

# Herman Hollerith and the Evolution of Electronic Accounting Machines

Thomas J. Bergin  
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American University

# Instant Quiz

- What is **technology**?
- Identify **five examples** of different technologies.
- How does technology arise, i.e., what is the **process of invention**?
- Identify three early **tools**.
- Identify the **technique** used to make these tools.

# Random House/Webster's Unabridged Dictionary, Second Edition (1998)

- **Technology, n,** is the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment drawing upon such subjects as industrial arts, engineering, applied science and pure science
- **technical, adj.,** belonging or pertaining to an art, science, or the like
- **technique, n,** the body of specialized procedures and methods used in any specific field, esp. in an area of applied science.

# Homo farber (man the tool-maker)

- **Homo, n**, the genus of bipedal primates that includes modern humans and several extinct forms, distinguished by their large brains and *a dependence upon tools*.
- Christian Jurgensen Thomsen (c 1816) in dividing artifacts for a Museum, identified the **Stone, Bronze** and **Iron** ages
- The Stone age was later divided into Greek-derived technical terms **Paleolithic, Neolithic**, and **Mesolithic (old, new, middle)**

# We are surrounded by technology

**Technology** is embodied in the **tools and techniques/processes** that **solve problems or empower people** to do things.

- **saw**: enables us to cut wood
- **hammer**: enables us to build homes
- **automobile**: enables us to move about
- **cities**: enable us to have shelter and safety
- **stove**: allows us to cook indoors
- **telephone**: allows us to communicate

# Philosophical Questions:

- Which came first the chicken or the egg?
  - Does technology result from man's **needs**? (“pull” theory)
- or
- Do people **invent** things that enable man to improve his lifestyle? (“push” theory)
  - In truth, both processes are operative at all times and in all ages.

# Census

- Article I, Section 2: Representatives and direct Taxes shall be apportioned among the several states...**according to their respective numbers**...(and) **every ...term of ten years**
- **1790: 1st US census**
- **Population: 3,929,214**
- **Census Office**

# Population Growth:

- 1790      4 million
- 1840      17 million
- 1870      40 million
- 1880      50 million
  
- 1890      63 million



# Census Process

- Originally done by Deputy Marshals on paper
- **Problems of mountains of paperwork** recognized almost immediately
- **Results of 1880 Census not available until 1888**
- **Concern that 1890 Census would not be finished before 1900**

# Herman Hollerith (1860-1929)



# Herman Hollerith

- Born: February 29, 1860  
(American Civil War: 1861-1865)
- Columbia School of Mines (New York)
- 1879 hired at Census Office
- 1882 MIT faculty (**T is for technology!**)
- 1883 St. Louis (**inventor**)
- 1884 Patent Office (Wash, DC)
- 1885 “Expert and Solicitor of **Patents**”

# Patents

- The **exclusive right** granted by a **government** to an **inventor** to manufacture, use, or sell an invention for a certain number of years; an official document conferring such a right....
- The purpose of patent laws is not to protect the inventor, but to **encourage disclosure of new discoveries for the benefit of society.**

# Infoplease.com

In the U.S., the law provides that a patent may be granted, **for a term of 20 years** from the date of application, to any person who has **invented** or **discovered** any **new and useful art, machine, manufacture, or composition of matter**, as well as any new and useful improvements thereof.

**A patent may also be granted to a person who has invented or discovered and asexually reproduced a **new and distinct variety of plant** (other than a tuber-propagated one) or has invented a new, original, and ornamental design for an article of manufacture, for a term of 20 years and 14 years, respectively.**

# Observation, Inspiration and Perspiration

- John Shaw Billings, MD, physician(responsible for health statistics)

“There ought to be some mechanical way of doing this job, something on the principle of the Jacquard loom, whereby holes in a card regulate the pattern to be woven.”

- Rail Road Ticket -- characteristics of the passenger punched into a card!
- Hollerith's brother-in-law was in the silk weaving business
- Seaton machine

# Census Trials

- 1880 Transcribe and Process  
10,491 inhabitants
- Record Tabulate
- Hollerith 72.5 hours 5.5 hours
- Pidgin 111 hours 45 hours
- Hunt 145.5 hours 55.5 hours

# Smithsonian Exhibit (old)



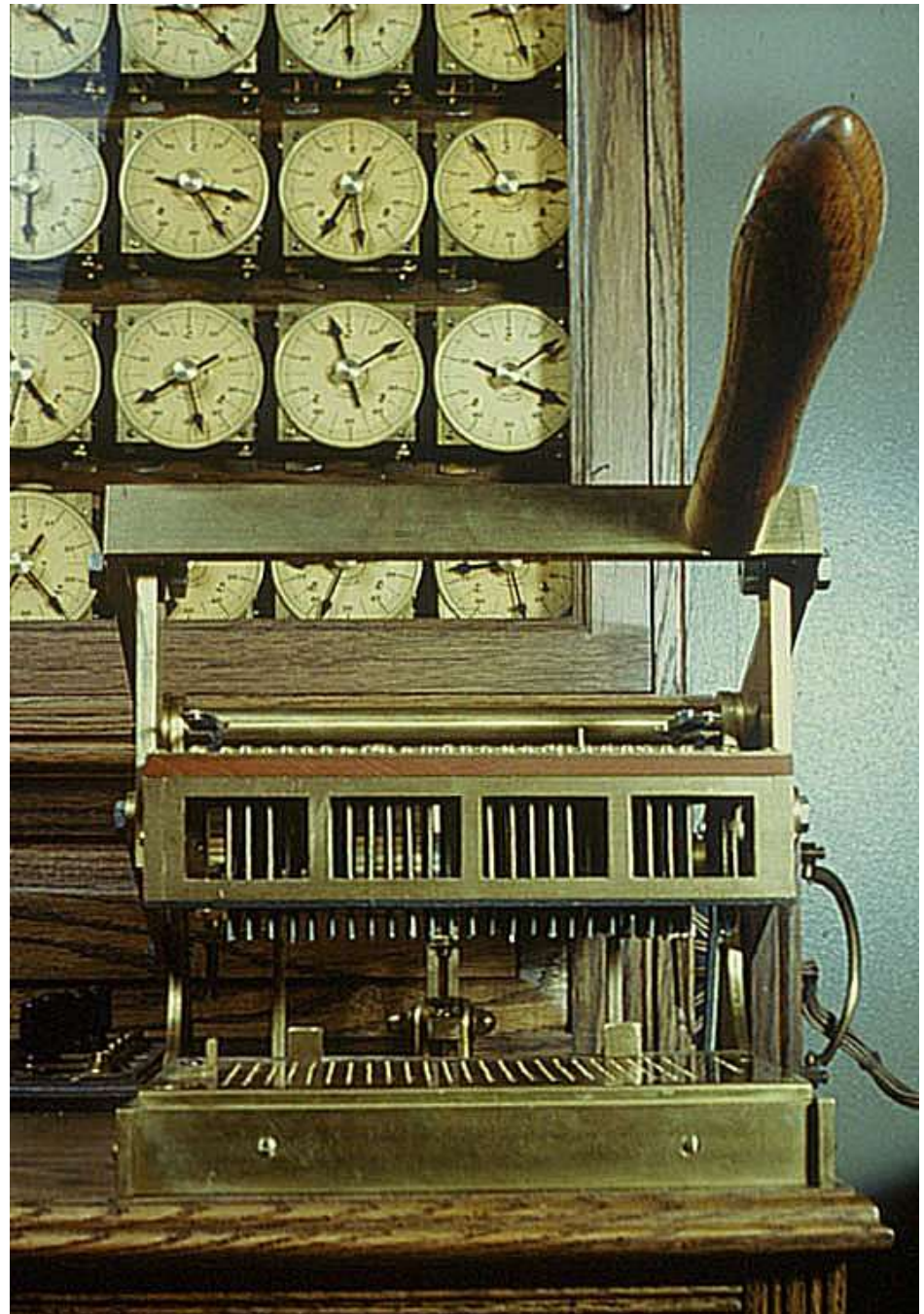


# Data recording

## *Pantograph Punch*



# Tabulating



# Sorting



# Enumeration and Tabulation

- **Enumeration** was the “simple” counting of the population
- **Tabulation** was the creation of specific reports on industries, medical statistics, literacy, etc.
- Porter: **The Office could not make valuable compilations that had previously been neglected because of time and expense.**

