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The first 13 pages of the manual are presented to give a flavor. The Computer History Museum has the manuals for further study.

IBM 604

Electronic Calculating Punch

Manual of Operation

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CONTENTS	.
INTRODUCTION	1
OPERATING Principles	6
OPERATING Features, 521 Punch UNIT	7
OPERATING FEATURES, 604 Calculating UNIT	8
OPERATION	9
PRINCIPLES OF Control Panel WIRING	11
CROSSFOOTING	13
Multiplication	17
Group Multiplication	19
Division	21
SUCCEsive CALCULATION	24
Checking MULTIPLICATION	29
Double-Punch Blank-Column Detection Method	29
Zero Balance Method	31
CHECKING DIVISION	34
SIMULTANEOUS MULTIPLICATION AND CHECKING	39
MULTIPLICATION FACTOR EXPANSION	41
Quotient EXPANSION	45
SUMMARY PUNCHING	49
SIGN CONTROL	53
PAYROLL: AVERAGE HOURLY RATE AND GROSS EARNINGS	57
PAYROLL: GROSS TO FIRST NET INCLUDING OASI AND SUI Limits	60
APPROXIMATE SQUARE ROOT	64

GANG PUNCMHING	68
DETERMINING CALCULATOR CAPACITY	71
INDICATOR LAMP PANEL	72
CHANNEL SCHEMATIC	75
CONTROL PANEL SUMMARY	77
SPECIAL DEVICES	83
TIMING CHART	85
INDEX	97

IBM 604, Operation, starting page 0004

[image similar to this](#)

IBM 604, Operation, starting page 0005

IBM 604 ELECTRONIC CALCULATING PUNCH

THE IBM Electronic Calculating Punch, Type 604, uses electronic methods for performing all basic types of calculations. Factors are read from IBM cards, the calculations are made by an electronic calculating unit in a fraction of a second, and the results are punched automatically in the cards.

The Type 604 adds or subtracts amounts punched in the same cards or in successive cards; it multiplies; it divides; and it performs these operations - repetitively and in combination as required for all general types of calculating problems.

Whether single, repetitive, or combination operations are required, and whether one or more results are punched in each card, the calculations are performed at a constant operating speed-100 cards per minute.

Information is read from a card and held in the machine until it has served its purpose in, the calculation. Several results may be calculated and held in the machine until they are punched. As many as 21 digits can be read from a card for calculating, and results of up to 29 digits can be punched. The number of digits read from a card can be increased to a total of 37 by a corresponding reduction in the number of punching positions.

For basic multiplication, an 8-digit multiplicand is multiplied by a 5-digit multiplier to produce a 13-digit product, but larger factors can be calculated by one or more multiplication recalculations, without reducing operating speed. For basic division, a 13-digit dividend can be divided by an 8-digit divisor to produce a 5-digit quotient, but additional dividend positions and additional quotient positions can be calculated in a single operation.

Group multiplication can be performed with either the multiplier or multiplicand as the group factor. Many other group operations can also be performed, such as the accumulation of factors from a group of cards and the punching of summarized or calculated results in the last card of a group.

Other information can be gang punched into cards as they are being punched with the results of calculations. Straight gang punching of common information into all cards, interspersed gang punching, and offset gang punching can be performed, either in combination with calculation or as an independent operation.

All calculations and punching are checked in a separate operation or, in some cases, in the same operation to insure accuracy. When the factors are reversed, the cards can be recalculated and the result can be punched a second time. A doublepunch and blank column detection feature is used to check for the punching of all positions on the first calculation as well as for a difference in punching during the checking operation. If neither blank columns nor double-punched columns occur in either operation, the calculation is proved to be correct. Another checking method is based on the calculation of a zero balance. An original punched result is subtracted from a second calculation of the result and the difference is tested for a zero balance, to prove agreement between the two calculations. By control panel wiring, any discrepancy can stop the machine, or offset the card in the stacker if that feature is specified.

IBM 604, Operating Principles, starting page 0006

OPERATING PRINCIPLES

THE Electronic Calculating Punch consists of two basic units, which are connected by a cable:

1. Punch Unit (Type 521)
2. Electronic Calculating Unit (Type 604)

The punch unit (Figure 1) has three card stations:

- a first reading station,
- a punching station,
- and a second reading station.

