CIRCUITS

THE FOLLOWING data pertain to both Type 24 and Type 26 machine diagrams unless otherwise designated.

Sections 1 and 2 supply the power chassis, power connections, drive motor and voltage options. Sections 3 and 4 contain both numerical and combination keyboards, sensing pin contacts and interposer magnets. Sections 5 and 6 show most of the machine relays, the tubes that energize them and the control circuits to their grids. Sections 7 and 8 contain reference data such as relay location charts, chassis location charts, special keyboard contact location and the electrical timing charts. Sections 9 and 10 are the mechanical timing charts. It should be noted that the punch cams are held to closer tolerance than the card feed cams. The latching time of the card feed clutch is at zero and the punch clutch at 345°. Another point to remember while discussing circuits is the comparable speeds of the two clutches. It will be seen that punching starts and can even complete the first auto-duplicate or auto-skip field before the card feed latches up, because the card feed operates at 60 RPM and the punch shaft at 20 times that rate or 1200 RPM.

The polarity traps (selenium rectifiers) will carry only 5 ma. current. This is far below the load drawn by a test light. *Serious damage* to the rectifier will result unless they are shorted out while circuits are checked with a trouble light.

Power Supplies

From either of the wiring diagrams, Type 26 W. D. 228005L or Type 24 W. D. 228001M, it may be seen that the fusetron protects the filament transformer and the drive motor. The full-wave selenium rectifier is protected by 3-ampere fuses. All fuses are mounted behind the chip box and are accessible by removing the chip box.

Because of the large capacitor (200 MFD) across the D. C. output, plus a high resistance bleeder, an average voltage taken across the rectifier when the machine is in operation ranges from 130 to 160 volts.

The grid bias voltage applied to the tubes is obtained from a half-wave selenium rectifier. The variable transformer taps are provided to obtain proper input voltage from the available AC supply. DC machines are furnished with a rotary converter, which converts the line DC into the necessary AC for the power supply.

Basic Tube Operation

Before proceeding with the circuit analysis, several elementary principles should be reviewed. The following discussion applies to the application of the 25L6 beam power tetrode used in this machine.

In Figure 58 it is assumed that the tube cuts off at —20 volts bias; therefore, no current flows in the anode circuit since the grid is held at —49 volts. With no current flowing through load R, there will be no potential drop across it, and point A will be at the same potential as the rectifier, i. e., +130 V. It is well to note at this time that all voltages are stated with reference to the cathode voltage as zero.

The 25L6 tube is designed so that with +130V on the plate and without a plus voltage on the screen grid, even though the control grid is at cathode potential, the tube will not conduct. It has been found that varying the plus voltage on the screen grid causes a variation in the voltage drop across the tube.

Now place +130V on the screen grid at SG in Figure 58 through resistor R1. By closing switch S,

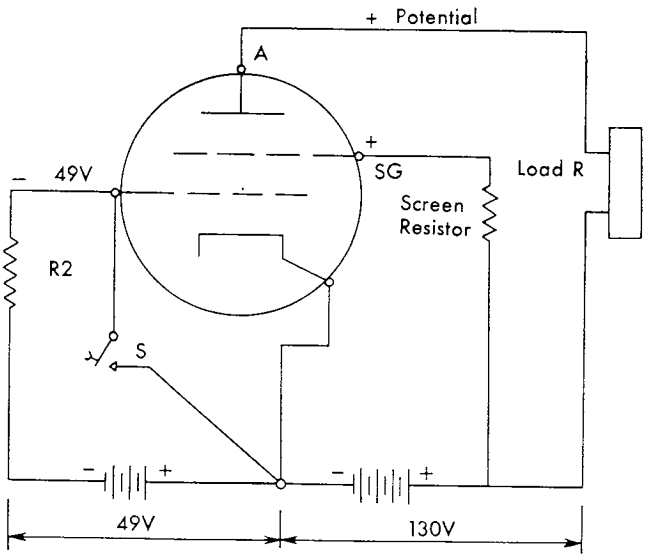


Figure 58. Normal Tube Operation Schematic

the control grid is placed at cathode potential. Conduction will take place through the tube and load resistor R. If the load resistance is 2000 ohms and the tube draws 40 milliamperes, a voltage drop of 80 volts exists. This results in a drop of 50 volts across the tube. By substituting load, R, with a relay or magnet coil, the use of the tube in this machine is illustrated. The net result is that there is a high starting voltage, approximately 80 volts across the coil.

A special application is made of tube 9 in the Type 26. An example is shown schematically in Figure 59. Assume that switch S is closed, causing the tube to conduct. If switch S1 is closed, grid SG will go to cathode potential and block the tube. The print suppression magnet in the plate circuit will become de-energized. This gives two means of controlling tube 9. While the field definition 12 contacts are holding the control grid at cathode potential, and the print suppression magnet is energized under normal operation, zero printing to the left of the first significant digit is operative by programming 2's and blocking tube 9 over the desired columns.