# 1890 Census

- Rough population count: **6 weeks!**
- **Census completed in less than 2 years**
- *Contract: machines were rented for 2 shifts; extra machines available; penalty of \$10/day; 24 hour maintenance; pantograph punches were sold*
- **10,220 pages of published reports**  
estimated at 14 years, if done manually (14:2)  
\$5,000,000 savings

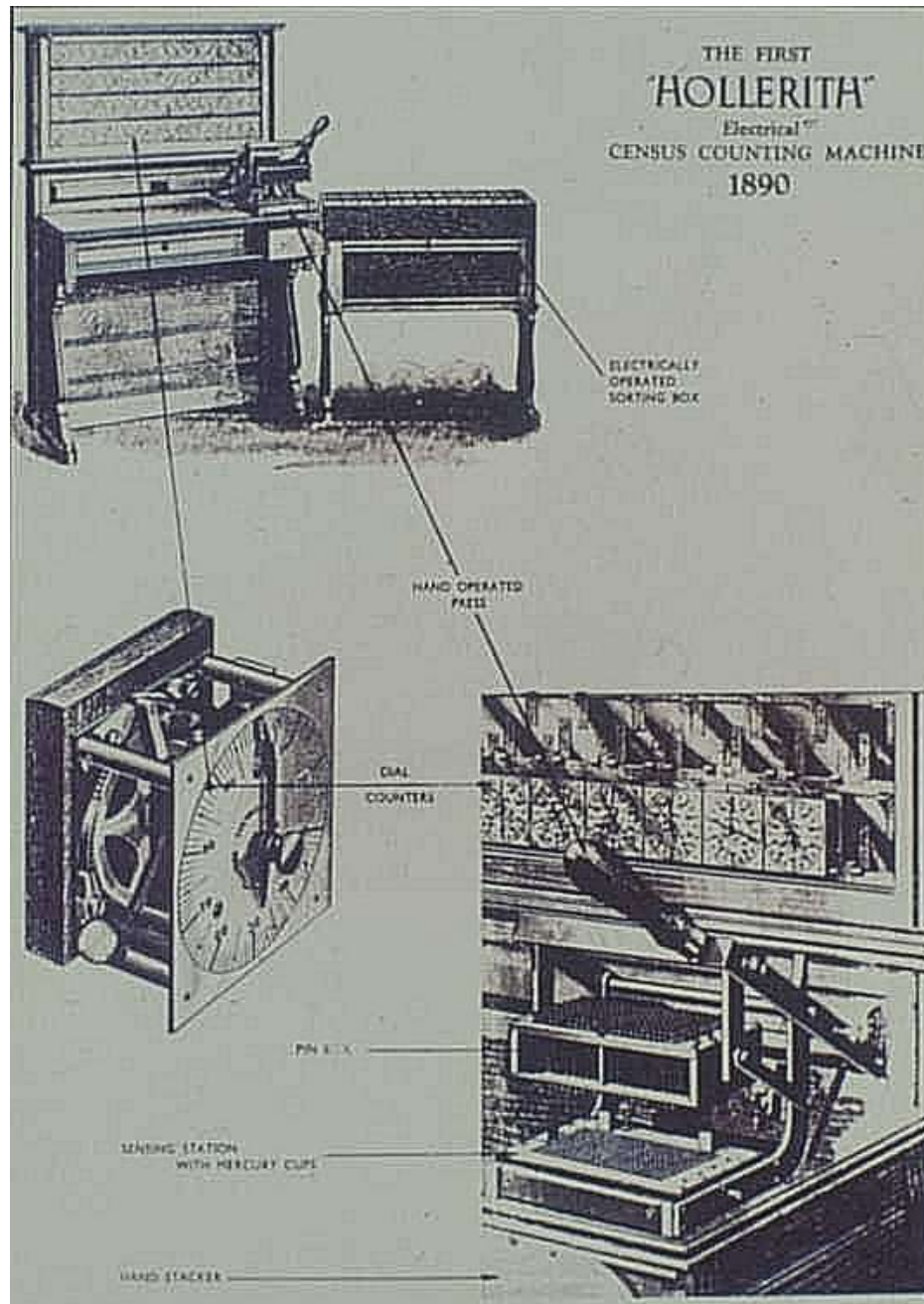
# Hollerith as Inventor

- 1885 Patents for railway air brakes
- 1886 Baltimore: machine for the compilation of mortality statistics
- 1887 Census Office  
files for patents on **card system**:  
*U.S. Patent Number: 395,781*  
***card = person; hole = characteristic***
- 1888 Surgeon Generals Office  
*in 6 months: 50,000 cards and dependency*
- 1889 Paris Universal Exposition: Gold Medal

# Scientific American (1890)



THE FIRST  
**'HOLLERITH'**  
*Electrical*  
CENSUS COUNTING MACHINE  
1890





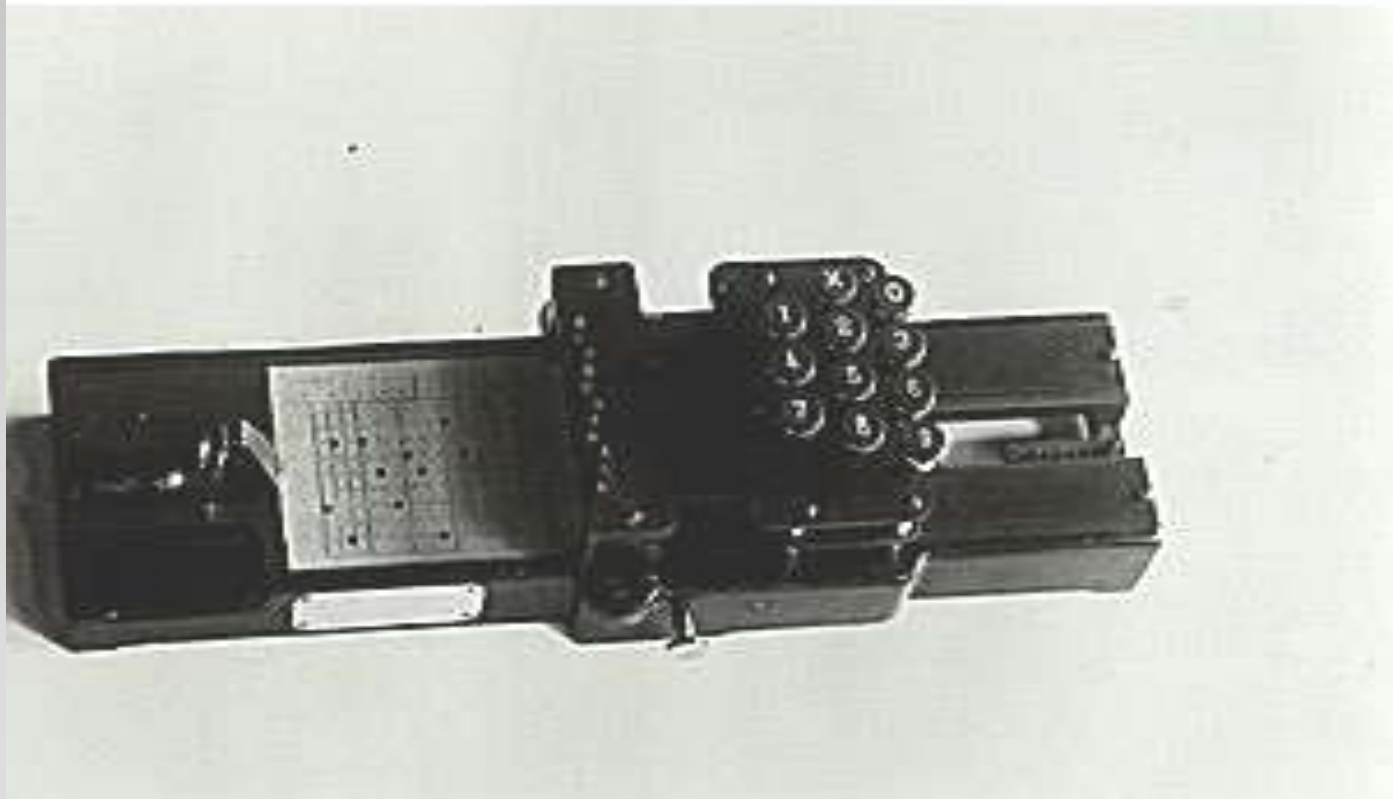


# Tabulating Machine Company

- **December 3, 1896**, the **Tabulating Machine Company** is chartered with Herman Hollerith as General Manager
- **1900 Census:**
  - automatic card feed (84,000/day)
  - key punch (0 to 9)
  - integrating tabulator (accumulator)
  - census completed in 2 1/2 years
- 1905 Hollerith terminates association with Census Office

