John Vincent Atanasoff (1903-1995)

Thomas J. Bergin

Computing History Museum

American University

Physics Building, Iowa State University

Another "lazy" man....

- **Iowa State College** **1930s**
- **JVA** on Physics faculty; looking for ways to simplify his calculating burden
  - did a study of existing computing equipment in 1935 and 1936; experimented with using 30 Monroe calculators on a common shaft; knew of the Bush Differential Analyzer at MIT
- modified *leased* IBM punched card equipment, much to the consternation of IBM salesman

The problem….

- *Simultaneous linear equations:*

$$2X + 5Y = 9$$

$$X + 2Y = 4$$

Gausian elimination:

$$2X + 5Y = 9$$

$$-\ X + 2Y = 4$$

$$X + 3Y = 5 \qquad X + 3Y = 5$$

$$-\ X + 2Y = 4 \qquad X = 5 - 3Y$$

$$Y = 1 \qquad X = 2$$

29 equations and 29 unknowns

- $2 X_1 + 5 X_2 - 3 X_3 + 7 X_4 + ... 6 X_{29} = 9$
- (-) $\quad X_1 + 2 X_2 + 4 X_3 + 2 X_4 + ... 8 X_{29} = 4$
- $\quad X_1 + 3 X_2 - 7 X_3 + 9 X_4 + ...-2 X_{29} = 5$
- (-) $\quad X_1 + 2 X_2 + 4 X_3 + 2 X_4 + ... 8 X_{29} = 4$
- **eliminant:** $\quad X_2 - 11 X_3 + 11 X_4 + ...-10 X_{29} = 1$
  - **Repeat with 29 pairs of equations from which X_1 has been eliminated**
  - **Repeat to eliminate X_2, yielding 27 equations in which X_1 and X_2 have been eliminated**

How many calculations are there?

- **Number of iterations: 29!** (29 factorial):

29 x 28 x 27 x 26 x25 x 24 x 23 x 22 x 21 x 20 x 19 x 18 x 17 x 16 x 15 x 14 x 13 x 12 x 11 x 10 x 9 x 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1
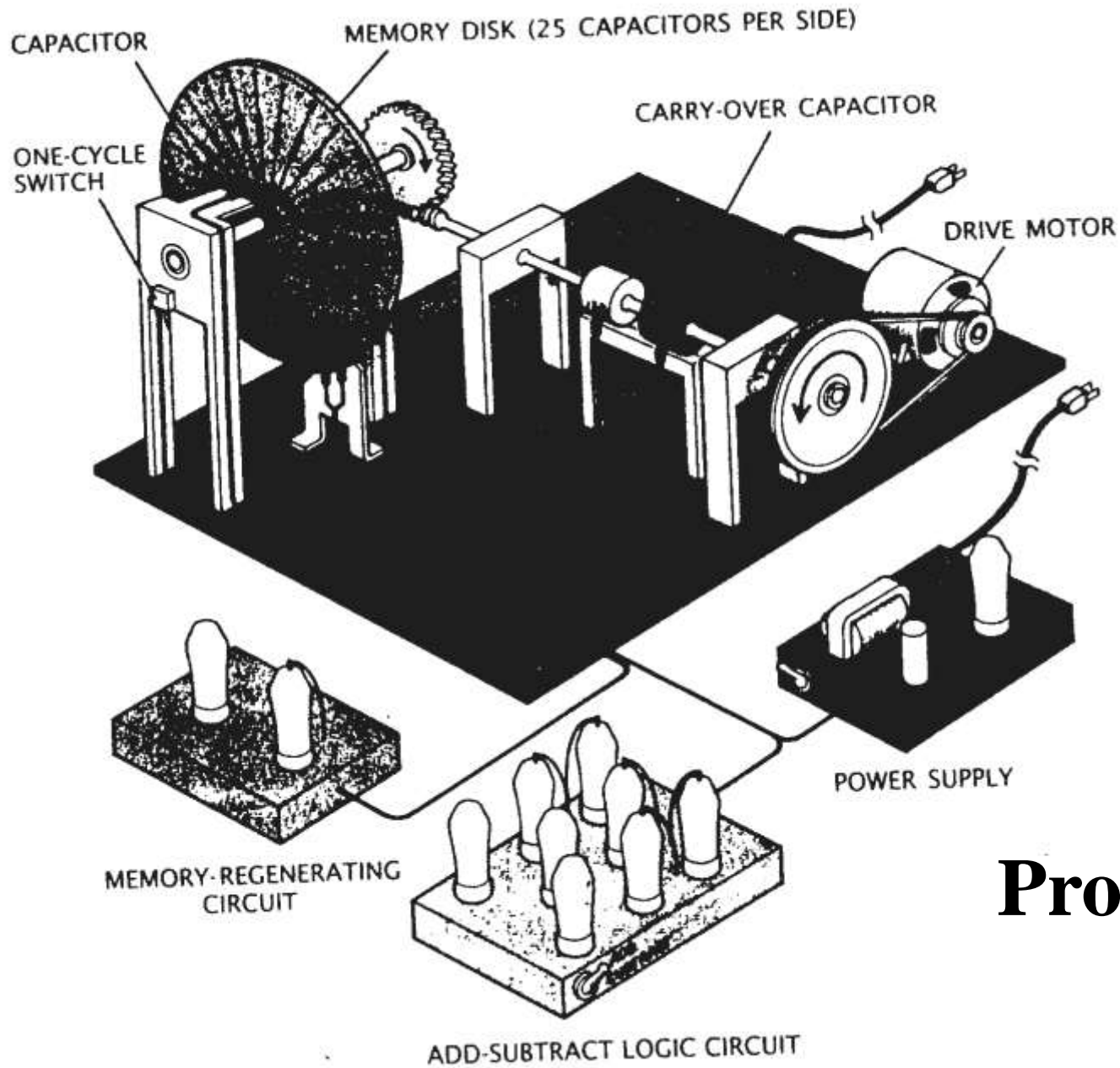
(n * n-1) / 2 or (29 * 28)/2 = 406 iterations

