

July 2, 1946.

C. D. LAKE ET AL

2,403,006

RECORDER MECHANISM

Filed Sept. 23, 1941

6 Sheets-Sheet 1

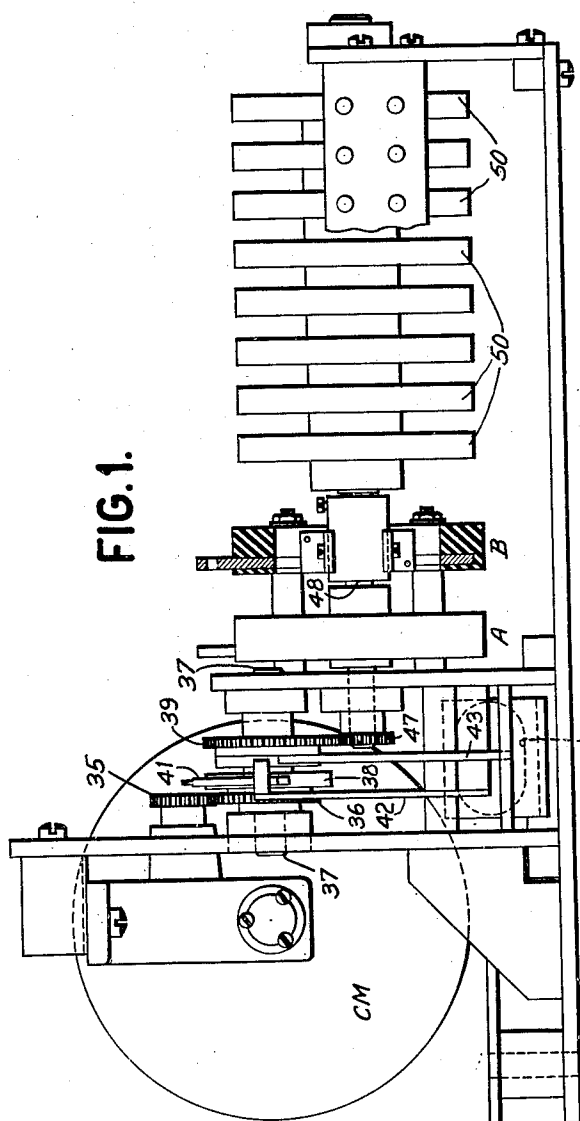


FIG. 1.

FIG. 3.

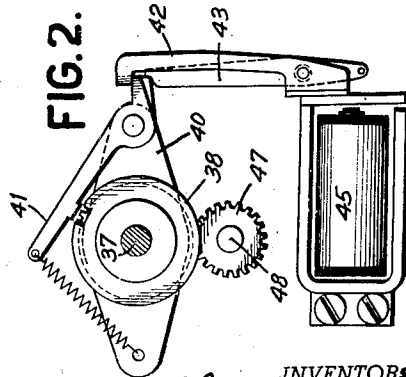
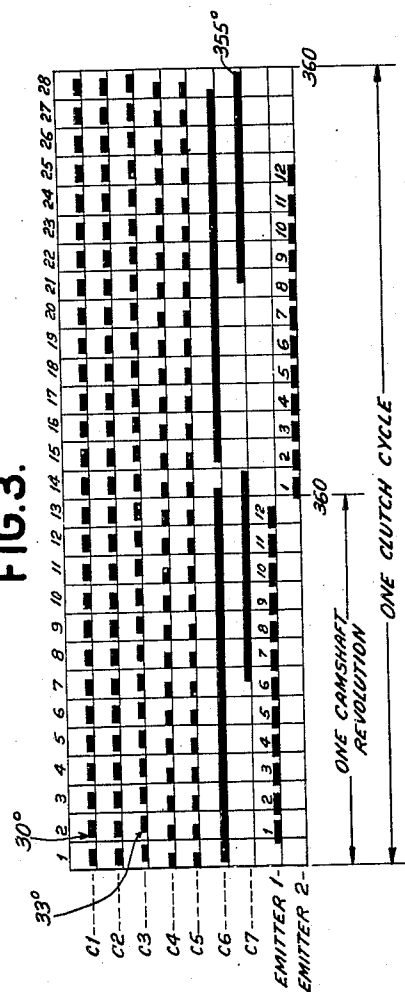


FIG. 2.

BY

INVENTORS
C. D. Lake
Francis E. Hammett
W. M. Wilson
ATTORNEY

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C. D. LAKE ET AL

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6 Sheets-Sheet 2

FIG. 4.

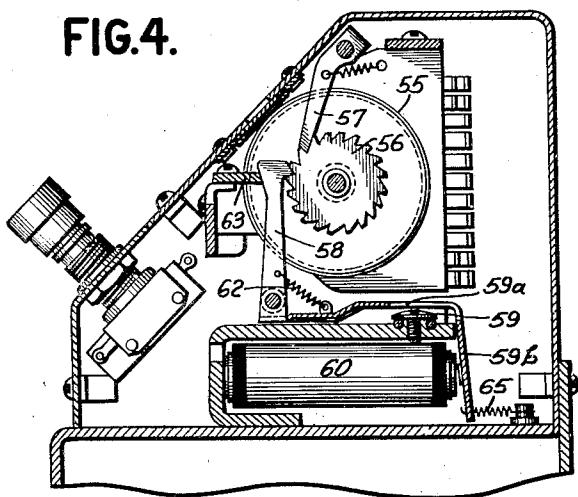


FIG. 5.

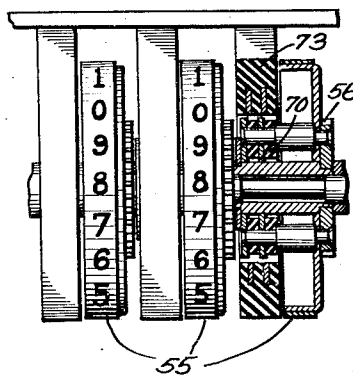


FIG. 6.

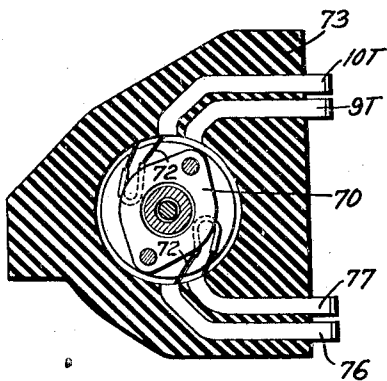
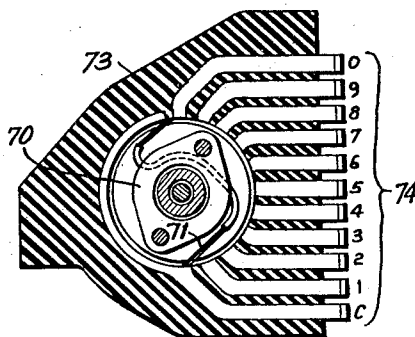


FIG. 7.



BY

INVENTORS
Clair D. Lake
Francis E. Hamilton
W. M. Wilson
 ATTORNEY

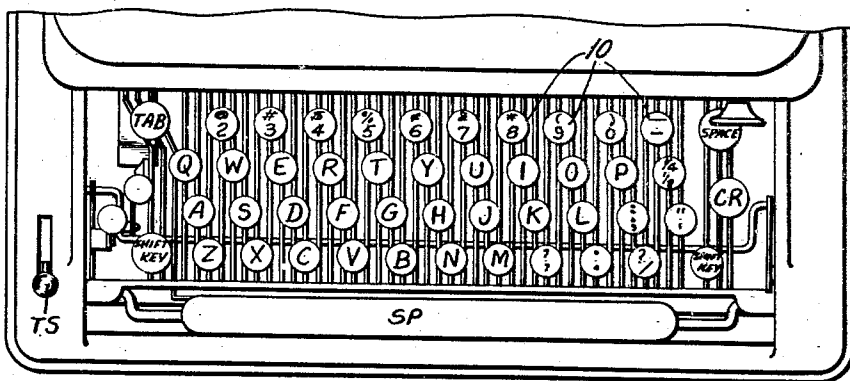
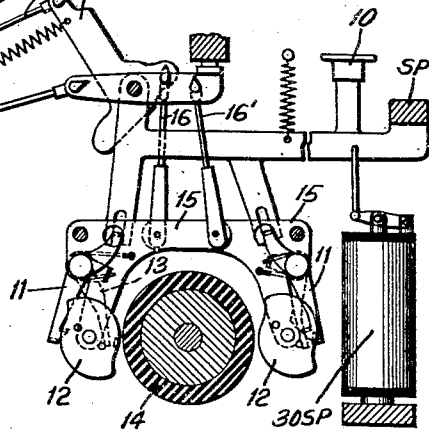
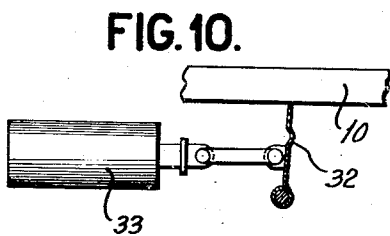
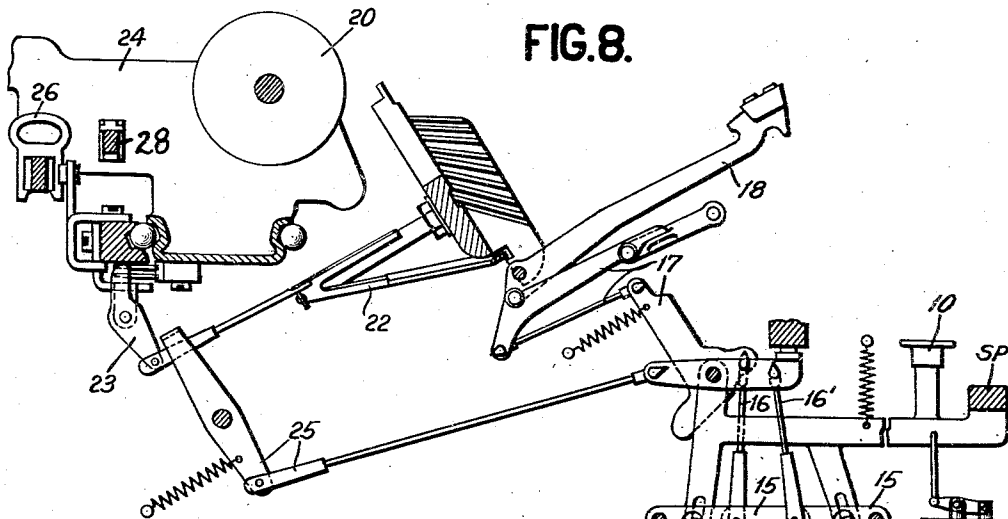
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2,403,006

