ELEC3020: Lecture 1-2

Some early History:

- Colossus
- Eniac
- Manchester Mk I
- Ferranti Mk I
- IBM 701

Classify…

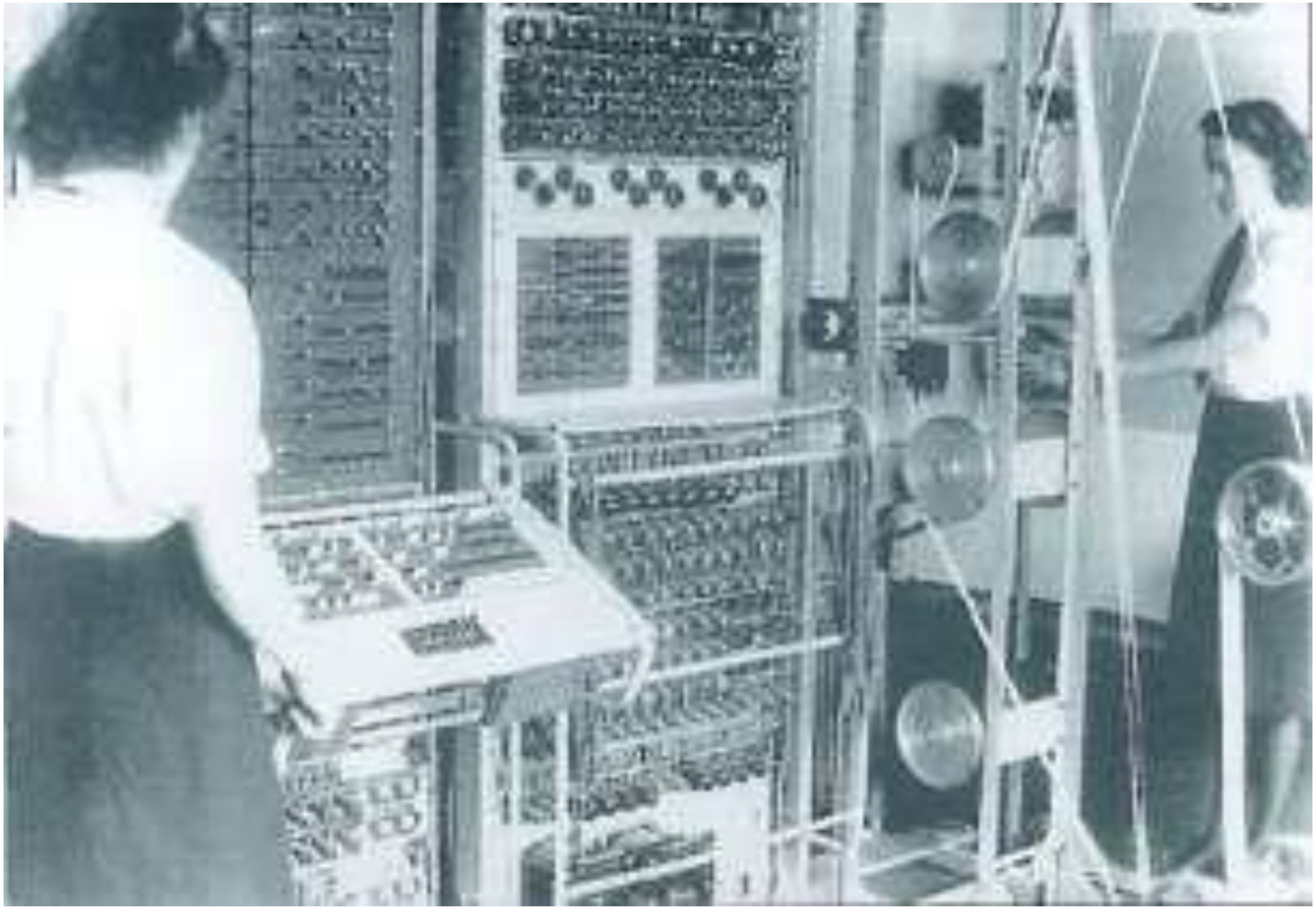
By Data Architecture

- Multi-layer cache (iA32 etc)
- Vector (Fujitsu VPP)
- Latency-hiding (HEP, Tera)