Similarity of Circuits

Because of the similarity of basic circuits in these machines, this circuit analysis applies to either wiring diagram 228001M (Type 24) or 228005L (Type 26). When there is a minor variation in tracing point-to-point, attention is called to it at that time.

The printing circuits for the Type 26 are isolated in a separate section following this description.

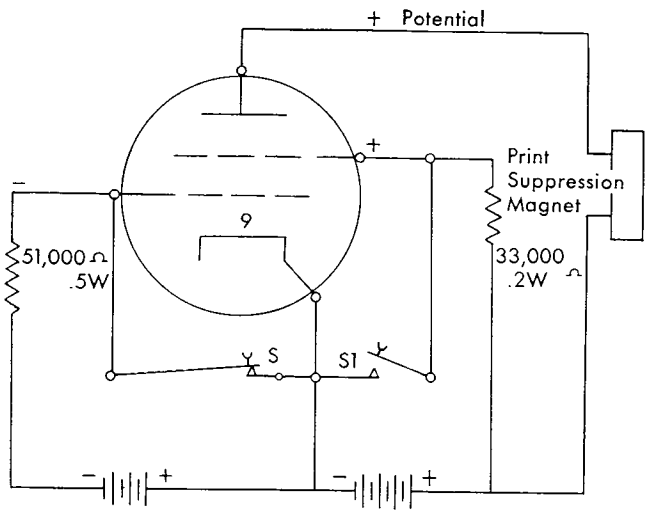


Figure 59. Zero Printing Schematic

Before proceeding with this circuit analysis, three points of reference should be established:

1. Post 76 is connected to all cathodes and the minus D. C. supply. If the cathode voltage is considered as zero in respect to tube circuits, completing a path from this post to a control grid (GR) is assumed to cause the tube to conduct.
2. Post 80 serves similarly to item 1 but for the plus potential.
3. Grid numbers correspond to tube numbers; hence, grid 3 is the control grid to tube 3.

When a circuit is completed from zero potential to any control grid, it will be understood that the relay or clutch magnet in the plate circuit of the associated tube is energized.

Function Charts

Function charts are designed to furnish a pictorial outline of a circuit function in terms of the relationship between the major components, and whether the component which causes the action is mechanical or electrical. They do not show the detailed paths of action. The purpose of the function chart is to present on one page the cause and effect of the more important elements of a given operation and serve as a guide to the understanding of the circuit as a whole. This should materially reduce service time by showing at a glance the highlights of a function without requiring the review of a relay outline or circuit description. It is believed that the function chart should be the first source of information when analyzing an operation.

If the machine failure is not located by the use of a function chart, the circuit action chart, when available, should be the next reference. The wiring diagram will serve as a source of information if there is a break in the circuit and a point-to-point check is required. The function chart will relieve the Customer Engineer of much of the necessity for review, as most service calls on circuits are due to contact point failures. The function chart and circuit action charts become valuable tools of analysis for the Customer Engineer, and of real help to those who wish to review the over-all circuit operation and maintain a high level of knowledge of the equipment.

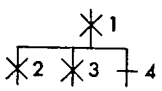
On a function chart, the action starts at the top of the page and reads down as time progresses. There is no fixed time scale. Since the function chart is a cause-

and-effect relationship of the various components of a given function, the reader must always proceed to the next lower component, and never in an upward direction. Note the last example of the function chart symbols (Figure 60). When a symbol is enclosed in a circle, it designates that the apparatus is a tube.

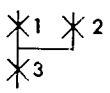
An electrical or mechanical apparatus is operated.

The apparatus is released (returns to normal).

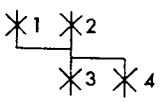
An example of sequential cause and effect. Relay 1 operates causing relay 2 to operate, which, in turn, causes operation of relay 3. Relay 3 then releases relay 4.



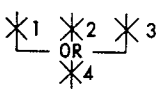
Multiple effects from a single cause. Relay 1 operates, causing the operation of relays 2 and 3 and the release of relay 4.



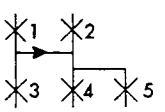
Multiple causes for a single effect. Both relays 1 *and* 2 must operate before relay 3 will operate.



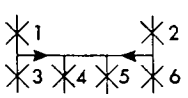
Multiple causes with multiple effects. Relays 1 and 2 must operate before 3 and 4 will operate.



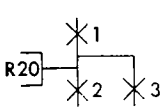
Alternate causes. Either relay 1, 2 or 3 will cause operation of relay 4.



An arrowhead located on a horizontal line gives the line direction so far as cause to effect is concerned. Relay 1 operates 3, but both 1 and 2 must operate to operate 4 and 5.



In some cases, two arrowheads may be necessary. Relay 1 operates 3 and relay 2 operates 6, but both 1 and 2 are necessary to operate relays 4 and 5.