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6 Sheets-Sheet 3



BY

INVENTORS
Clair D. Lake
Francis E. Hamilton
ATTORNEY

July 2, 1946.

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2,403,006

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Filed Sept. 23, 1941

6 Sheets-Sheet 4

FIG. 12a.

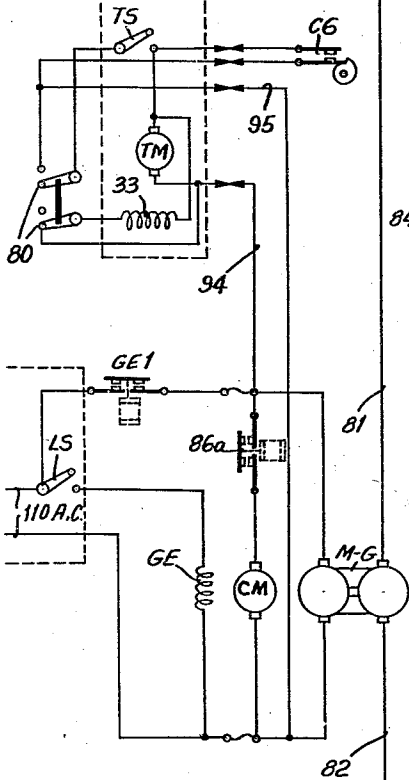
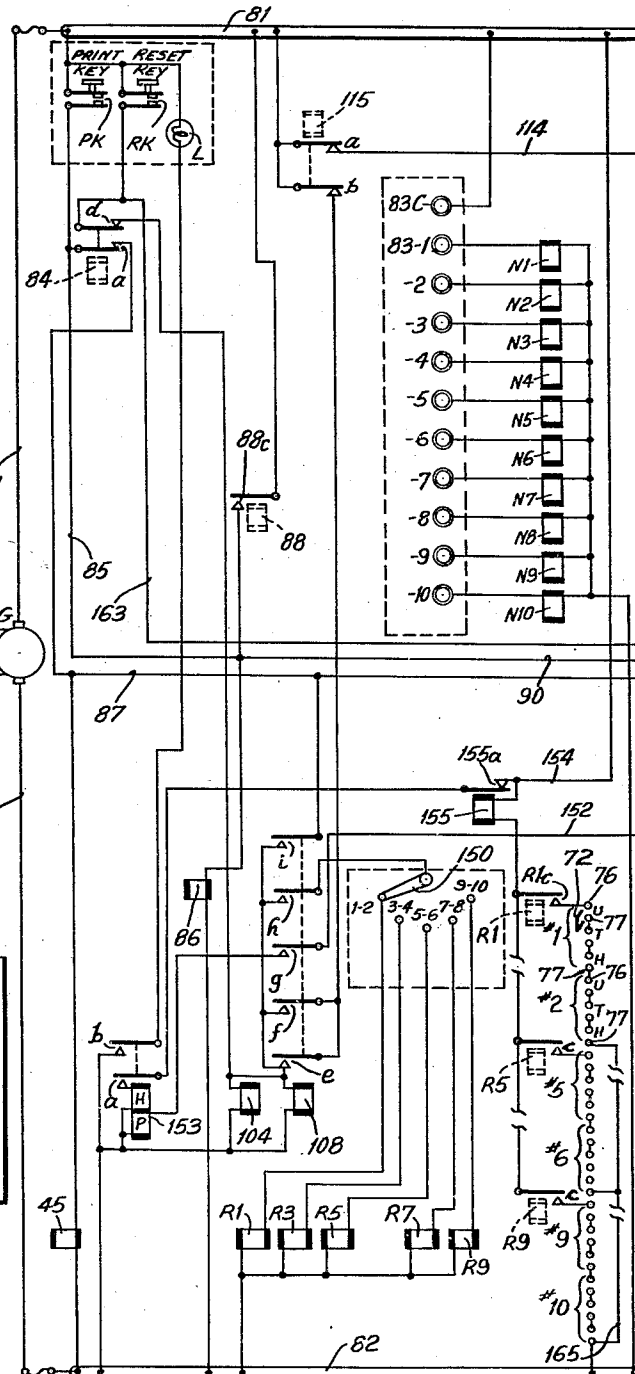


FIG. 11.

TEST DEP'T	DATE	
STATION	TEST NO.	RESULT
8	125	40.89
10	5	3.60
6	98	64.75



BY

INVENTORS
Clin D. Lake
Francis C. Hamilton
W. M. Wilson
 ATTORNEY.

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C. D. LAKE ET AL

2,403,006

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Filed Sept. 23, 1941

6 Sheets-Sheet 5

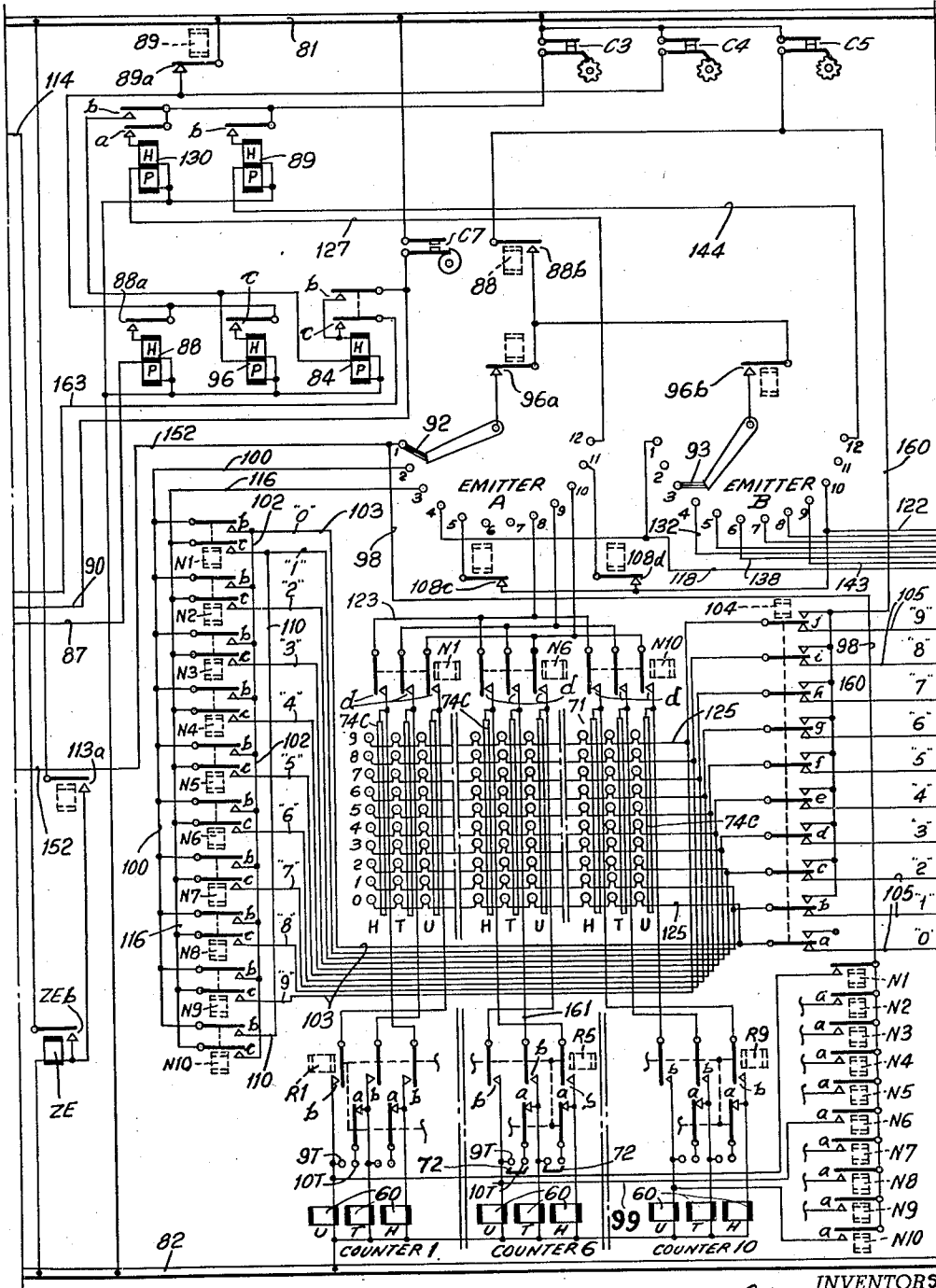


FIG. 12b.