By parallelism:

- Uniprocessor
- SMP
- Vector
- Cluster
- Hyperthreaded

COLOSSUS



COLOSSUS

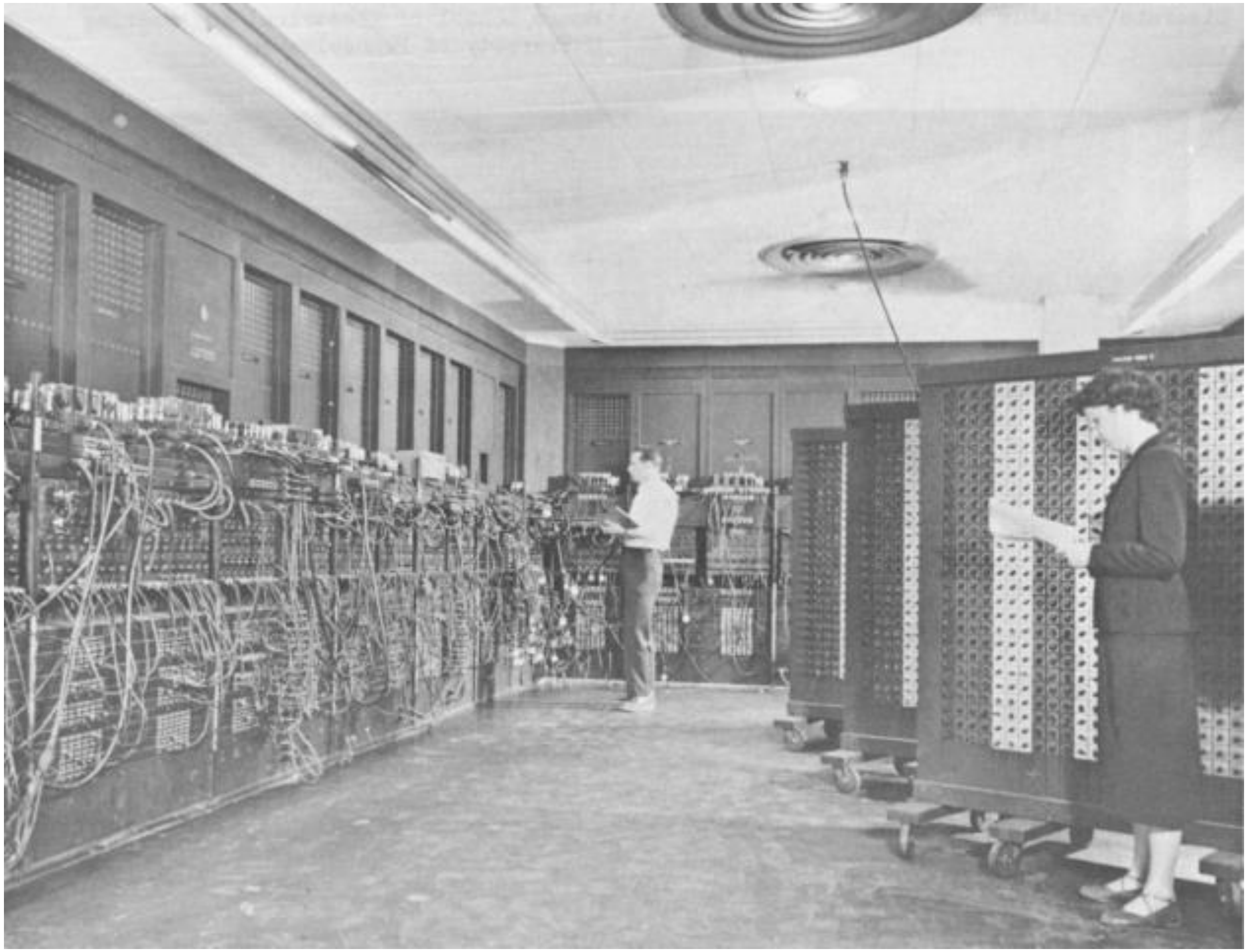
- Lorenz was a highly sophisticated cypher used personally by Hitler and his High Command. As D-Day approached, breaking 'Tunny', as Lorenz was known, was to become increasingly important.

