DECEMBER, 1961

Series C

BURROUGHS CALCULATOR

INSTRUCTION BOOK

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INSTRUCTION BOOK

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APPLICATION AND OPERATION

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APPLICATION AND OPERATION

Simplex calculators are non-listing machines which add, subtract, multiply and divide in a single register. These are either hand operated or electrically operated machines.

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

Electric calculators are power driven machines, the power for operation being furnished by the motor. These machines have subtraction control keys which are located in front of the number one keys. Depressing one of the subtraction control keys adds a nine in this column and in all columns to the left.

Duplex calculators are electrically operated machines with a second register located at the rear of the machine. Amounts accumulated may be transferred to the rear register by using the plus key, or subtracted from the rear register by using the minus key.

Addition

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

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

9999999740 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 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

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.

Decimals are multiplied in the same manner as whole numbers. By means of the pointers on the case in front of the dial 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 preceeding ciphers, the pointer is not moved.

PRORATING

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 adjusted to the nearest cent, a total of the separate calculations may not exactly equal the amount prorated.

The purpose of the Prorating Feature on the Duplex calculator 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. Also, the separate calculations are automatically adjusted to the nearest cent, it being necessary to use the full cent key on the first calculation only.

Example -

Without Prorating Feature

	Results to nearest cent
12.05 x 19% - 2.28950	2.29
x 16% - 1.92800	1.93
x 31% - 3.73550	3.74
x 13% - 1.56650	1.57
x 21% - 2.53050	2.53
100% - 12.05	12.06

With Prorating Feature

With Prorating Feature

Front Register			Amt. transferred to Rear Register
12.05 x 19%	-	2.28950	
Full Cent	-	5	
		2.29450	2.29
Retained on dials		450	
12.05 x 16%	-	1.92800	
		1.93250	1.93
Retained on dials		250	
12.05 x 31%	-	3.73550	
		3.73800	3.73
Retained on dials		800	
12.05 x 13%	-	1.56650	
		1.57450	1.57
Retained on dials		450	
12.05 x 21%	-	2.53050	
		2.53500	2.53
			12.05

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Section II

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BASIC FUNCTIONS

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HAND CALCULATOR

Key Depression Furnishes Power to Accumulate Amounts

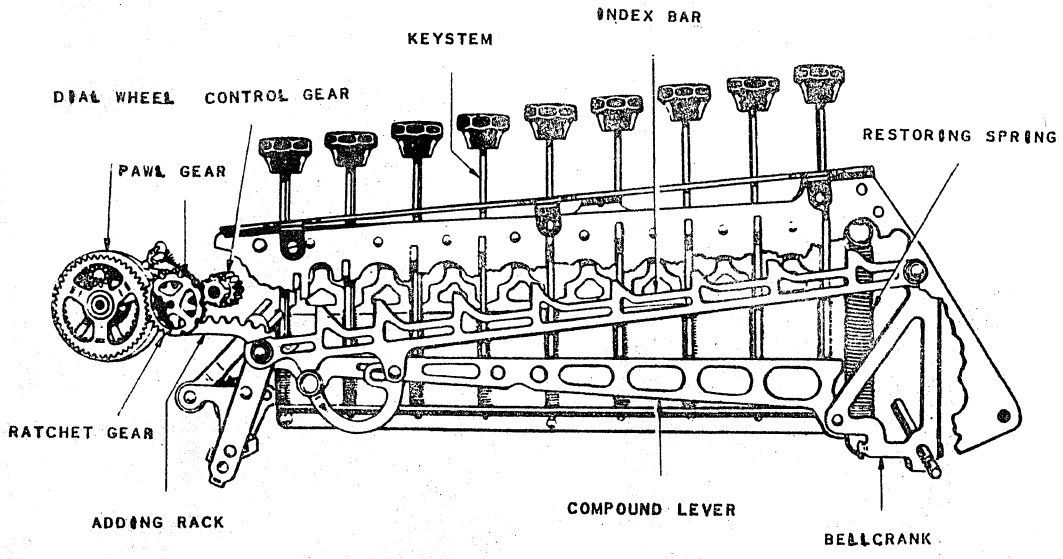

Fig. II-1

When a key is depressed, a step on the keystem lowers the compound lever to drive the index link forward, through the bellcrank, until the index link limits against the depressed keystem. The forward movement of the index link swings the adding sector to turn the pawl gear a corresponding amount.

When the key is released, the spring on the bellcrank restores the adding sector to normal. As the adding sector restores the adding rack rotates the pawl gear, the driving pawl engages and turns the ratchet gear, which in turn rotates the dial wheel to accumulate the amount.

Each dial wheel is connected to the next dial wheel on the left by a train of gears to enable amounts to be carried over in the same manner as when making a mental calculation. These gears have a ratio of ten to one, so that a complete revolution of a dial wheel (ten digits) causes the next dial wheel to the left to move one tenth of a revolution (one digit).

Dials are Cleared by Clearing Handle

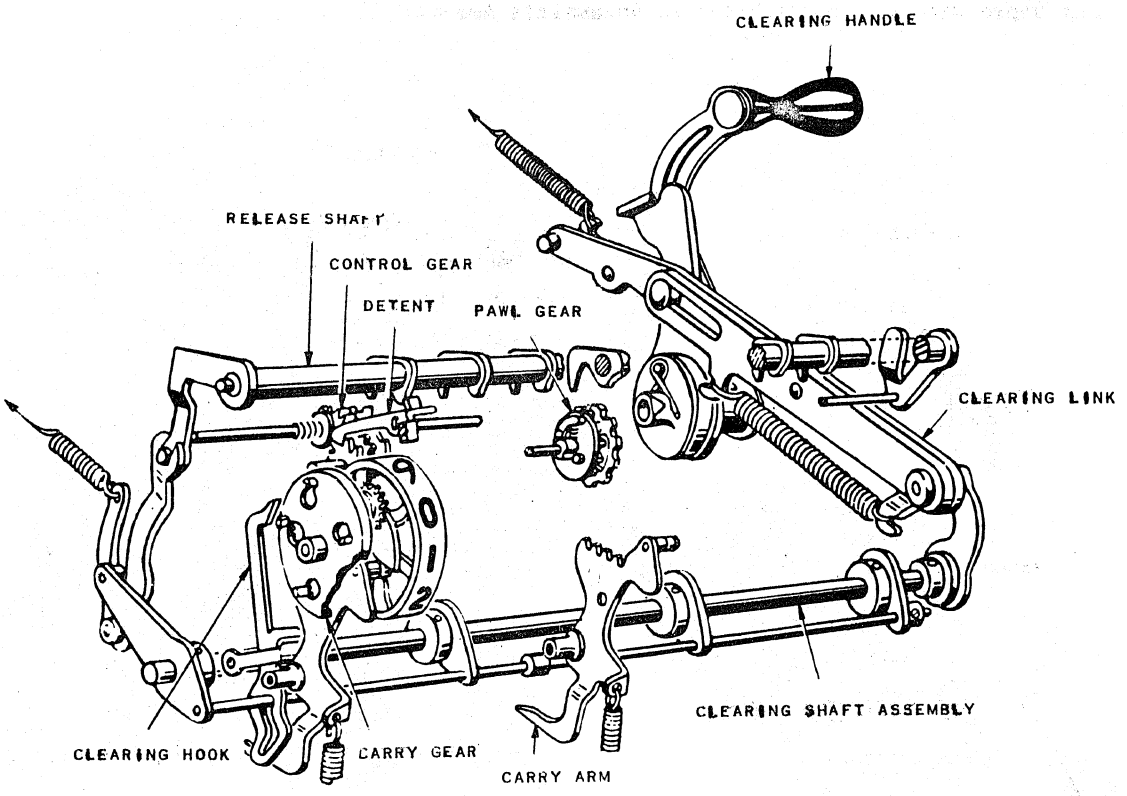

Fig. II-2

To clear previously accumulated amounts from the dial wheels the clearing handle is pulled forward. As the handle is moved forward, the clearing shaft assembly is rocked to position the clearing hooks over the lugs in the carry gears. The left end of the clearing shaft assembly rocks the release shaft which cams the control gears sideways to clear the pawl and ratchet gears. The fingers on the release shaft lower the driving pawls on the pawl gears and raise the detents which allows the dial wheels to be turned to cipher position by the carry arms.

ELECTRIC CALCULATOR

Adding Sector is Power Driven

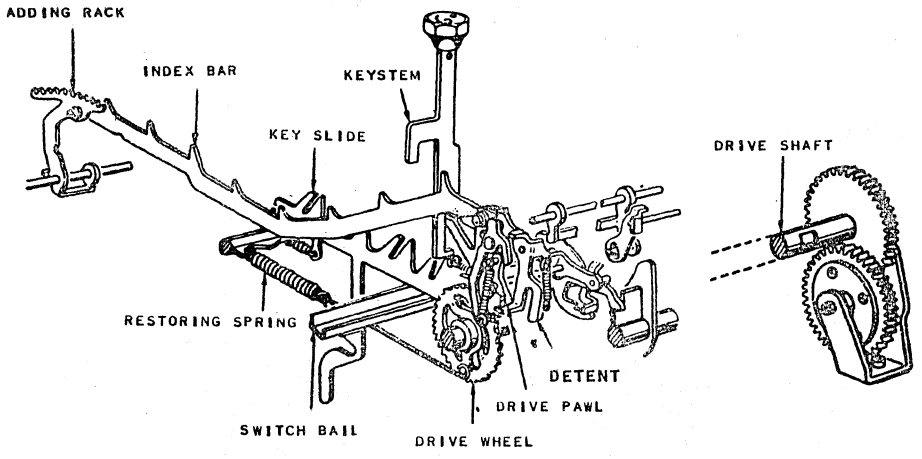

Fig. II-3

On the electric calculator the adding sector is driven by the motor, thus providing a very light and uniform key depression.

When a key is depressed, the key slide is cammed rearwards which rocks the switch bail to start the motor and rotate the drive wheels. The rearward movement of the key slide swings the detent clear of the drive pawl allowing the pawl to engage the rotating drive wheel which drives the adding sector forward until it limits against the depressed keystem. When the adding sector contacts the keystem, the drive pawl is disengaged from the drive wheel and the sector is restored by spring tension.

The amount is accumulated on the dial wheel in exactly the same manner as on the hand calculator.

Clearing Mechanism is Power Driven

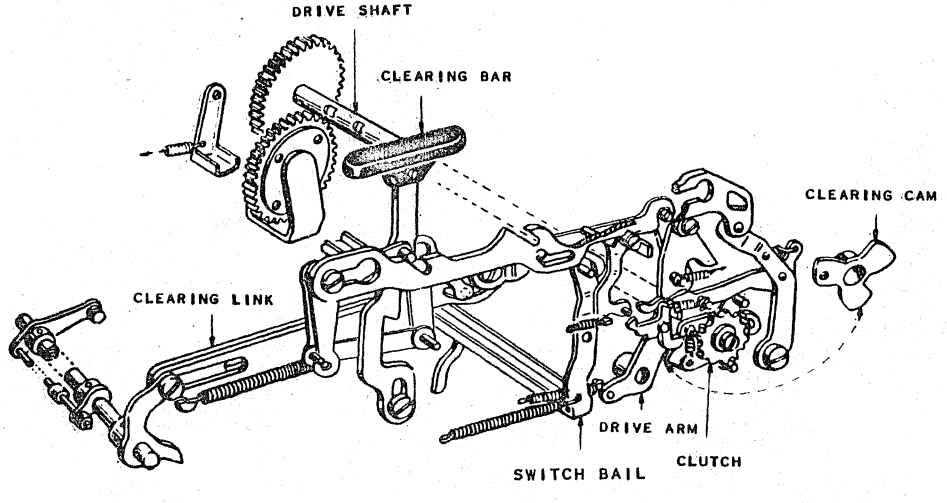

Fig. II-4

The clearing operation relative to the dial wheels is the same as on the hand calculator but the power to accomplish it is supplied by the motor.

Depression of the clearing bar rocks the switch bail to operate the motor and start the drive shaft revolving. Continued depression of the clearing bar engages the clutch to couple the clearing cam to the revolving drive shaft. The clearing link is driven forward by the cam and the drive arm.

Power is Provided by the Motor

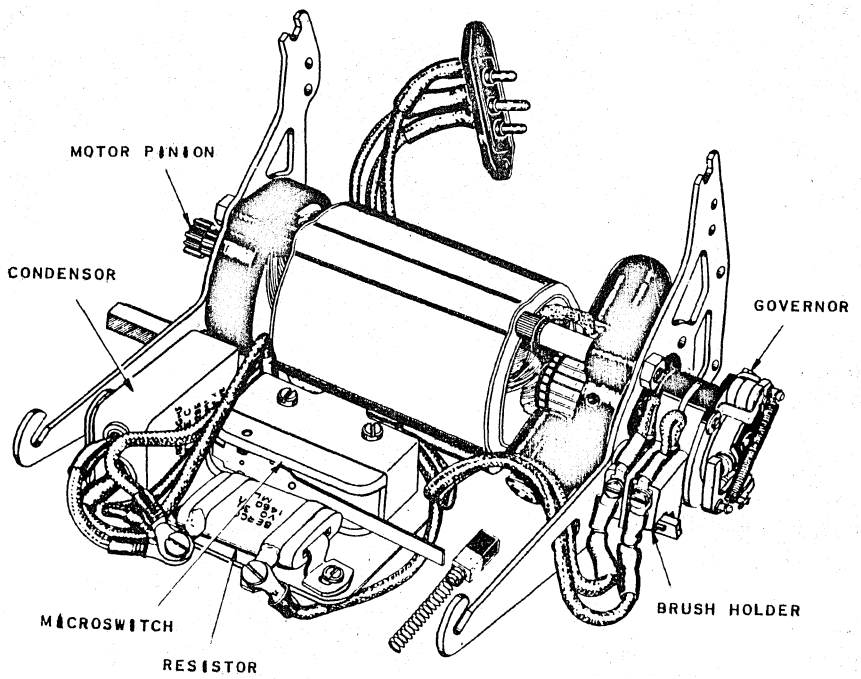

Fig. II-5

Power to operate the machine is provided by an electric motor which drives a shaft containing a set of drive wheels for the adding sectors and a clutch for the clearing mechanism.

A centrifugal governor controls the motor speed, which is adjustable to provide a drive shaft speed of 120 r.p.m. The motor, being of the 'Universal' type, will operate on either direct or alternating current provided that the voltage is within the range shown on the specification plate attached to the motor.

Safety Clutch protects Mechanism

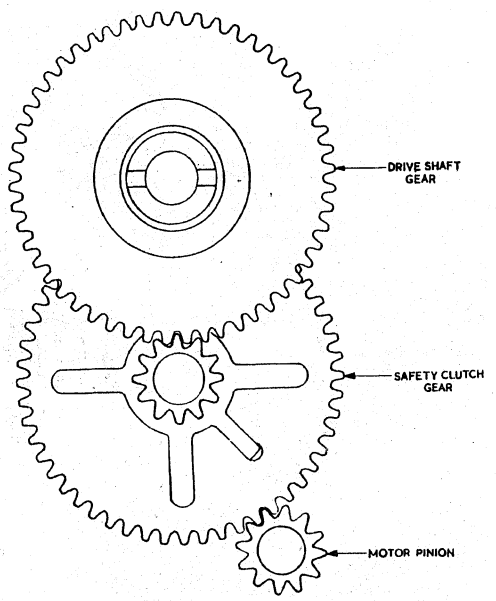

Fig. II-6

Power is transmitted from the motor to the drive shaft through a train of gears, one of which contains a safety clutch. The safety clutch is designed to slip at a predetermined load so that in the event of the machine locking, no damage to individual parts will result and the motor will not be stalled.