BY

INVENTORS
Clair A. Lake
Francis C. Hamilton
W. M. Wilson
 ATTORNEY

July 2, 1946.

C. D. LAKE ET AL

2,403,006

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Filed Sept. 23, 1941

6 Sheets-Sheet 6

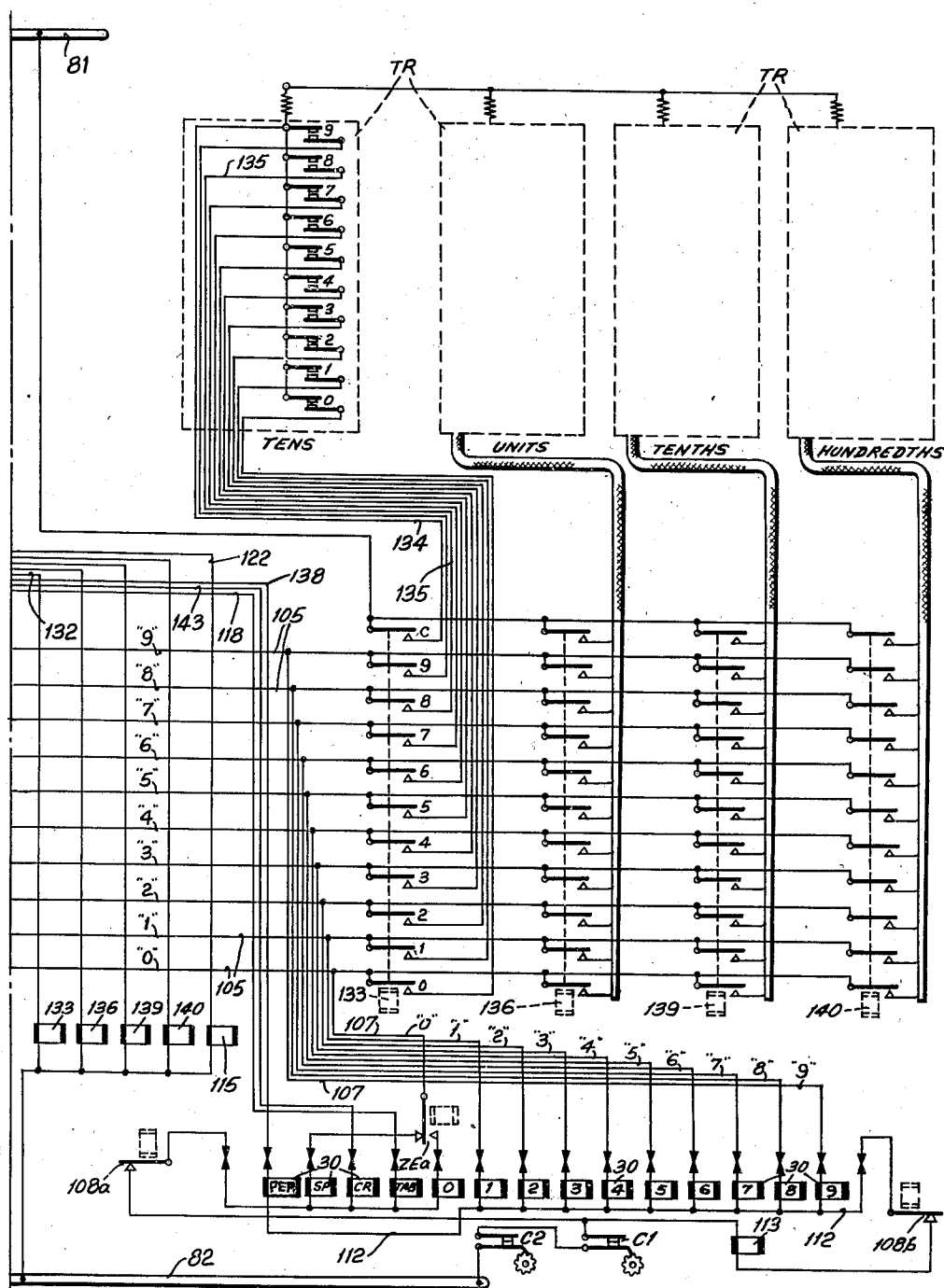


FIG. 12c.

BY

INVENTORS
C. D. Lake
Francis E. Hamilton
 ATTORNEY

UNITED STATES PATENT OFFICE

2,403,006

RECORDER MECHANISM

Clair D. Lake, Binghamton, and Francis E. Hamilton, Endicott, N. Y., assignors to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application September 23, 1941, Serial No. 411,964

11 Claims. (Cl. 234—58)

1

This invention relates to means for recording information, such as test information.

Tests may be made at different stations. A common test result indicator and a common recording unit are provided. The invention is directed to recording of the test result along with identifying data including the station at which the test was made and the sequence or serial number of the test for the station. The invention resides further in recording of information automatically with respect to any selected one of a plurality of information sources. The invention also contemplates novel means to preselect certain data for recording during a recording cycle of the machine. The invention has for other objects, the provision of:

Electrical cyclically operating means for causing recording of data by a typewriter and operations auxiliary to recording; e. g. tabular spacing and carriage return operations.

Serial numbering control means providing for serial numbering of the tests recorded for each test station or of the information pertaining to each information source.

Automatic starting and stopping means for the motor of a motor driven typewriter unit used as the recording unit.

Automatic means for unlocking the typewriter keys when the typewriter motor is under automatic control.

Novel means to preselect serial number counters for resetting and for effecting resetting.

Novel means to eliminate recording of zeros by the typewriter prior to typing of the first significant digit.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is an elevational view of the cyclic, clutch driven emitters and contact operating cams,

Fig. 2 is a detail of the clutch,

Fig. 3 shows the timing chart,

Fig. 4 is a vertical side section through a sequence counter,

Fig. 5 is a front view of sequence counter orders, showing one in section,

Fig. 6 is a section through the carry and zero detecting commutator of a counter order,

Fig. 7 is a section through the value readout commutator of a counter order,

Fig. 8 is a side section through the typewriter,

2

Fig. 9 is a plan view of the typewriter keyboard, Fig. 10 is a detail of an automatic key lock release,

Fig. 11 shows a portion of a sheet on which the test data of several stations are recorded, and Figs. 12a, 12b, and 12c constitute the circuit diagram.

Briefly, the machine comprises a typewriter and a robot for automatically operating the typewriter. The robot control the typewriter to record information pertaining to tests made at a plurality of test stations. The kind of test made and the calculation of the test result are not subjects of the present invention and will not be discussed. The computed result of a test at any of the stations is given by a common result indicator. A serial number counter is provided for each test station. When information relating to a test at a station is to be recorded, the desired station is selected by the operator and clutch driven means brought into operation for a recording cycle. During the cycle, the identity of the station is recorded, unity is added to the serial number counter of the selected station, the new serial number is recorded, and the test result given by the common indicator is recorded.

The typewriter (Figs. 8, 9, 10)

Any suitable well known typewriter may be used as the recording means, but it is preferred to use the typewriter known as the "Electromatic" and the general principles of which are disclosed in Patents Nos. 1,775,055 and 1,873,512.

Fig. 9 shows the keyboard of which keys are the character keys, CR the carriage return key, Tab the tabular spacing key, and SP the space bar.