- Many of the Tunny messages still took several weeks to decypher; far too long for the intelligence to be of use. Max Newman became convinced that the answer lay in building a computing machine such as that described in a pre-war thesis by Alan Turing.

- The first attempt, named 'Robinson' after the designer of cartoon contraptions Heath Robinson, worked on the principle that no machine can generate a truly random sequence of letters. Robinson was a partial success but it depended upon the high-speed synchronization of two streams of paper tape. The paper kept ripping.

- Enter Tommy Flowers, who built a machine with thermionic valves (vacuum tubes) to do the same job as Robinson but without the need for the synchronization of the tapes. The result was Colossus, the world's first programmable electronic computer.
[http://www.bletchleypark.org.uk/colosusfilm.rhtm]

ENIAC



ENIAC

"...With the advent of everyday use of elaborate calculations, speed has become paramount to such a high degree that there is no machine on the market today capable of satisfying the full demand of modern computational methods. The most advanced machines have greatly reduced the time required for arriving at solutions to problems which might have required months or days by older procedures. This advance, however, is not adequate for many problems encountered in modern scientific work and the present invention is intended to reduce to seconds such lengthy computations..."

*From the **ENIAC** patent (No. 3,120,606), filed 26 June 1947.*

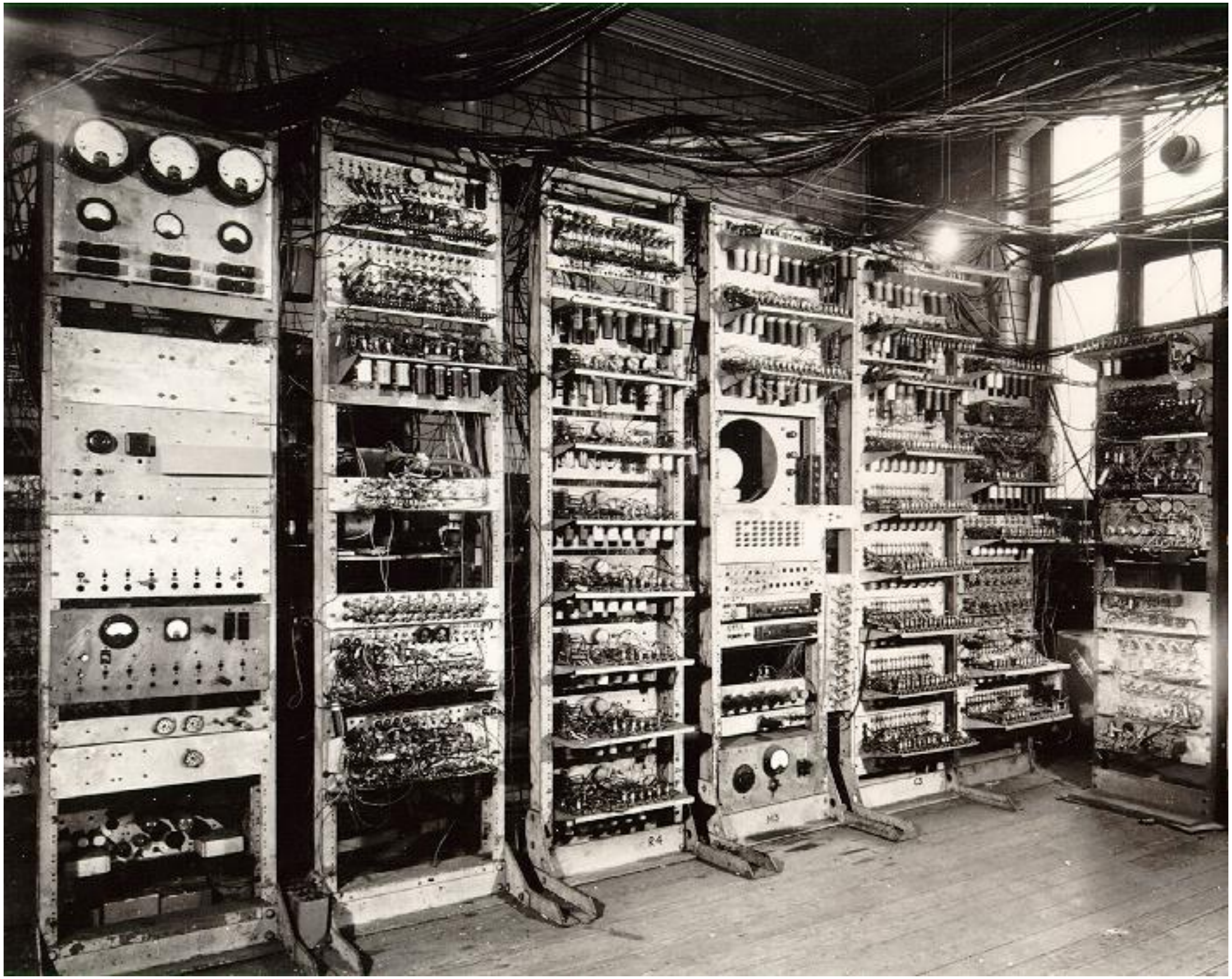
ENIAC...