# Numeric key punch

*photo courtesy of IBM Corporation*



# James Powers

- **1905: Original Hollerith patents expire**
  - ◆ Simon North: establishes machine laboratory at the Census Office (direct competition)
- Powers was a Russian immigrant
- 1907 hired at Census Office
- 1910 Census used **Burroughs** adding machines
- 1911 Powers Accounting Machine Company
- **1924 Powers encodes the alphabet**
- 1927 **Remington Rand** (James Rand)

# Computing Tabulating Recording Company, (C-T-R)

- 1911: Charles Flint

**Computing** Scale Company  
(Dayton, OH)

**Tabulating** Machine Company,  
and

International Time **Recording**  
Company (Binghamton, NY)



# CTR

- Thomas J. Watson  
(1874-1956)



hired as first president

- 1924 Watson renames CTR as  
**International Business Machines**



# The Industry:

- 1929 Herman Hollerith dies (age 17!)
- 1928 IBM: 80 column card *rectangular holes*
- 1930 RemRand: 90 column card *round holes*
- 1930 Census uses commercial machines
- 1930's **EAM** industry expands:
  - Agriculture Adjustment Administration: **CHECK\$**
  - Social Security Administrationvirtually all large public and private organizations are **dependent on Electric Accounting Machines**

# What seems to be the problem?

*photo courtesy of IBM Corporation*





# Lab: Punched Cards

- “What the Punched Card Can Do”
- Slide of Punched Card
- Punched Cards
  - Plain
  - Alphabet and Numbers
  - “Add 8 and 12 SMILE”
  - How much is six and seven....
  - Binder of Sample Cards & **brush**
  - Slides of IBM Equipment
- Plug board

# IBM 80 column card



# "Hollerith" Code

- **Numeric:** 0 to 9 (one hole)
- **Alphabetic** (two holes)
  - A to I      12 punch + 1 to 9
  - J to S      11 punch + 1 to 9
  - T to Z      10 punch + 2 to 9
- **Special Characters** (three holes)  
    , . ; # \$ ( ) \* & @

# A great idea, now how do we make it work?

- Basic idea is to break all processing into specific tasks, and
- Build machines to do each task
  - encoding and verifying
  - counting
  - addition and subtraction
  - sorting and merging
  - printing
  - transmitting to another location

The following slides are from a "**Data Processing Orientation**" prepared by the IBM Corporation for their customers in the 1950's (done as 35 mm slides).

Dr. Bergin was given these slides when he was employed by the US Veterans Administration (from 1966 to 1982).

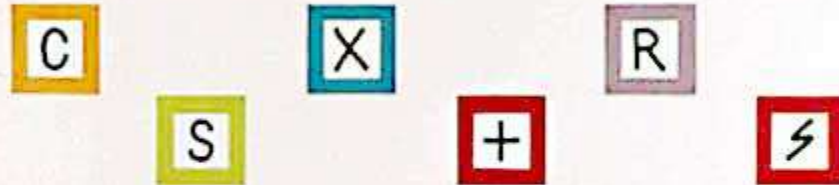
## stages in development in data processing

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- ▶ Simplification of Individual Functions
- ▶ Mechanization Introduces Combinations of Functions
- ▶ Punched Card Introduces Compatibility of Equipment
- ▶ Punched Tape Introduce Compatibility to Wide Range of Equipment
- ▶ Electronic Computers Introduce Intercommunication and Rapid Processing

# 1<sup>st</sup> STAGE

SIMPLIFICATION OF INDIVIDUAL FUNCTIONS



BETTER WORK FLOW

BETTER ARRANGEMENT OF DATA

BETTER RECORDING OF DATA

BETTER STORING OF DATA

BETTER COMMUNICATIONS

# 2<sup>nd</sup> STAGE

Mechanization Introduces Combinations of Functions

**+** **R** PRINTING ADDING MACHINE

**S** **+** **R** CASH REGISTER

**C** **S** **R** MICROFILM CARD FILE

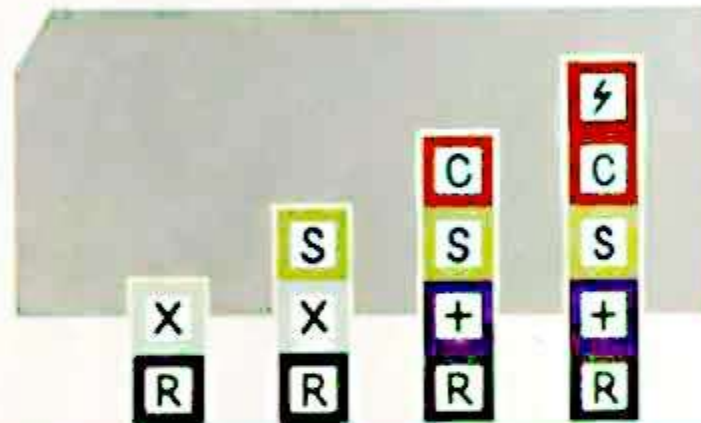
**S** **X** **+** **R** COMPUTING BILLING  
MACHINE

**C** **S** **+** **R** PROOF MACHINE



# 3<sup>rd</sup> STAGE

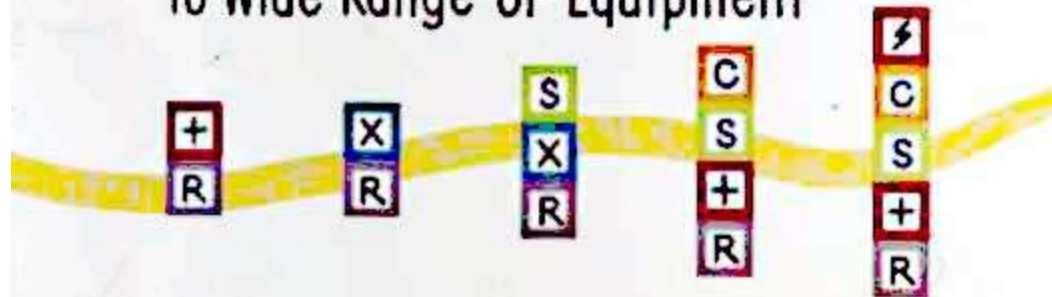
Punched Card Introduces Computability of Equipment



- \* Key Punch
- \* Sorters
- \* Collators
- \* Accounting Machines (Tabulators)
- \* Summary Punch
- \* Verifiers
- \* Statistical Machines
- \* Reproducers
- \* Calculating Punch

# 4<sup>th</sup> STAGE

Punched Tape Introduces Compatibility to Wide Range of Equipment



- \* Teletypewriter
  - \* Cash Register
- \* Computer
  - \* Flexowriter
- \* Tape-to-Card Converter
  - \* Typewriter Tape Punch