A bracket is used to remind the reader that an apparatus previously operated is needed to cause further action. In the example, relays 1 and 20 are needed to operate 2. Relay 1 alone operates 3. Relay 20 does not affect 3 because the bracket enters below the line leading to relay 3.

Figure 60. Function Chart Symbols

CIRCUIT DESCRIPTION

The circuits are described and explained in the following manner. First is a brief discussion of the operation, when necessary, followed by an objective and a circuit outline. The outline does not include all the points in the circuit, only those required to follow the circuit. Numbers in parentheses are the wiring diagram section locations.

Starting the Machine

OBJECTIVE: To feed cards to the punch station and to make the punching, duplicating and program controls operative; R3 must be energized.

1. (4B) Depress feed key and energize card feed clutch magnet. First card goes to punch bed.
2. (4B) Card lever contact (switch) makes at 210°.
3. (4B) Depress feed key again to energize card feed clutch magnet. Register first card at punch station and feed second card to punch bed.
4. At 70° of second card feed cycle, R3 is energized through CF3.
5. (6B) R3 holds through 3AL and program cam contact 2.
6. (5B) R3BUN/O makes punching, duplicating and program controls operative.

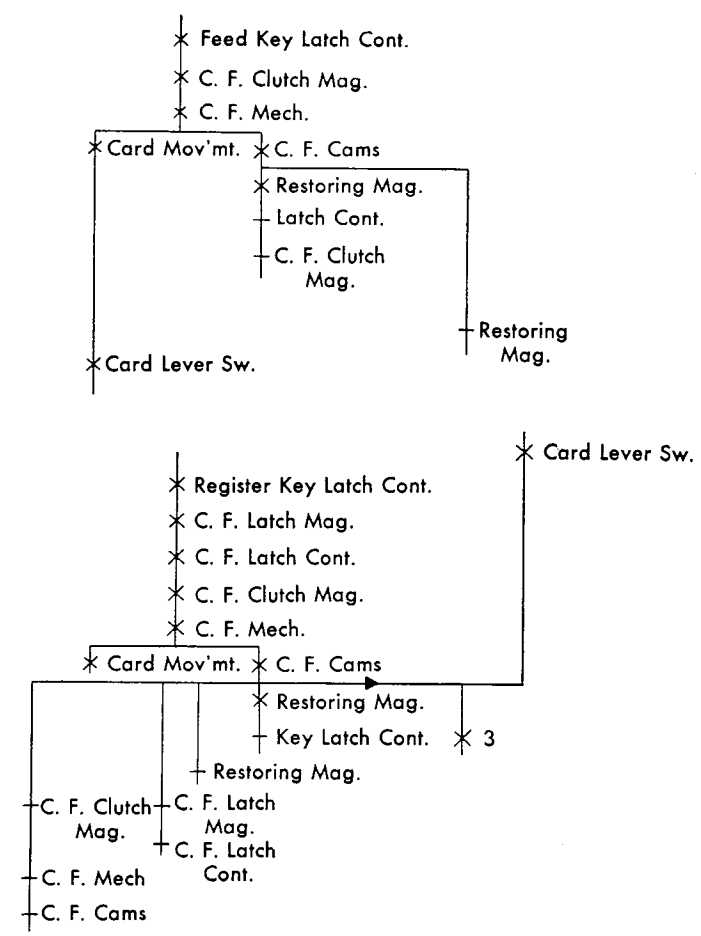


Figure 61. Function Chart, Feed and Register Cycles

7. (5B) Program cam contact 2 drops R3 between cards to make above circuits inoperative.

See Figure 61 for the function chart of feed and register cycles.

Escape and Punch Cycles - Manual Punching

Whenever an interposer magnet is energized, the corresponding punch operating interposer unlatches and closes the two interposer bail contacts in parallel. The interposer magnets can be energized from the keyboard during manual punching or from a pin contact during duplicating. When the interposer bail contact closes, grid 3 is driven from its normal bias of —49 volts to cathode or zero potential and tube 3 conducts, energizing the escape magnet.

OBJECTIVE: To escape one column and punch by depressing an alphabetic or numerical key.

1. (3 & 4) Depress key and close bail or latch contact, or both.
2. (4A & B) Interposer magnet or magnets are energized.
3. (6A) Interposer bail contacts close to cause tube 3 to conduct, energizing the escape magnet.
4. (5 & 6A) Escape armature contact closes to cause tube 1 to conduct and energize R22.
5. (6B) R22 holds through 22-1 and P2.
6. (5B) R22-4N/O energizes punch clutch magnet through tube 7.
7. (6A) R22-3N/C opens circuit to tube 3 to drop escape magnet.

See Figure 62 for a function chart of this operation.

