure adding the amount on a rapid repeat key operation.

In machines without the compound leverage detent D, the restoring key stroke is slightly longer, as the keys must restore almost to normal prior to the next depression. Because of this condition, the key action is not quite as fast or as responsive.

Function

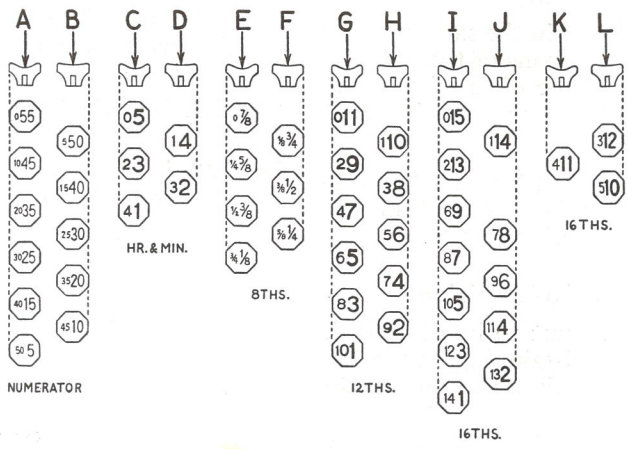
Depressing keystem A moves slide C rearward to swing bail M, closing the switch to start the motor and revolve drive wheels J. Slide C through cam latch H, also moves detent D rearward to clear drive pawl I, permitting spring K to draw the drive pawl into the revolving drive wheels.

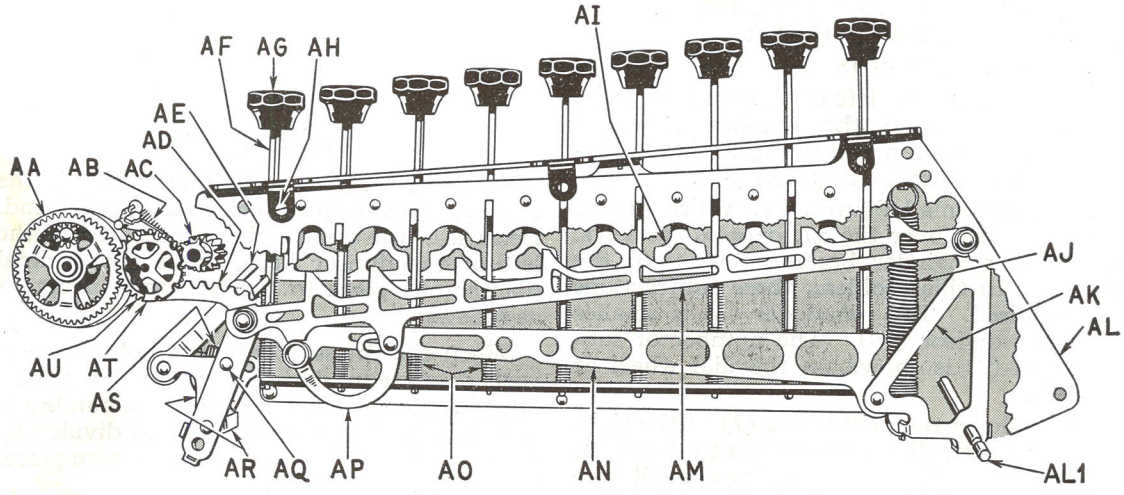
The drive pawl motion causes stud F to lock cam latch H over tie strip G, and disengage it from detent arm E, holding the keystem depressed until the sector indexing is completed.

Disengaging the drive pawl from the drive wheels permits spring L to raise the cam latch off the tie strip and reset on the detent arm as slide and keystem restore to normal through their respective springs. Slide C restoring to normal allows the motor switch to open.

ADDING SECTOR, KEY DRIVEN (Plate 2)

(Plate 1 in Symbol Book only)





Adding Sector, Key Driven (Plate 2)

The key action of the hand calculator is controlled by the construction of the sector assembly. This assembly includes index link AM, compound lever AN, bell-crank AK, compensator bail assembly AR, and adding sector AD.