This is your mind on ... C_2H_5OH....
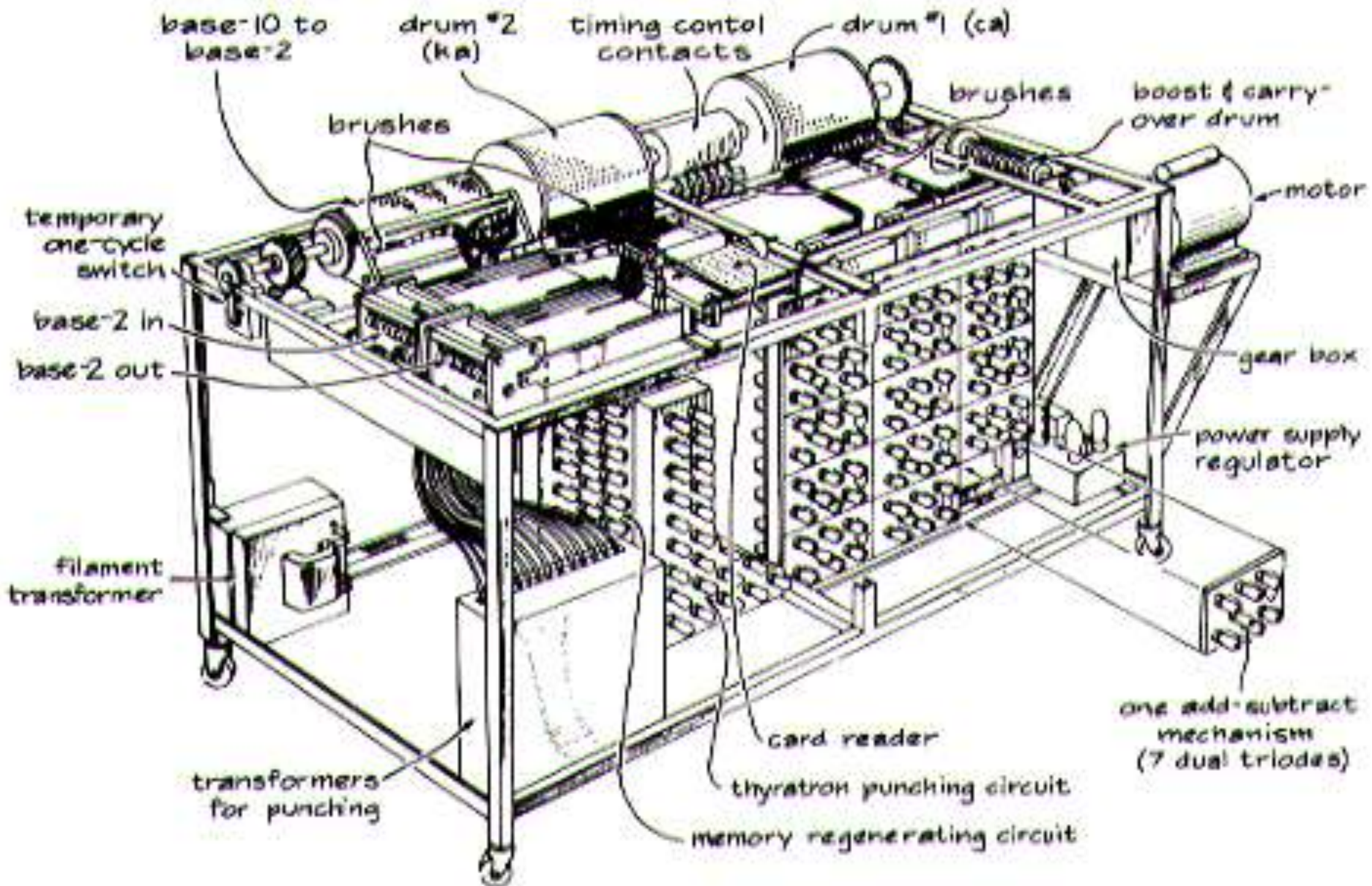## (ethyl alcohol)