DUPLEX CALCULATOR

Amounts Accumulated in Front Register can be transferred to Rear Register

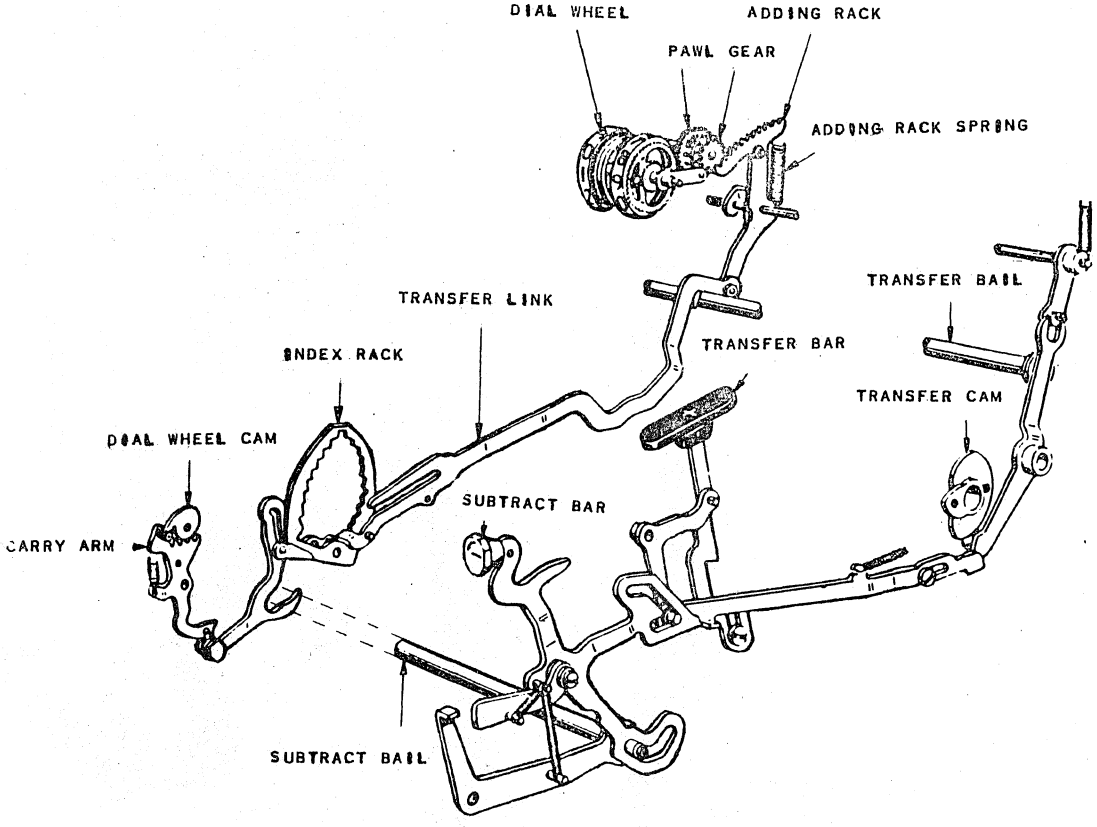

Fig. II-7

On the Duplex Calculator amounts which have been accumulated in the front register can be transferred to the rear register by depression of the transfer bar.

As the front register dial wheels are turned to accumulate amounts, the dial wheel cam rocks the carry arm to lower the index rack to a step corresponding to the figure on the dial wheel.

Depression of the transfer bar starts the motor, trips the clutch and releases the transfer bail. This allows the rear register adding racks to move forward under spring tension until the transfer links are limited by the index racks. As the transfer cam rotates, the transfer bail is driven forward to restore the adding racks and the amount is accumulated on the rear register dial wheels. After the adding racks have been restored, the

front register dial wheels are cleared.

Amounts in Front Register can be subtracted from Rear Register.

Subtraction from the rear register is achieved by transferring the complement of the amount in the front register to the rear register.

The subtract operation is basically similar to the transfer operation. Depression of the subtract bar indexes the transfer mechanism and swings the index racks downwards to position the upper steps, which correspond to the complement of the amounts on the dial wheels, into the path of the transfer links.

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Section III

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MECHANISMS AND ADJUSTMENTS

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ADDING SECTOR, KEY DRIVEN

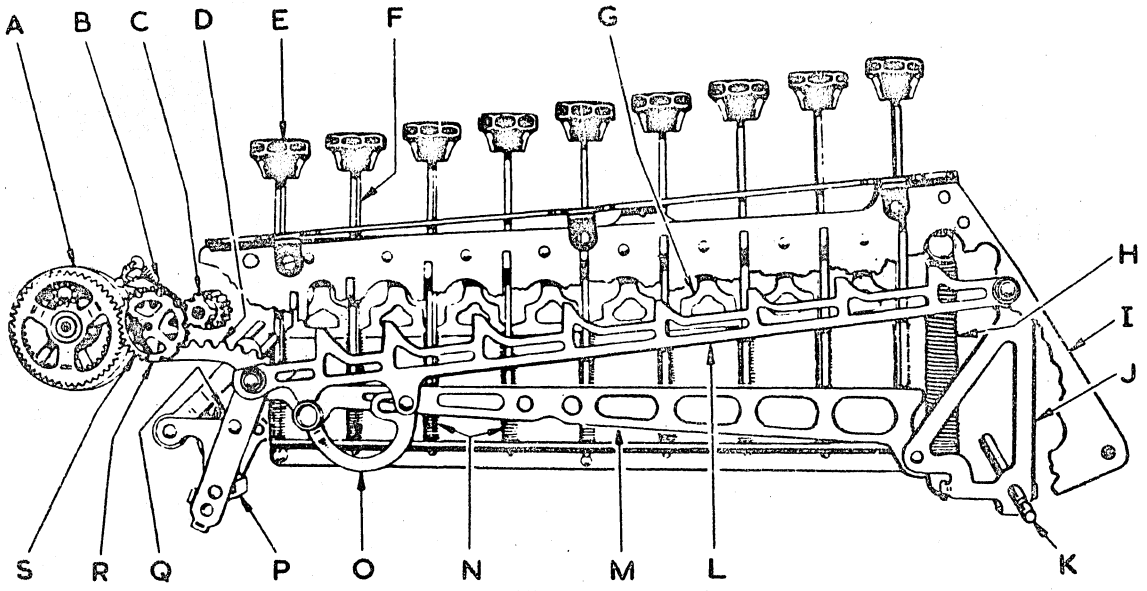

Fig. III-1

The key action of the hand calculator is controlled by the construction of the sector assembly. This assembly includes index link L, compound lever M, bellcrank J, compensator bail assembly P and adding rack D.

When a key is depressed, a step on the keystem lowers compound lever M which swings bell-crank J to drive index link L forward until it limits against the depressed keystem. The forward movement of index link L swings adding rack D to rotate pawl gear R.

KEY PRESSURE IS EQUALISED

Compound lever M 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, this contributes toward a full key stroke. The decreased resistance on key depression is due to the upper anchor of spring H being fixed, while the lower anchor moves toward the pivoting point of bellcrank J. This is most effective on keys from five to nine.

Compensator bail P provides a gradually increased resistance to depression of the lower keys due to expanding spring Q. This is effective on keys one through five, the greatest expansion of spring Q taking place on depression of the one key.

DEPRESSION OF TWO KEYS IN ONE COLUMN IS PREVENTED

Key interlocks G prevent the depression of more than one key in each column. The combined clearances between interlocks G in any column allows only one keystem to pass between them.

At normal, keystems F are held upward by compression springs N to limit in the slots of partition plate I. This holds the keystems clear of interlocks G.

Tests and Adjustments

1. To provide free action of keystems F.

With the adding sector manually held forward, check each keystem for freedom of movement.

To Adjust - twist or bend the keystem as required.

2. To ensure free movement of the adding sector.

With spring H unhooked and the machine standing on its front end, the adding sector should drop of it's own weight.

To Adjust - bend the 'U' form of the adding sector and bellcrank J to obtain slight side play. Check all moving parts to be free from binds.

3. To ensure full travel of the adding sector when a key is depressed.

With a key held depressed, index link L should limit against the keystem and compound lever M should have slight downward play. If this condition cannot be obtained, it indicates that curved link O is bent.

To Adjust - replace the adding sector.

ACCUMULATION

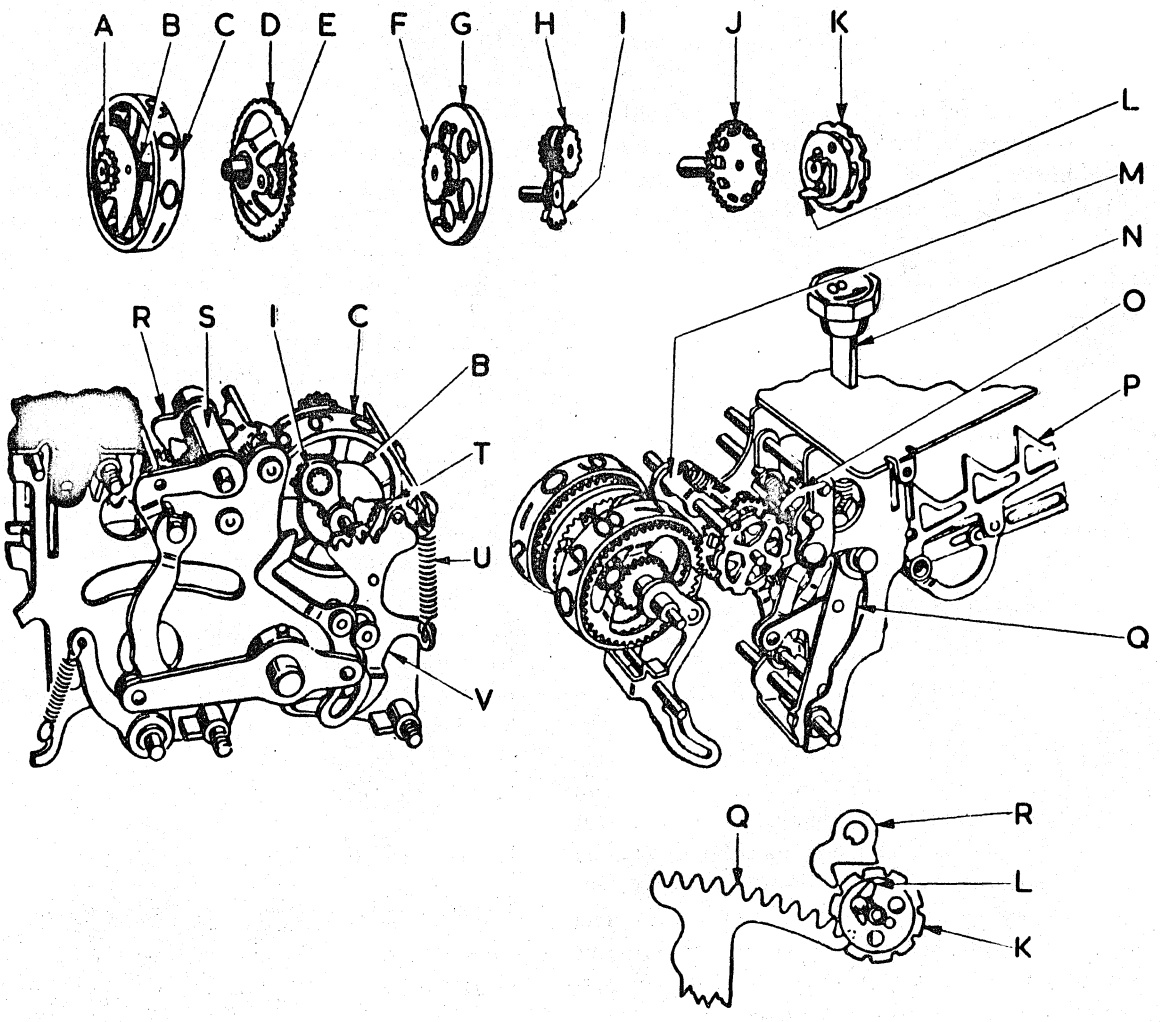

Fig. III-2

The accumulating 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 adding sector forward, expanding spring H, Fig. III-1 to furnish power to revolve the dial wheels and various gears. This takes place when the adding key is released and the sector restores to normal.

SECTOR OPERATION

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

On the return stroke of the sector, adding segment Q rotates pawl gear K and drive pawl L engages the lug of ratchet gear J to rotate it. Ratchet gear J rotates universe gear D and through planet gear E, which is carried by the universe gear and meshed with the internal gear of dial wheel C, the dial wheel is turned to add the amount.

PLANETARY GEARING

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

When adding an amount, planet gear E is carried around the stationary sun gear F by universe gear D. In the carry operation the sun gear itself rotates which causes planet gear E to revolve on it's own axis to register the carry on the dial wheel. This method of gearing permits the simultaneous adding and carrying operation.

CONTROL GEAR PREVENTS OVERTHROW OF DIAL WHEELS

The control gear prevents an overthrow of the ratchet gear and dial wheel when the adding sector is suddenly stopped on the return stroke. This overthrow is due to the connection between the pawl and ratchet gears being a ratchet drive pawl. Pawl gear K and drive pawl L 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, pawl gear K must stop, but ratchet gear J which is driven by pawl L may have sufficient momentum to continue rotating further than it was actually moved by the drive pawl. If the ratchet gear is allowed to overthrow, it results in an overthrow of the dial wheel causing over-addition.

Control gear O is in constant mesh with ratchet gear J, but in mesh with pawl gear K only on the return stroke of the sector. This meshing arrangement is possible due to the widely spaced teeth on the right hand 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 of the sector, pawl gear K drives ratchet gear J which in turn rotates control gear O, 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 also must stop which prevents overthrow of the dial wheel.

CARRY OPERATION

The carry operation is performed through a train of gears, a timer cam and a carry

arm which imparts the motion to the dial wheel through the planet gear. This train of gears is interconnected from one column to another and has a ratio of ten to one. For example, when a dial wheel makes a complete revolution, the dial wheel in the next column to the left will make one tenth of a revolution.

As dial wheel C is rotated during the addition of a figure from one to nine, gear A turns gear H on oscillating arm I. At the same time, cam B on the dial wheel is moving carry arm V forward which rocks gear H rearward. This rearward movement of gear H counteracts the rotation of the gear and prevents it from turning carry gear assembly G, thus preserving the alignment of the dial wheel in the next column. As the dial wheel moves beyond the nine position, the peak of timer cam B clears roller T which allows spring U to rock carry arm V rearward and oscillating arm I forward. The forward movement of the oscillating arm, through gear H, turns carry gear G which transmits the carry to the next dial wheel through the sun and planet gears. This completes the carry in one quick operation and provides reading alignment of the dial wheel figures at all times.

TESTS AND ADJUSTMENTS

1. To provide the correct position of pawl L relative to finger R and segment Q.

With the adding sector in the home position, the forward edge of pawl L should align with an imaginary vertical line through the centre of the hub of pawl gear K, and finger R should contact the top central portion of the pawl.

To Adjust - change the mesh between pawl gear K and segment Q.

2. To provide free action of the adding sector.

Adding segment Q should align centrally between the sides of pawl gear K.

To Adjust - bend segment Q sideways.

3. To provide the correct depth mesh between adding segment Q and pawl gear K.

T There should be slight play (approximately .010) of pawl gear K in the teeth of segment Q.

To Adjust - bend the front end of segment Q up or down as required.

CLEARING MECHANISM, HAND CALCULATOR.