Briefly, referring to Figs. 8 and 9, depression of a key 10 releases latch 11 from a cam 12, permitting a spring-pressed lever 13 to move the cam against the periphery of a friction shaft 14 driven continuously by the regular typewriter motor TM (shown only in the circuit diagram Fig. 12a). The cam 12 is rotated by the shaft to cause the cam carrier 15 to rock in a direction for depressing a link 16. Through linkage 17, the link 16 impels the type bar 18 towards the sheet on platen 20 to type the selected character. In the final increment of movement of the type bar, it strikes a universal bar 22 to actuate escapement lever 23 for releasing the escapement mechanism to effect a character spacing movement of the platen-mounting carriage 24 after the character has been typed. Depression of space bar

SP acts through a set of elements 11, 12, and 13 and shaft 14 to move a link 15' down to operate a linkage 25 for actuating the escapement lever 23 to cause character spacing.

The carriage return mechanism is of the kind disclosed in Patent No. 1,955,614 and is set in operation by depression of carriage return key CR. As usual, line spacing occurs as an incident to carriage return operation.

The tabulating mechanism is set in operation by depression of key Tab, and is of the kind disclosed in Patent No. 1,935,436. The usual settable tab stops 26 control the extent of tab spacing upon each tab spacing operation.

Element 28 is the usual settable margin stop to stop the carriage return movement when the left margin position has been reached by the carriage.

For each digit key, for the period or decimal point key, and for the space bar SP, carriage return key CR, and tab spacing key Tab, a solenoid 30 is provided. Energization of a key solenoid results in automatic depression of the associated key or space bar. The solenoids may be distinguished by appending the designation of the function of the related key or bar to the common designation 30 of the solenoids; i. e., solenoid 30SP is the solenoid for operating the space bar and solenoid 30—1 is the solenoid for operating the key which causes typing of digit 1. The keys may be manually operated or, alternatively, may be automatically operated by the solenoids.

The typewriter has the usual bar 32 (Fig. 10) which moves upwardly to position for locking the key levers against operation when the regular typewriter switch TS is set in "off" position. When this switch is moved to "on" position, it rocks bar 32 down to release the key levers. In the present case the typewriter is not only operable manually but also automatically during certain cyclic periods of operation of the robot. To keep the typewriter motor running during these cyclic periods only, when control of the typewriter by the robot is desired, the regular typewriter switch is rendered ineffective and cyclic means provided to switch the motor on and off automatically. As the locking bar 32 may be initially in locking position, a key unlocking solenoid 33 is provided which, upon energization, moves bar 32 down to key unlocking position. The energization of the solenoid 33 is effected during the cyclic periods when the typewriter motor is automatically set running. When it is desired to operate the typewriter manually, the solenoid 33 is disconnected from circuit and the regular typewriter switch TS is rendered effective.

The robot

The robot includes a motor CM (Fig. 1) which drives a gear 35 meshed with a gear 36, the hub of which is freely rotatable on a shaft 37. Rigidly carried by the hub of gear 36 is a single-notched one revolution clutch collar 38 (also see Fig. 2). Mounted freely on shaft 37, alongside the clutch collar 38 is a gear 39, the hub of which carries an arm 40. Arm 40 carries a clutch dog 41, the tooth of which is adapted to engage in the notch of clutch collar 38. Normally, the clutch dog 41 is held in disengaged position by a latch lever 42 and a rebound latch 43 carried thereby. Upon energization of a clutch magnet 45, the latch lever releases the clutch dog which is enabled thereby to clutch the gear 39 to the gear 36 for common rotation.

Gear 39 is meshed with a gear 47 on a shaft 48. The gear ratio is such that shaft 48 makes two revolutions to one revolution of the gear 39. Shaft 48 carries the brushes of emitters A and B of common construction. Also carried by shaft 48 are various contact closing cams 50 for closing cam contacts C1 to 7 in circuits which will be traced later.

The robot includes sequence or serial number counters, one for each of the test stations to count the number of tests made and recorded at the related station. Each sequence counter, in this instance, has three orders; hundreds, tens, and units orders. The construction of one sequence counter is shown in Figs. 4 to 7. Each counter wheel 55 has two duplicate sets of digit positions 0 to 9. Fixed to the side of each counter wheel is a twenty-toothed ratchet 56 having one tooth for each digit position. Coacting with the ratchet teeth of each ratchet 56 is a detent 57 for preventing clockwise rotation of the ratchet and indicator wheel (as viewed in Fig. 4). Also coacting with each ratchet is the tooth of an actuating pawl 58. The pawl is pivotally carried by the free end of the horizontal arm 59a of a bell crank lever 59. The vertical arm 59b of the lever constitutes the armature of the counter magnet 60. A spring 62 between pawl 58 and the arm 59a urges the pawl clockwise to maintain its tooth engaged with the ratchet. The back of the upper portion of the pawl 58 is inclined and engaged with a bar 63, such engagement holding the pawl in position to inhibit the counterclockwise rotation of the ratchet when the pawl is in normal, lower position. Upon energization of the magnet 60, the lever 59 rocks clockwise and lifts the pawl until its tooth is above the tooth next higher to the one previously engaged thereby. Upon deenergization of the magnet, a spring 65 connected to the arm 59b of lever 59 restores the lever in a counterclockwise direction, causing the pawl to descend. During this action of the pawl, it turns the ratchet through one tooth distance and thereby advances the indicating wheel one value step from one digit position to the next.

Secured to each indicating wheel is a rotor 70 of insulating material. The rotor carries axially spaced, separate brush pairs to coact with contact segments imbedded in a fixed moulding 73 of insulating material. One brush pair 71 coacts with digital value segments 74—0 to 9 and a common segment 74C. During each half a revolution of the indicator wheel, or while it is being moved through one set of digit positions, one of the brushes 71 successively engages with the ten value segments while the opposite brush 71 engages the common segment 74C. Two diametrically opposite similar brush pairs 72 are provided (Fig. 6). When the indicator wheel is in a 9 digit position, the brushes 72 of one pair bridge the segments 9T and 10T. As the wheel moves on to 0 position, the diametrically opposite brush pair 72 bridges commutator segments 76 and 77 for a purpose explained later. It will be evident that the brush pairs 72 alternate in function during successive half revolutions of the counter wheel.

It is understood that the counter wheels may be left blank in case it is not desired or necessary to visibly show the counter reading.

Other parts of the robot will be described subsequently in the explanation of the circuits and of the operation of the machine in selecting, reading out and recording information.

Before starting operations under control of the robot, the operator may manually operate the typewriter to type on a sheet (Fig. 11) the date, other classifying information, and headings such as shown in this figure. Alternatively, such information and headings may be preprinted on the sheets. To prepare the typewriter for control by the robot, a switch 80 is placed in lower position as viewed in Fig. 12a, rendering the regular typewriter switch TS ineffective to control operation of the typewriter motor TM. The operator closes line switch LS, connecting a relay coil GE to a suitable voltage supply, thereby energizing the coil to close switch GE1. The closure of this switch initiates operation of a motor-generator unit M—G to supply direct current to opposite circuit sides 81 and 82 of the robot.

The present disclosure takes into consideration ten test stations referred to as stations 1 to 10. There are ten station relay coils N1 to N10 (Fig. 12a) and ten associated plug sockets 83—1 to 10 for the ten correspondingly numbered stations. To select a station for which a record is to be made, the operator connects a plug wire (not shown) between the common plug hub 83C and the plug socket numbered similarly to the desired station; e. g. to select station 6, the plug wire is connected between socket 83C and the socket 83—6. A circuit is thereupon completed from line side 81 via the socket 83C and the connected socket 83—6 through coil N6 to line side 82. A recording cycle is then initiated by depressing the print key (Fig. 12a) to close its contacts PK. This completes a circuit from line side 81 via the print key contacts PK and normally closed relay contacts 84a through clutch magnet 45 (also see Figs. 1 and 2). Concurrently, a branch circuit extends from the print key contacts PK via a line 85 through a relay coil 86 to line side 82. Another branch circuit is completed from key contacts PK via relay contacts 84a and a line 87 (continue with Fig. 12b) through the pickup coil P of a duo wound relay magnet 88 to line side 82.

Energized coil P of magnet 88 closes contacts 88a to establish the circuit of holding coil H of this magnet via normally closed relay contacts 88a.

Energized relay coil 86 (Fig. 12a) closes contacts 86a to complete the circuit of robot motor CM (also see Fig. 1).

At this time, motor CM is in operation and clutch magnet 45 is energized. Hence, a clutch cycle is initiated during which the cam and emitter shaft 48 (Figs. 1 and 2) makes two revolutions. To maintain coil 86 energized and motor CM in operation after release of the print key, energized magnet 88 closes contacts 88c (Fig. 12a), shunting the print key contacts. Another shunt circuit for motor relay coil 86 extends from line side 81 (Fig. 12b) via cam contacts C7 and a line 90 (continue with Fig. 12a) through coil 86 to line side 82.

During each of the two revolutions of shaft 48 occurring during a clutch cycle, the brushes 92 and 93 of emitters A and B (Fig. 12b) wipe the emitter spots, but during the first revolution only emitter A is rendered effective and emitter B does not become effective until emitter A has completed its functions.