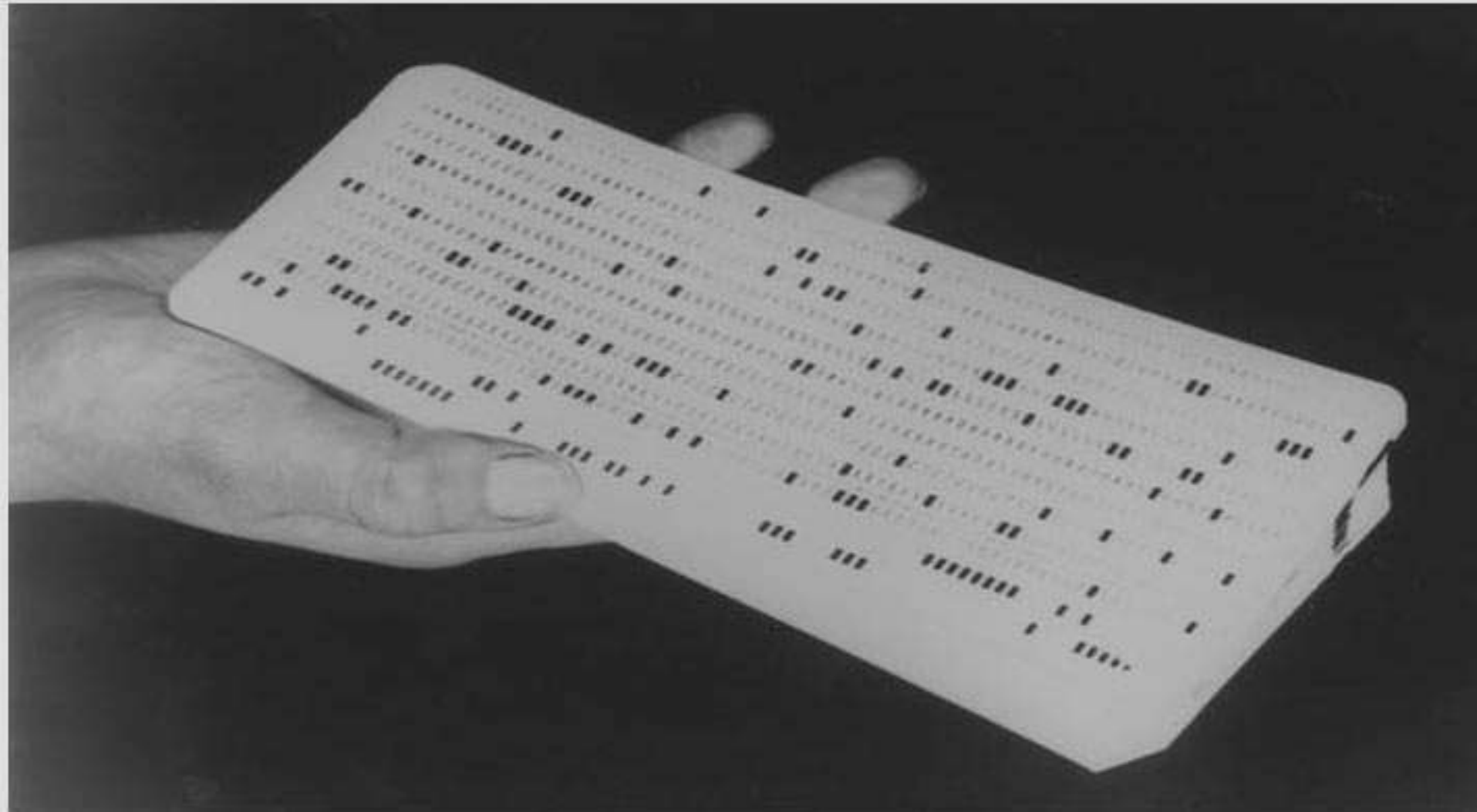
**machine  
functions**

**INTERNATIONAL BUSINESS MACHINES CORPORATION**

# Machine Functions

- The following slides were converted from 35mm slides used by IBM salesman. These slides were given to Dr. Bergin while he was employed by the US Veterans Administration.
- The photographs are from the IBM Archives and are used with permission.

# Deck of Punched Cards

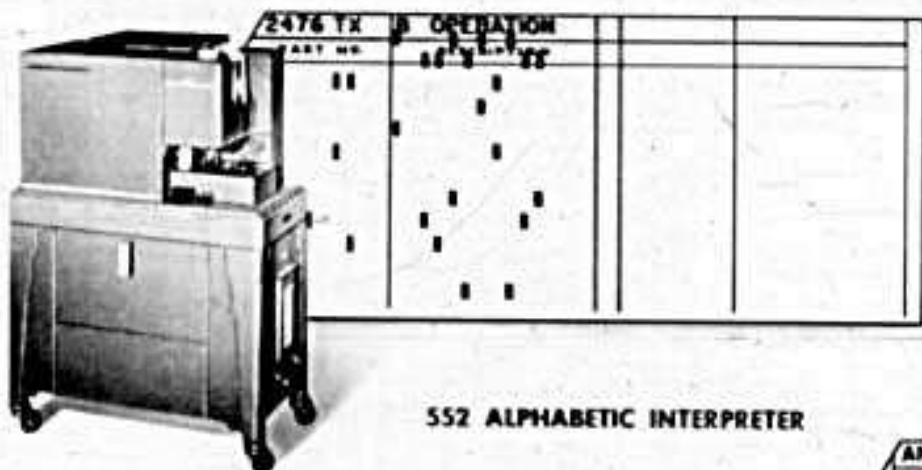


# IBM 026 Keypunch

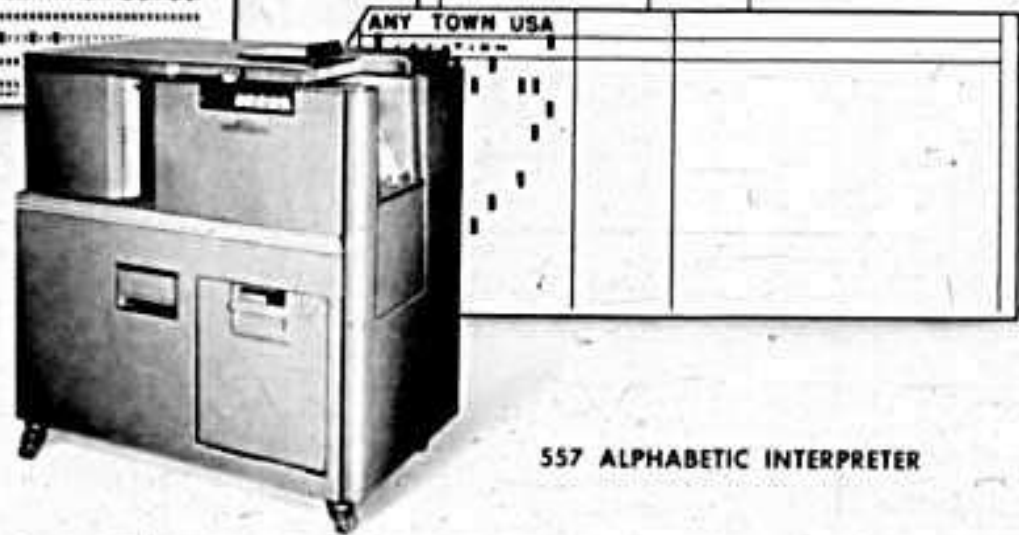
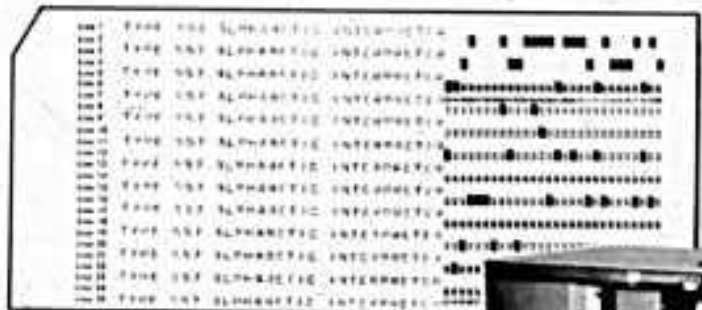
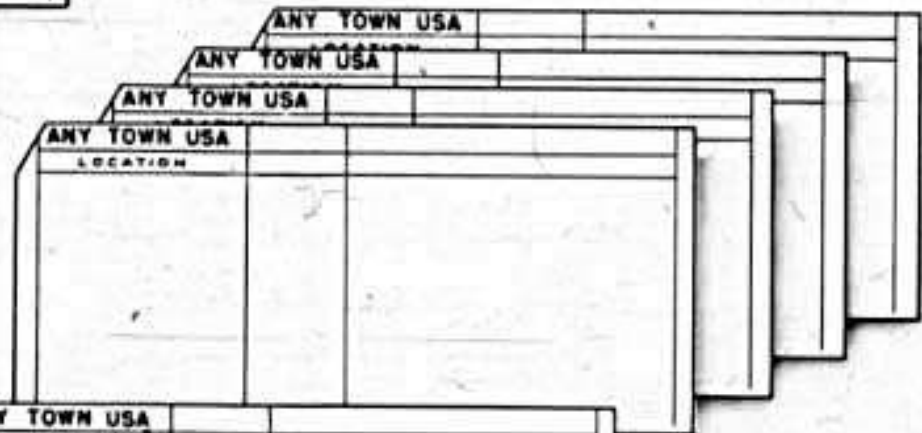
*photo courtesy of IBM Corporation*