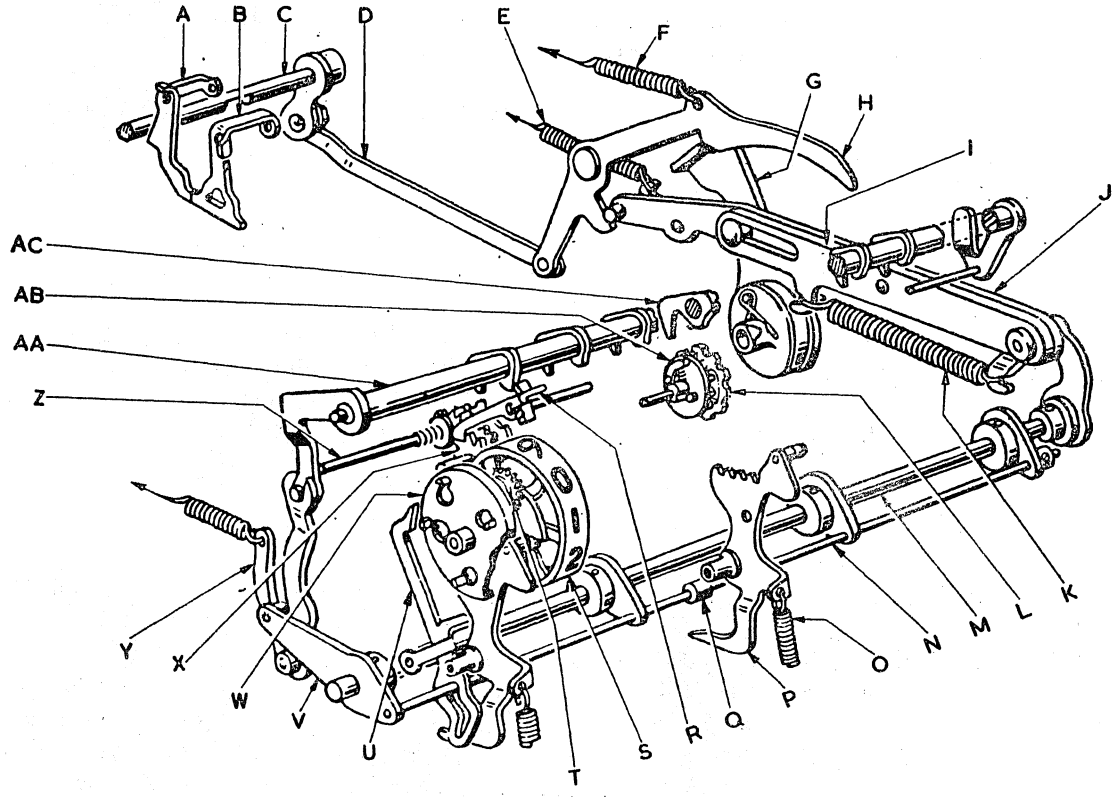

Fig. III-3

When the clearing handle is pulled forward, the dial wheels are turned back to the cipher position thus clearing the previously accumulated figures from the dials.

The forward movement of the clearing handle rocks arm G, carrying link J with it, which permits spring F to raise check pawl H clear of the formed ear on arm G. As pawl H is raised, link D rocks shaft C which moves interlock A forward against key locks B to prevent depression of the adding keys. The formed ear of arm G moving under the curved portion of pawl H maintains the keys locked throughout the clearing operation.

Link J, through spring K, moves link I forward to rock shaft assembly M. Shaft assembly M, through arm V and cam arm Y, rocks shaft assembly AA which causes finger AC to disengage drive pawl AB from the lugs of ratchet gear X and raise check pawl R clear of the ratchet gear. The rocking of shaft assembly AA also cams control gear shaft Z to the left to disengage the control gear from the pawl gear.

The downward movement of shaft N in the cam slot of arm U swings the upper hook over the lug on carry wheel W, rotating it and oscillating arm T slightly rearward. This motion of the gears moves the roll in carry arm P off the dial wheel timer cam to allow the wheel to be revolved by spring O, carry arm P and oscillating arm T.

The continued downward movement of shaft N moves roller Q against the foot of carry arm P to ensure that the dial wheel remains at cipher.

On the return stroke of the clearing handle, spring E restores link J which rocks shaft assembly M rearwards and allows the parts moved to the clearing position, to restore to normal.

TESTS AND ADJUSTMENTS

1. To ensure free movement of shaft assembly A.A.

Shaft assembly AA should have minimum end play between the side frames.

To Adjust - bend the side frames.

2. To ensure free movement of control gear shaft assembly Z and correct position of the control gears.

a) With the clearing handle normal, the control gear should have full hold on pawl gear L and there should be approximately .005" end play of shaft assembly Z.

b) With the clearing handle forward, the control gear should be completely disengaged from pawl gear L and there should be approximately .005" end play of shaft assembly Z

To Adjust - bend the cam arms at the ends of shaft assembly AA.

3. To ensure disengaging drive pawl AB from ratchet gear X on a clearing operation.

Fingers AC on shaft assembly AA should be set centrally between the pawl and ratchet gears.

To Adjust - bend fingers AC.

4. To provide the correct amount of lift of check pawls R and ensure that all dial wheels clear at the same time.

With the clearing handle held fully forward, there should be slight play between the formed ear of check pawl R and fingers AC.

To Adjust - bend the formed ear of check pawl R.

5. To prevent interference between arm U and carry wheel W.

With the clearing handle forward, the hook of arm U should have good side hold on the lugs of carry wheel W but should not contact the side of the carry wheel.

To Adjust - bend arm U as required.

6. To ensure clearing the dial wheels on a fast operation.

With the clearing handle held fully forward, there should be slight rearward play (not more than 1/32") of each dial wheel S. Repeat this test for each of the five lugs on the carry wheel.

To Adjust - bend the foot of carry arm P towards or away from roller Q.

Accumulating Mechanism Protected Against Harsh Operation of the Clearing Handle.

The adding and carrying mechanisms are protected against a sudden or harsh clearing operation by check pawl H and spring K which forms a yielding connection between links I and J.

If the clearing handle is struck a sharp blow, spring F does not have sufficient time to raise check pawl H clear of the formed ear on arm G thus preventing forward movement of the clearing handle.

If the dial wheel or one of the connecting gears fails to turn, they cannot be forced as spring K will yield as the clearing handle is pulled forward.

CLEARING HANDLE FULL STROKE MECHANISM

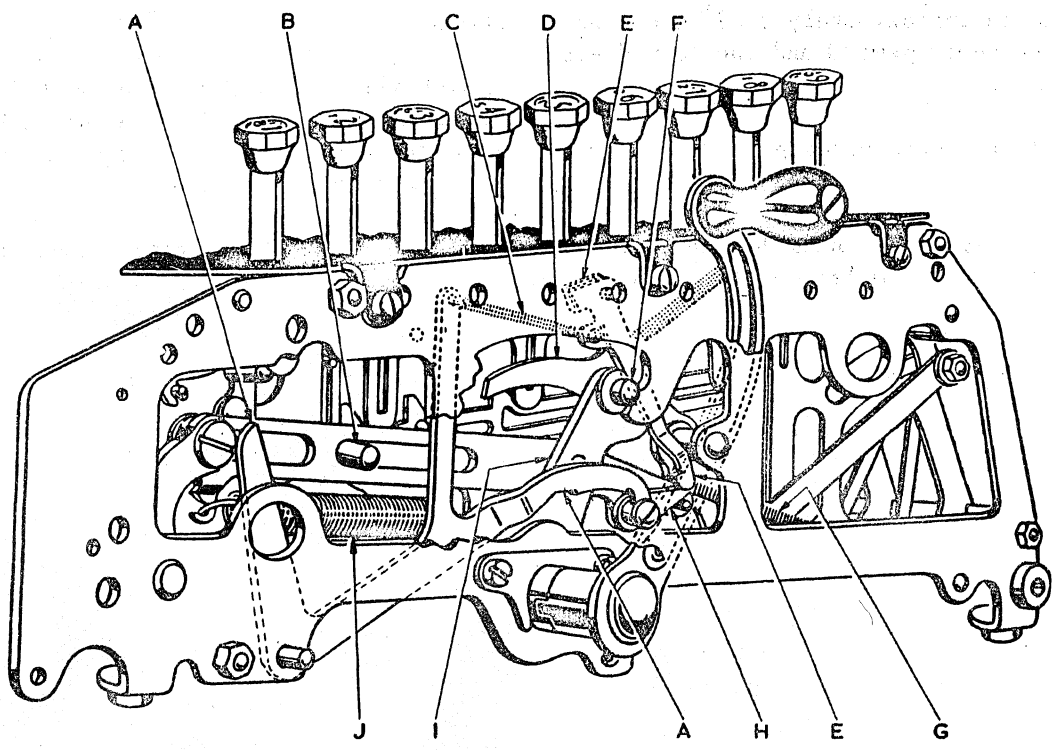

Fig. III-4

The full stroke mechanism ensures that the dial wheels are completely cleared by compelling a full forward stroke of the clearing handle. If the handle is pulled partially forw[illegible] the full stroke mechanism prevent[illegible] from restoring to normal thus retaining the adding keys blocked against depression.

As the clearing handle is pulled forward, full stroke lever A is pulled down on to the flat surface of hub assembly H and latch E moves forward under tension of spring C. Near the end of the forward stroke, stud B raises full stroke lever A to permit latch E to latch it in the upward position. When the clearing handle restores to normal, stud F moves latch E to release full stroke lever A.

If the clearing handle is not pulled fully forward, stud B does not raise full stroke lever A to latch it on latch E. Therefore, when the clearing handle is released, full stroke lever A prevents full restoration of the handle which maintains the adding keys blocked against depression.

Should the dial wheels fail to turn on a clearing operation, spring J expands and stud B does not raise full stroke lever A. This causes the clearing handle to latch forward on the front step of full stroke lever A. Rearward pressure on the clearing handle overcomes the tension of spring G, permitting hub assembly H to turn slightly and release from the step of full stroke lever A.

TESTS AND ADJUSTMENTS

1. To prevent depression of the adding keys following a short stroke of the clearing handle.

With the clearing handle held by the rear step of full stroke arm A, there

should be approximately 1/32" clearance between check pawl D and the formed ear of arm I.

To Adjust - bend check pawl D.

2. To allow the clearing handle to fully restore after completion of the forward stroke.

With the clearing handle held fully forward, full stroke lever A should have approximately 1/32" latching lead over the formed ear of latch E.

To Adjust - bend the vertical projection of lever A.

KEY ACTION AND ADDING SECTOR

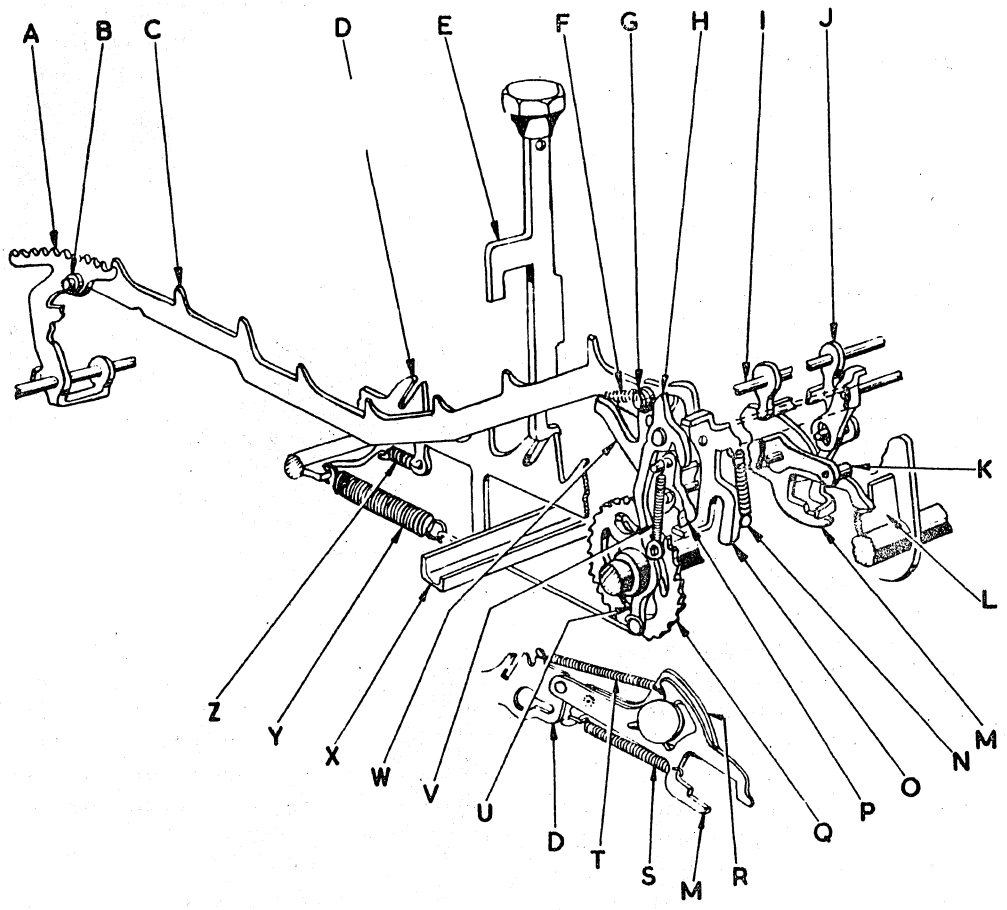

Fig. III-5

To add the ount in the front register, index bar C of the adding sector assembly is driven forward by the motor until the upper projection limits against the depressed keystem. The index bar has eight upper projections corresponding to keys one to eight. The nine limit for the index bar is provided by stud B limiting in the forward end of the slot in the partition plate. At normal, the rearward limit for the adding sector is provided by a projection on segment assembly A which limits on a stud in the partition plate.

KEY FUNCTION

Depression of keystem E cams slide D and latch M rearward. The vertical projection of slide D rocks bail X to close the motor switch and start drive wheel Q revolving. Continued depression of the keystem, through the step of latch M, rocks part J to move detent O clear of drive pawl P. As detent O clears the drive pawl, spring V pulls the drive pawl into the teeth of drive wheel Q. As the drive pawl swings downward, stud K lowers latch M over tie strip L to retain slide D rearward and hold the key depressed. The downward movement of latch M releases part J and detent O is restored by spring N.

Auxiliary cam R, through spring S, ensures that latch M maintains hold over the tie strip should the drive pawl contact

the high point of a tooth on the drive wheel.

SECTOR FORWARD STROKE

Drive wheel Q picks up drive pawl P which is attached to arm U, moving the adding sector forward against the depressed keystem. When index bar C limits against the keystem, arm U continues to move forward in its upper slot causing stud G to rock reverse arm H to reverse the pull of spring V, As reverse arm H is rocked, its rearward hook contacts the spring anchor stud of drive pawl P to disengage the drive pawl from the drive wheel.

SECTOR RETURN STROKE

When the drive pawl disengages from the drive wheel, latch M is permitted to release from tie strip L which allows slide D and the keystem to restore. Spring Y supplies the power for the return stroke and the amount is added by adding segment A. Towards the end of the return stroke, reverse arm H contacts shaft I to change the directional pull of spring V and to seat the drive pawl on the shelf of detent O.

BOOSTER ARM

Booster arm W which is part of assembly U, absorbs the shock of the drive pawl engaging the revolving drive wheel and prevents a premature disengagement of the drive pawl. The formed ear of the booster arm engages a step in index bar C thus preventing the index bar from moving in the slot of assembly U.

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

Spring F holds index bar C against the forward end of the slot in assembly U to retain the clearance between the booster arm and the step of the index bar.

YIELDING DRIVE WHEEL

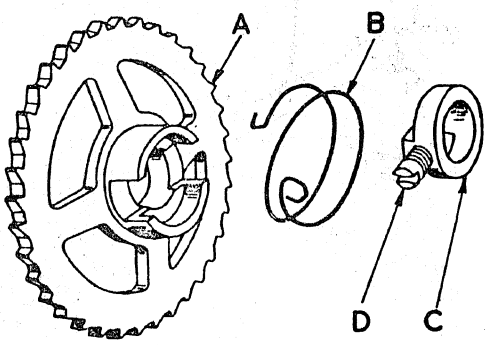

Fig. III-6

The yielding drive wheel prevents under addition caused by the drive pawl holding only by its point on a tooth of the drive wheel and then slipping off to re-set on detent O before the sector has reached its indexed position.