- By today's standards for electronic computers the **ENIAC** was a grotesque monster. Its thirty separate units, plus power supply and forced-air cooling, weighed over thirty tons. Its 19,000 vacuum tubes, 1,500 relays, and hundreds of thousands of resistors, capacitors, and inductors consumed almost 200 kilowatts of electrical power.

- But **ENIAC** was the prototype from which most other modern computers evolved. It embodied almost all the components and concepts of today's high- speed, electronic digital computers. Its designers conceived what has now become standard circuitry such as the gate (logical "and" element), buffer (logical "or" element) and used a modified Eccles-Jordan flip-flop as a logical, high-speed storage-and-control device. The machine's counters and accumulators, with more sophisticated innovations, were made up of combinations of these basic elements.

- **ENIAC** could discriminate the sign of a number, compare quantities for equality, add, subtract, multiply, divide, and extract square roots. **ENIAC** stored a maximum of twenty 10-digit decimal numbers. Its accumulators combined the functions of an adding machine and storage unit. No central memory unit existed, per se. Storage was localized within the functioning units of the computer.
  Martin H. Weik

The Manchester Mark 1



And its first program…

18/7/48 Kilburn Highest Factor Routine (amended)–

Instn.	C	25	26	27	Line	01234	13 14 15
-24 to C	$-b_1$	–	–	–	1	00011	010
c to 26			$-b_1$		2	01011	110
-26 to C	b_1				3	01011	010
c to 27			$-b_1$	b_1	4	11011	110
-23 to C	a	r_{n-1}	$-b_n$	b_n	5	11101	010
Sub 27	$a-nb_n$				6	11011	001
Test					7	—	011
Add 20 to Cl					8	00101	100
Sub. 26	r_n				9	01011	001
c to 25		r_n			10	10011	110
-25 to C					11	10011	010
Test					12	—	011
Stop	0	0	$-b_N$	b_N	13		111
-26 to C	b_n	r_n	$-b_n$	b_n	14	01011	010
Sub. 21	$b_n - 1$				15	10101	001
c to 27	b_{n+1}			b_{n+1}	16	11011	110
-27 to C	$-b_{n+1}$				17	11011	010
c to 26			$-b_{n+1}$		18	01011	110
22 to Cl.		r_n	$-b_{n+1}$	b_{n+1}	19	01101	000

or 000

20	-3	10111 etc
21	1	10000
22	4	00100

or 10100

23	$-a$
24	b_1

	init.	final
25	–	r_N (= 0)
26	–	$-b_N$
27	–	b_N

The Manchester Mark 1...