Shortly after the clutch cycle starts, cam contacts C8 (Figs. 3 and 12a) close. A circuit is thereby completed from one side of the main sup-

ply line via now closed relay contacts GE1 and a wire 94 through typewriter motor TM and cam contacts C6 and a wire 95 to the opposite side of the main supply line. A parallel circuit proceeds from wire 94 via switch 80 in lower position, through key unlocking solenoid 33 (also see Fig. 1) and via contacts C6 to wire 95. Solenoid 33 now unlocks the typewriter keys for operation while the typewriter motor rotates shaft 14 (see Fig. 8). During the open intervals of cam contacts C6, the typewriter motor stops running, but during these periods recording is not to occur. By this means, the typewriter motor is set in operation only during desired portions of the cycle of the robot, and with switch 80 in lower position, the regular typewriter switch TS is prevented from initiating operation of the typewriter motor.

During the first revolution of cam shaft 48, emitter A is effective while emitter B is ineffective until the 13th machine cycle point (see Fig. 3). The current feed to brush 92 of emitter A (see Fig. 12b) is through relay contacts 88b and 96a. Contacts 88b are closed at this time as a result of energization of magnet 88 which occurred when the print key was depressed, as explained before. Contacts 96a are normally closed and do not open until the emitter A brush has reached its last spot, i. e., spot 12, as will be described later.

The current feed to the brush 93 of emitter B is through relay contacts 88b and 96b. Contacts 88b do not open until the brush 93 reaches the 12 spot of emitter B. Contacts 96b will be closed when magnet 96 is energized upon engagement of emitter A brush 92 with spot 12. Thus, contacts 96b close and contacts 96a open at the same time and emitter A is rendered ineffective while emitter B is made effective.

The operations controlled by emitter A will now be explained. The first such operation is the addition of unity to the sequence counter of the selected station. For convenience, the counters will be referred to by the numbers of their stations. Thus, if station 6 is selected, its counter 6 will be advanced one step to add "one" to its previous count reading. The count manifested by a sequence counter indicates the number of the test being recorded for the related station. The selection of a station is effected by energization of one of the coils N1 to N10 (Fig. 12a). The energized coil will close its contacts a (Fig. 12b, lower right) and through these contacts, an impulse will be routed to the counter magnet or magnets of the sequence counter for the selected station. The count impulse circuit will be completed upon brush 92 of emitter A reaching emitter spot 1. Assume, for example, that station 6 has been selected; hence, coil N6 is energized and contacts "a" of this coil are closed. When brush 92 engages spot 1 of emitter A, the following circuit is completed (Fig. 12b):

Count impulse circuit.—Line side 81, make and break contacts C5, relay contacts 88b and 96a, brush 92, emitter spot 1, and wire 98 to the common side of all the a contacts of coils N1 to N10; thence via closed contacts a of coil N6 and a wire 99 through the units order counter magnet 60 of counter 6, to line side 82.

Energization of units order magnet 60 (also see Fig. 4) of counter 6 followed by its deenergization as brush 92 leaves spot 1 of emitter A, causes the units order of this counter to advance one step, adding unity to its previous reading. If the units order is at "9" at the time the count impulse cir-

cult is completed, the tens order magnet also will be energized to advance the tens order of the selected counter 1 step, thereby taking care of carry from units order to tens order. As previously described, when a counter order is in "9" position, brush pair 72 is bridging contacts 9T and 10T (Fig. 6). Therefore, with the units order in this position, the circuit of tens order magnet 80 will branch off from wire 99 via contacts 9T and 10T of the units order bridged by brush pair 72, thence via one of the normally closed group of a contacts of a reset relay coil R5 and through the tens order magnet 80 of counter 6. If the tens order also is at "9" at the time the count impulse circuit is closed, a branch circuit extends from line 99 via the carry contacts 9T, 10T and 72 of the units order and the contact R5a previously referred to, thence via the carry contacts of the tens order and another contact R5a through the hundreds order counter magnet 80. Through the circuit or circuits described above, unity will be added to the previous count reading of the sequence counter of the selected test station.

After brush 92 of emitter A has engaged spot 1 to initiate addition of unity to the selected counter, the emitter brush successively engages spots 2 and 3 to initiate automatic recording of the identifying number of the counter in a field of columns under heading "Station" on the sheet (Fig. 11). In the assumed example, counter 6 was selected and coil N6 energized. Coil N6 closed contacts N6b (Fig. 12b). All the N1b to N9b contacts are between a common wire 100 and a common wire 102. Wire 102 is connected to a "0" line 103 which leads to the normally closed side of relay contacts a of a relay coil 104 from which the "0" wire 105 extends to a "0" wire 107 (Fig. 12c). This wire 107 is connected to the common blade of switching contacts ZEa. When contacts ZEa are in normal condition, they lead to the space bar operating solenoid 30SP of the typewriter. When contacts ZEa are in shifted condition, they lead to the 0 key solenoid 30. Contacts ZEa will be shifted, in a manner subsequently described, as a result of the typing of the first significant digit in a record field under one of the headings on the sheet (Fig. 11). Thus, contacts ZEa and their operating coil ZE are elements of zero elimination means to prevent typing of a zero preceding the first significant figure. When any of the test stations 1 to 9 are selected, the first column of the field under heading "Station" on the sheet will not contain a significant digit. Hence, upon the emitter A brush 92 engaging spot 2, a circuit will be completed through space bar solenoid 30SP as follows, (start with Fig. 12b): From line side 81, via contacts C5, 88b, and 96a to brush 92; thence via emitter spot 2 to line 100 and the closed one of the contacts N1b to N9b to line 102, "0" line 103, the lower side of contacts 104a, and to connected "0" wire 105. The circuit continues through "0" wire 107 and the left side of contacts ZEa through space bar solenoid 30SP, and via normally closed contacts 108a and make and break contacts C1 and C2 to line side 82.

When counter 10 is selected, related contacts N10b (Fig. 12b) are closed. These contacts connect wire 100 to a wire 110 leading to the "1" line 103. Hence, when emitter brush 92 reaches spot 2, a circuit proceeds through contacts N10b to "1" line 103, which connects to the lower side of switching contacts 104b. From there, the circuit continues via "1" wire 105 and the "1" line 107 through the 1 digit key solenoid 30-1 to the

common line 112 of the digit and period key solenoids 30-1 to 9 and 30PER. The circuit is completed by way of normally closed relay contacts 108b through a coil 113 and contacts C1 and C2 to line side 82.

Coil 113, which is energized when any of the significant digit key solenoids 30-1 to 30-9 or the period key solenoid 30-PER is energized, closes contacts 113a (Fig. 12b) to pick up zero elimination control coil ZE. Coil ZE closes stick contacts ZEb to provide a holding circuit extending from the side 82 through the coil, its b contacts and a wire 114 (continue with Fig. 12a) through normally closed relay contacts 115a to line side 81. Coil ZE shifts contacts ZEa (Fig. 12c). Thereafter, until coil ZE is deenergized by opening of its stick circuit, a "0" impulse will be routed through solenoid 30-0 and cause a "0" to be printed, whereas prior to the shifting of these contacts, the impulse was directed to the space bar solenoid 30SP.

The units order digit of the identifying number of the selected counter is typed when emitter A brush 92 reaches spot 3. Spot 3 is connected to common wire 116 (Fig. 12b) connected to one side of each of contacts N1c to N10c. Contacts N10c, if closed, connect wire 116 to the previously mentioned wire 102 which leads to the "0" line 103. The typing of the tens order digit of counter number 10 has caused zero elimination control contacts ZEa to be shifted, as explained before. Hence, the circuit routed through the c contacts of coil N10 will proceed to the key solenoid 30-0, causing a "0" to be typed in the units column under heading "Station" (Fig. 11).

The closure of the c contacts of any of the other coils N1 to N9 will route a circuit to the correspondingly numbered digit key solenoid 30. For example, with contacts N6c closed, the circuit initiated by engagement of spot 3 of emitter A with emitter brush 92 will extend from line 116 through contacts N6c to the "6" line 103, thence through the normally closed side of contacts 104g and the "6" line 105 to the "6" line 107 (Fig. 12c); thence through solenoid 30-6 and through the previously traced path to line side 82.

After the station identifying number has been printed on a line of the record sheet, the sheet will be tabular spaced to the first column under the heading "Test No." The tabular spacing operation is effected under control of emitter A as the brush 92 engages emitter spot 4. A circuit is established which begins as in the previous emitter circuits and continues from spot 4 via a wire 118 (turn to Fig. 12c) through the tab key solenoid 30TAB and by way of contacts 108a, C1, and C2 to line side 82. Energization of solenoid 30TAB causes tabular spacing movement of the carriage to the first column of the Test No. field.

In order to provide for elimination of zeros preceding the first significant digit in the Test No. field, the zero elimination means is restored to initial condition before typing begins in this field. For this purpose, coil ZE which was energized and held as a result of the typing of the first significant digit in the Station field is deenergized before typing begins in the Test No. field. This is done by opening relay contacts 115a (Fig. 12a) in the stick circuit of coil ZE. To open contacts 115a, coil 115 is energized by a circuit established when emitter A brush 92 engages spot 5. This circuit extends from emitter A spot 5 through normally closed relay contacts 108c, thence via

a wire 122 (continue with Fig. 12c) through coil 115 to line side 82.