The drive wheel assembly consists of drive wheel A, torsion spring B and drive collar C which is locked to the drive shaft with set screw D. This arrangement allows the wheel to idle a fixed distance when the drive pawl is released, thus permitting more time for the drive pawl to seat securely in the drive wheel teeth. Spring B is assembled with one end attached to set screw D and the other end hooked around the spoke of wheel A nearest to set screw D to take up the idling movement of the wheel in the direction of rotation.

TESTS AND ADJUSTMENTS

1. To prevent a premature disengagement of the drive pawl and to allow the booster arm to re-set on the step of the index bar.

With the adding sector in the normal

position, there should be approximately .010" clearance between the formed ear of booster arm W and the step of index bar C.

To Adjust - bend the booster arm

2. To ensure that key slide D receives the same amount of rearward movement from each keystem.

Using Kit C43 1/8 to hold the drive pawl normal, depress each key in the column and observe the rearward movement of latch M. This should be the same from each keystem.

To Adjust - bend the lug at the bottom of the keystem. Bend the lug towards the rear of the machine for more movement or towards the front of the machine for less movement.

3. To ensure that detent O clears drive pawl P when a key is depressed.

With the drive pawl held in its normal position by Kit C43 1/8 and a key held depressed there should be .030" to .040" clearance between the nose of the drive pawl and the shelf of detent O.

To Adjust - bend the long arm of part J towards the front of the machine to increase the clearance or towards the rear of the machine to decrease the clearance.

Note : Excessive clearance between the pawl and the detent reduces the lead of the step of latch M over the formed ear of part J when the keystem restores.

4. To provide the correct clearance of cam latch M over tie strip L.

With the adding sector and detent O normal and a key partially restored, there should be .006" to .010" clearance of the upper arm of latch M over tie strip L. Check this by holding a key depressed and inserting a .006" feeler gauge in the slot of the tie strip under the nose of latch M. Under these conditions the latch and the keystem should restore when the key is released. Using a .010" feeler gauge, the latch should bite on the feeler gauge and prevent the latch and keystem from restoring.
Be sure to hold the feeler gauge parallel with the under side of the latch when making these tests.

To Adjust - bend the lower arm of latch M upwards for less clearance or downwards for more clearance.

Note : Excessive clearance allows the cam latch to limit on the stud in the drive pawl instead of on the arm of part J, thus reducing the hold of the cam latch step on the formed ear of J.

5. To ensure maximum hold of cam latch M over tie strip L and prevent overaddition due to a premature release of the keystem.

With the adding sector normal, there should be from .018" to .020" clearance between stud K in the drive pawl and the top of cam latch M.

To Adjust - proceed as follows. To decrease the clearance, place a screw driver under the nose of the drive pawl supporting it on the wheel and the tie strip, then strike the drive pawl arm which contains stud K, a light downward blow.

To increase the clearance, support the arm which contains stud K and strike the nose of the drive pawl a light downward blow. Detent O should be held rearward while making this adjustment.

6. To ensure that drive pawl P reverses correctly when index bar C limits on the depressed keystem.

Depress the number two key and turn the

drive gears slowly and steadily by hand. When the index bar limits on the keystem, the drive pawl should fully reverse and the sector should restore to normal to reset the drive pawl on the shelf of detent O.

To Adjust - if the drive pawl drops back into the teeth of the drive wheel instead of resetting on the shelf of the detent, tilt the spring stud in the drive pawl, towards the front of the machine.

7. To provide the correct lateral position of drive wheel Q.

The nose of the drive pawl should have flush hold on the drive wheel and there should be slight clearance between the side of the drive wheel and arm U.

To Adjust - loosen the set screw in the hub of drive wheel Q and move the drive wheel as required. When tightening the set screw, ensure that it contacts the flat surface of the drive shaft.

GEAR DRIVE AND SAFETY CLUTCH

The motor power is transmitted to the drive wheels through the pinion on the armature shaft, intermediate gear G and its pinion which is meshed with gear D. Gear D is connected to drive wheel shaft E by drive pin C which engages a slot in the hub of the gear.

A safety clutch is incorporated in intermediate gear G which slips if the load on the gear becomes excessive. This prevents damage to the machine and motor if the machine should lock. The machine is driven through the clutch assembly by four ball bearings B which are held in the pockets of disc I by the arms of spring A.

If the machine locks, the motor continues to turn intermediate gear G, the load on pinion J overcomes the tension of spring A and the ball bearings are forced out of the pockets of disc I.

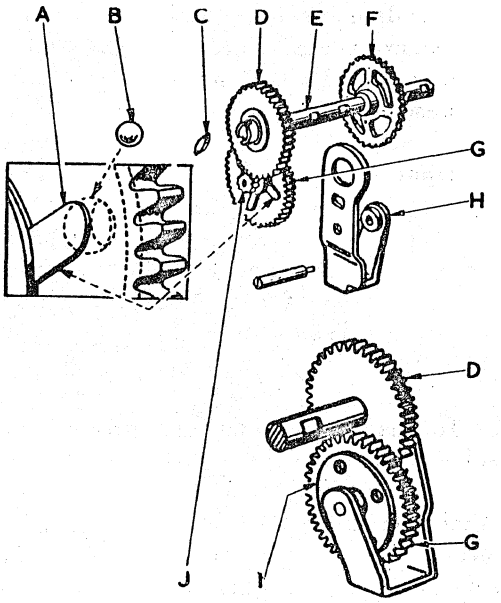

Fig. III-7

TESTS AND ADJUSTMENTS

1. To obtain quiet operation of the drive gears.

The mesh of the motor pinion and intermediate gear G should be as deep as possible consistent with quiet operation.

To Adjust - swing bracket H as required.

ADDING SECTOR AND DRIVE WHEEL MECHANISM - REDESIGNED

A redesigned adding sector and drive wheel mechanism has been incorporated on all electric Series C machines from Serial No. C69329S. This new mechanism increases the machine operating speed by giving a quicker sector pick-up and reduces chatter of the listing keys.

Split Drive Pawl

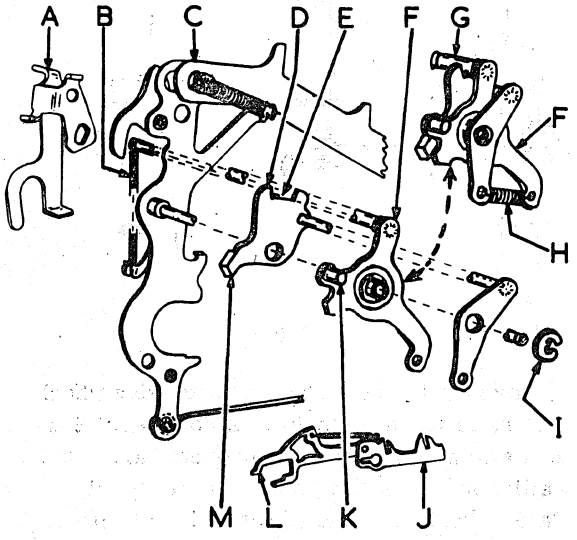

Fig. III-7-1

The adding sector carries a two part split drive pawl and reverse arm assembly mounted on a post of the adding sector. This assembly consists of reverse arm assembly F (Fig. III-7-1) which carries stud G for the reverse spring B and stud K which lowers the cam latch L on key slide J.

The split drive pawl assembly M is made up in a 'U' form and mounted on hubs on each side of reverse arm assembly F, with spring H providing a yielding joint between the two parts. Clip I secures the whole assembly to the adding sector C.

With the adding sector in the home position, the reverse arm assembly F rests on the platform of detent A and through the reverse spring stud G, holds the drive pawl M clear of the drive wheel.

Depression of a listing key moves detent A rearward to release the reverse arm assembly F which under the tension of springs B and H lowers the drive pawl M into the teeth of the drive wheel. If the drive pawl does not seat fully in a tooth space of the wheel, the spring H will yield allowing reverse arm assembly F to drop its full distance and latch key slide J over the tie strip. Pocket E allows for the amount of yield required should the drive pawl M land on the top of a tooth on the drive wheel at the start of an operation.

When the sector C limits on the indexed keystem and the drive pawl assembly is reversed, momentum causes spring joint H to yield which if uncontrolled would result in the forward part of the drive pawl M contacting the drive wheel resulting in over-addition. Projection D provides an overthrow limit by contacting post G on reversal.

Split Drive Wheel

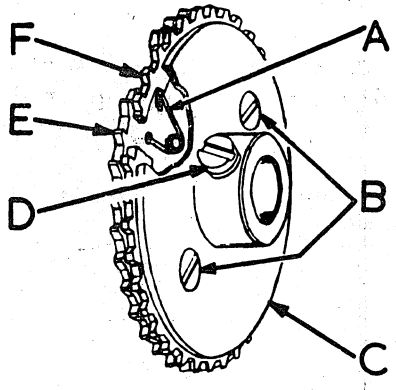

Fig. III-7-2

The split drive wheel assembly consists of a toothed gear and hub assembly E (Fig. III-7-2) auxiliary toothed gear ring F, a torsion spring A, cover plate C and securing screws B.

Spring A holds gear ring F slightly in advance of the main gear E and provides a cushioning effect when the drive pawl engages the drive wheel allowing time for the drive pawl to seat fully should it enter only on the point of a tooth. Screw D secures the main gear and hub assembly direct to the drive wheel shaft. This construction provides a quicker sector pick-up and machine operation and overcomes wheel wobble encountered with the earlier drive wheels.

Tests and Adjustments

The Tests and Adjustments on Pages 12, 13 and 14 remain the same except for adjustment 5. For machines with split drive pawl construction the adjustment should read.

1. To ensure maximum hold of cam latch L (Fig. III-7-1) over the tie strip and prevent over-addition due to a premature release of the keystem.

With the adding sector normal there should be from .012 to .018 clearance between stud K in the reverse arm assembly F and the top of cam latch L.

To Adjust: Bend the projection of assembly F which carries stud K up or down as required.

Note: Do not tip the stud as this may loosen the riveting.

DRIVE PAWL AND DRIVE WHEEL COMBINATIONS

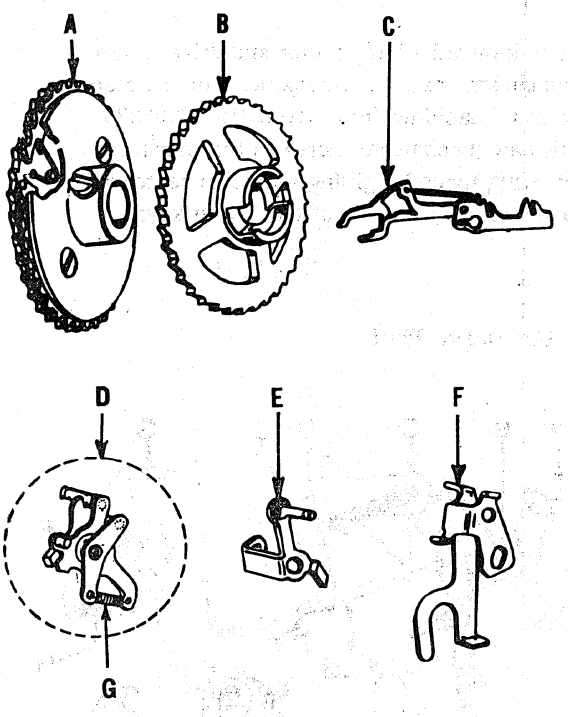

Fig. III-7-3

1. Drive pawl E should be used with drive wheel B or its earlier non-flexible version. Pawl E is still available for field replacement, as are the earlier adding sectors which carry this pawl. Pawl E should not be used with drive wheel A due to the possibility of non-accumulation from rapid key depression.
2. Drive pawl D should be used only with drive wheel A.
3. Drive wheel A is designed to increase the adding sector speed above that which is obtained with drive wheel B (minimum speed of 470 strokes per minute is required).
4. Drive wheel B and its non-flexible version are no longer available for field replacement. Should either of these earlier drive wheels need replacement, fit drive wheel A. The use of drive wheel A also requires that the adding sector in that particular column should be the current part equipped with split drive pawl D.

SUBTRACT CONTROL KEY MECHANISM

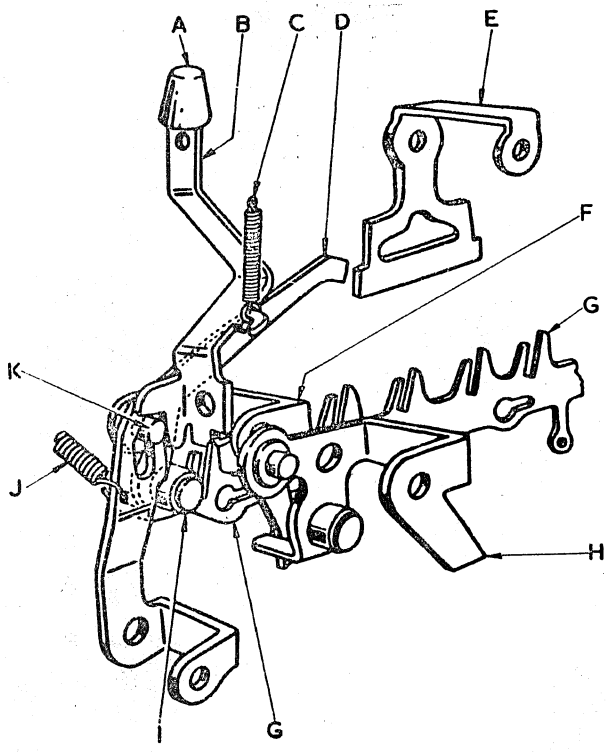

Fig. III-8

The subtract control keys, which are located to the front of the number one 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. Depressing a subtract control key adds a nine in that column and in all columns to the left.

When keystem B is depressed a projection on the keystem contacts stud K which rocks bail F. The rocking of bail F causes roller I to move slide G rearwards to start the motor and trip the drive pawl to actuate the adding sector.

Bail F has a formed ear which overlaps the foot of the bail in the column to the left. This overlapping of the bails is the means of imparting the movement from one bail to the next one on the left.

ADDING KEYS ARE BLOCKED

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

TESTS AND ADJUSTMENTS

1. To ensure the accumulation of nines in each column to the left of the depressed subtract control key.

There should be minimum clearance between the formed ear on bail H and the foot of bail F.

To Adjust - swing the formed ear of bail H.

2. To ensure free movement of keystems B.

Depress and hold the subtract control key in the extreme right hand column, test the key in each column to the left for freedom of movement and full restoration.

To Adjust - bend or twist the keystem as required.

3. To ensure free movement or bails H and F.

Hold down the subtract control key in the extreme left hand column and depress the key in the next column to the right. Check that bails H and F restore freely. Repeat this test for each column, holding down the next key to the left of the one being tested.

To Adjust - bend the bail across the 'U' form.