- 17 Instructions
- Computes Highest Proper Factor of a number
- A major innovation was the Williams tube memory

[http://www.computer50.org]

Ferranti Mark I

The Ferranti Mk I

A commercial machine based on the Manchester Mark I:

- *Store organised in 20-bit addressable "line"s, an instruction taking one line and a number two consecutive lines (see layout).*
- Serial 40-bit arithmetic, with hardware add, subtract and multiply (with a double-length accumulator) and logical instructions.
- The enhanced order code included a number of new "one-off" instructions (e.g. a random number generator, and an instruction counting the number of **1**s in a word), a set of instructions to make the 8 B-lines more generally useful, and a few improvements/additions to the Arithmetic and Control instructions.
- **8** modifier registers (B-lines, for modifying addresses in instructions); *simple B-line arithmetic and tests*.
- Single-address format order code with about **50** function codes
- **8** pages of random access main store *(one CRT per 64 * 20-bit line page)*
- **512** page capacity drum backing store, 2 pages per track, about 30 milliseconds revolution time
- Standard instruction time: **1.2** milliseconds, *multiplication **2.16** milliseconds*
- Peripheral Instructions : read and punch a line of 5-hole paper tape; transfer a given page (or track) on drum to/from a given Williams-Kilburn Tube "page" (or page pair) in store.