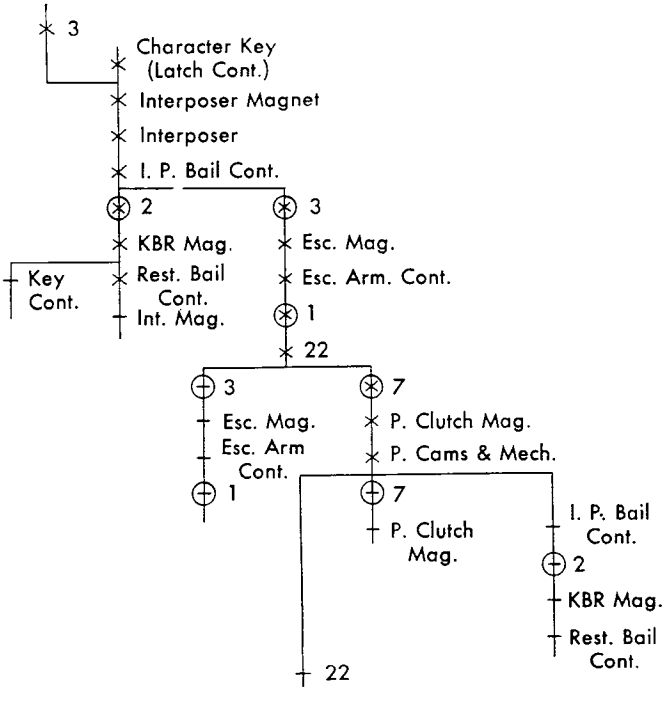


Figure 62. Function Chart, Manual Punching

Time Elements

Although the escapement armature contact is made only momentarily, R22P coil gets approximately an 8 ms. impulse because of the 22MFD capacitor from grid to cathode of tube 1. The time taken to charge this capacitor delays the time when grid 1 reaches cut-off bias (—17V.). The 47-ohm resistor in series with this capacitor protects the escapement armature contacts when it makes the first time because it limits or retards the discharge of the capacitor.

To show relationship between the electrical function and mechanical functions, time in milliseconds (ms.) is used. When auto-duplicating is being performed, the punch clutch never latches up between columns; therefore, the punch shaft makes 20 (or 18 on the Type 26) revolutions per second. Breaking down this table further, the punch index travels 7.2° in 1 ms. on the Type 24.

The escapement wheel teeth move past a given point at the rate of 12 ms. per tooth and one tooth corresponds to one card column. It takes approximately 6 ms. to move the escape armature out of a tooth. At the end of the armature travel its contact closes and energizes R22 (Figure 63).

When R22 picks up and breaks the circuit to grid 3, the escape magnet is de-energized and its armature drops back on the escape wheel before the middle of the next tooth. Therefore, when the armature is held attracted for a skip, the card progresses at 12 ms. per

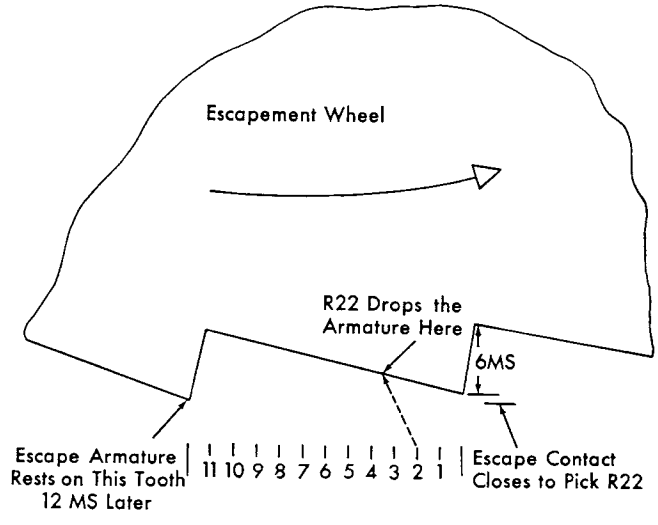


Figure 63. Escapement Timing Chart

column until stopped again by the escape magnet armature. A capacitor is placed around the interposer bail contacts to assist conduction if the contacts should bounce.

Skip Key

OBJECTIVE: To skip over manual alphabetic or numerical fields without punching an X.

1. (3A) Depress skip key to energize R21P.
2. (6B) R21H holds through 21-1 and P2 until 65° of the punch cycle.
3. Space interposer magnet energized through 21-2.
4. (5A) Escape magnet is energized through tube 3 and interposer bail contacts.
5. (6A) R22 is energized through escape armature contact and tube 1.
6. (6A) Punch clutch magnet is energized through 22-4N/O and tube 7.
7. (6A) P3 makes at 10° to energize R25 through 21-4 and tube 4.
8. (6A) Escape magnet is energized through 25-4 and 21-4.
9. (6A) R25 holds through 25-1 and program contact number 12.
10. (6A) Escape magnet holds through 25-4 and number 12 program contact.

Note: Unprogrammed, the above reduces to a space operation.

Skipping, Dash Skip Key

OBJECTIVE: To skip a numerical manual field by depressing the dash-skip key and to punch an X in the first column of the field skipped.