CLEARING MECHANISM, SIMPLEX CALCULATOR

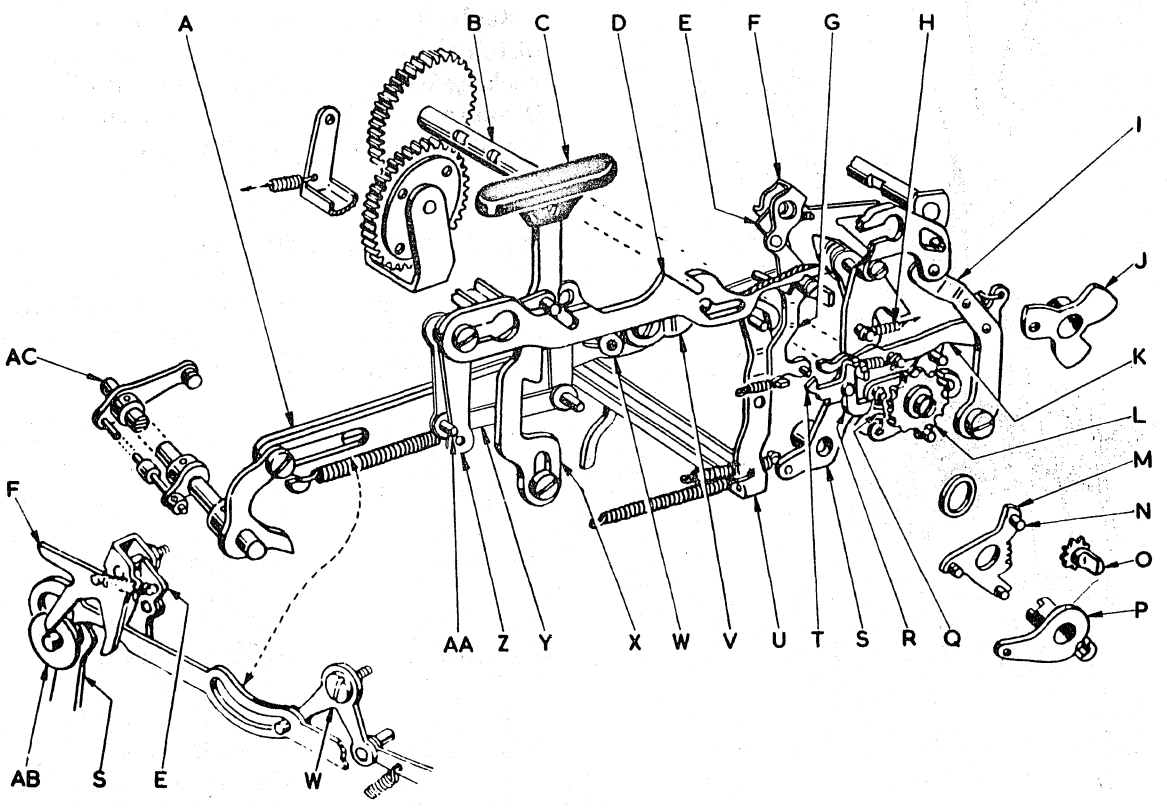

Fig. III-9

This mechanism clears the amount on the wheels when clearing bar C 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.

Depression of the clearing bar rocks bellcrank Z to contact stud AA and, through link Y, rocks bellcrank W to lower link A to engage the stud in drive arm S. At the same time, slide D is cammed forward to close the motor switch and start clutch gear L revolving. Further depression of the clearing bar trips clutch pin O into clutch gear L to connect clearing cam J with the revolving drive shaft. As the clearing cam revolves, it drives link A forward through drive arm S, which rocks shaft assembly AC to clear the dial wheels.

CLEARING CAM

Three point clearing cam J permits three complete clearing operations to take place during one revolution of the cam, which permits a very fast clearing operation. This type of cam is used only on Simplex calculators.

The clearing cam is connected to clutch member P by two flat surfaces on the clutch member which engage two flats in the hub of the clearing cam.

MOTOR AND CLUTCH TRIP MECHANISM

Depression of the clearing bar cams slide D forward which lowers arm V to

contact a stud in bail U, swinging the bail rearwards. A finger on bail U closes the switch to start the motor. Slide D is latched forward by pawl G to hold the clearing mechanism indexed and ensure power for the clearing operation.

The forward movement of slide D, through arm I, moves link K forward. A projection on link K contacts the formed ear on clutch limit pawl R, swinging it forward to clear the end of clutch member M. Spring Q draws the clutch member down and it's toothed segment rotates drive pin O to engage clutch gear L.

Clutch member M revolving with gear L causes stud N to raise link K which releases clutch limit pawl R and permits it to restore under the tension of spring H. As clutch member M engages limit pawl R, the drive pin is turned clear of the teeth is clutch gear L.

On the forward stroke of the clearing operation stud AB in the drive arm contacts the front finger of assembly F to swing pass-by pawl E over the stud in latch G. On the return stroke, stud AB contacts the rearward finger of assembly F which swings pass-by pawl E downwards to release latch G. As latch G is rocked, its lower stud is engaged by hook T to prevent relatching slide D if the clearing bar is manually held depressed.

TESTS AND ADJUSTMENTS

1. To ensure that slide D is latched before the clutch is tripped.

Depress the clearing bar slowly until slide D latches on the formed ear of latch G, limit pawl R should have approximately 1/64" hold on clutch member M.

To Adjust - bend the forward formed ear of latch G.

2. To ensure tripping the clutch when the clearing bar is fully depressed.

With the clearing bar held fully depressed, there should be approximately 1/64" clearance between limit pawl R and clutch member M.

To Adjust - bend the formed ear on limit pawl R.

3. To ensure that latch G does not relatch slide D if the clearing bar is held depressed.

Hook T should have a full hold on the stud in latch G.

To Adjust - bend the formed ear on hook T.
Note - Care must be taken when making this adjustment as the part is hard.

4. To ensure starting the motor prior to latching slide D.

a) With the clearing bar normal, there should be approximately 1/64" clearance between the stud in bail U and arm V.

b) When the switch is open, there should be approximately 1/32" separation of the contact points (Note - This applies to machines with the open type switch only)-

To Adjust -

a) Weave the arm of bail U above its pivot point.

b) Bend the finger of bail U which contacts the switch arm.

5. To provide the correct relationship of drive pin O.

With clutch member M held on limit pawl R, the flat surface of drive pin O should

clear the teeth of clutch gear L.

To Adjust - change the mesh of drive pin O with the toothed segment of clutch member M.

CLEARING MECHANISM, DUPLEX CALCULATOR - EARLY STYLE

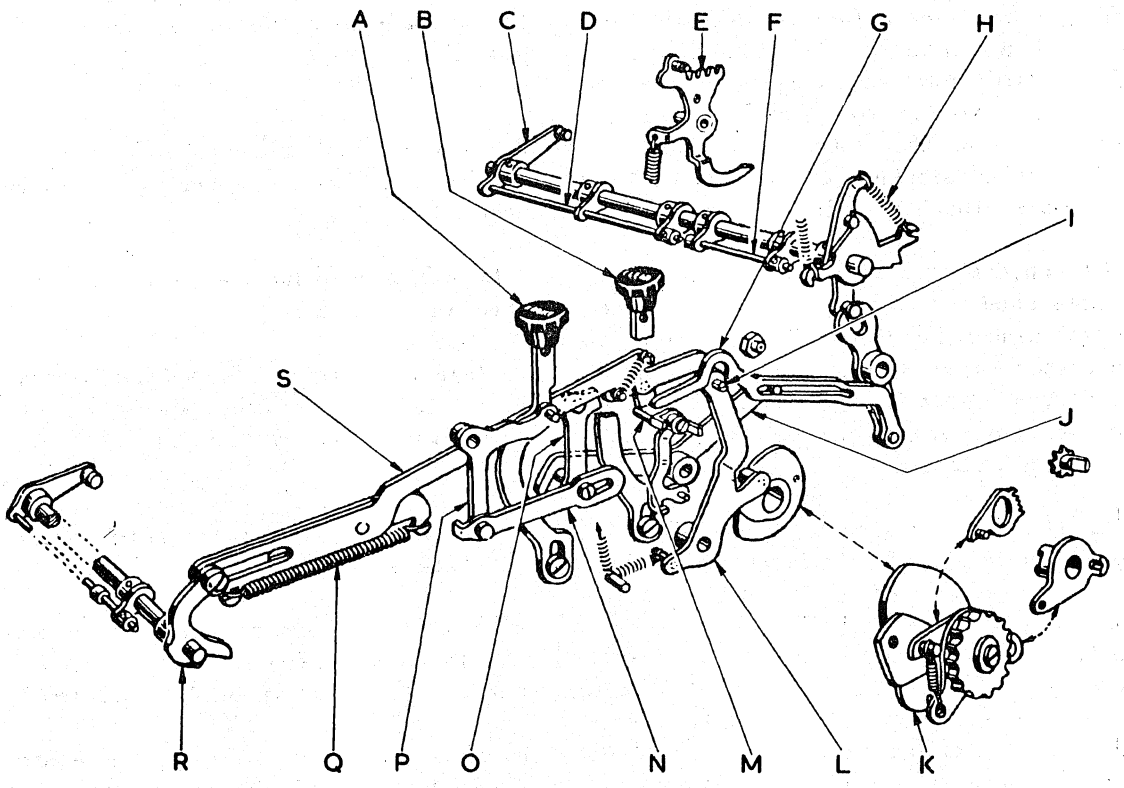

Fig. III-10

This mechanism consists of two clearing keys to clear amounts in the front and rear registers. Depression of the 'Front' key clears the front register only, depression of the 'Clear' key clears both front and rear registers.

CLEARING CAM

The clearing cam used on the Duplex calculator is a single point cam which provides one clearing operation per revolution of the cam. This is necessary to allow time for the transfer operation to take place before the front dials are cleared.

FRONT CLEAR KEY

Depression of the 'Front' key starts the motor and trips the clutch. Its operation is much the same as that of the clearing bar on the Simplex calculator which is explained in detail on page 8. The main difference being that on this early style mechanism, link S is permanently connected to drive arm L.

CLEAR KEY

Depression of the 'Clear' key couples the rear register clearing mechanism with the front register clearing mechanism. Shaft assembly C performs the same function in the rear register as shaft assembly R in the front register, the clearing operation in both registers is the same.

When 'Clear' key B is depressed, it also depresses the 'Front' key through bellcrank O, link N and bellcrank P which starts the motor and trips the clutch. The stud in bellcrank O rocks arm J, lowering the hook of lever G over screw I in drive arm L. When cam K revolves it drives link S and lever G forward through drive arm L, rocking shafts R and C to clear both registers. The forward extension of coupling lever G moves under stud M to prevent it disengaging from screw I.

CLEARING SHAFT ASSEMBLY

Rear register clearing shaft assembly C has two shafts D and F split in the fourth column to permit the extra travel of the adding sector in that column to add the automatic one. This necessitates the third carry arm E having its tail formed to the right instead of the left and the partition plate is cut away to accommodate this

The adding mechanism in the rear register is protected against damage by spring H in the same manner that spring Q protects the front register. If the dial wheel or one of the connecting gears fail to revolve backwards in the rear register on the clearing operation, spring H will yield.

TESTS AND ADJUSTMENTS

Note - Tests and Adjustments 1 through 5 for the Simplex calculator clearing mechanism should be applied to both clearing keys of the Duplex calculator.

To ensure clearing the rear register when the 'Clear' key is depressed..

With the 'Clear' key latched down, coupling lever G should have full hold on screw I.

To Adjust - bend the front end of lever J.

CLEARING MECHANISM, DUPLEX CALCULATOR - IMPROVED

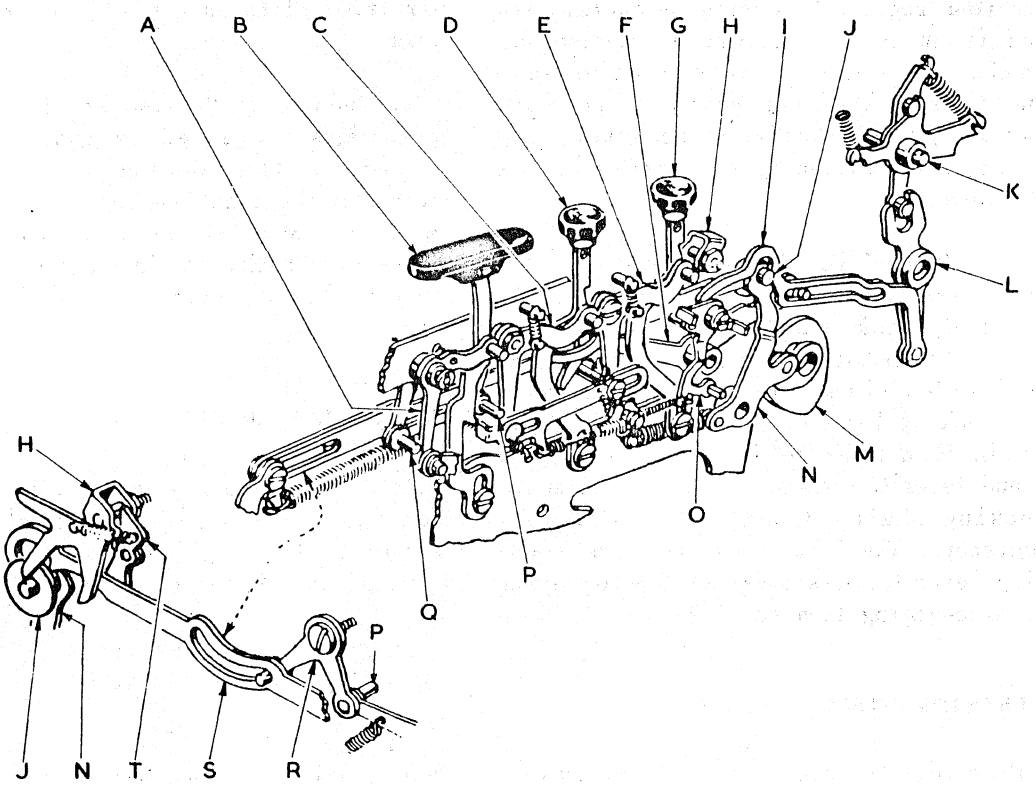

Fig. III-11

This mechanism permits independent clearing of the front and rear registers. Depression of the 'Front' key clears the front register only, depression of the 'Rear' key clears the rear register only. Both keys may be depressed simultaneously if it is desired to clear both registers.

REAR REGISTER CLEARING

Depression of 'Rear' key G rocks bellcrank E and through the stud in the bellcrank, rocks lever F to lower link I which engages stud J in drive arm N. Also, depression of key G cams slide D, Fig. III-9, forward to start the motor tripping cam M, through drive arm N, link I and lever L rocks rear register clearing assembly K.

FRONT REGISTER CLEARING

Front register clearing is indexed by depression of 'Front' key D which rocks bellcrank C to contact stud P and rock bellcrank R forward. Bellcrank R lowers link S to engage stud J in drive arm N. Depression of key D also cams slide D, Fig. III-9 forward to start the motor and trip the drive clutch. Rotation of the clearing cam, through drive arm N, drives link S forward to clear the front register.

FRONT AND REAR REGISTER

Simultaneous depression of keys D and G engages both links I and S with stud J to permit clearing both front and rear registers in one operation.

TRANSFER

Transfer of amounts from the front to the rear register is indexed by the depression of bar B, bellcrank A and stud Q. Stud Q, through its connecting link, swings bellcrank R to lower link S. The transfer function is fully described elsewhere.

TESTS AND ADJUSTMENTS

Note - Tests and Adjustment 1 through 5 for the Simplex calculator clearing mechanism should be applied to both of the clearing keys and the transfer bar of the Duplex calculator.

1. To ensure clearing the rear register.

At normal, link I should clear stud J and should be lowered to engage stud J fully and without bind when key G is fully depressed.

To Adjust - bend the forward end of lever F.

2. To ensure clearing the front register.

Link S should clear stud J in normal position and should be lowered to engage stud J fully and without bind when either key D, bar B or the subtract bar is fully depressed.

To Adjust - bend the rear arm of bellcrank R.