After the tabular spacing of the typewriter carriage to bring the first column of the Test No. field to typing position is completed, the readout of the test sequence number begins. In order to allow sufficient time for the tabular spacing to be completed before this readout occurs, the readout is not initiated until the emitter A brush 92 reaches spot 8. Meanwhile, the tabular spacing, begun as the spot 4 was engaged by the emitter brush, will be completed.

The test sequence number is readout of the selected counter. This test sequence number is the number of times the results of tests made at the selected station have been listed. Each time a station is selected, the corresponding counter is stepped ahead one unit, as previously explained, so that the counter corresponding to each station registers the count and sequence of the test records for the selected station. When a counter is selected, the corresponding N coil (Fig. 12a) is energized, as described before. Besides the other contacts closed by the N coil, it closes a group of *d* contacts (Fig. 12b), each in series with one of the common segments 74C of the selected counter. For example, if coil N6 is energized, contacts N6*d* are closed and the hundreds, tens, and units orders of the selected counter 6 will be read out by circuits routed through the N6*d* contacts and completed as brush 92 successively wipes spots 8, 9, and 10. Assume, for instance, that counter 6 registers 010. The hundreds order readout circuit starts as the other emitter A circuits and proceeds from spot 8 to a line 123, the N6*d* contacts of the hundreds order, the connected common segment 74C, the brush pair 71, the 0 value segment, the "0" line 125; thence through the normal side of contacts 104*a* and by a previously traced path through the solenoid 30SP. Energization of this solenoid causes character spacing of the typewriter carriage. The "0" preceding the first significant digit of the sequence count is not printed.

The tens order counter readout circuit is formed upon engagement of brush 92 with spot 9 and, with the tens order in position "1," the circuit is routed via the connected digit "1" lines to solenoid 30—1. The circuit also energizes coil 113 which causes energization of coil ZE and shifting of contacts ZE*a* (Fig. 12c). Thus, the "0" in the units order of counter 6 will be readout when brush 92 engages spot 10 by a circuit routed through the shifted side of contacts ZE*a* to solenoid 30—0. In the above manner, serial number 010 in selected counter 6 is typed as 10 in the Test No. field.

The test result in the common result indicator is to be recorded next. There are four orders of the indicator designated in Fig. 12c by TR. Each order has ten contacts corresponding to digits 0 to 9, as indicated for the tens order only. One of these contacts in each order is closed to indicate the digit of the result in the order. The means by which the contacts are selectively closed is not part of the present invention. They may be considered as key contacts or as contacts of a relay accumulator.

Before the test result is recorded, the zero elimination relay ZE is deenergized. Upon engagement of brush 92 with spot 11, a circuit is completed via normally closed relay contacts 108*d* and wire 122 (turn to Fig. 12c) through coil 115. Coil 115 opens contacts 115*a* (Fig. 12a), breaking the stick circuit of coil ZE (Fig. 12b).

Brush 92 moves on to emitter spot 12 and completes a circuit via a wire 127 through the pickup coil P of a magnet 130. Contacts 130*a* and *b* close. Contacts 130*a* complete a circuit from line 81 via make and break contacts C3 through holding coil H of magnet 130. Contacts 130*b* complete a circuit from line 81 via contacts C3 and in parallel through the pickup coils P of magnets 84 and 96. Contacts 96*c* close and establish a circuit from line 81 via normally closed 89*a* relay contacts through the holding coil H of magnet 96. When cam contacts C3 open towards the end of the 12th cycle point (Fig. 3), the holding coil of magnet 130 and the pickup coils of magnets 84 and 96 are deenergized. The holding coil of magnet 96 remains energized until contacts 89*a* open subsequently. Coil H (96) maintains contacts 96*a* open and contacts 96*b* closed, respectively disconnecting the emitter A brush from circuit and connecting the emitter B brush 93 into circuit.

The pickup coil of magnet 84 has been energized, as explained above, and contacts *b* and *c* of the magnet closed. Through contacts *b* and cam contacts C7, a circuit is completed through holding coil H of magnet 84. This circuit is broken when contacts C7 open near the end of the 14th cycle point (Fig. 3). Coil H (84) opens contacts 84*a* (Fig. 12a) in the circuit of clutch magnet 45. As a result, if the operator has been unnecessarily holding the print key down, the clutch magnet will be deenergized nevertheless. As long as the operator continues to hold the print key down, another circuit for coil H (84) is completed from line 81 via the print key by contacts PK, wire 90 (turn to Fig. 12b), the *b* contacts of magnet 84, and through coil H (84) to line 82. In this manner, coil H is energized at about the midpoint of the clutch cycle to open contacts 84*a* in the clutch magnet circuit and will remain energized if the print key is held down. If the key is held down until cam contacts C7 reclose during the second half of the cycle, the circuit of coil H (84) through these cam contacts will be re-established. The print key must be released and then depressed again after cam contacts C7 reopen near the end of the cycle before the clutch magnet 45 can be energized again to initiate a new cycle.

Emitter B has been rendered effective now by closure of contacts 96*b*. Engagement of brush 93 with spot 1 completes a circuit from line 81 via contacts C5, still-closed contacts 88*b*, and now-closed contacts 96*b* to brush 93 and spot 1 which is connected to line 118 leading to the tab solenoid 30TAB (Fig. 12c). Energization of this solenoid causes tabular spacing of the sheet to bring the Result field (Fig. 11) to typing position. Spots 2 and 3 of emitter B are inactive to provide time for tab spacing to be completed before recording of the result begins. When brush 93 engages spot 4, a circuit is completed via a wire 132 (Figs. 12b and 12c) through a magnet 133. Magnet 133 closes the column of contacts 0 to 9 and *c* (Fig. 12c). It will be noted that each of the contacts 0 to 9 is connected at one side of the corresponding 0 to 9 lines 107 and at the opposite side to a corresponding 0 to 9 contact of the tens order of result indicator TR. The common side of contacts 0 to 9 of the tens order of TR is connected to line side 81 through contacts *c* of coil 133. Depending on which one of the TR contacts is closed, a circuit will be completed to the related solenoid

30. For instance, with the 8 contacts of TR tens order closed, the circuit is completed from line 81 via contacts 133-c, wire 134, the 8 contacts, wire 135, contacts 133-8 and wire 107-8 through solenoid 30-8.

As soon as brush 93 of emitter B leaves spot 4, coil 133 is deenergized and the readout circuit for the tens order of TR is broken. Engagement of brush 93 with spot 5 energizes a coil 136 (Fig. 12c). Coil 136 closes a column of contacts to read out the digit in the units order of TR in the same manner as explained with respect to the relay contacts of coil 133 and the tens order. After the units order digit is typed, a decimal point is to be typed. This is done as brush 93 engages the 6 spot, completing a circuit extending from this spot via a wire 138 (Figs. 12b and 12c) through the solenoid 30-PER which operates the period key to print a decimal point. As this circuit includes coil 113, zero elimination coil ZE will be energized and contacts ZEX shifted even if the tens and units orders of TR both read zero. Thus, a zero in the tenths order or in both the tenths and hundredths orders will be typed as "0's" even if not preceded by a significant digit.

Brush 93 after leaving spot 6 engages successively with spots 7 and 8 to cause successive energization of coils 139 and 140 (Fig. 12c). These coils close columns of contacts such as the 133 column to cause successive readout and typing of the values in the tenths and hundredths orders of the indicator TR.

Emitter spot 9 of emitter B is connected to a line 143 which continues in Fig. 12c through the carriage return solenoid 30CR. Hence, after recording of the common result read out of indicator TR, brush 93 engages spot 9 to energize solenoid 30CR. As a result, the record sheet (Fig. 11) is line spaced and brought to position for receiving the next line of information.

Emitter B spot 10 is connected to wire 122 which leads to coil 115 (Fig. 12c). Energization of this coil opens contacts 115a (Fig. 12a) to break the stick circuit of zero elimination coil ZE.

When brush 93 reaches spot 12, a circuit is completed from this spot via a wire 144 to the pickup coil P of duo wound magnet 30. Contacts 30b close and establish a circuit from line side 81 through cam contacts C3, contacts 30b, holding coil H (30), to line side 82. Magnet 30 opens contacts 30a to break the main circuits of the holding coils of magnets 30 and 36. The exact timing of the deenergization of these holding coils is controlled by cam contacts C4 which are in shunt with relay contacts 30a. Upon deenergization of coils H (30) and H (36), contacts 30b and 36b open to disconnect the emitter B brush 93 from line side 81. Both emitters are now ineffective until a new cycle of printing operations is initiated.