1. (3A) Depress dash-skip key to energize 11 interposer magnet and R21P through 30-4.
2. (6B) R21H holds through 21-1 and P2 until 65° of punch cycle.
3. (5A) Interposer bail contacts close to energize escape magnet through tube 3.
4. (6A) R22 is energized through escape armature contact and tube 1.
5. (6A) Punch clutch magnet energized, through tube 7 and 22-4N/O, to punch an X.
6. (6A) At 10° of punch cycle, R25 is energized through P3, 21-4 and tube 4.
7. (6A) The same circuit energizes escape magnet through tube 3 and 25-4.
8. (6B) P1 makes at 180° of the punch cycle to start skipping. This insures that punches and sensing pins are clear before skipping begins.
9. (6A) R25 holds through program 12 contact and 25-1.
10. (6A) The escape magnet holds through program 12 contact, 25-1 and 25-4.

For a function chart of this operation see Figure 64.

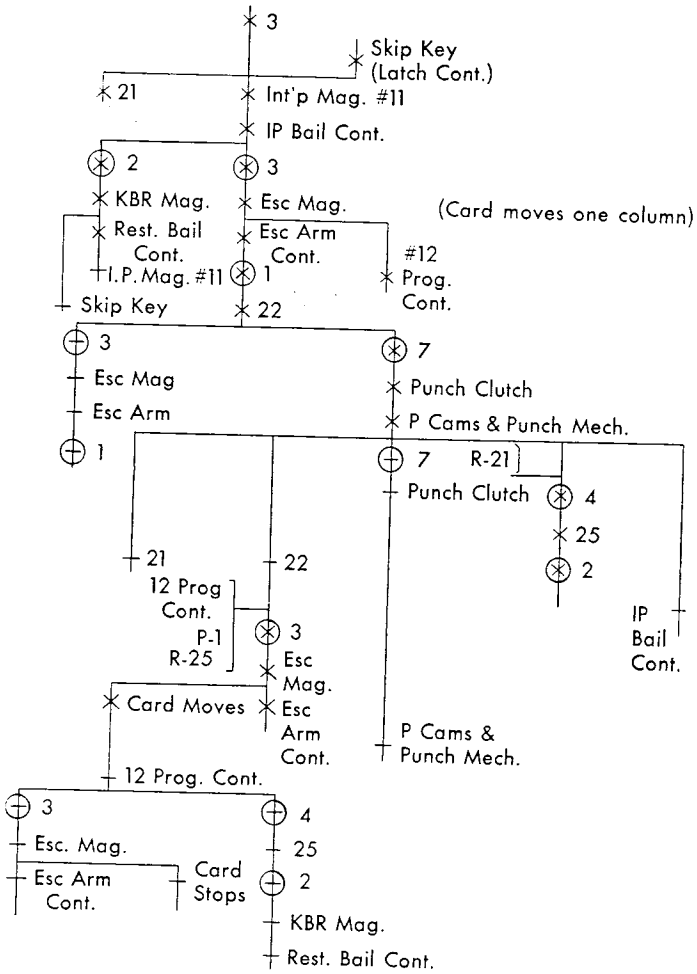


Figure 64. Function Chart, X Skipping

Key Duplication

When not programmed, key duplication is at 100 ms. per column. Relay 27-5N/C breaks the series circuit through the DUP key to grid 5 for each column, thereby providing a pin sensing cycle ahead of each escape and punch operation. Doubling the operating time gives more precise control when duplicating, for example, to a column in error.

OBJECTIVE: To duplicate certain columns by depressing duplicate key.

1. (5A) Depress duplicate key to energize R28 through tube 5.
2. (6A) R28 holds through 28-1 and 22-4N/C or P4 in parallel.
3. (6B) Relay 2 is energized through 28-4 and holds through P2.
4. (6A) Tube 7 conducts and energizes punch clutch magnet through 2BL.
5. (6B) Relay 27 is energized through 2BU and P3 at 10°, and holds through 27-1.
6. (4B) P5 impulse through 27-2 completes circuit to sensing pin contacts.
7. (4) Pin sensing contacts energize interposer magnets.
8. (6A) Interposer bail contacts close to energize escape magnet through tube 3.

9. (6A) Escape armature contact closes to energize R22 through tube 1.
10. (5B) R22-4 points break hold circuit to R27 and R28.
11. When R27-5N/C closes, tube 5 again conducts with DUP key depressed.

Note: For each column duplicated by using the duplicate key without program card control, there will be a read cycle only preceding each escape and punch cycle.

For a function chart of this procedure see Figure 65.

Keyboard Restore Magnets

OBJECTIVE: To restore keyboard after manual punching during skipping and during duplicating operations.

1. (6A) After each manual punching operation, the keyboard restore magnets are energized when tube 2 conducts.
2. (6A) Interposer bail contacts complete a circuit through 28-3N/C and 25-3N/C to grid of tube 2.
3. (6A) During a skip operation through 25-3N/O.
4. (6A) During a duplication operation through 28-3N/O.