CLUTCH MECHANISM - IMPROVED

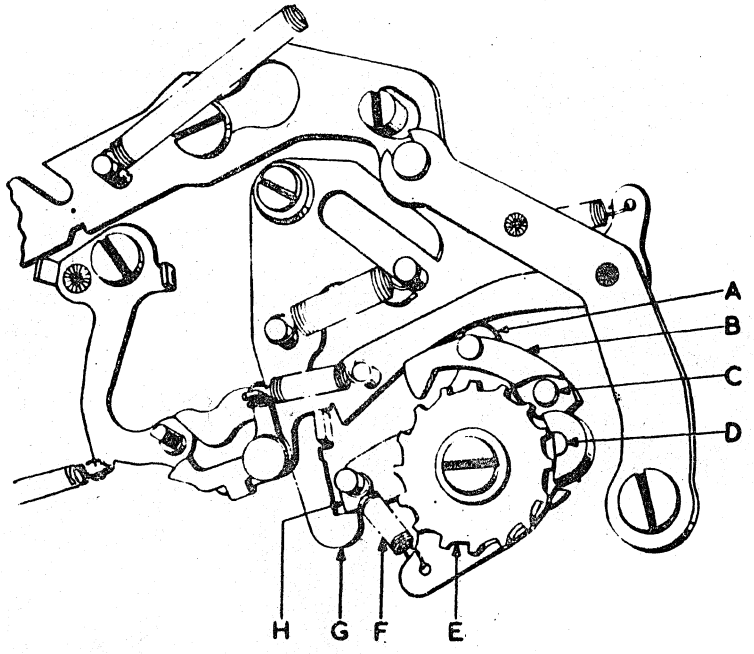

Fig. III-12

CLUTCH MECHANISM - IMPROVED

This improved clutch assembly is generally similar to the mechanisms shown in Figures 5 and 6, except forthe additional pawl B which prevents clutch dog D from slipping out of the tooth space in clutch gear E when transferring amounts to the rear register.

The cumulative effect of several adding rack springs C, (Fig. III-15), at the time the roller on arm K (Fig. III-15) follows the abrupt contour of cam L (Fig. III-15), attempts to drive clutch hub assembly A in advance of clutch gear E and clutch dog D may be cammed out of the clutch gear. This condition permits a violent and uncontrolled movement of bail H (Fig. III-15) and it is possible for the rebound of the bail to effect the position of the adding sectors. This may cause a lock on the control gears of the rear register, particularly in the first and fourth columns when the sectors are in the fully indexed position.

Pawl B maintains the correct relationship of clutch hub assembly A and clutch gear E, ensuring the bail H (Fig. III-15) moves at the controlled speed of the main drive shaft. This also ensures a much quieter transfer operation.

OPERATION

When the clutch is tripped, spring F rocks clutch member H to engage clutch dog D in the normal manner. At the same time stud C in clutch member H moves the front end of pawl B into an advanced tooth space of clutch gear E. At the end of the machine cycle, clutch member H is normalised by latch G, disengaging clutch dog D from clutch gear E and, at the same time, moving stud C away from pawl B.

KEYBOARD INTERLOCKS

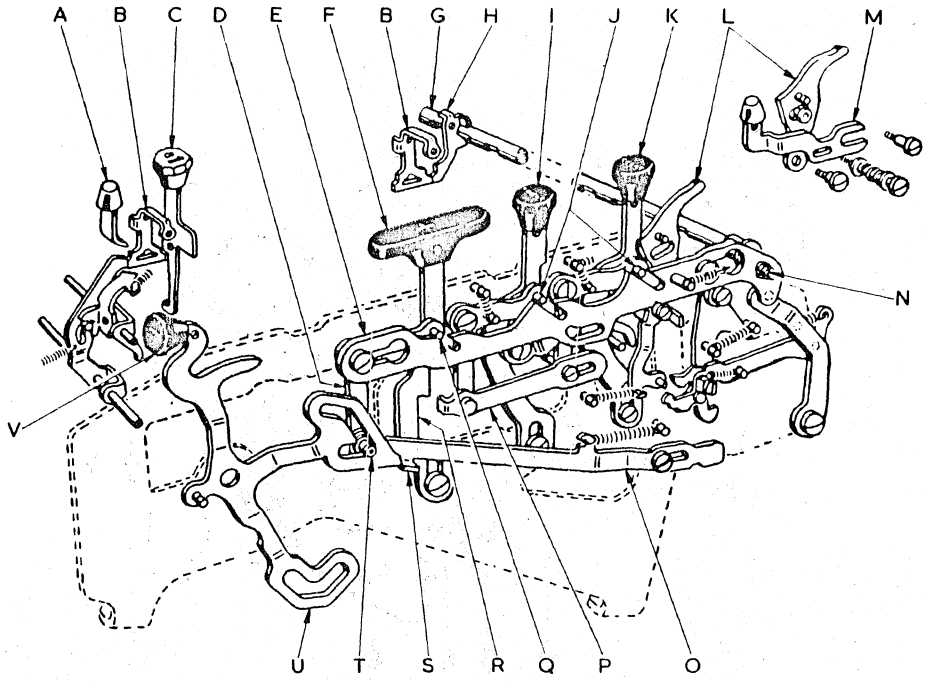

Fig. III-13

KEYBOARD INTERLOCKS

The keyboard interlocks are arranged to permit the operation of the clearing keys I or K, transfer bar F, subtract key V, or the adding keys C.

The subtract key operates the transfer bar, but the transfer bar depression is independent of the subtract key. On early style machines 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 is depressed, the other keys are blocked.

RESULT KEY FUNCTION

Depressing clear key K clears the front and rear registers on early style machines, and the rear register only on later machines. Clearing key I marked 'Front' clears the front register only. Transfer bar F marked with a plus sign (+), clears the front register and transfers the amount to the rear register. Subtract key V, marked with a minus sign (-), clears the front register and subtracts the amount from the rear register.

CLEARING KEY LATCH - EARLY

Latch L 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 L may be disabled by moving the button on slide M rearward.

TRANSFER BAR INTERLOCK

Depressing the transfer bar cams slide E forward through stud Q, blocking the depression of clearing keys I and K through studs J. The transfer bar also rocks bellcrank D to block the subtract key through formed ear S on link O moving under keystem U.

The adding keys C and the subtract control keys A are blocked by slide E rocking shaft G through screw N, which moves arm H 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 the subtract key and the transfer bar are interconnected.

TRANSFER BAR AND CLEAR KEY INTERLOCK

Simultaneous depression of the transfer bar and either of the clear keys is prevented by link P. When either of the clear keys are depressed, link P moves under a step in transfer bar keystem R. When the transfer bar is depressed, link P is blocked by the transfer bar keystem.

REAR CLEAR KEY LATCH

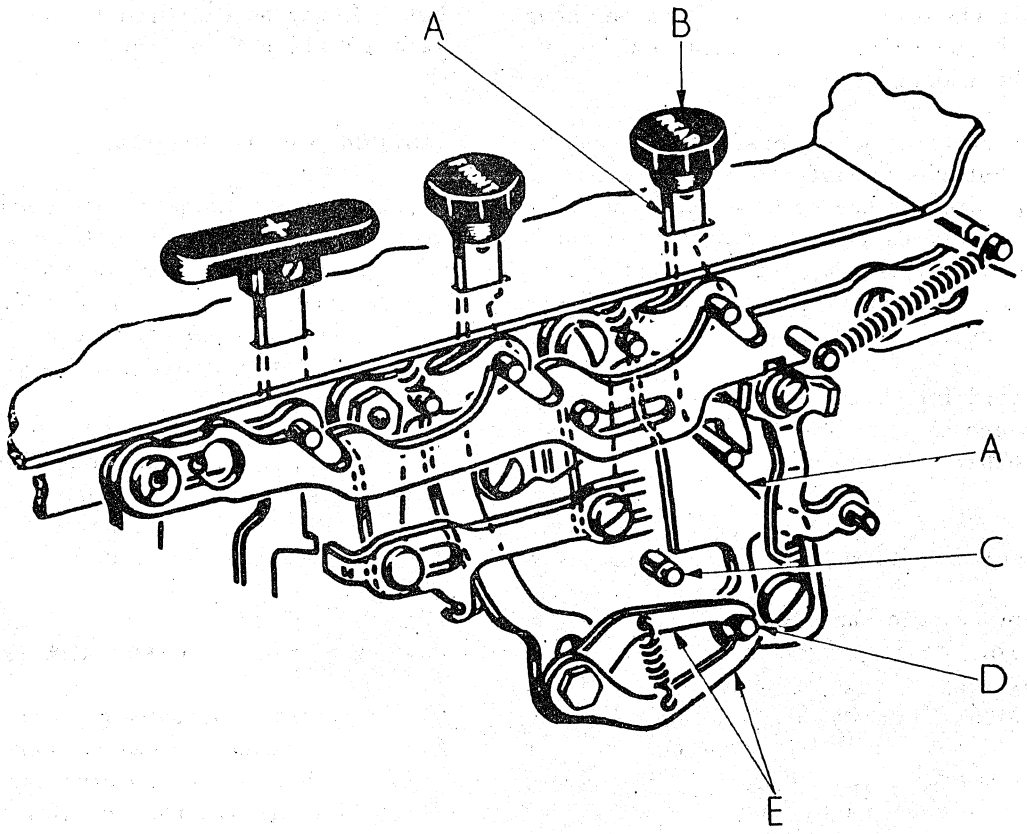

Fig. III-14

Inadvertent clearing of the rear register on machines having the independent front and rear register clearing mechanism is prevented by moving rear clear key B rearward. This positions the step of keystem A over stud C, thereby preventing depression of the key. Keystem A is held in its forward or rearward position by stud D and detents E.

IMPROVED KEYBOARD INTERLOCK MECHANISM

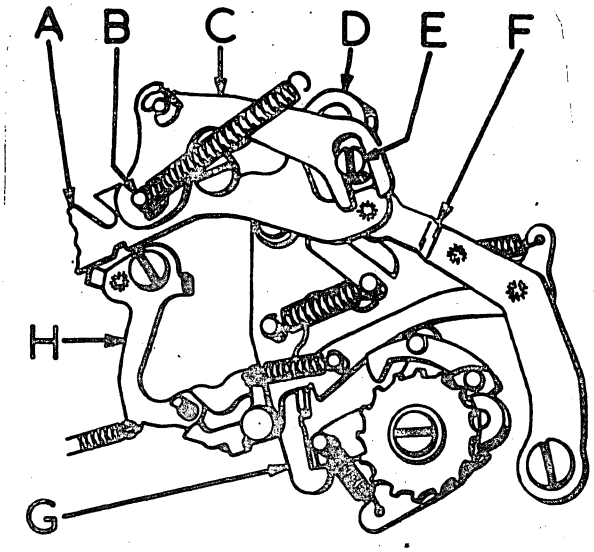

Fig. III-13-1

An improved keyboard interlock mechanism has been incorporated on all electric Series C Machines from Serial No. C69301S. This mechanism provides for positively locking the keyboard when the clearing bar or a control key is latched or held down.

Depression of the clearing bar or a control key cams slide A forward to rock key lock shaft D through post B, lever C and eccentric E. The slot in lever C for post B contains a dwell which enables adjustment of the key lock shaft to be maintained during full travel of slide A. By the time slide A has reached latching position by latch H, lever C and key lock shaft D have been fully indexed. The further movement of slide A, necessary for the release of clutch latch G by arm F results in post B moving up the dwell without altering the position of lever C and keylock shaft F.

Tests and Adjustments

First perform tests and adjustments 1 and 2 on Page 17 and then continue as follows:

3. To ensure locking the keyboard during a clearing or control key operation.

With slide A held by latch H, check for key lock shaft D to hold key locks fully forward with minimum play and all keys to be locked against depression.

To Adjust - Position eccentric E as required and tighten lock nut.

TRANSFER AND SUBTRACT OPERATION

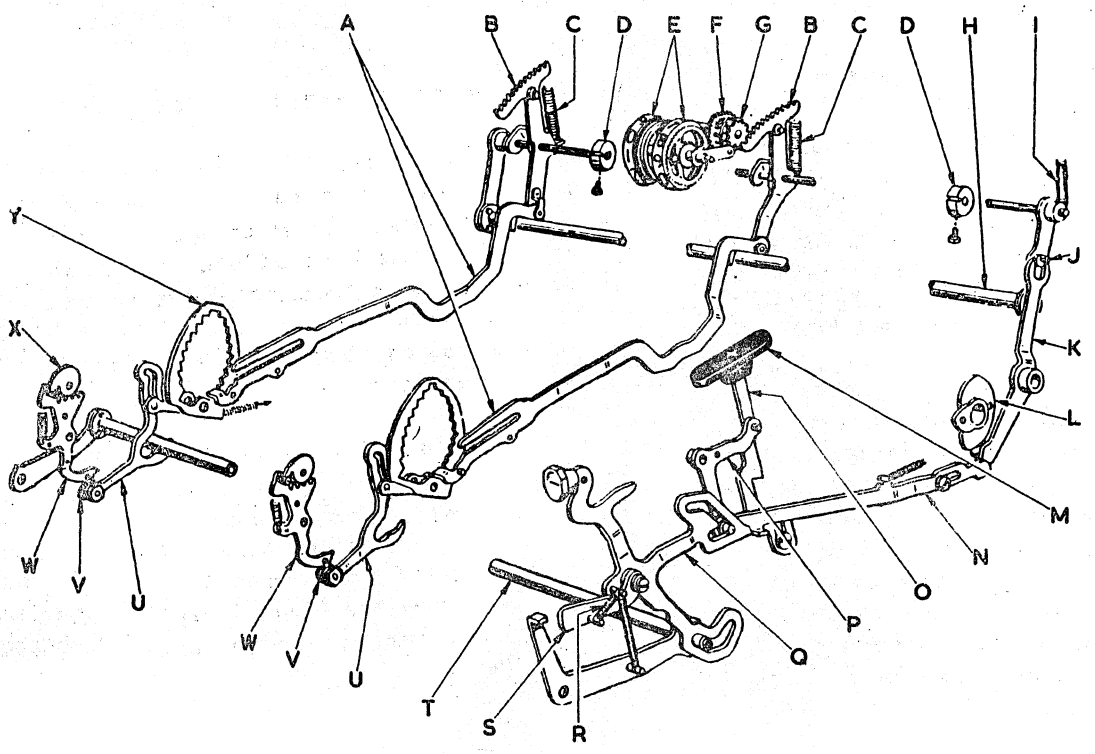

Fig. III-15

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

POSITIONING THE INDEX RACKS

As the front register dial wheel is rotated, timer cam X rocks carry arm W and link U to lower the index rack to a step corresponding to the figure on the dial wheel.

INDEXING THE AMOUNT

Depressing transfer bar M starts the motor, trips the clutch and, through bell-crank P, moves slide N forward to release arm K. As cam L rotates, spring I rocks transfer bail H rearward. The rearward movement of the transfer bail permits springs C to rock adding sectors B until transfer links A limit against the step of the index racks. The movement of adding sector B rotates pawl gear G to index the drive pawl in the ratchet gear tooth corresponding to the amount on the front register dial wheel.

ADDING THE AMOUNT

Cam L drives transfer bail H forward through arm K and eccentric J. The bail contacts the foot of the adding sector which turns the pawl and ratchet gears to add the amount on the rear register dial

wheels. After the bail has restored the adding sectors and transfer links to normal the amount is cleared from the front register dials

SUBTRACT OPERATION

The subtract key subtracts the amount in the front register from the total in the rear register. The subtract mechanism operates in conjunction with the transfer mechanism, the transfer bar is pulled down when the subtract key is operated.

The subtract key automatically finds the complement of the amount in the front register, transferring it, plus an automatic one, to the rear register. Index rack Y has an upper series of steps graduated from 0 to 9, the subtract key swings the rack downwards to position the step which corresponds to the complement of the amount in the front register into the path of the transfer link. Operating the subtract key when both registers are clear adds a nine in each rear register dial wheel because the complement of cipher is nine. The nines are cancelled to cipher by the automatic one.

SUBTRACT PROBLEM

3750	amount in rear register
825	amount in front register
9999999174	complement of front register, adds in rear register
1	automatic one, adds in rear register
0000002925	Rear register, total.

POSITIONING THE INDEX RACKS

As amounts are added in the front register, timer cam X locates the step on index rack Y to a corresponding position through carry arm W and link U. Operating the subtract key rocks bail T and, through link U, lowers the upper step of the index rack into alignment with the formed ear on transfer link A. Index bail T is controlled by the lower slot in subtract key lever Q.

SUBTRACT KEY OPERATION

The rearward slot in subtract key lever Q rocks bellcrank P to lower the transfer bar, start the motor and trip the clutch. The remainder of the operation is the same as a transfer operation except that the transfer links limit on the upper steps of the index rack instead of the lower steps.