Cards are placed in the hopper face down, twelve edge first. Factors are read from the card and transferred to the electronic calculating unit as the card passes the first reading station. All calculations are made by the calculating unit as the card moves from the first reading station to a punching station. Calculated results are then transferred back to the punch unit and punched in a card as it passes the punching station. At the second reading station, the card maybe read for gang punching, recalculation, and double-punch and blank-column checking. **Cards feed continuously from one station to the next at the rate of 100 per minute. Thus, while one card is being read for calculation another card is being punched, and a third card may be read for checking.**

The electronic calculating unit performs all calculations. It consists of seven basic parts:

1. Factor Storage Units
2. General Storage Units
3. Multiplier-Quotient Unit
4. Electronic Counter
5. Program Unit
6. Channel
7. Shift Unit

Factor storage units store factors read from the card for use in developing results of a calculation, or store the results of a calculation for later use in developing further calculations.

General storage units can be used in the same manner as factor storage units and, in addition, when they are not used to store factors from the card, they may be used to store results of a calculation for punching purposes.

The **multiplier-quotient unit** is similar to factor storage units and, in addition, it may be used to store the multiplier factor when multiplying or to develop the quotient when dividing.

The **electronic counter** (13 positions) must be used during calculating time for the four basic arithmetical operations of adding, subtracting, multiplying or dividing. Factors cannot be read directly from the card into the counter but results may be punched from the counter.

The **program unit** supplies electronic impulses to control operations, such as read in and read out functions of storage units and the counter. on specific program steps. Twenty program steps are standard, but the number may be increased to 40 or 60.

Figure 1. Card Stations

IBM 604, Operating Principles, starting page 0007

Exits and entries of all storage units and the counter are connected together internally by an **8-position channel**. This means that only one factor (1 to 8 positions) maybe transferred over the channel on any one program step. The only control panel wiring required to effect the transfer is the read in and read out controls of the counter and storage units.

The **shift unit** permits factors transferred from a storage unit to the counter or from one storage unit to another to be shifted to the left as many as five positions. It also allows as many as five positions to be dropped when transferring results from the counter to a storage unit. This shifting is controlled by control panel wiring, and on any one program step is limited either to read in or to read but not both at the same time. The shifting which is inherent in multiplication and division is accomplished automatically by this unit on multiply and divide steps.

A schematic of the channel and shift unit is described in a later section of the manual.

OPERATING FEATURES, 521 PUNCH UNIT

OPERATING FEATURES of the Type 521 Punch Unit are shown in Figure 2. {image is 9 illegible pushbuttons on a row}

Main Line Switch

When the main line switch on the punch is turned on and the POWER ON key on the calculating unit is depressed, power is supplied to both units. Operation may be started approximately three minutes later, during which time the electronic tubes heat. The red unlabeled light on the punch turns on when this switch is on.

Start Key

The start key is depressed to feed the cards and to start calculation. This key is effective only when both unlabeled lights are turned on. If the punch unit is used independently, the start key may be depressed as soon as the main line switch is turned on.

Stop Key

The stop key stops the operation of both the punch and calculating units when depressed.

Reset Key

When an error is signalled by one of the four lights located on the punch, the machine may be restarted after the reset key is depressed.

Light (unlabeled)

This light turns on when the main line switch is turned on. The light turns off as cards are passing through the machine and turns on again whenever the machine stops.

Unfinished Program Light

The red unfinished program light turns on, the machine stops, and all punching is suppressed in those rare instances when a calculation cannot be completed in the time that it takes for the card to move from the first reading station to the punch station. This light is operated by control panel wiring.

Double-Punch Blank-Column Light

The red double-punch blank-column light turns on and the machine stops whenever a double punch or a blank column is sensed. This light is operated by control panel wiring and is normally used in conjunction with checking operations.

IBM 604, Operating Principles, starting page 0008

Zero Check Light

The red zero check light turns on and the machine stops if, in a checking operation, the punched result subtracted from the recalculated result does not equal zero. This light is operated by control panel wiring.

Product Overflow Light

The red product overflow light turns on and the machine stops if the result of a calculation exceeds the number of card columns to be punched. This light is operated by control panel wiring.