- Iowa: a *dry state*! Atanasoff drove **1937** 200 miles, across the Mississippi, to Illinois
  - *Prohibition*: 18th Amendment, January 16, 1920
  - Repealed: 21st Amendment, December 5, 1933
  - Some states remained dry
- Troubled by all the calculations....
- How to store the coefficients in his equations?

Insights

- **Capacitors** for storage
- Used **binary number** system
- Direct calculation via **logic**
- **Electronic** device using **vacuum tubes**

CAPACITOR

MEMORY DISK (25 CAPACITORS PER SIDE)

CARRY-OVER CAPACITOR

ONE-CYCLE SWITCH

DRIVE MOTOR

MEMORY-REGENERATING CIRCUIT

POWER SUPPLY

ADD-SUBTRACT LOGIC CIRCUIT

Prototype

base-10 to base-2

drum #2 (ka)

timing contol contacts

drum #1 (ca)

brushes

brushes

boost & carry-over drum

temporary one-cycle switch

motor

base-2 in

base-2 out

gear box

filament transformer

power supply regulator

transformers for punching

card reader

one add-subtract mechanism (7 dual triodes)

thyratron punching circuit

memory regenerating circuit

"Abacus"

Clifford Berry and the ABC

- Graduate student acted as the "engineer"
- built **prototype, 1938-1939**
  - \$ 650 grant from Iowa State University
    - \$200 for materials; \$450 for Clifford Berry
  - Berry accorded honors: **Atanasoff-Berry Computer**
- work on **full-scale machine, 1939-1942**
  - \$5,000 grant
- work abandoned in 1942: not fully operational; Atanasoff goes to *Naval Ordnance Laboratory* in Washington, D.C.