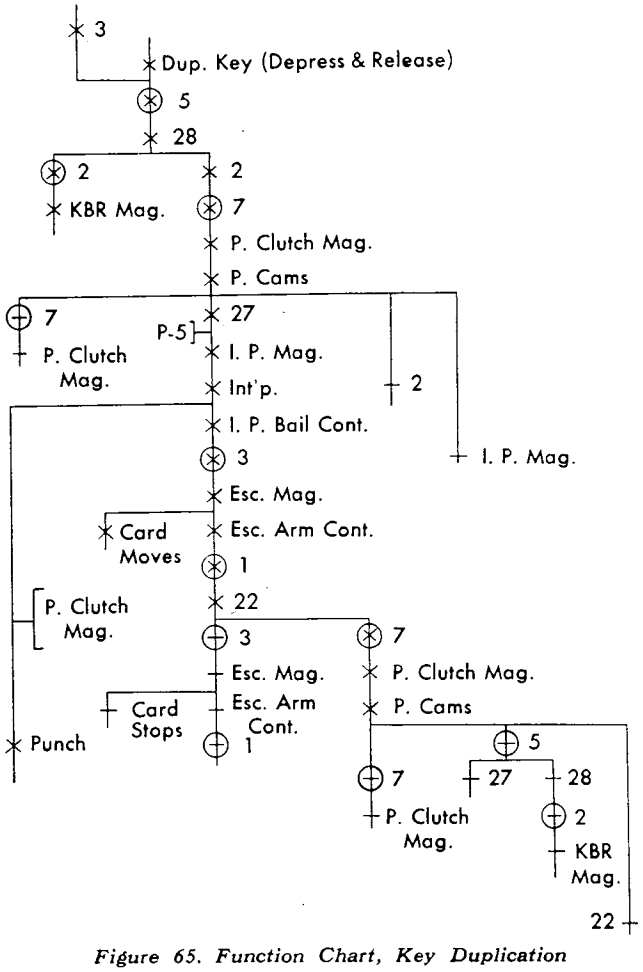


Figure 65. Function Chart, Key Duplication

Release Key, Not Programmed, Auto-Feed Switch ON

OBJECTIVE: To release card to next station and feed another card.

1. (6B) Depress release key to energize R1.
2. (6A) Tube 4 conducts to energize R25 when a circuit is completed to grid 4 through 1BU, 3BLN/O and program handle switch 1N/O.
3. (6A) Tube 3 conducts to energize escape magnet when a circuit is completed to grid 3 through 1BU, 3BLN/O, program handle switch 1N/O and 25-4N/O.
4. (6A) R25 holds through its own pick circuit until R3 drops.
5. (6A) The same holds true of the escape magnet.
6. (5B) R1BL restores keyboard.
7. (5B) Card-to-card skip takes place through program cam contact 1.
8. (4B) Card feed clutch magnet is energized through program cam contact 2.

NOTE: With the auto-feed switch off, the card does not register at the next station and there is no card feed cycle.

Multiple Punching in One Column

It is possible to multiple punch in one column by holding the MP key depressed while operating the desired numerical keys.

OBJECTIVE: To punch more than normal number of holes in one column.

1. Hold down MP key until punching is completed.
2. Depress desired key to cause standard escape and punch cycles.
3. (6A) R24 is energized through tube 6 when circuit is completed to grid through MP contact N/O and escape armature contact. This circuit holds through 24-1.
4. (6A) Further escapement is prevented by 24-3N/C.
5. (6A) Further punch cycles are made available through 24-3N/O.
6. MPN/C contact opens circuit to R30 to prevent alphabetical punching.

Automatic Skipping

OBJECTIVE: To skip automatically over predetermined columns by program card control.

1. (5A & 6A) Program contact 11 closes to cause tube 4 to conduct and energize R25.
2. (6A) Tube 3 conducts through 25-4N/O and energizes escape magnet.
3. (5A) Relay 25 holds through 12 program contact, 25-1N/O and tube 4.
4. Skip stops after last 12 in program card when R25 drops.

Card-to-Card Skip

In order to skip from column 81 through 88 to column one of the column indicator, a program cam and contact is provided.

OBJECTIVE: To skip automatically over columns between cards and register next card at punch station.

1. (5B) Program cam contact 1 makes in column 80 1/3 and causes tube 4 to conduct through 24-2N/C.

2. (6A) Relay 25 is energized through tube 4.
3. (6A) Tube 3 conducts and energizes escape magnet through 25-4N/O.
4. (5B & 6A) Escape magnet holds through program cam contact 1 until column 88 1/6.
5. (4B & 5B) Card feed clutch magnet is energized through program cam contact 2 at column 81 1/2.
6. Card from punch station registers at read station column 1 and card from punch bed registers at punch station column 0.