Mercury Delay Memory…

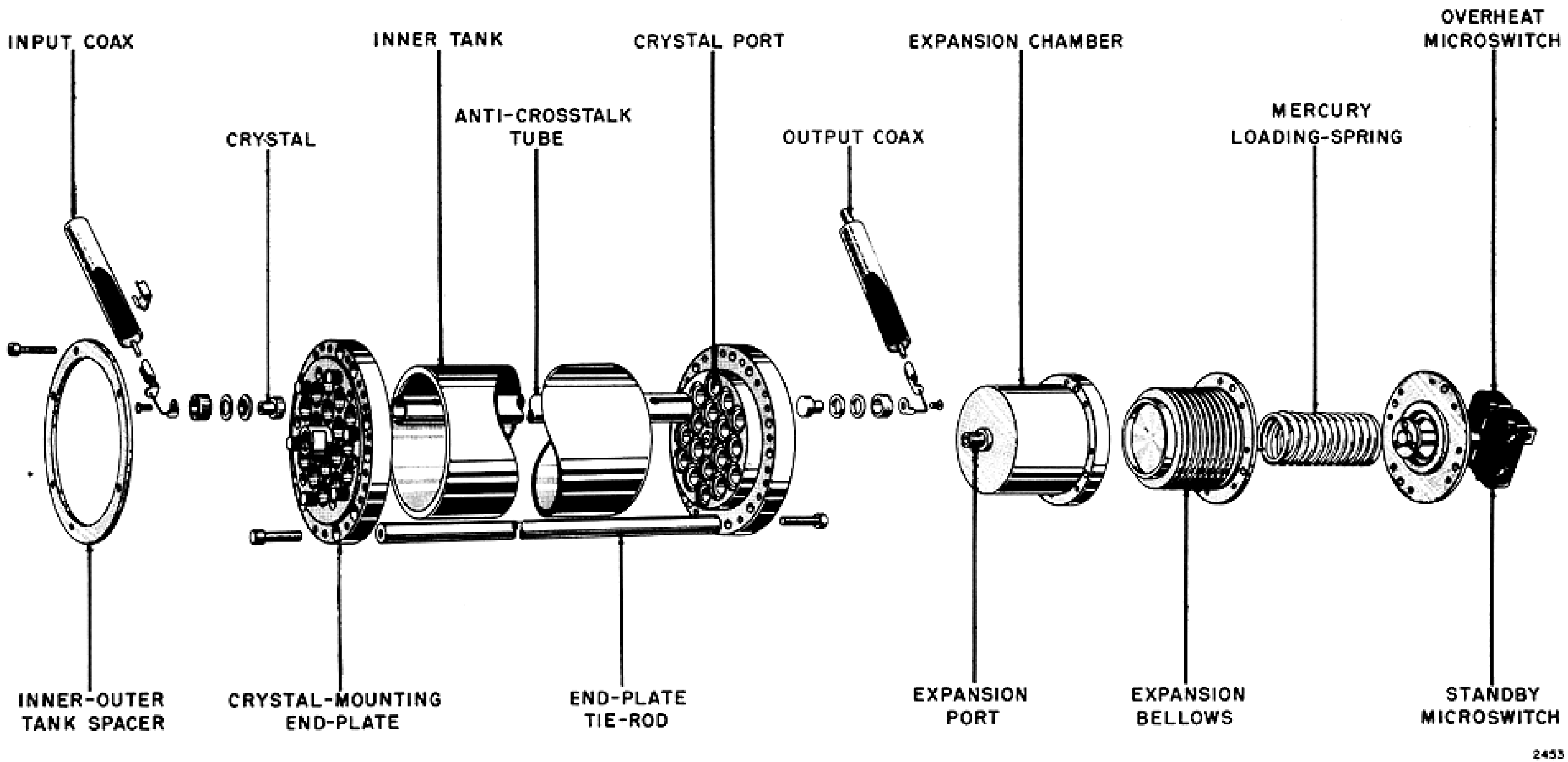
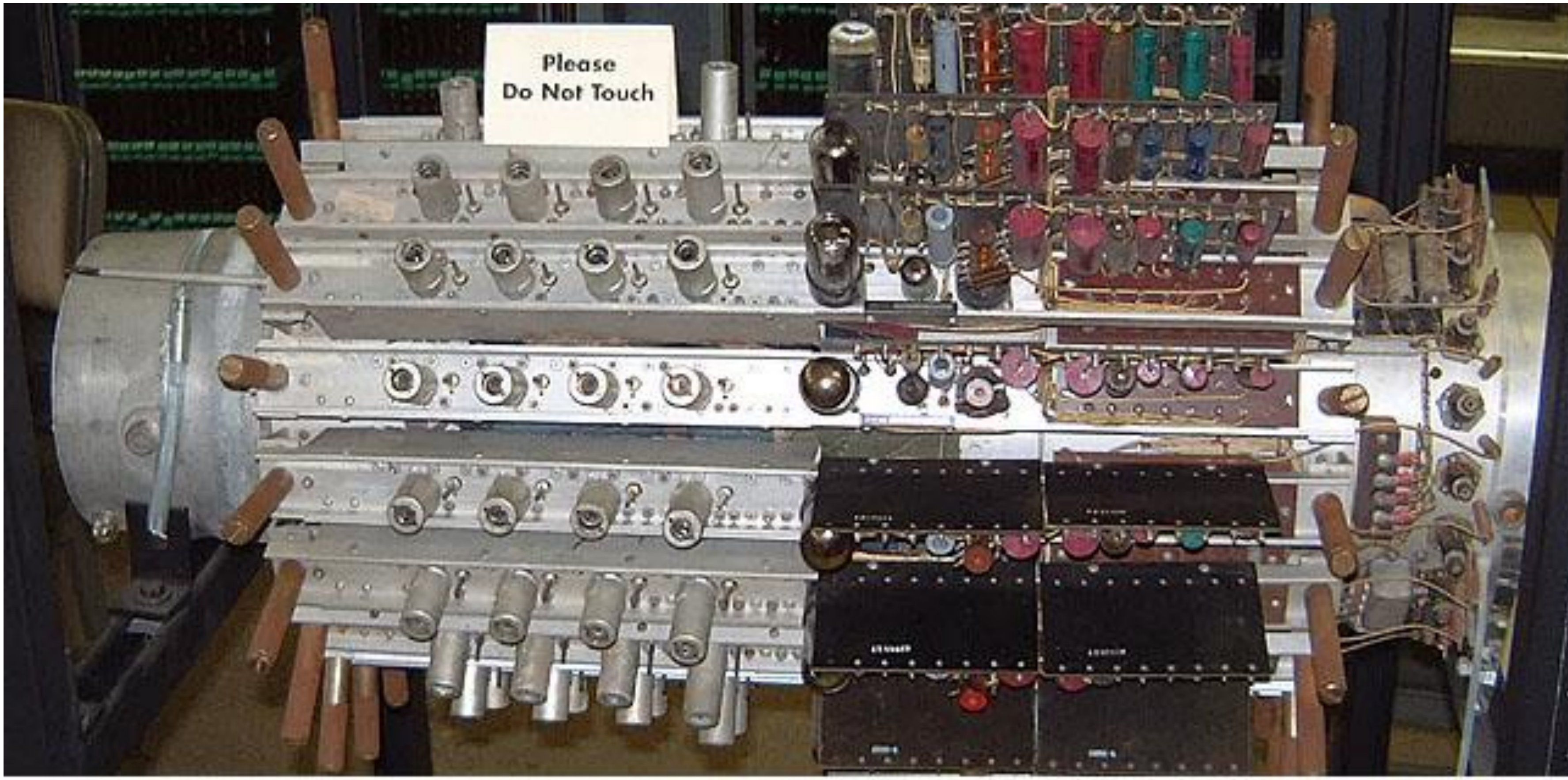