Clifford Edward Berry (1918-1963)
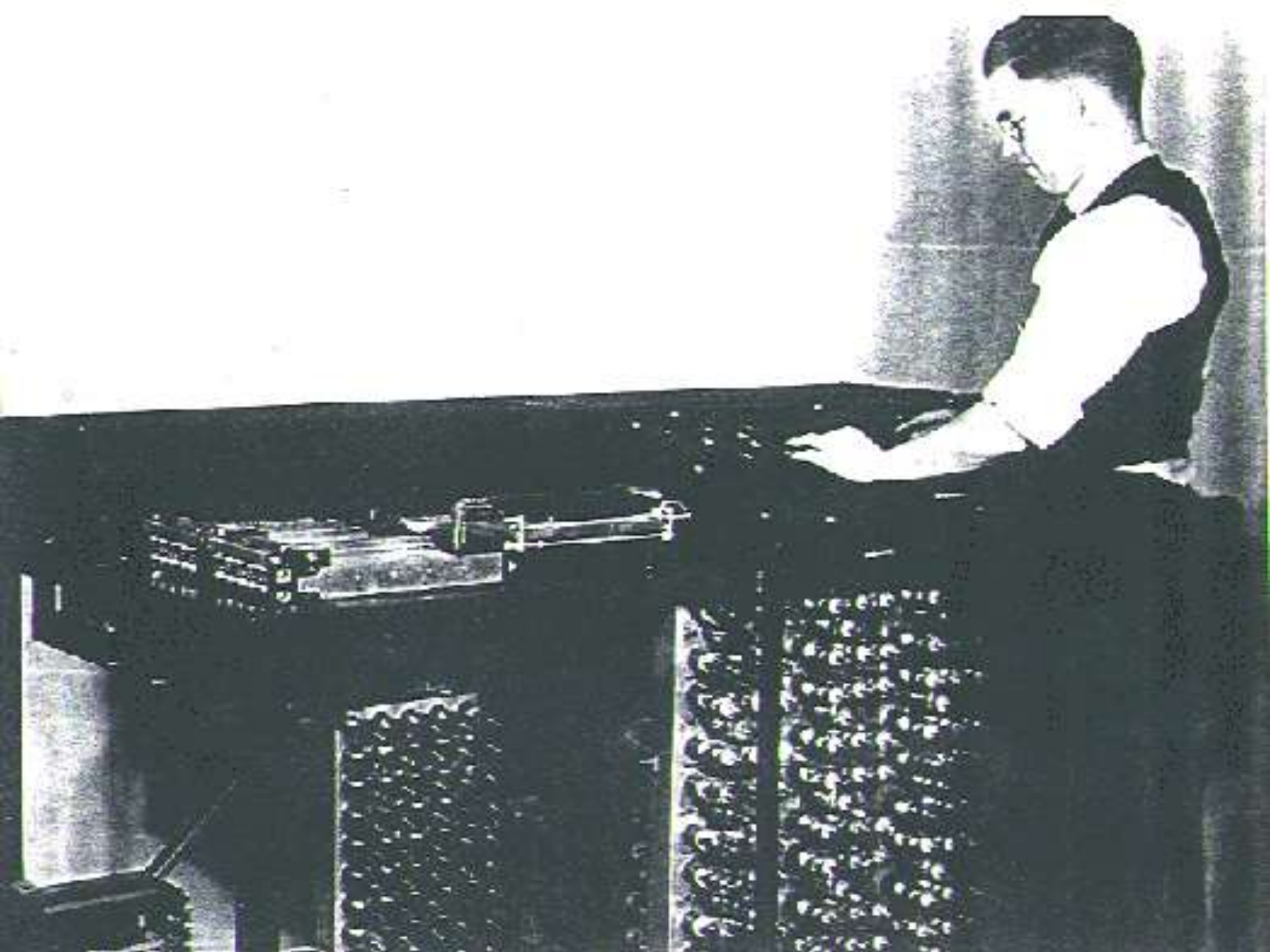
ABC

- **First machine to demonstrate electronic techniques in *digital calculation* and to use a *regenerative memory***

- **600 vacuum tubes:**
  - **300 in arithmetic unit: *addition and subtraction***
  - **300 in control and memory**

- **Capacitor memory: 30 numbers/drum (*Abacii*)**
  - **number = 50 bits (1500 capacitors/drum)**

ABC

- Used punched cards as input
  - two readers: decimal and binary
- Output was "punched cards:"
  - burned holes in cards with something like a spark plug
- Plug board
- Binary to decimal conversion units

Architecture

- 1. Separate memory and computation
- 2. Digital (rather than analog)
- 3. Electronic switches
- 4. Binary number system
- 5. Calculate by logic nor counting
- 6. Memory required "jogging"
- 7. Capacitor for memory (ICs today)
- 8. Modular units
- 9. Vector processing
- 10. Control by a clock

Controversy

- American Association for the Advancement of Science, Philadelphia, PA **Dec.26, 1940**

- John Mauchly gives a lecture on calculation for weather predictions; Atanasoff is in audience.