# INTERPRETING



552 ALPHABETIC INTERPRETER

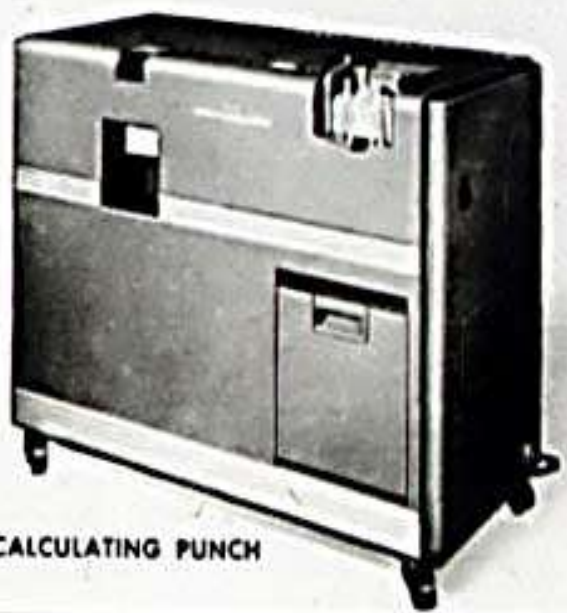


557 ALPHABETIC INTERPRETER

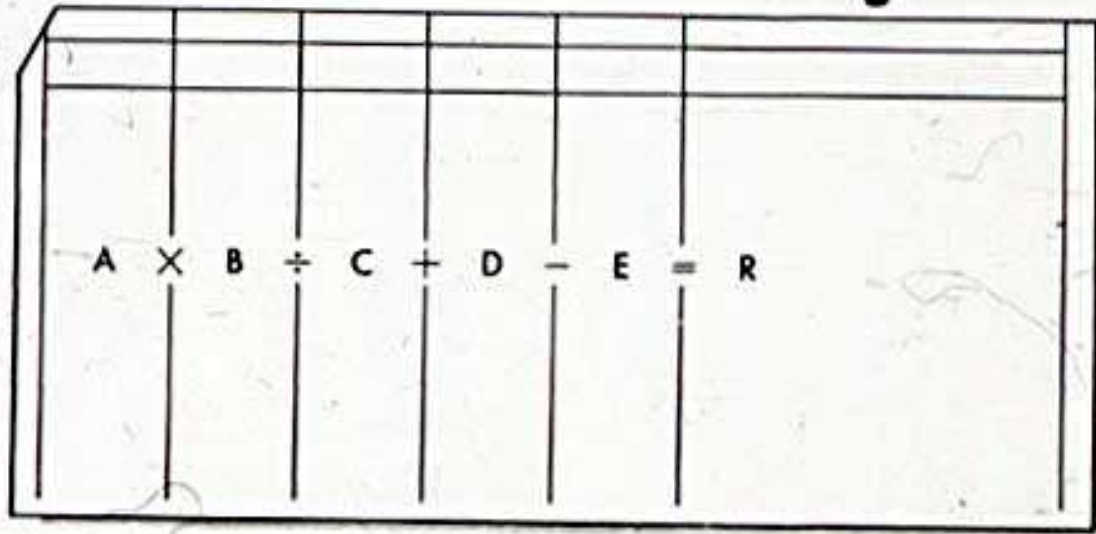
# CALCULATING



607 ELECTRONIC CALCULATING PUNCH  
(604 IS SIMILAR)



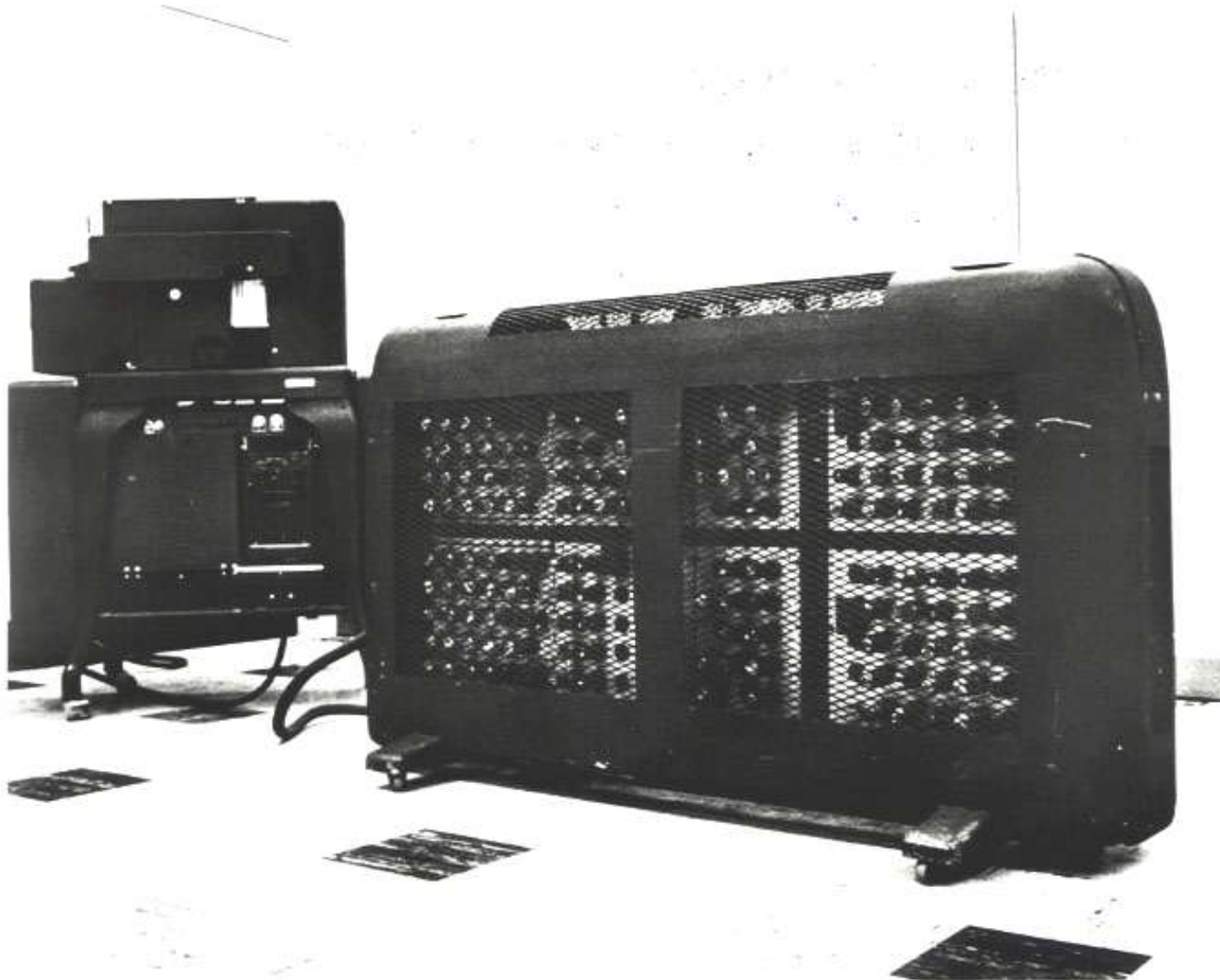