As magnet 30 is deenergized, relay contacts 30c (Fig. 12a) open, breaking the circuit of coil 36 through these relay contacts. When cam contacts C7 open, coil 36 is deenergized, and the circuit of motor CM opens to interrupt operation of the motor.

If the operator desires to operate the typewriter manually, switch 80 (Fig. 12a) is shifted to upper position. Closure of typewriter switch TS then establishes the circuit of typewriter motor TM as follows: From one side of the supply line to wire 95, and via the upper blade of switch 80 and switch TS through the motor TM and via contacts GEX to the opposite line side.

At certain times, it is desired to return the station counters to zero. In order to reduce the maximum current requirements of the machine, only two counters at a time may be reset. It is

thus necessary for the operator to make a selection of the two counters to be reset at the same time during a reset cycle. Five reset cycles will be required to reset the ten counters. The selection of the counters to be reset is made by manually setting a switch arm 150 (Fig. 12a) in engagement with one of the five terminals designated 1-2, 3-4, 5-6, 7-8, and 9-10. The two counters selected for reset are indicated by the designation of the terminal engaged by arm 150. For instance, if counters 1 and 2 are to be reset, arm 150 is set at terminal 1-2. The operator then depresses the reset key (Fig. 12a), completing a circuit from line side 81 via reset key contacts RK and the normally closed d contacts of coil 84 through relay coils 104 and 108 in parallel to line side 82.

Coil 108 closes its contacts e, f, g, h, and i (Fig. 12a) and opens its a and b contacts (Fig. 12c, at bottom) and also its c and d contacts (Fig. 12b). The opening of contacts 108a and b prevents the making of any key solenoid circuits. The opening of contacts 108c and d prevents making of the circuit of coil 115 (Fig. 12c) under control of emitter A.

Closure of the e and f contacts of coil 108 establishes a stick circuit for coils 104 and 108 from line side 81 via normally closed relay contacts 115b and contacts e and f of coil 108 through coils 108 and 104 to line side 82.

With contacts e, f, and h of coil 108 closed and the switch arm 150 at terminal 1-2, for instance, a circuit is completed from line side 81 via contacts 115b, in parallel through contacts 108e and 108f, thence via contacts 108h to switch arm 150, thence via terminal 1-2 through a reset relay coil R1 to line side 82. Similarly, if switch arm 150 were at terminal 3-4, reset coil R3 would be energized; if at terminal 5-6, coil R5 would be energized; if at terminal 7-8, coil R7 would be energized; and if at terminal 9-10, coil R9 would be energized.

Closure of contacts f, e, and i of coil 108 completes a circuit from line side 81 via contacts 115b, parallel contacts 108e and f, thence via contacts 108i to line 87, thence through clutch magnet 45 to line side 82. Concurrently, a circuit branches off from the connection of contacts 108i and line 87 through the pickup coil P of magnet 30 (Fig. 12b). Contacts 30a close to establish the circuit of the holding coil H of magnet 30 extending also through normally closed relay contacts 30a. Coil H (30) maintains contacts 30b (Fig. 12b) closed to connect emitter A brush 92 to line side 81. Contacts 30c are held closed by coil H (30) to establish a circuit through motor relay coil 36 (Fig. 12a). Coil 36 closes switch 80a (Fig. 12a) to cause motor CM to be set in operation.

With the clutch magnet 45 and motor CM now energized, a clutch cycle (Fig. 3) takes place. Within the 2nd cycle point, brush 92 of emitter A is engaged with emitter spot 1, establishing a circuit from line side 81 via contacts C5, 30b, 30a, brush 92, spot 1, a line 152 (turn to Fig. 12a), contacts g of energized coil 108, and through the pickup coil P of a duo wound magnet 153 to line side 82. Coil P (153) closes related contacts a, completing a circuit from line side 81 via a wire 154 and normally closed relay contacts 155a and now-closed contacts a (153) through holding coil H of magnet 153 to line side 82. The holding

coil maintains the *b* contacts of magnet 153 closed to maintain a circuit through a reset signal lamp L. The signal lamp L will remain lit until the selected two counters are correctly reset to zero positions, in a manner explained later.

In accordance with the setting of switch arm 150 (Fig. 12a), one of the reset relay coils R1, R3, R5, R7, or R9 is energized, as previously explained. Each of these coils controls resetting of the pair of counters designated by the terminals (Fig. 12a) to which they are connected. Assuming, for instance, that switch arm 150 was set at the terminal 5-6, coil R5 is energized and controls resetting of counters 5 and 6. Referring to Fig. 12b, coil R5 opens its *a* group of contacts and closes its *b* group. While Fig. 12b shows diagrammatically only counter 6 of the pair of counters 5 and 6, it is understood that two more contacts *a* of coil R5 and three more contacts *b* of this coil are associated with the circuits of counter 5. Likewise, each of the other reset relay coils controls *a* and *b* contacts of the related pair of counters. Opening of the *a* group of contacts of the reset relay coil breaks the carry circuit paths between lower and higher orders of the selected counters, since carry is not desired during resetting operation. Closing of the *b* group of contacts of the reset relay coil for the selected counters prepares counter magnet impulsing circuits for completion under control of the readout commutators of the selected counters. The counter magnet of an order will be energized and deenergized as many times as the number of unit steps the counter order must advance to reach zero position. Thus, a counter magnet will be impulsed nine times if its counter order is at "1."

The reset counter impulse circuits include make and break contacts C5 (Fig. 12b). These contacts are connected between line side 81 and a line 160 common to the upper sides of contacts *b* to *j* of relay magnet 104. The upper sides of contacts 104b to *j*, when closed, connect line 160 to the "1" to "9" lines 125 of the readout commutators. At this time, magnet 104 (Fig. 12a) is energized by the stick circuit previously traced; hence, the upper sides of contacts 104b to *j* are closed. The upper side of contacts 104a are not in circuit so that the "0" line 125 is not connected to line 160.

Reset impulses will be fed to the counter magnets of both selected counters through the C5 contacts, the upper sides of contacts 104b to *j* and the readout commutators of the selected counters and both counters will be similarly reset. Resetting of only one selected counter will be explained in detail. Assume, for example, that counter 6 is registering number 098. Since no reset impulse can be fed through the "0" line 125, the hundreds order of counter 6 will remain in "0" position. With the tens order in "9" position, upon closure of cam contacts C5, a circuit is completed from line side 81 via contacts C5, line 160, the upper side of contacts 104j, and the connected "9" line 125 to the 9 value segment of the readout commutator of the tens order. The circuit continues through brush pair 71 to common segment 74C, thence via a wire 161 and the connected *b* contacts of reset relay coil R5 through the tens order magnet 60 of counter 6 and to line side 82. Contacts C5 break shortly after and the magnet 60 is deenergized. The energization and deenergization of magnet 60 of the tens order of counter 6 advances this order to zero position where it stays.

At the same time as the impulse was fed to counter magnet 60 of the tens order, an impulse is

fed to the magnet 60 of the units order. The latter impulse is routed through contacts 104i, "8" line 125, the "8" value segment of the units order of counter 6, the brush pair 71, segment 74C, and the connected R5b contacts to magnet 60 of the units order. Energization and successive deenergization of this magnet advances the units order of counter 6 from "8" position to "9" position. The next closure of contacts C5 sends another impulse by way of contacts 104j and the "9" position of the readout commutator of the units order to the counter magnet. Energization and deenergization of this magnet advances units order from "9" to "0" where it remains.

It is clear that nine reset impulses are the maximum required to reset any counter order, and resetting will be completed by the time one-half the clutch cycle has elapsed. After resetting has been effected, brush 92 of emitter A engages emitter spot 12 and completes the circuit of coil P (130). Contacts 130a close and establish the circuit of coil H (130). Contacts 130b also close and pick up coils P of magnets 96 and 84. Contacts 96c close and establish the circuit of coil H (96). This coil will now maintain contacts 96a open and 96b closed, thereby disconnecting emitter A from circuit and connecting emitter B into circuit.

Energized coil P (84) closes related *b* and *c* contacts. As before, closure of contacts *b* forms a circuit via cam contacts C7 for coil H (84). This circuit will open when cam contacts C7 break near the end of the first revolution of cam shaft 48 (Fig. 1) but will be re-established if the operator continues to hold the reset key down until the contacts C7 reclose. Should the reset key be held down, a circuit for coil H (84) is established from line side 81 via the reset key contacts RK (Fig. 12a), a line 163 (turn to Fig. 12b), the *c* contacts of magnet 84 and through coil H (84) to line side 82. This circuit will stay closed until the reset key is released. Thus, coil H (84) will remain closed until the reset key is released and cam contacts C7 open. While coil H (84) is energized, it holds contacts 84d (Fig. 12a) open, breaking the reset key circuit of coils 104 and 108. Since the clutch magnet circuit is made under control of the coil 108, the circuit will be broken when coil 108 is deenergized by opening of its stick circuit through contacts 115b, in a manner explained later. Thus, the continued depression of the reset key will not succeed in maintaining coil 108 energized, and a new reset cycle can be initiated only by releasing the reset key and depressing it again after contacts C7 open near the end of the clutch cycle.