- Mauchly and Atanasoff talk after the lecture; Atanasoff says he is building a calculating device; correspondence ensues.

- Mauchly drives to Ames, Iowa in **June 1941** to see the *partially constructed ABC*

Controversy

- **August 1942** John Mauchly writes "The Use of High Speed Vacuum Tube Devices for Calculating" at the U. Of Pennsylvania, which is ignored!

- **1943** Mauchly and Eckert prepare a proposal for the US Army to build an Electronic Numerical Integrator

- **June 26, 1947** Eckert and Mauchly apply for patent on the ENIAC which "embodies our invention...."

Honeywell Vs Sperry Rand

- Sperry Rand had purchased many of Eckert and Mauchly's patent rights

- Honeywell did not want to pay royalties

- Sperry Rand sued Honeywell in Washington DC

- Honeywell counter-sued in Minneapolis, MN

- Suit starts in Minneapolis on **May 26, 1967**

  – Defense Evidence: R.K. Richards, *Electronic Digital Systems*, New York, Wiley (1966)

Berry Letter to R.K. Richards

Thank you for your letter of April 30, 1963. It is unfortunate that Dr. Atanasoff has not responded….

The machine was designed for a single purpose, namely to solve large sets of linear simultaneous algebraic equations (up to 30 X 30). It used binary arithmetic internally, with a word length of 50 bits.

Richards, R.K., *Electronic Digital Systems*, Wiley, New York, 1966

- *"The ancestry of all electronic digital systems appears to be traceable to a computer which will here be called the Atanasoff-Berry Computer. This computer was built during the period from about 1939-1942."*

Patent summary

- **41. Patent Grant--Intent of Patent Laws**

- *Since patent laws are founded on public policy to promote progress of science and useful arts, public is a material party to, and should be considered in, every application for a patent.*

- **0. Introduction:**

- *...The ENIAC patent was alleged to have the exclusionary power to effectively dominate the entire electronic data processing industry....*

Judge Larson found:

- **28. *Use and Sale --***

  Single public use of patented machine more than a year before patent application is filed, even without profit to inventor, establishes a public use bar.

- *1.1.4.16 The use of the ENIAC machine for the Los Alamos calculations was a non-experimental public use ... prior to the critical date disclosed in the ENIAC patent,* *and an absolute statutory bar to the valid issuance of the ENIAC patent.*

- ***34. Patentability -- Evidence of--***

- ***Utilization of ideas in device prior to time of alleged invention, whether or not device was abandoned, is evidence that, when ideas are incorporated in a later development along the same line, they do not amount to invention.***

- **3.1.1** *...the invention claimed in the ENIAC patent is broadly "the invention of the Automatic Electronic Digital Computer."*

- **3.1.2** *Eckert and Mauchly did not themselves first invent the automatic digital computer, but instead derived that subject matter from one Dr. John Vincent Atanasoff.....*

- **3.1.4** *Between 1937 and 1942, Atanasoff, then a professor of physics and mathematics at Iowa State College, Ames, Iowa, developed and built an* **automatic electronic digital computer for solving large systems of simultaneous equations.**

- **3.1.5** *In December, 1939, Atanasoff completed and* **reduced to practice** *his basic conceptions in the form of an operating breadboard model of a computing machine.*

Trial Summary

- **Started: May 26, 1967**
- **Trial**: 135 days
  - 77 witnesses
  - 80 witnesses via depositions
  - 25,686 exhibits by Honeywell
  - 6,968 exhibits by Sperry Rand
- **Transcript:** 20,667 pages
- **Ruling: October 19, 1973**

And then there's news holes!