Automatic Duplication

Automatic duplication is started by sensing a zero in the highest order column of a field in the program card followed by 12 holes sensed in every remaining column of the field.

OBJECTIVE: To duplicate automatically with program card control.

1. (5A & 6A) The zero program contact closes to cause tube 5 to conduct and energize relay 28.
2. (6A) A hold circuit for R28 is completed through 28-1N/O point and P4 or 22-4N/C in parallel.
3. (6B) R2 is energized through 28-4N/O and holds through 2ALN/O and P2.
4. (6B) R2BLN/O completes a circuit to grid of tube 7 to energize punch clutch magnet.
5. (6A) R27 energizes through 2BUN/O and P3 and holds through 27-1N/O.
6. (4B) P5 impulse completes a circuit through 27-2N/O to pin sensing contacts.
7. (4) Sensing pin contacts energize interposer magnets.
8. (6A) Tube 3 conducts to energize escape magnet when interposer bail contacts close to complete circuit to grid 3.
9. (6A) Escape armature causes tube 1 to conduct to energize R22.
10. (6A) R22-4 causes tube 7 to conduct to energize punch clutch magnet.
11. (6A) R22-3 points open circuit to tube 3 to permit only one escapement.
12. (5A) After the first escapement, the 12 program contact makes and holds R27 and R28.
13. Auto-duplication continues until the last 12 in the program card drops R27 and R28.

Alphabetic Field Control

A row of 1's, the alphabetic field designation, must be placed in the program card in any manually punched alphabetic field. Relay 30 points shift the keyboard from numerical to alphabetic. The 1's will cause R30 to be energized through tube 8. If a numerical or an alphabetic field which has blank columns is to be duplicated, a row of 1's should be placed in the program card in addition to the auto-duplication control. The 1's picking up R30 will cause the interposer bail contacts to be by-passed by R30-1 and R27-3, and thus will cause escape and punch cycles for the entire field. Thus, it is unnecessary to pin-sense a hole in every column to keep the machine running. In a numerical duplicated field, it is necessary to pin sense a hole in every column to operate the interposer bail contacts to keep the machine running. By not programming 1's, this feature can be used as a blank column check. On machines with the numerical keyboard, the 1 punch is still used to permit spacing over blank columns even though R30 is not used in the machine.

OBJECTIVE 1: To shift keyboard to alphabetic under program control.

1. (5B) The one program contacts cause tube 8 to conduct and energize relay 30.
2. (3B) R30-2N/O points close to make a circuit available to interposer magnets 1 to 9 through bail contacts.
3. (3B) R30-3N/O points close to make a circuit available to interposer magnets 0, 11, and 12 through bail contacts.

OBJECTIVE 2: To space over blank columns when auto-duplicating under program control.

1. (5A) R30-1N/O points shunt interposer bail contacts to energize escape magnet through R27-3 and tube 3.

OBJECTIVE 3: To prevent skipping when zone 11 is sensed during auto-duplication of alphabetic information.

1. (4A) R30-4N/C opens circuit to R21P.

Release Key - Programmed

OBJECTIVE: To release card and perform remaining programmed operations during release.

A. Blank column in program card.
   1. (5B & 6B) Release key contact energizes R1.
   2. (5B & 6B) R1 holds through 1AL and program cam contact 2.
   3. (6A) Escape magnet energizes through tube 3; circuit to grid 3 is through 1BU, 3BLN/O, program handle switch 1, 25-3N/C, 28-3N/C and 25-4.
   4. (6A) Escape armature causes tube 1 to conduct and energize R22.
   5. (6B) R22-4N/O causes tube 7 to conduct and energize punch clutch magnet.

B. 12's in program card.
   1. (5A & 6A) Program contact 12 completes circuit through 1AU to grid of tube 4 to energize R25.
   2. (5A) R25-3N/C opens 1BU circuit.
   3. (5A & 6A) Circuit holds through 12 program contact.

C. 11 in program card.
   1. (5A) R25 is energized as in skip operation through 11 program contact.
   2. (5A) Holds through 12 program contact.
   3. R25-3N/C opens 1BU circuit.

D. 0 in program card.
   1. (6A & 6B) R28 and R27 are energized as described under auto-duplication.
   2. (5A) R28-3 disables the 1BU circuit which energizes the escape magnet.
   3. Programmed auto-duplication occurs.

Zero Print Suppression

The suppression of zeros to the left of the first significant digit in a field is automatic on the Type 26 and operates under control of the field definition 12's. Until a significant digit 1 through 9 is punched, either by key or sensing contact, print R31 will be normal.

OBJECTIVE: To suppress printing of zeros until a significant digit is punched.

1. (6B) Program contact 12 completes a circuit to grid of tube 9 which causes the print suppress magnet to energize.