Figure 1-19. Inner Mercury Tank, Exploded View


Please
Do Not Touch

...was horrid

Used in EDSAC and UNIVAC1:

- The principal internal storage in the Univac I system is the 1000-word acoustic delay-line memory, consisting of 100 10-word mercury registers. Twelve additional 10-word registers function as intermediate storage for input and output; six more are spares.
- The total of 126 mercury channels is contained in seven mercury tanks. 1-78.
- Physically, each of the 10-word register circuits is made up of three sections:
  - The acoustic delay, consisting of a channel in a column of mercury, with receiving and transmitting crystals mounted at opposite ends.
  - An intermediate-frequency (i-f) chassis, electrically connected to the receiving crystal, and containing amplifiers, a detector, and a compensating delay. The i-f chasses are mounted on the shell of the mercury tank which they serve.
  - A recirculation chassis, containing a cathode follower, a pulse former and retimer, a modulator, which drives the transmitting crystal, and input, clear, and memory-switch gates. These chasses are mounted in the sections adjacent to the mercury tanks.

IBM 701

IBM 701

The Model 701 Defense Calculator was IBM's first production computer designed for scientific calculation. It rented for about $16,000 per month. In all, 19 units were manufactured, most of them for US national laboratories, the US Weather Bureau, aircraft manufacturers, etc. The first unit was installed in 1952 at IBM Headquarters in New York City, replacing the SSEC. The 701 came in eleven pieces:

- Two electrostatic storage units held 72 cathode-ray tubes (CRTs), sufficient to provide 2048 36-bit words.
- Three power supply and distribution units.
- The electronic analytical and control unit (CPU).
- Plus card punches, readers, and recorders, a printer, a magnetic tape unit (the world's first), and a drum.

The IBM 700 series were binary (as opposed to decimal) vacuum-tube logic computers with 36-bit words. The 704 was a 701 with core (rather than CRT) memory, floating-point arithmetic, and a bunch of new instructions. 123 of them were sold from 1955 to 1960. There was also a 705, but it had a 35-bit (not 36-bit) word. The 709 succeeded the 704, adding overlapped i/o, indirect addressing, and decimal instructions. The 7090 was a 709 with transistor, rather than vacuum-tube, logic. The 7040 and 7094 were scaled-down and -up 7090 variations. The 36-bit 700- and 7000-series were IBM's scientific computers from 1952 until the appearance of the 32-bit 360 in 1964.

The IBM 700 Series lives on in the terminology of the LISP programming language: "CAR" stands for "Contents of Address part of Register", and similarly for CDR and "Decrement".