OPERATING FEATURES, 604 CALCULATING UNIT

OPERATING features of the Type 604 calculating unit are shown in Figure 3. {illegible image of 4 push buttons vertically and the large array of neon lamps}

Power On Key, Power Off Key

The power on and off keys operate like a main line switch for the calculating unit. When the power on key is depressed, power is supplied to the electronic tubes, the STARTING light turns on immediately, and the unlabelled light turns on after approximately three minutes if the main line switch on the punch unit is on. When the power off key is depressed, power to the calculating unit is turned off.

Starting Light

This red light turns on when the power on key is depressed and turns off when the unlabeled green light comes on.

Light (Unlabeled)

This green light turns on approximately three minutes after the power on key has been depressed. It indicates that the machine is ready to operate provided the main line switch on the punch unit is also turned on. The light turns off when the control panel in the calculating unit is removed.

Program Test Key, Program Test Light

Depressing the program test key makes it possible to operate the 604 one step at a time and causes the program test light to turn on immediately. Depressing the key a second time returns the 604 to high-speed operation.

Control Panel Light

This red light turns on when the control panel is removed from the 604.

Program Advance Key

The program steps (indicated by the PROGRAM STEP lamps on the neon panel) may be advanced one at a time by depressing the program advance key. The Indicator Lamp Panel is described in a later section of the manual.

OPERATION

THE machine is prepared for operation by inserting properly wired control panels in each unit, by turning on the main line switch, located on the punch, and by depressing the start key on the calculating unit. The electronic tubes require approximately three minutes to heat before the machine is ready to operate.

Cards are placed in the hopper of the punch unit face down, 12's edge first. In this machine an X punch can be used to control the reading of information from the card and, consequently, this position must be read before the factors are read.

The punch unit start key is depressed to feed the cards and start calculations. The red unlabelled light on the punch turns off as cards are calculated, punched, and moved into the stacker continuously. The machine stops and the light turns on again when the hopper is empty, the stacker becomes full, the stop key is depressed, or an error or other condition is recognized through control panel wiring.

Scheduling of work on the 604 should call for as continuous operation as possible. Leave the machine turned on if it is to be inoperative for a short period of time (one hour or less). If the calculator is inoperative for a longer period of time, it should be turned off.

The operation of the Type 604 is fully explained in the examples that follow with a detail description of the control panel hubs preceding their use in each example. For a clear understanding of the capabilities of the machine as well as a thorough knowledge of the wiring principles, each example should be studied in the sequence presented.

IBM 604, Operating Principles, starting page 0010



[Figure 4. Control Panels](#)

IBM 604, Operating Principles, starting page 0011

PRINCIPLES OF CONTROL PANEL WIRING

A SEPARATE control panel (Figure 4) is required for the punch unit and for the calculating unit. All functions that concern card reading or card punching are wired on the punch control panel and all functions concerning the actual calculation are wired on the calculator control panel.

The punch unit has a double panel and the calculating unit a single panel. Letters down the side and numbers across the top of each panel facilitate reference to specific hubs which in the text will be preceded by *Cal* for the calculator control panel or *Pch* for the punch control panel.

Some hubs are entries and some are exits. Exit hubs are always connected to entry hubs either directly

or by selection and the wiring may be changed to suit each new application.

Hubs that are connected by a vertical, diagonal, or horizontal line are alike, or common. Their purpose is to eliminate the need for split wiring.

All hubs performing similar functions are grouped together and labelled with their general title. Within each group, they are numbered or named according to their specific function.

The control panel for the punch is positioned in the lower left front of the punch unit, and the control panel for the calculating unit is positioned on the upper left side of the calculating unit.

Planning the Operation

A problem to be calculated on the 604 should first be studied to determine the most logical use of the storage units and the sequence of the steps to be taken by the machine, before any attempt is made at control panel wiring. The steps taken by the machine after the card is read, start off automatically from step 1 to step 20 on the standard machine and are referred to as "programs." Since only one function can be performed on each program step, lack of proper planning could easily result in using all of the program steps without completing the problem.

To assist in planning the operation a planning chart (Figure 5) has been devised with a vertical arrangement of the read cycle and 20 program steps and a horizontal arrangement of the units into which factors may be entered. The chart is divided as follows:

Operation Notes. One space is allowed for each of the steps that the machine takes, including the read and punch cycles. This column is reserved for making explanatory notes about the particular operation being performed.