Print Suppression

The program card control for print suppression is the 3 hole. Any column or field that is to have printing suppressed should have the program card punched with a 3 in that column or field. The 3-punch star wheel is designed to read one column later than the 12, 11, 0 and 1 star wheels. It could also be stated that star wheel contact 3 makes one column late. For example, if program card column 5 is punched with a 3, the late reading star wheel will drop into the 3 hole during the escapement on the escape and punch cycle on which detail column 5 is being punched. Consequently, program contact 3 will be made when detail column 5 is being punched and printed, and may be used to cause print suppression. It will break with the following escapement of the escape and punch cycle when detail column 6 is to be punched so that normal printing will be resumed in detail column 6.

OBJECTIVE: To suppress all printing in a field.

1. (5A & 6B) Program contact 3 completes a circuit to grid of tube 9, causing it to conduct and energize print suppression magnet.

Printing - R31

OBJECTIVE: To print first significant digit after zeros and to print all alphabetical information.

1. (4) Energizing a digit interposer magnet energizes R31P or R31H.
2. (6B) R31-1N/O completes a hold circuit for R31 through 12 program contact to the grid of tube 10.

Left Zero Print

It is possible to print zeros to the left of the first significant digit or special characters, using only a zone punch, by punching a 2 in the program card in the columns involved. This star wheel is similar to star wheel 3 and also reads one column late. Consequently, a 2 hole in program column 5 would cause program contact 2 to make on the escape and punch cycle during which column 5 is being punched and printed. Program contact 2 is wired to the screen grid of tube 9 and drops the potential from the normal plus value of the plate voltage to cathode potential, thus blocking the tube. The print suppress magnet will then be de-energized and allow printing in that column or field. For comparison, program contacts 12, 11, 0 and 1 make a column ahead of the detail card to initiate controls, but since printing is driven by the punch clutch and set up by the punches themselves, program contacts 2 and 3 make and control on the column of the operation they control.

OBJECTIVE: To print zeros to the left of a significant digit.

1. Program contact 2 completes circuit to screen grid of tube 9 to prevent print suppression magnet from energizing.

CIRCUIT CHANGES

Beginning in December, 1953, the following revisions were made in the machine circuits:

1. Wiring diagrams changed to 228001N and 228005M for Type 24 and Type 26, respectively.

2. Relay 2 was removed. The main function of relay 2 was to energize the punch clutch magnet for a pin sensing cycle in the first column of duplication. In the new circuit R28 is picked by the 0 sensing wheel contact as before. The impulse to energize the punch clutch comes through 28-4N/O, 27-4N/C, and 3BUN/O. R27 is picked by P3 (10°-60°) through R28-5N/O to permit pin sensing on the first cycle. R27 then holds in parallel with R28 as before through tube 5.

3. A rectifier was added between post 19 and post 66 to prevent a back circuit. The change prevents the voltage induced by the drop-out of R21 from disturbing the space interposer magnet.

4. Tube 6 is removed from the circuit. R24, in the new circuit, is picked through the M/P key contact, an R28 normally closed point, an R-22 normally open point, and R3BUN/O. R24 holds through the M/P key contact and 24-1.

5. A new program cam is installed which permits a later break timing for program cam contact 2. The contact breaks at column 82-1/2 to 84 instead of column 81-1/2 to 83 as before.

6. Other minor circuit changes were made which do not affect machine functions, e.g., some cabling was rerouted to conserve wire.

After December 1, 1955, machines included a number of changes. The wiring diagram advanced to 228001R for the 24 and 228005N for the 26. Some other changes are listed below.

1. Removal of the rear terminal panel.

2. Relocation of tube chassis to the rear of the machine (a ten-tube chassis).

3. A power supply panel that mounts the transformer, rectifiers, and the tube chassis.

4. A new rear relay gate.

5. The keyboard cable wiring routed directly to functions that it controls (no intermediate terminal wiring).

With this change, all but one relay have been renumbered. A cross reference of relay numbers is listed below.

OLD NUMBER	NEW NUMBER
1	1
2	Removed
3	2
21	45
22	46
24	47
25	48
27	50
28	51
30	53
31	54

The logic and circuit action is not changed. Each relay in the new circuit serves the same purpose as its counterpart in the earlier circuit. Wherever possible, corresponding relay contacts are retained for each individual circuit. None of the operating principles have been changed.

In following the circuits of the new machines, observe that in this manual the old relay numbering is used. Use the cross reference table above, if it is necessary to convert to new relay numbers.

Starting in February 1957, some machines have a new-style tube chassis using printed circuits.

REDUCTION DRIVE (Figure 85)

MACHINES PRODUCED since July 1956 use a reduction drive that is not encased in a housing. Speed reduction is achieved through a system of external gears. The drive motor operates two belts: (1) to drive the punch clutch, and (2) to operate the reduction gearing, which in turn operates the continuously running gear train and, through the friction drive, the escapement gear train.

Machines with the high-speed-skip device have an additional pulley located on the drive motor shaft. This cog belt pulley drives the high-speed-skip mechanism.