602A CALCULATING PUNCH



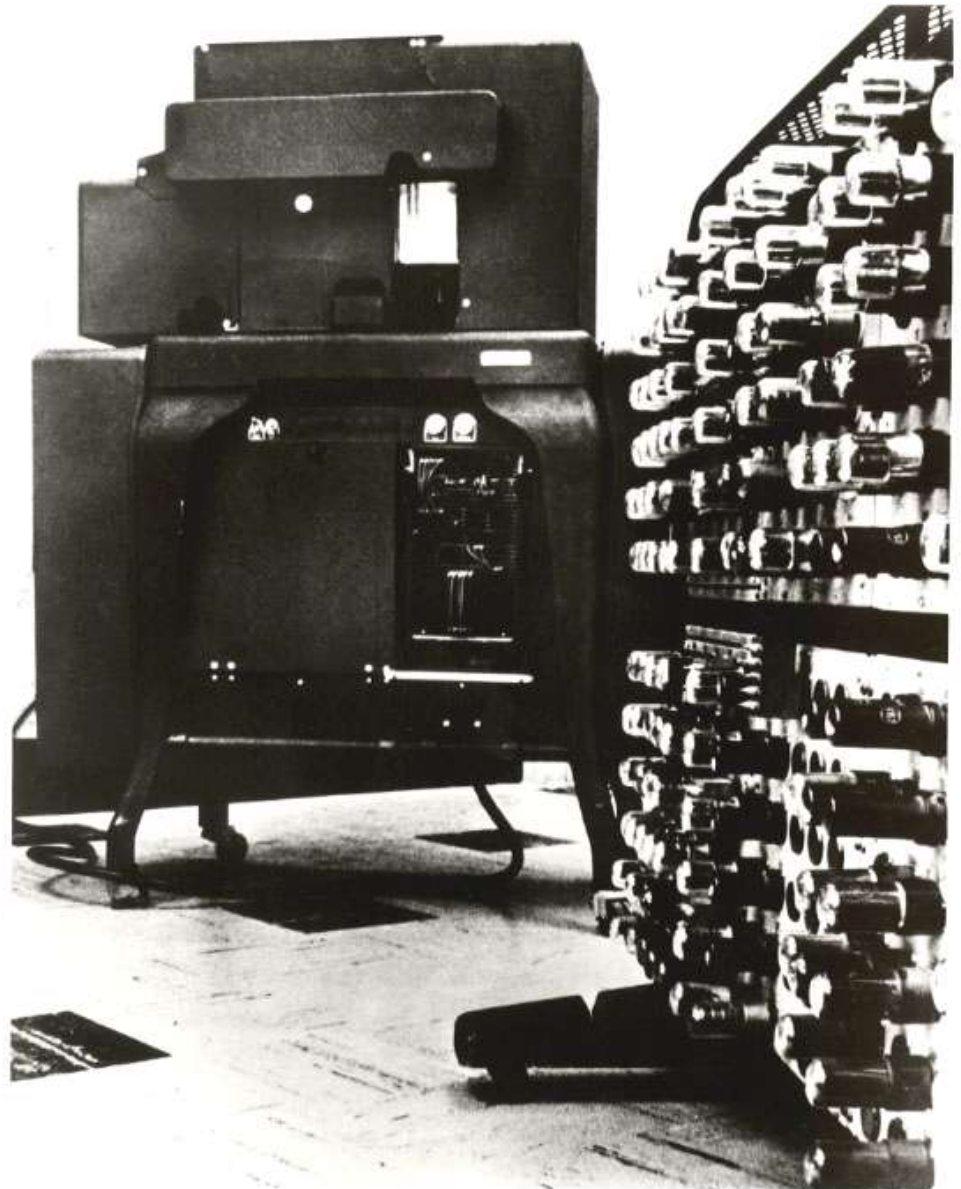


# IBM 603 Electronic Multiplier

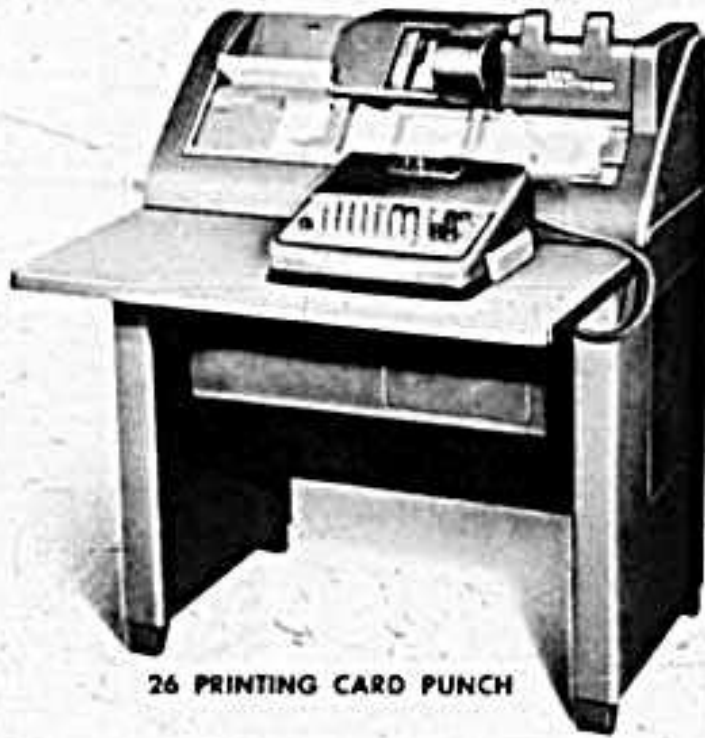
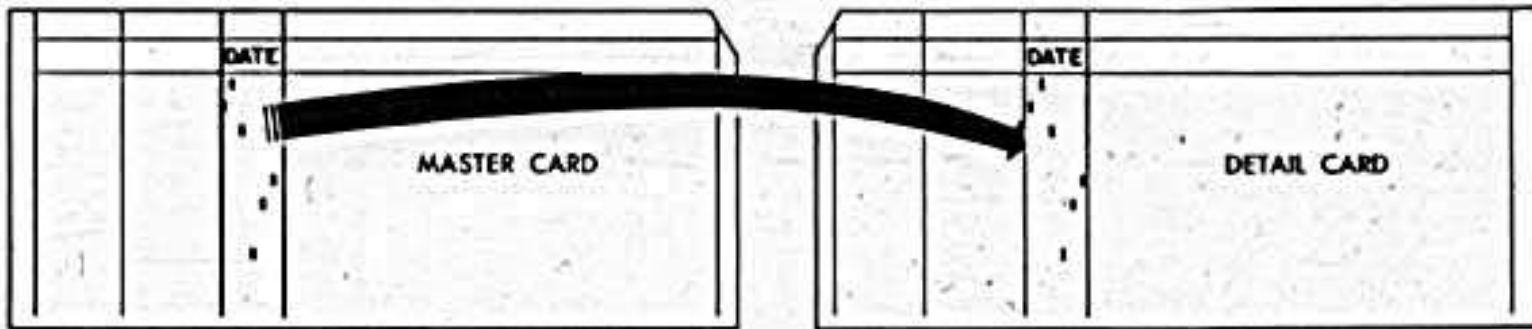
(September 1946) *photo courtesy of IBM Corporation*