Program Suppress. Some problems require that certain program steps be suppressed or made inactive. This column is reserved for identifying the condition under which suppression of the program step is required (X, D, + or - balances).

Program Number. This column identifies the read cycle, each of the 20 program steps and the punch cycle, which on this machine is the same as the read cycle.

Factor Storage. The four factor storage units are represented in this column, two of them having 3 positions and two having 5 positions. Activity in or out of these units is indicated on the proper program step.

Mult. Quot. This column is used for indicating the multiplier, quotient or other information that is stored in the multiplier quotient unit.

Counter. This column represents the 13-position electronic counter.

General Storage. The four general storage units are represented in this column, two of them having 3 positions and two having 5 positions. Activity in or out of these units is indicated on the proper program step.

The upper half of the area allotted to each program step is used for writing symbols, letters or words to identify a factor. The lower half of the area identifies the number of positions each unit contains and is used for writing actual figures resulting from the manual calculation of a representative problem.

The position to the right of the dotted line, in each unit, is used exclusively for sign control and is not

to be used as the units position.

The counter is shaded on the read cycle to indicate that it cannot be read into at that time. The factor storage and the multiplier quotient units are shaded on the punch cycle to indicate that they cannot be used for punching.

[IBM 604, Operating Principles, starting page 0012](#)



[Figure 5. Planning Chart](#) The control panels may be wired directly from the planning chart for the chart is, in effect, a step by step analysis of the wiring to be done. This is especially true of the calculator control panel which is so closely related to the planning chart that a single explanation will serve for both.

The following sequence will be followed in discussing each of the problems:

1. Explanation of the control panel hubs to be used in the problem and not previously used in a preceding example.
2. Read cycle wiring under the heading Read. This wiring concerns only the punch unit.
3. Program wiring under the program number itself. This wiring concerns only the calculating unit.
4. Punch and other wiring on the punch control panel not previously described.

[IBM 604, Crossfooting, starting page 0013](#)

CROSSFOOTING

$$A - B = +- T$$

The NUMBER of factors that may be crossfooted is limited only by the number of factors which may be stored the machine on the read cycle. This example shows a simple crossfooting operation in which factor B is subtracted from A to give a plus or minus result T. If T is minus, the Type 604 will punch it as a true figure and identify it as minus by punching an X over the units position.



Factor Storage Entry (Pch A, 25-44). These hubs are entries to the factor storage units for factors read from the card. They are normally wired from first reading, second reading or from the digit selectors. Factors read into the factor storage units may be held until required in the calculation, but may not be punched from these units. An X punch over any column, or over the units position for reasons other than sign control, must eliminated by a column split. Without elimination in other than units positions, an incorrect zero may be entered. More than a single digit in a column causes the sum of the digits to enter storage without a carry. Factor storage entry or exit during calculation is controlled by the calculator control panel.



First Reading (Pch S, 25-44). These hubs are exits for factors read from the 80 columns of the card at the first read station.



Counter Exit (Pch S, 31-44). The result of a calculation is always obtained in a 13-position electronic counter. The counter receives impulses only during a calculation, not from the card. Results can be punched from counter exit hubs.



Punching (Pch T-W, 25-44). The punching hubs are entries for punching results in any assigned columns of the card. These hubs are wired for all punching, including gang punching.



Calc (Pch A-B, 1-2). The calculate switch must be ON whenever the calculation punch units are used together. It must be wired OFF when the punch unit is used independently of the calculating unit for gang punching operation.



Card Cycles (Pch P-Q, 11-22). The 24 common card cycles hubs emit an impulse after 12 through 9 on each card reading cycle. Since card movement is synchronized, a card cycles impulse may be used to control functions at all three stations at the same time.



Factor Storage Read In (Pch R-S, 15-18). Each factor storage unit has a pair of common read in hubs which accept only an X impulse to perform two functions:

1. Clear but the = r vin >'e reading,
2. Enter a new reading.

They are normally wired from card cycles to enter factors from the card.



Ctr R & R - Counter Read Out and Reset (Pcb T, 11-14). The four common counter read out and reset hubs accept card cycles impulses to read information out of a counter for punching and to reset the counter.

{This is the end of page 13, and the end of the sample of the manual.)