A snap depression of the subtract key is prevented by check pawl S. If the key is struck a sharp blow, spring R does not have sufficient time to raise the pawl clear of the formed ear on bail T, thus blocking the forward movement of the arm and preventing depression of the subtract key.

TESTS AND ADJUSTMENTS

1. To ensure full re-set of adding sectors B and transfer links A without cramping transfer bail H.

With the machine normal, there should be very slight forward and rearward play of adding sectors B.

To Adjust - turn eccentric J until a satisfactory condition is obtained for the majority of sectors, then bend the tails of the other sectors to obtain a similar condition.

Note - Always keep the high point of eccentric J upwards to ensure that the transfer bail clears the first adding sector which travels a greater distance due to the automatic one.

2. To check that the length of transfer link A is correct.

With the front register clear, add fives in half the columns and nines in the other half. Disconnect the power and depress the transfer bar. Operate the machine manually until the rear adding sectors in the columns with nines indexed, limit in the slot of the partition plate. The control gear tooth space of pawl gear G in the columns in which fives were added should align with those having nines. If any of the columns having a five are different, this indicates that the transfer link is off test. Repeat the test for both sides of the keyboard by reversing the figures.

To Adjust - replace the transfer link.

3. To ensure transferring the correct amount to the rear register.

a) Register eights on the front register dial wheels and, with the power disconnected, depress the subtract key and operate the machine manually until transfer links A limit on the index racks. The formed ear of the transfer link should have a full hold on the step of the index rack and there should be slight clearance between the upper surface of the formed ear and the horizontal face of the step.

b) Register threes on the front register dial wheels and, with the power disconnected, depress the transfer bar and operate the machine manually until transfer links A limit on the index racks. The formed ear of the transfer link should have a full hold on the step of the index bar and there should be a minimum of .010 clearance between the lower surface of the formed ear and the horizontal face of the step.

To Adjust - turn eccentric V.

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

4. To ensure that slide N restores to block arm K when the transfer bar or subtract key releases.

There should be approximately 1/64 clearance between the formed ear on slide N and the lower end of arm K.

To Adjust - bend the formed ear on slide N.

AUTOMATIC ONE AND DECIMAL NON-TRANSFER MECHANISM

AUTOMATIC ONE, FIRST COLUMN

The automatic one required on subtraction to produce a carry in the first column is obtained from index rack K. The complement steps on index rack K are arranged to include the automatic one and permit the transfer link and adding sector to travel one space further in the first column. The slot in the rear register partition plate is lengthened to permit the extra travel of the adding sector..

DECIMAL NON-TRANSFER MECHANISM

Depressing decimal non-transfer key E 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 computations in the front register.

When key E is depressed, arm F contacts the stud in bellcrank G to rock shaft L and lower arms I into the path of studs J in the transfer links. If the decimal non-transfer key is depressed while the transfer links are rearward, the spring connection on arm F will yield as the transfer links restore to normal.

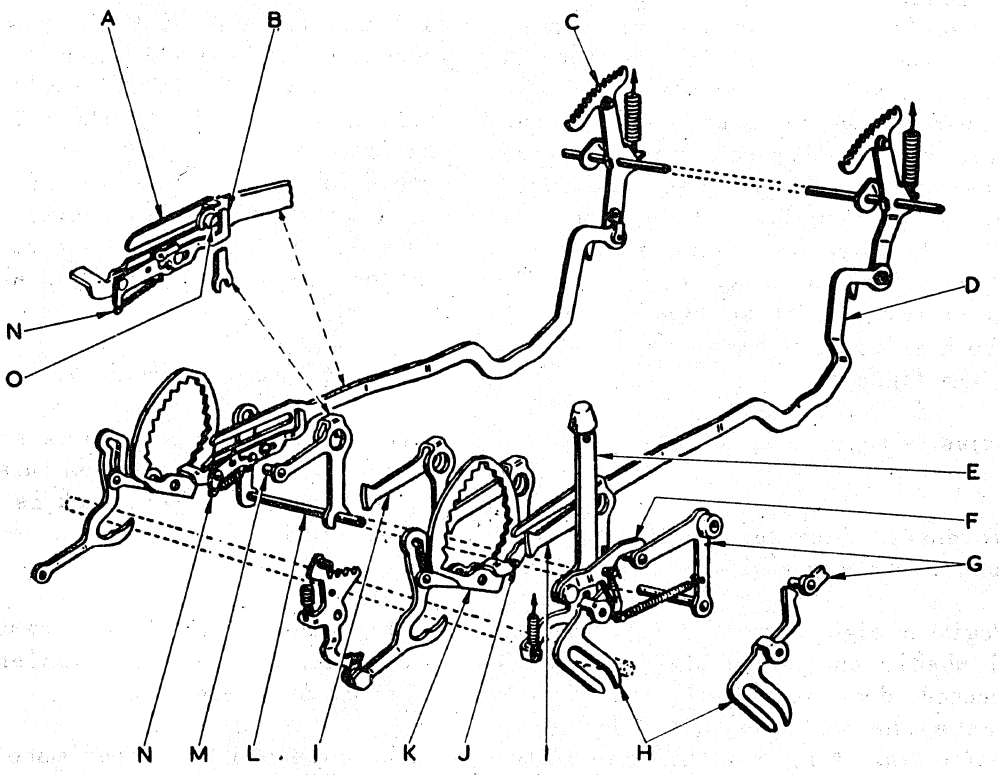

Fig. III-16

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 A in the fourth column carries slide B to permit the extra travel of the transfer link and adding sector to add the automatic one. The formed ear of the transfer link is part of slide B which has slots to increase the length of the transfer link. When slide B is latched by pawl N, the transfer link is the regular length. This permits the use of a standard index rack in the fourth column.

When the subtract key is depressed with the decimal non-transfer key latched down shaft L is moved slightly beyond its latched position by bellcrank H. This extra movement of shaft L causes stud M to lower pawl N clear of the stud in slide B. As the transfer link moves rearward, slide B moves forward to extend the length of the transfer link to add the automatic one.

As the transfer link is moved forward to restore, the vertical projection on slide B contacts stud O in the partition plate to reset the slide and latch it on pawl N. The fourth column partition plate slot in the rear register is longer to permit the extra travel of the adding sector as in column one.

TESTS AND ADJUSTMENTS

1. To ensure that the automatic one in the fourth column takes place only when

the decimal non-transfer key is latched down.

When the transfer link A is moved fully forward by the transfer bail, slide B should reset on pawl N with minimum lead.

To Adjust - bend the vertical projection of slide B.

2. To prevent transferring amounts in the first three columns when the decimal non-transfer key is latched down.

With the decimal non-transfer key latched down, arms I should have full hold on studs J in the transfer links.

To Adjust - bend arm F.

PRORATING MECHANISM

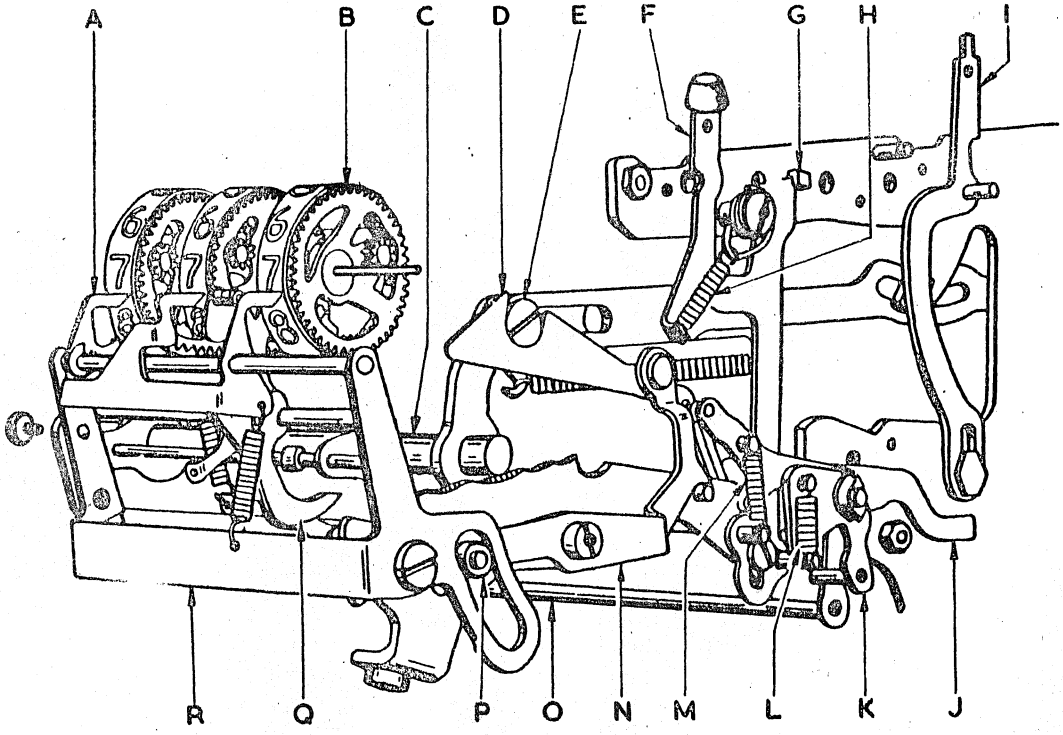

Fig. III-17

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 (Fig. III-16). 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 (Fig. III-16). Bail Assembly O (same as L, Fig. III-16) 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.

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 bellcrank 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 L (Fig. III-3) to reset behind the correct lug of ratchet gear J (Fig. III-3).

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

Full Cancellation of all Dial Wheels in the front register withprorating 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 space 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.

TYPE C MOTOR WITH LEE TYPE GOVERNOR

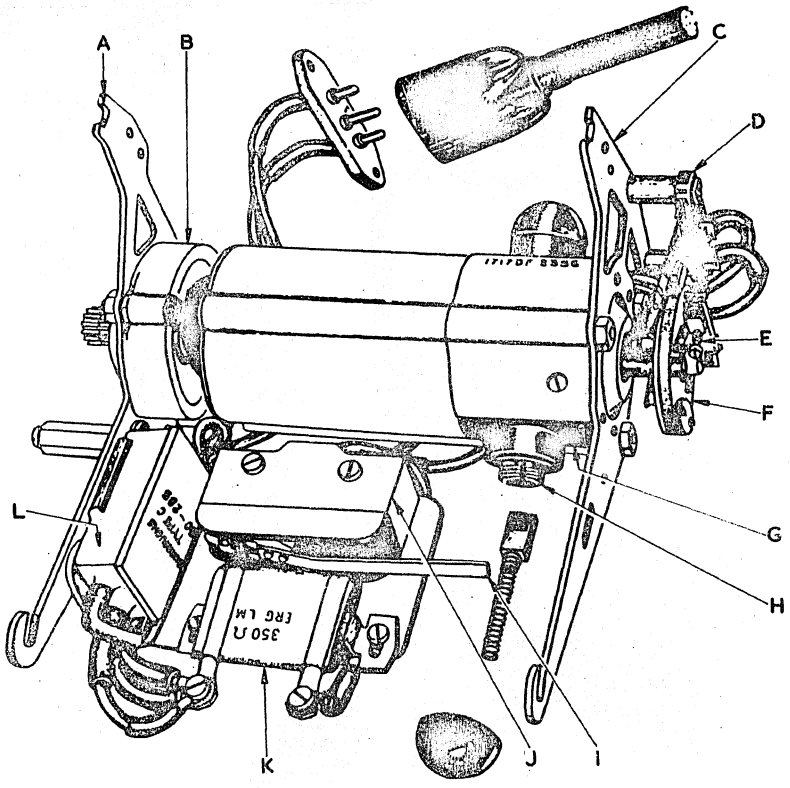

Fig. III-18

The power to operate the electric calculator is furnished by the Type C motor. This motor is of the AC-DC type and is capable of operating on either direct or alternating current within a specified range of coltages. The motor is secured to the underside of the machine by brackets A and C.

The armature runs in ball bearings which are of the fully shielded type that require no lubrication. The bearings fit into plastic end covers B and G. End cover G also contains the commutator brush holders H, which are held in position by set screws.

The speed of the motor is controlled by governor F which is secured to the end of the armature shaft. The Lee Type governor has one pair of contacts which are opened by centrifugal force when the motor speed exceeds that for which the governor has been adjusted. Connections to the governor are made through carbon brushes which are held against two rings on the governor by the arms of assembly D.

Resistor K is connected across the governor to permit a certain amount of current (determined by the value of the resistor) to by-pass the governor. When the governor points are opened by centrifugal force, sufficient current flows through the resistor to provide even motor performance. Without the resistor, the motor speed would be uneven due to the abrupt intermittent current flow as the governor points open and close.

Microswitch J replaces the open type switch used on earlier motors. This has resulted in a considerably lighter key depression since the return springs on

the switch operating bail are no longer required.

Condensor L prolongs the life of the governor and switch points by absorbing the current which tends to arc across the points when these are separated.

TESTS AND ADJUSTMENTS

1. To ensure the correct machine operating speed.

The drive shaft should rotate at 120 R.P.M. This can be checked by holding an adding key depressed, placing a screw driver over the hub of a drive wheel and counting the number of times the set screw contacts the screw driver.

To Adjust - loosen the locknut on screw E and turn the screw clockwise to increase the speed or counter-clockwise to decrease the speed.

2. To ensure that the drive wheels are rotating at speed before the drive pawl is released.

The microswitch should close when an adding key is depressed approximately 5/32" (this is the thickness of the upper part of the keytop). When the key is released slowly, the microswitch should open before the key is fully restored. Repeat this test for each column.

To Adjust - bend the finger on the switch operating bail.

3. To prevent heavy key depression and bending of parts.

With the power off and a key held fully depressed, switch arm I should not limit on the body of the microswitch.

To Adjust - re-check adjustment 2 and if necessary, re-form switch arm I.

TYPE C MOTOR WITH BURROUGHS TYPE GOVERNOR

This motor is basically the same as the motor described in Fig. III-18, the only difference being in the type of speed governor used.

The Burroughs type governor is of very robust construction and has two sets of contact points which parallel each other. The points are normally held closed by spring E and are opened when the centrifugal force exerted on the arms overcomes the tension of the spring.

Connections to the governor are made through brushes G which are housed in brush holder F. The governor brush is fitted with a shunt wire which serves as a direct connection between the terminal and the brush. This prevents the burning and sticking of the brush, caused by the current arcing between the brush and the holder.

TESTS AND ADJUSTMENTS

To ensure the correct machine operating speed.

The drive shaft should rotate at 120 R.P.M.

To Adjust - alter the tension of spring E.