When a key is depressed, a step on the keystem lowers the compound lever and through bell-crank AK, the index bar is driven against the keystem. The motion of the index bar swings the adding sector forward, which rotates a gear to register the amount.

Compound Lever

Compound lever AN provides a lighter key action with a decreasing pressure resistance on the key as it is fully depressed. Since the key action becomes lighter on the depression, it contributes toward a full key stroke. This decrease on key depression resistance is due to the top anchor of spring AJ being fixed, while the lower anchor moves toward the pivoting point of bell-crank AK. It is most effective on keys from five to nine.

Compensator Bail

The compensator on the front end of index bar AM provides a gradual increased resistance on the depression of the lower keys, due to expanding spring AS. It is effective on keys one through five, and is the means of equalizing the key touch. The greatest expansion of the compensator spring takes place on the depression of the one key, because this key has the lightest touch.

Key Interlocks

Key interlocks AI permit the depression of

Application

Addition is accomplished by depressing the keys which represent the figures to be added. The large figures on the keytops are used. To add 8, depress the eight key in the units column. To add 67, depress the six key in the tens column and the seven in the units column.

There are no large ciphers on the keytops as ciphers are automatically registered on the dial wheels.

Subtraction is accomplished by adding the complement of the number to be subtracted to the amount registered on the dial wheels.

The large keytop figures represent the amount that will add if the keys are depressed, and the small figures represent the complement. This arrangement eliminates the need of mentally computing the complement.

Since there are no small figure nines on the keyboard, no keys are depressed in the columns in which nines appear in the amount to be subtracted.

Depress the keys that represent the amount to be subtracted, using the small figures less one. Depress also, the keys with the small ciphers to the left of the columns used in the subtracted amount. The small cipher keys are used to cancel one unit produced in complementary subtraction in the column to the left of the problem.

When a cipher appears in the unit column of the amount to be subtracted, the one is dropped from the second bank, etc.

Subtract Problems and Complement Layouts

10	minus 2 equals 8.
10	added in dial wheels, using large figure one
9999999998	complement of 2, added in dial wheels, use small 1 and cipher keys for the 9's to the left.
8	answer
5500	minus 260 equals 5240.
5500	added in dial wheels, using large figures
9999999974	complement of 260, added in dial wheels, use small 25 and cipher keys for the 9's to the left.
5240	answer
729	minus 595 equals 134.
729	added in dial wheels, using large figures
9999999405	complement of 595, added in dial wheels, use small 5 and 4 and cipher keys for 9's to the left.
134	answer
3842	minus 301 equals 3541.
3842	added in dial wheels, using large figures
9999999699	complement of 301, added in dial wheels, use small 300 and cipher keys for 9's to the left.
3541	answer

On Calculators having the red subtraction control keys, the control key in the column immediately to the left of the amount being subtracted, is depressed instead of the small cipher keys.

Multiplication is accomplished by repeated addition. The large figures on the keytops are used. The amount to be multiplied, the multiplicand, is held on the keyboard and the keys are depressed the number of times indicated by the multiplying factor. When ciphers occur in the multiplying factor, no operation is required. The multiplicand is moved one place to the left for each such cipher.

To multiply 35 x 3, the five key in the unit column, and the three in the tens column are depressed three times. The product, 105, registered on the dial wheels is the same as obtained by adding 35 three times.

To multiply 35 x 23, multiply by three as explained in the previous example. Next, move the multiplicand over one place and depress the keys twice. The product in the dial wheels should be 805.

INTRODUCTION

This book describes the operation, mechanical functions, tests and adjustments of the hand and electric calculators.

Calculators are non-listing machines which add, multiply, subtract, and divide in a single register.

Hand calculators are key driven machines, since the power for operation is manually furnished by the key depression.

Electric calculators are power driven machines, since the power for operation is furnished by the motor. Electric calculators have subtraction control keys in front of the number one keys. Depressing one of the subtraction control keys adds a nine in that column as well as in all columns to the left.

Duplex subtractor calculators are motor driven machines with a rear register into which amounts from the front register may be transferred. Duplex subtractor calculators have a subtract key which permits subtracting the front register amount from the total in the rear register. All Duplex subtractor calculators have the subtraction control keys.