Emitter B has been rendered effective, as previously explained, since contacts 96b have been closed. Engagement of brush 93 of emitter B with spot 10 closes the circuit of coil 115 (Fig. 12c). Contacts 115b open, breaking the stick circuits of coils 104 and 108 (Fig. 12a). The parts controlled by these coils are now restored to normal condition.

Engagement of emitter B brush 93 with the 12 spot completes the circuit of coil P (89). Coil H (89) thereupon is energized by a circuit through contacts 89b and cam contacts C3. Contacts 89a open, breaking the circuit therethrough of coils H of magnets 88 and 96. These coils are completely deenergized upon the opening of contacts C4 following opening of contacts 89a. Contacts 96b and 88b now open and emitter B, as well as emitter A, is rendered ineffective. Contacts 88c (Fig. 12a) also open, breaking the cir-

cuit therethrough of motor relay coil 86. When cam contacts C7 open near the end of the clutch cycle, the remaining circuit of coil 86 is opened. Contacts 86a open and motor CM stops.

If the selected counters have been properly reset to zero positions during the reset cycle, lamp L (Fig. 12a) will be extinguished. Each counter order has a brush pair 72 bridging contacts 76 and 77 when the counter order is in zero position (see Fig. 6). Referring to Fig. 12a, the segment 77 of the units order of the lower number counter of each pair of counters to be concurrently reset is connected to the segment 76 of the tens order, the segment 77 of the tens order is connected to segment 76 of the hundreds order, the segment 77 of the hundreds order is connected to segment 76 of the units order of the second of the pair of concurrently reset counters, and so on to segment 77 of the hundreds order of the second of the pair of counters which is connected through a line 165 to line side 82. When all the orders of the pair of counters are properly reset to zero positions, their brush pairs 72 will connect the segments 76 and 77 in series to line 165. The units order segment 76 of the lower numbered counter of the pair of counters to be concurrently reset is wired to one side of the c relay contacts of the related reset relay coil. Thus, if relay coil R1 is energized to select counters 1 and 2 for resetting, contacts R1c are closed and if the counters have been properly reset to zero, a circuit will be completed from line side 81 via wire 154 through a magnet 155, thence via contacts R1c and the zero commutator elements 75, 76, and 77 of counters 1 and 2, to line 165 and line side 82. Magnet 155 opens contacts 155a breaking the stick circuit of coil H (153). Contacts 155b open, breaking the circuit of lamp L.

It will be noted that in Figs. 12a and 12b, the hundreds, tens, and units orders are differentiated, respectively, by letters H, T, and U. In Fig. 12a, the group of zero commutator elements of counter 1 are designated by "#1," the group of such elements of counter 2 by "#2," and so on.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In combination, a typewriter with digit type actions, a motor, and mechanism operated by the motor for effecting power operation of the type actions upon their selection for the typing of data, a robot including selecting means for the type actions and cyclic means for rendering the selecting means effective, a circuit for the typewriter motor, and means operated by the cyclic means for closing the circuit to cause the motor to operate during cyclic periods of operation of the robot and to remain idle at other times.

2. The combination as defined in claim 1, in which the typewriter includes locking means for the type actions and a releasing device therefor and in which said means operated by the cyclic means operates the releasing device concomitantly with the closure of the motor circuit.

3. In combination, a typewriter, electrical agencies energized to effect operations of the typewriter in the recording of data and in re-

lated functions including intra line and line spacing operations, a robot including a power drive, a plurality of successively effective emitters concurrently operated by the power drive, means co-acting with the emitters for closing circuits of said agencies in succession to cause operation of the typewriter, and means for connecting the emitters into circuit in succession including means controlled by one emitter in a predetermined position thereof for causing disconnection thereof from circuit and connection of the next emitter into circuit.

4. In combination, a typewriter with type actions and a sheet support cooperative therewith for typing data, character by character, on the sheet, automatic operating agencies for the type actions, a plurality of separate automatically operable multiorder value registers, means for selecting any one of the registers to have the value registered thereby typed, means controlled by the selecting means for controlling the automatic agencies to operate the type actions to type identifying data on the sheet for identifying the selected register, and means coacting with the selected register, order by order, for controlling the automatic agencies to operate the type actions for typing the value registered thereby, one digit after another, on the sheet.

5. In combination, digit by digit recording mechanism for recording serial numbers, digit by digit, on a record sheet and including digit recording actions and automatic operating agencies therefor, a plurality of serial number counters with means individual to each counter for advancing it step by step, means for selecting at will any one of the counters, means controlled by the selecting means for operating the advancing means of the selected counter to advance the selected counter one step to register a new serial number, and means rendered effective by the selecting means and coacting with the selected counter after it has been advanced to register the new serial number for operating said automatic agencies to cause the digit recording actions to record the new serial number, digit after digit whereby the number of times each counter has been selected is recorded.

6. In combination, a typewriter with digit type actions and a cooperative sheet support for typing numbers, digit by digit, on the sheet, automatic operating agencies for the type actions, several, separate denominational order number registers, means to select any one of the registers for having its registered number typed, operative connections rendered effective by the selecting means between the selected register orders and the automatic operating agencies, and means for enabling the selected register orders to act in succession, one order after another, through said connections to cause the automatic operating agencies to operate the digit type actions to type the number registered by the selected register, digit by digit, on said sheet.

7. In combination, recording mechanism of the column by column recording type including recording elements and automatic electrical operating agencies therefor, a denominational order value register with a readout commutator for each order, a control magnet for each order and means effective upon each operation of a magnet to advance the order one unit value step, circuit connections between the readout commutators and the automatic agencies, means for closing said circuit connections between the agencies and the commutators, order by order, to cause the registered value to be recorded column by col-

umn, said connections including switching contacts normally connecting the agencies to the commutators and shiftable to connect the control magnets, instead, to the readout commutators, a controller, means operated under control thereof for shifting said contacts to connect the control magnets to the readout commutators, and make and break contact means for closing the circuits of the magnets through the commutators and said shifted contacts to cause successive operations of the magnets to advance the register orders step by step to zero positions.

8. The combination as defined in claim 7, there being several such registers and the circuit connections between the commutators and the control magnets also including normally open contacts, selecting means for the registers, and means controlled by the selecting means for closing the normally open contacts between the commutators of the selected register only and the control magnets for said register.

9. In apparatus including a common value result indicator and common digit by digit recording mechanism, separate plural order number registers, means to select at will any said register, cyclic recording-sequence control means, selective readout connections between the control means and the different registers, means controlled by the selecting means for rendering effective only the readout connections to the selected register, readout means rendered sequentially effective by said cyclic means, during a cycle thereof, and acting through the effective readout connections for reading out the selected register, order by order, to cause the recording mechanism to record the registered number, digit after digit, and means controlled by said cyclic means in the same cycle for reading out the common value result indicator to cause the recording mechanism to record the value result along with the number in the selected register.

10. In apparatus including a common value indicator for indicating the result value of a test made at any of separate test stations and a common digit by digit recording mechanism, separate, plural order serial number registers, each to count the tests made at a different one of the stations and to register the serial number of the test, means to select at will any said station for recording of the value result of a test made thereat and of the serial number of the test, common cyclic recording-sequence control means, selective operative connections between the common cyclic means and the registers for the stations,

means controlled by the selecting means for rendering effective only the said connections between the common cyclic means and the register for the selected station, means rendered sequentially effective by the cyclic means, in a cycle thereof, for acting through the effective connections to readout the serial number of the test from the register for the selected station, order by order, to cause the recording mechanism to record this serial number, digit after digit, in a field of a record sheet, and means controlled by the cyclic means, in the same cycle, to readout the test value result from said indicator to cause the recording mechanism to record the test value in a contiguous field of the sheet.

11. In combination with a typewriter having zero and significant digit type actions and a character spacing action, a plurality of multidimensional order number representing means, cyclic sequence control means, means controlled by the cyclic sequence control means, during one cycle thereof, for reading out a first one of the representing means and a second of the representing means, one after another and order by order, and including means to cause operations of said actions to type the represented numbers, digit by digit, in contiguous fields of a line of a record sheet, shiftable means normally conditioned to disable the zero type action from operating and enable the spacing action to operate upon the reading out of a zero from said representing means, means automatically effective upon the reading out of a first significant digit for alternatively conditioning the shiftable means to enable the zero type action to operate and disable the spacing action from operating upon subsequent readout of a zero from the representing means, and means controlled by said cyclic sequence control means for restoring the shiftable means to normal condition after the typing of the number in the first number representing means in one cycle and prior to the reading out, in the same cycle, of the second number representing means, whereby the shiftable means after being shifted to alternative condition upon readout of the first significant digit from the first representing means is restored to normal condition in readiness to be shifted again to alternative condition upon the readout of the first significant digit from the second number representing means.

CLAIR D. LAKE.
FRANCIS E. HAMILTON.