# IBM 603 *photo courtesy of IBM Corporation*



# DUPLICATING



26 PRINTING CARD PUNCH

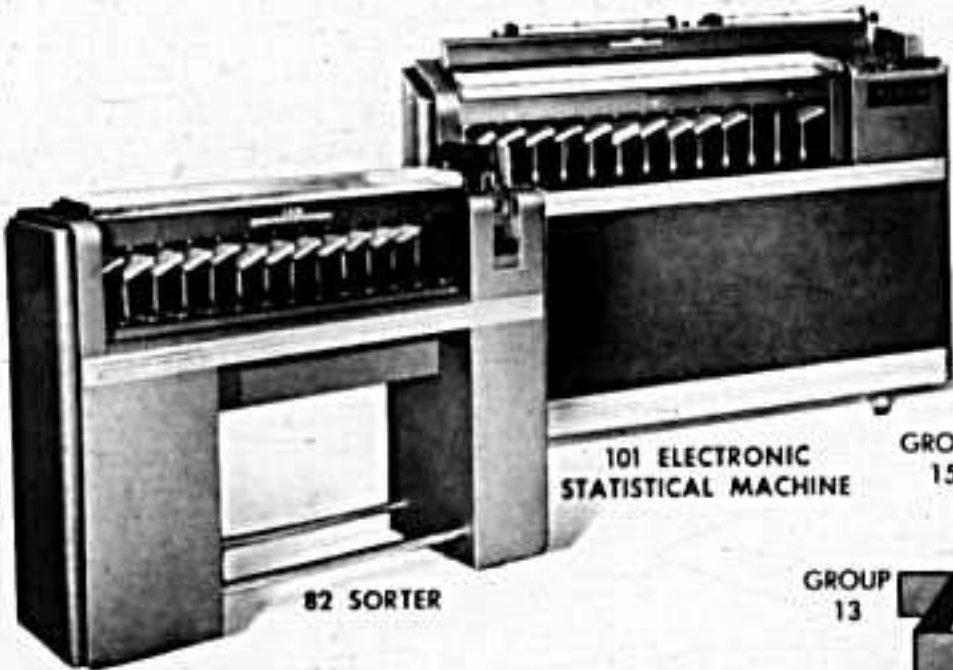


24 CARD PUNCH



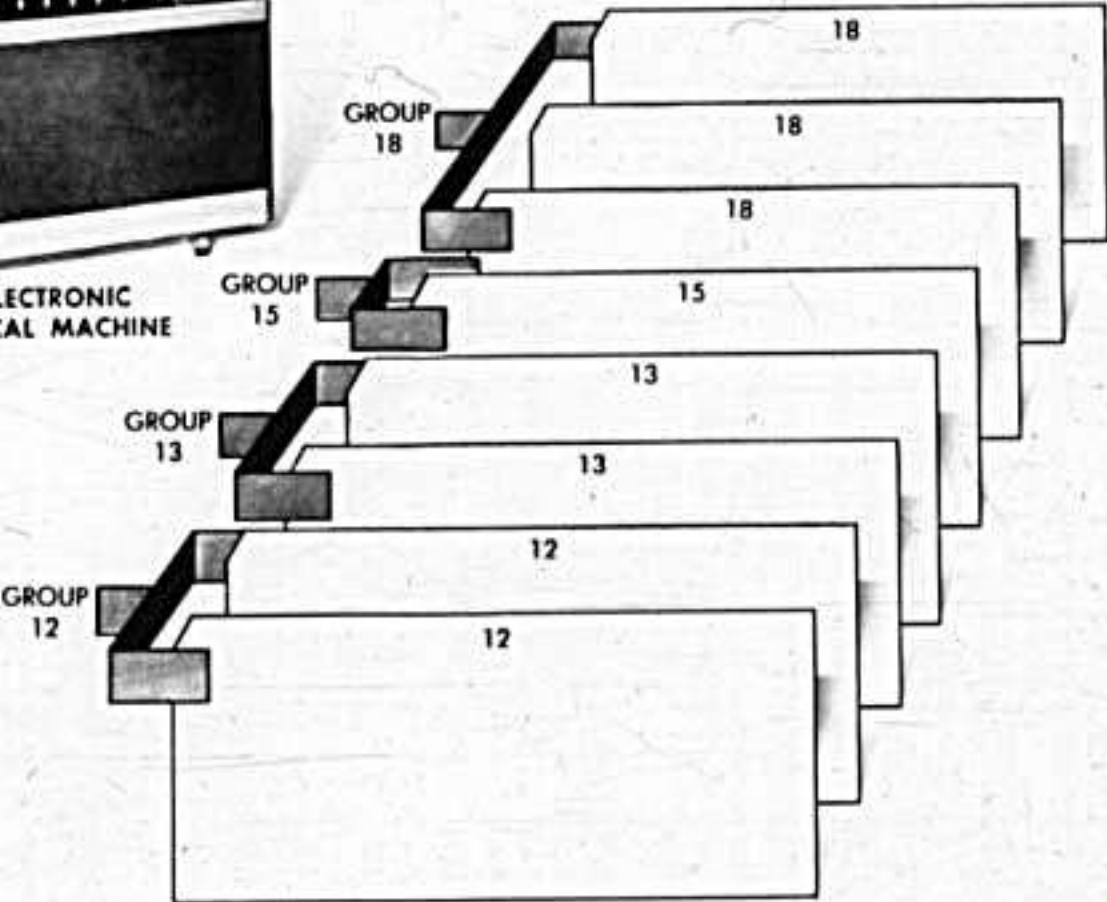
526 SUMMARY PUNCH

# SORTING



82 SORTER

101 ELECTRONIC  
STATISTICAL MACHINE



# Horizontal Sorter (1930s)

*photo courtesy of IBM Corporation*



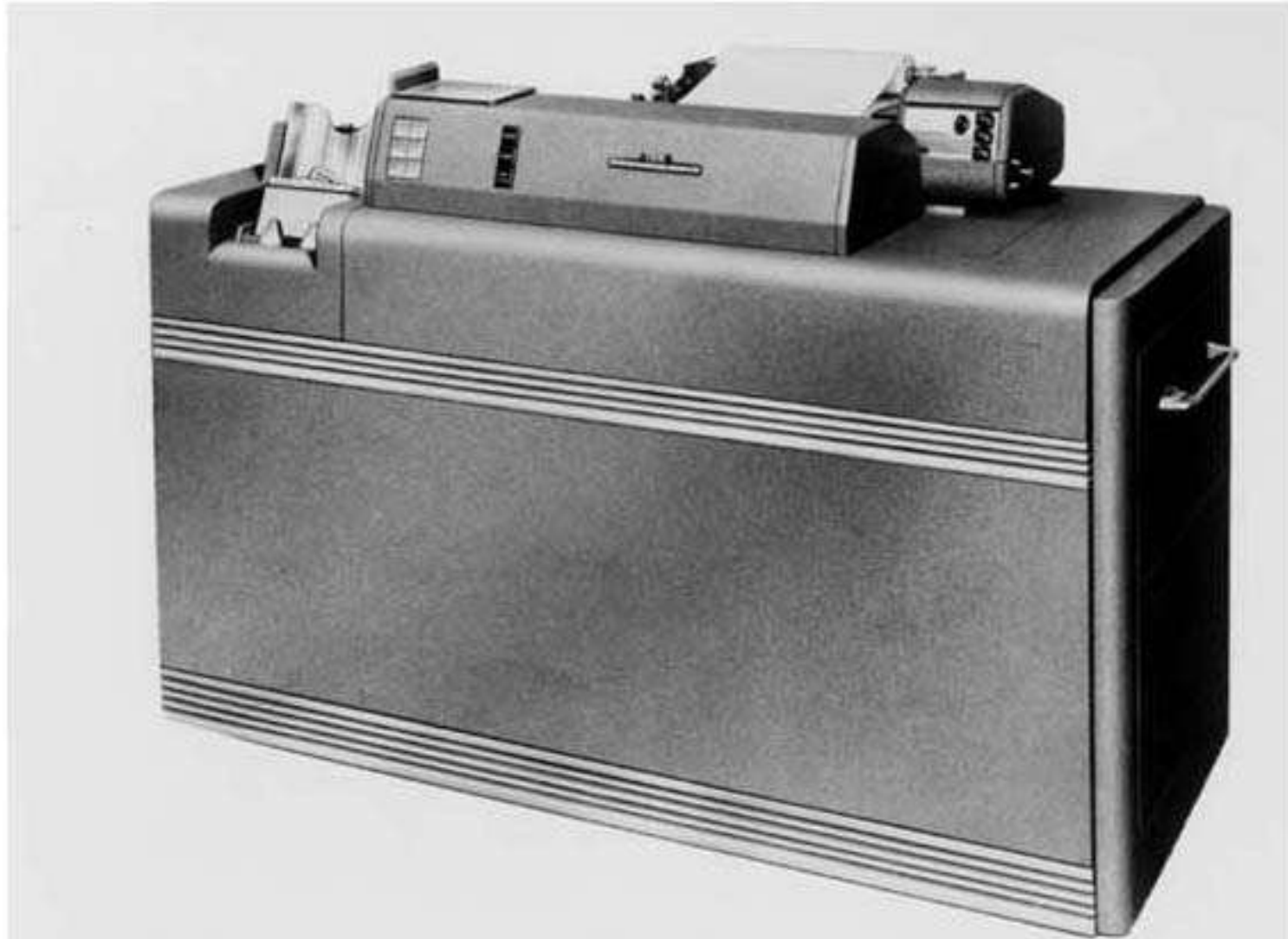
# Using a sorter (1950s?)