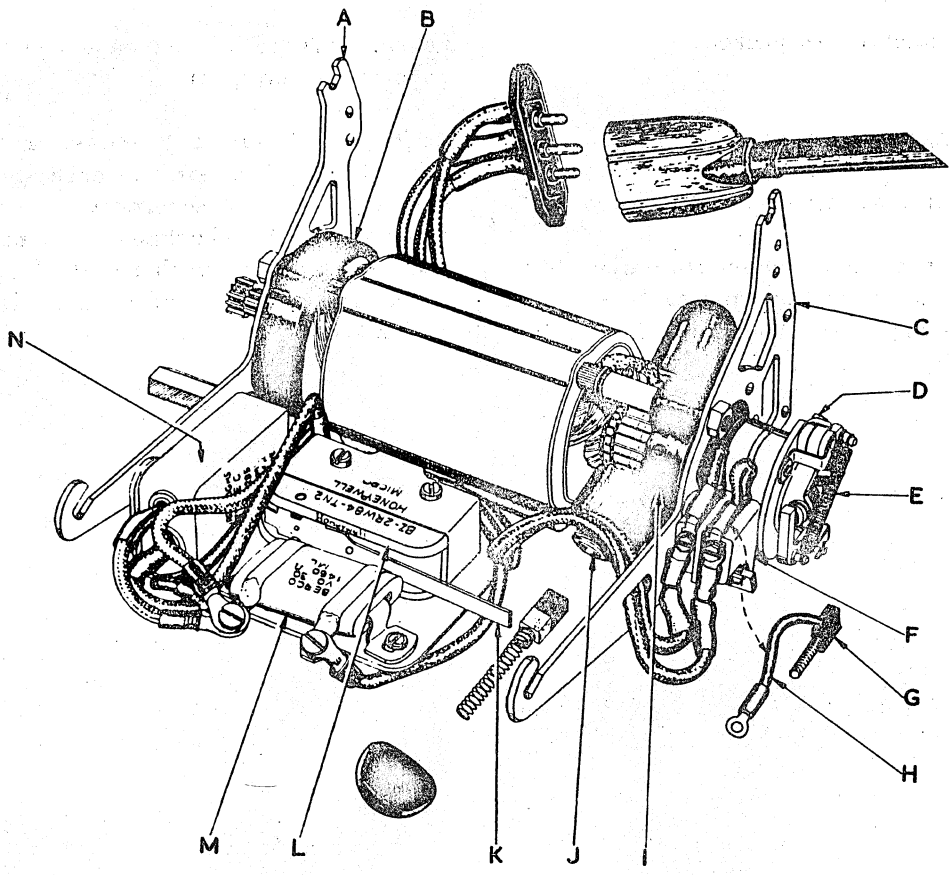

Fig. III-19

SHOCKMOUNTS

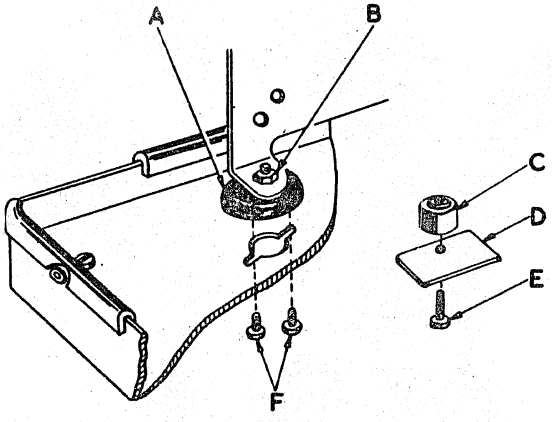

Fig. III-20

To reduce machine operating noise which is transmitted to and amplified by the base and case, currently manufactured machines are mounted on rubber shockmounts A.

The shockmounts are screwed into the tapped hubs of the machine side frames and can be adjusted to alter the height of the machine so that the machine does not contact the case. Thus the machine is completely insulated from the base and case. Lock nut B prevents the shockmount turning and losing adjustment when the base is removed for servicing purposes. The shockmounts are secured to the base by screws F.

To prevent movement of the machine within the case and subsequent damage during shipment, shockmounts A are replaced by solid mounts C, plates D and screws E

when the machine is packed.

TESTS AND ADJUSTMENTS

To ensure quiet machine operation

There should be approximately .005" clearance between the upper surface of the keyboard plate and the case. Noise will be transmitted if the case and keyboard contact at any point.

To Adjust - remove the case and loosen lock nuts B. Replace the case and remove screws F. Using a screwdriver in the slot provided, turn shockmounts A to adjust the height of the machine. Replace screws F. Remove the case and tighten lock nuts B. Replace the case.

Burroughs

SERIES C CALCULATOR

INSTRUCTION BOOK

Section IV

SERVICING PROCEDURES

Printed in U.S. America 12-1-61

For Form 376

INDEX - SECTION IV

PREVENTIVE MAINTENANCE GUIDE

Series C Calculator Machines

Preventive Maintenance and Lubrication Procedure

Each Preventive Maintenance Inspection is to be directed toward the cleaning, correct lubrication and adjustment of the machine. Throughout the inspection, particular attention should be given to the condition and operation of parts and mechanisms. Parts showing evidence of pending mechanical failure should be replaced.

It is also important that Correction Index parts be installed at the time of the Preventive Maintenance Inspection when use of such parts will improve performance, minimize customer interruptions and reduce service time.

Approved Lubricants and Cleaning Agents

1. Machine Oil S131A.
2. Machine Grease S167 1/4A.
3. Case Cleaner and Polish S11.

Maintenance

1. Inquire whether the machine has been performing satisfactorily, and if the operator has observed any peculiarities of operation that might require correction.
2. Make an operating test run of the machine, using all calculating keys and control bars. Determine any peculiarities of operation with respect to speed, sound, and operating results.
3. Inspect and clean the outside surfaces of the machine.
4. Remove the case and base. Clean the keyboard top plate.
5. Inspect the dial wheels and carry mechanism.
   A. Check for freedom of movement and alignment.
   B. Clean the dial wheel numerals.
   C. Check for defaced dial wheels.
   D. Apply Oil S131A sparingly to all gears, bearings, and pivot points in the accumulation section, and lightly apply Grease S167 1/4A to camming surfaces, such as the feet of the carry arms, the enclosed cams of the cancelling hooks, and the clearing control shaft actuating arm.
6. Inspect the right and left side frames.
   A. Check for loose screws, nuts and damaged springs.
   B. Check all parts for wear and freedom of movement.
   C. Apply Oil S131A to all pivot points and bearing surfaces. Apply Grease S167 1/4A to camming surfaces, parts that contact camming surfaces, the clearing clutch members, main drive shaft bearings, and points of contact of all sliding parts.
7. Inspect the adding sectors for freedom of movement and apply Oil S131A to all bearing and pivot points. Apply Grease S167 1/4A to the guide slots in the partition plates.

8. Inspect the transfer mechanism in duplex machines for freedom of movement, and lubricate all bearing and pivot points with Oil S131A. Apply Grease S167 1/4A to the cam slots of the transfer index racks and to the points of contact between the shaft of the direct subtract indexing bail and the transfer index rack links.

9. Inspect the main drive shaft assembly. (Electric Models).

   A. Check for loose screws in drive wheels.
   B. Inspect the torsion springs on yielding drive wheels.
   C. Apply Grease S167 1/4A to the chain of drive gears, their bearings and to the clearing and transfer cams.

10. Inspect the power section. (Electric Models).

   A. Inspect the switch points.
   B. Inspect the governor brushes.
   C. Inspect the governor points and springs.
   D. Remove and inspect the commutator brushes.
   E. Remove all carbon dust.
   F. Check the machine speed. Adjust to proper speed.

11. Inspect the inside of the case.

   A. Clean the inside of all dial wheel windows with a dry cloth or a cloth moistened with water.

12. Operate the machine to be sure that any peculiarities pointed out by the operator or observed during the initial test run have been corrected. Apply adjustments or replace parts as required to effect correction.

13. Install the base and the case.

14. Clean all keytops and motor bars.

15. Re-run the operating tests to satisfy yourself that the inspection is complete and effective.

16. Request the operator to test the machine while you are making out your report.

REMOVAL AND REPLACEMENT PROCEDURES

KEYBOARD PLATE AND KEYSTEMS

Removal

1. Remove all keytops.
2. Remove the screws securing the keyboard plate to the side frames.
3. Carefully raise the keyboard plate until the fixing lugs clear the side frames. Move the keyboard plate to the right to prevent the keystems moving out of their slots in the partition plates then lift the keyboard plate clear of the keystems.
4. The individual keystems can now be removed.

Replacement

1. Ensure that all keystems are in alignment and positioned to the right.
2. Place the keyboard plate over the number 9 keystems taking care not to move the keyboard plate over to the left. Then, applying downward pressure to the keyboard plate and reaching under the plate with a spring hook, guide the keystems into their respective slots.
3. Secure the keyboard plate to the side frames and replace the keytops.

KEY INTERLOCKS

Removal

1. Remove the adding sector.
2. Remove the wire clip from the end of the key interlocks pivot shaft and using a follow up shaft, withdraw the shaft sufficiently to clear the interlock to be removed.
3. Remove the interlock through the bottom of the machine.

Replacement

Replace the parts in the reverse order.

DIAL WHEEL

Removal

1. Remove the shaft retaining plate from the left hand side frame.
2. Unhook the carry arm springs from the anchor strip. Remove the anchor strip and hook the springs into the notch in the partition plate.
3. Measure off and insert a follow up shaft through the right side frame and through the wheel to be removed.
4. Index amounts on the dial wheel until the planet gear is positioned forward.
5. Withdraw the follow up shaft just far enough to clear the dial wheel to be removed and remove the wheel.

Replacement

1. Register 0 in the column to the left.
2. Place the planet gear near the figure five on the dial wheel to be installed.
3. Rock the carry arm forward and install the dial wheel assembly.
4. Check the dial wheel for correct alignment of figures using gauge Kit 547A on the figure 5 or 7. (The long side of gauge is used for the front register dials and the short side for the rear register dials).

DIAL WHEEL ALIGNMENT

1. Index amounts until the planet gear is forward and upward and not more than 7 is registered on the wheel.
2. Hold the dial wheel with the left hand with the index finger on the upper side and the thumb underneath against both the dial band and the universe gear.

3. Withdraw the follow up shaft sufficiently to free the wheel, move the wheel forward and slightly upwardto unmesh the universe gear from the ratchet gear and the planet gear from the sun gear.
4. Turn the universe gear in the direction the figure should move to align and remesh the gears. Turning the universe gear one tooth will move the figure 1/64" after the gears are remeshed. Great care must be taken not to turn the dial wheel during unmeshing and meshing and to change the mesh of the gears the same number of teeth at both points of meshings. After aligning this dial wheel, it will probably be found that the dial wheel to the left is incorrectly aligned. This can be corrected as follows.

RE-ALIGNMENT OF DIAL WHEEL TO THE LEFT.

1. Index amounts on the dial wheel just replaced until the planet gear is to the rear and any figure but 0 is registered.
2. Hold the dial wheel (just replaced) and withdraw the follow up shaft sufficiently to free this wheel.
3. Gently push downward and rearward on the wheel until the dial wheel gear is just out of mesh with the oscillating gear on the left. Do not break the mesh between the universe gear and the ratchet gear or between the planetgear and sun gear.
4. Turn the carry gear assembly (to the left of the dial wheel just replaced) until its lugs are aligned with the lugs on adjacent carry gears.
5. Raise the dial wheel back into mesh and replace shaft.
6. Re-check the alignment of the dial wheels and adjustment 6, Page 8, Sec. III.

CARRY GEAR ASSEMBLY

Removal

(Check Adjustment 6, Page 8, Sec. III before removing parts).

1. Using a follow up shaft, remove the dial wheel to the left of the carry gear to be removed (see Dial Wheel Removal).
2. Withdraw the follow up shaft slightly and remove the carry gear.

Replacement

1. Register 0 on the dial wheel to the right.
2. Position the aligned teeth of the oscillating gears four tooth spaces to the right of the lug on the carry wheel (include the tooth space under the lug) The aligned teeth are identified by a chamfer on one tooth of the oscillating gear
3. Keeping the aligned teeth of the oscillating gears upward, install the carry gear assembly with the first tooth of the oscillating arm segment in the first tooth space of the carry arm and with the aligned teeth between 0 and 9 on the dial wheel to the right. This provides the correct relationship between the lugs on the carry gear and the cancelling hook. It should also be noted that the lugs on all carry gears are in alignment across the machine.
4. Check adjustment 6, Page 8, Sec. III for proof of correct relationship between cancelling hooks and carry gear lugs.
5. Install the dial wheel to the left.

ADDING SECTOR, ELECTRIC MACHINES

Removal

1. Remove the motor.
2. Loosen the set screws in the drive wheels.
3. Remove the screw securing the clutch gear to the drive shaft.
4. Remove the clutch unit drive shaft and drive wheels.
5. Remove the drive pawl detent.

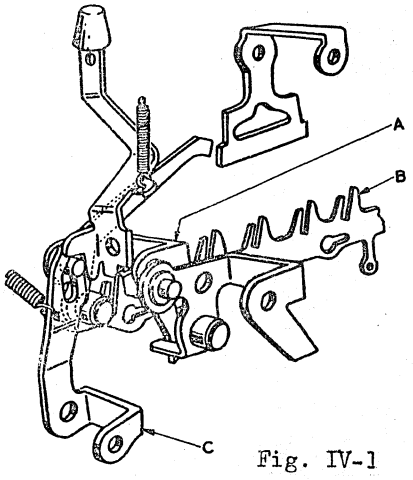

Fig. IV-1

6. Remove keyslide B.
7. Using a follow up shaft, remove bail A and interloc' arm C.

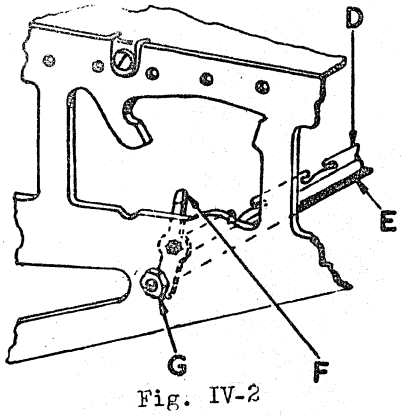

Fig. IV-2

8. Loosen nut G and swing retaining hook C aside. Remove the nut from the right end of shaft B and remove the shaft through the left side frame.
9. Unhook the springs from anchor strip A and remove the anchor strip through the left side frame.
10. Remove the adding sector.

Replacement

1. Install the adding sector. Align the first tooth of the adding segment with the tail of the pawl on the pawl gear.
2. Replace the parts previously removed.
3. Place a .002" feeler gauge between the clutch unit and the right side frame. Position the right hand drive wheel against the partition plate and tighten the set screw. Locate the remainder of the drive wheels in position.

REAR REGISTER

Removal

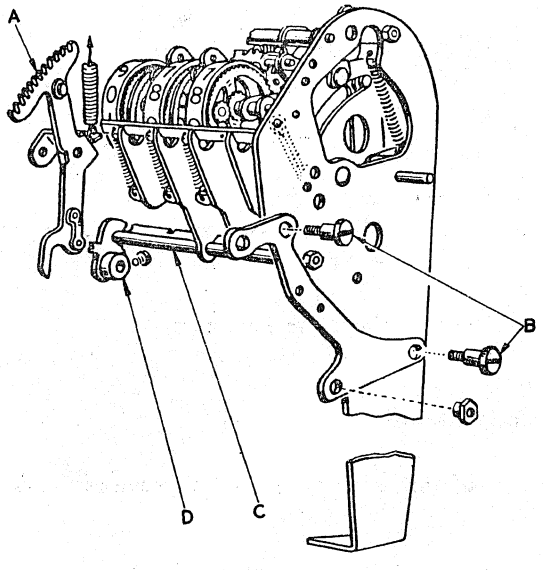

Fig. IV-3

1. Disconnect all of the transfer links from adding sectors A.

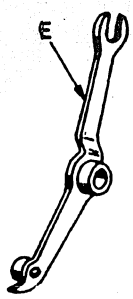

Fig. IV-4

2. Remove arm E.

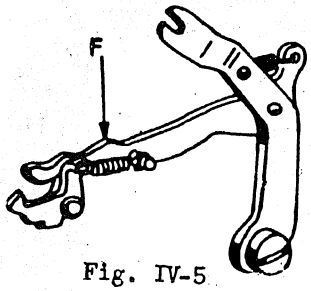

Fig. IV-5

3. Remove clutch trip arm F.

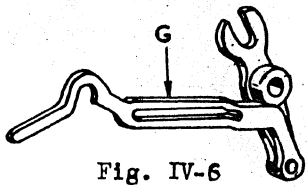

Fig. IV-6

4. Remove cancelling arm G.
5. Loosen the set screw in brace D and move the brace clear of shaft C.
6. Remove screws B.
7. Remove the rear register.

Replacement

Replace the parts in the reverse order.

Burroughs

SERIES C CALCULATOR

INSTRUCTION BOOK

Section V

CORRECTION INDEX

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For Form 376

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