*photo courtesy of IBM Corporation*



# IBM 402 Accounting Machine

*photo courtesy of IBM Corporation*



# Plug Boards

- Some of the machines were able to perform more than one task. Such machines were controlled by a "plug board" in which the steps were "programmed" into the board with wires. In most cases, these boards were wired for one process such as "monthly billing" and used over and over again.



# Typical Small Installation

*photo courtesy of IBM Corporation*



# BIGGEST BOOKKEEPING JOB BEGINS

## Social Security Board Has Gigantic Task

By LUT RICHARDS,

Staff Correspondent of The News

Baltimore, Jan. 9.—The world's biggest bookkeeping job is under way here.

Thanks to the Social Security Board, this city is now famous for one thing more than fried chicken and terrapin—a lot of Maryland. For here's where all those security blanks came last month, after the deadlines closed. In piles as big as haystacks, they're being counted, sorted and spider-webbed on sheets that will pay pensions a good many years away.

When you finished your apportionment of 500,000 out of 250,000 and 500,000 last month, the apportionment started in this state and rolled out into the rest of the United States.

By train and by truck, the big rolls came to Baltimore. The small white slips were rolled in to bundles of 1,000, all bundled up in a postmaster's heavy wrapper. And they're still coming.

600,000 a Day.

At the rate of 600,000 a day, the old age benefit accounts of 25,000,000 workers are being entered and fed away in the huge, noisy Chandler-Balding, right on the edge of Baltimore Harbor. They eat eight the glossy machine feeds with 2,500 employees and the same rhythm in 400 of 80,000,000 worth of electric tabulating machines.

If it were these machines which carry the load. Without them, the Social Security Act would have been impossible. Its administration would



John G. Winant  
He's the boss of the work.

RECORD CARD										
NAME	ADDRESS	DATE OF BIRTH	DATE OF DEATH	DATE OF ENTRY	DATE OF EXIT	DATE OF REENTRY	DATE OF REEXIT	DATE OF REENTRY	DATE OF REEXIT	ACTUAL CARD
1	2	3	4	5	6	7	8	9	10	11
12	13	14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31	32	33
34	35	36	37	38	39	40	41	42	43	44
45	46	47	48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63	64	65	66
67	68	69	70	71	72	73	74	75	76	77
78	79	80	81	82	83	84	85	86	87	88
89	90	91	92	93	94	95	96	97	98	99
100	101	102	103	104	105	106	107	108	109	110

This is the actual card that tells the story of your laboring life to the Social Security Board. The holes punched in various places serve as guides to the intricate machines used for filing them away.

have sunk under its own weight. The very heart of a national program would have been swept away in a food puff.

As a bookkeeping job, there's nothing like it anywhere. In England, where there's social security for the first person the accounting is done by hand—and the work sheets were operated in two London city blocks.

The next biggest to this is only 5 per cent as large. It's the office central of the German railroads, all operated by the Reich.

They're incredible, the machines down here. They do everything but take off their hats and bow. Kicker-free and pie-in-the-face, plugged into a motor, help them to list your account by name, then by number, and keep track of

you before they're through or you won't be lost in transit.

The whole works has the air of starting and keeping your account sheet. Down here they call it a ledger card leading. The by-products of creating it are the two safety positions mentioned above—alphabetical list and a numerical list.

These three details affect your card the minute it arrives.

Office records (lists and application forms) (SSB) are received in batches of 100. They come with ten or fifteen sheets which are checked to see if all included items are in their numerical sequence.

The forms are then recorded on pre-numbered tally sheets by area, group and individually, and when

you ask how that is done it brings out an interesting point about the numbers. The three classes of numbers—although you haven't been told—have already not only apart from your fellowmen. Thus, your number 601-27-4111, really means this:

601—City of Baltimore  
27—Group  
4111—Individual

Tally sheets, checked into blocks of 5,000 security account numbers, are changed into block records—

and right here they are put through an elaborate sleight-of-hand that gives the office its name of the job. The block record gets a reference number and a card supercharged with symbols. From now

# Typical Office

*photo courtesy of IBM Corporation*



# Payroll Department

*photo courtesy of IBM Corporation*



# Data Processing Installation

*photo courtesy of IBM Corporation*



# USES of punched cards

- Library books *UMD ID*
- Retail clothing sales
- Engineering drawings using microfilm
- Warehouse stock management
- Bills of lading for railroads and truck lines
- Mortgage payments
- Loan and insurance payments
- **PASS AROUND** Card Notebook with samples.

# In conclusion....

United States census: [www.census.gov](http://www.census.gov)

- 228,289,000 on 12/1980
- 248,143,000 on 1/1/1990
- 274,245,985 at 10:54 EST on Feb. 13, 2000

# References

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- Biles, et al, “Herman Hollerith: Inventor, Manager, Entrepreneur -- A Centennial Remembrance,” *Journal of Management*, Vol. 15, No.4, 1989
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- Bache, *IBM’s Early Computers*, MIT Press, 1986.
- Campbell-Kelly in Aspray, *Computing Before Computers*, Iowa State U. Press, 1990



# Biographies:

- William Rogers, *THINK, A biography of the Watsons and IBM*, Stein and Day, 1969
- Belden and Belden, *The Lengthening Shadow: The Life of Thomas J. Watson*, Little Brown, 1962
- Thomas Watson, Jr., *Father, Son and Company*, Bantam, 199065

# Show and Tell

- Census Sheets from 12th Census
- Rail road ticket
- Slides of Hollerith Machines
- Player Piano Roll
- Punched cards

# Show and Tell: Punched Cards

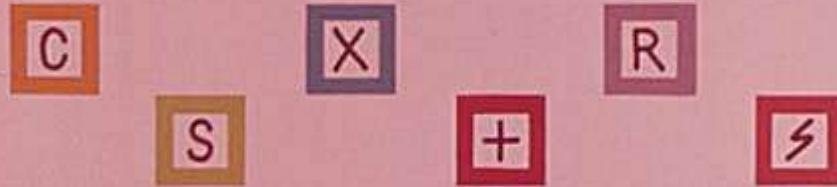
- 1945 IBM Sales Booklet
- Punched Card Annual
- IBM Manuals
- IBM Home Study Course
- *Casey's Punched Cards*
- UNIVAC Booklet with 90 column card
- **MUSEUM: IBM 029 Keypunch**

### What the PUNCHED HOLE can do

00000000000000000000000000000000	Add itself to another number	00000000000000000000000000000000
11111111111111111111111111111111	Subtract itself from another number	11111111111111111111111111111111
22222222222222222222222222222222	Print itself	22222222222222222222222222222222
33333333333333333333333333333333	Eliminate itself	33333333333333333333333333333333
44444444444444444444444444444444	Select itself	44444444444444444444444444444444
55555555555555555555555555555555	Produce an automatic balance forward	55555555555555555555555555555555
66666666666666666666666666666666	Cause a form to feed to a predetermined position or to be ejected automatically, or to space from one position to another	66666666666666666666666666666666
77777777777777777777777777777777		77777777777777777777777777777777
88888888888888888888888888888888		88888888888888888888888888888888
99999999999999999999999999999999	Cause a total to be printed	99999999999999999999999999999999
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27		28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50

# 1<sup>st</sup> STAGE

## SIMPLIFICATION OF INDIVIDUAL FUNCTIONS



BETTER WORK FLOW

BETTER ARRANGEMENT OF DATA

BETTER RECORDING OF DATA

BETTER STORING OF DATA

BETTER COMMUNICATIONS