- Larson's Judgement rendered: **October 19, 1973**
- "Saturday Night Massacre" **October 20, 1973**
  - (President Nixon fires Archibald Cox as Chief Watergate Prosecutor)
- Sperry Rand decides not to appeal the decision.
- Forgotten until 1987-1988, when Mollenhoff, Burks, and Mackintosh publish their interpretations of the facts: *history is made and a new controversy begins*.
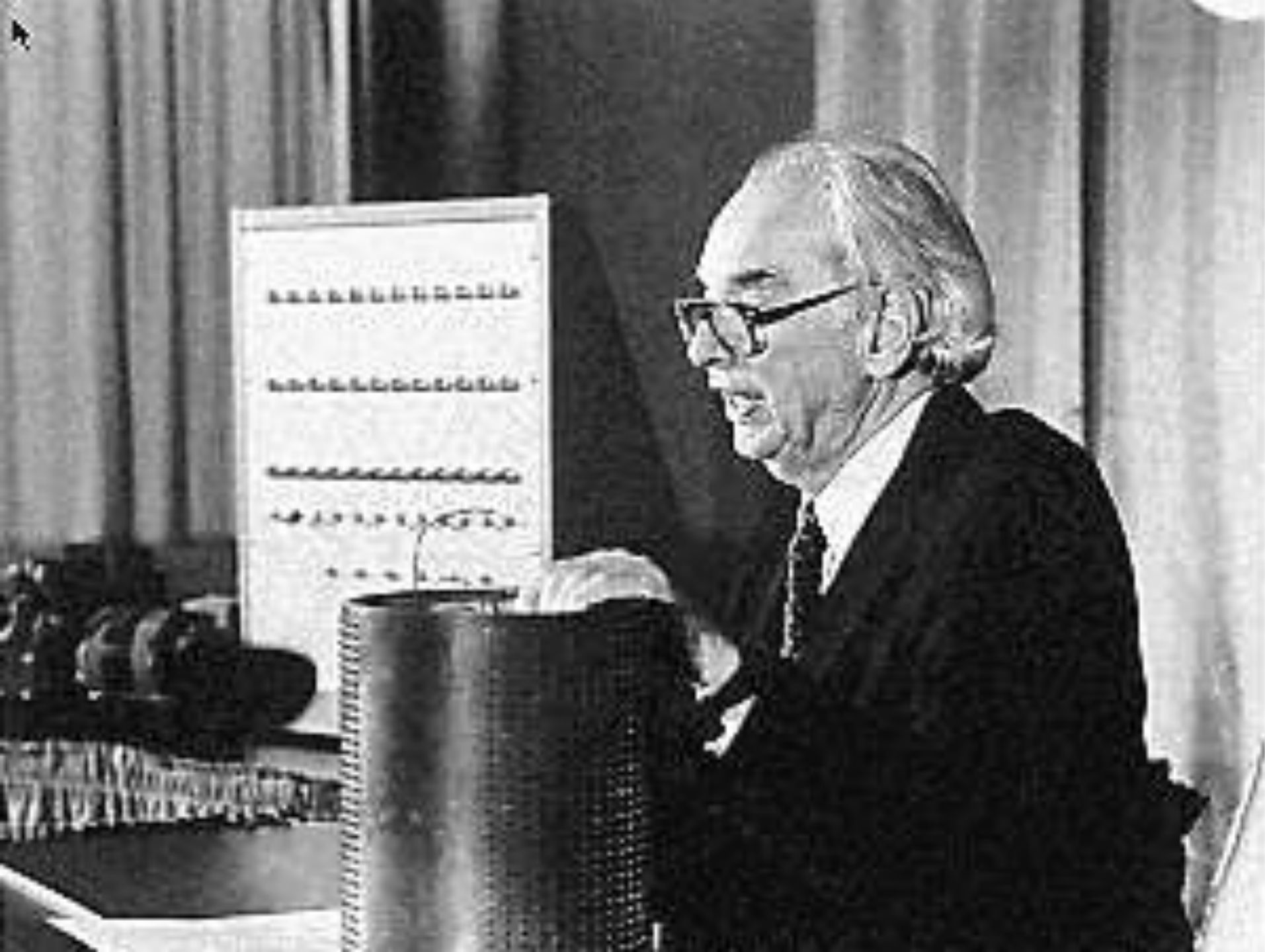
Re-creation, 1995-1996

- **John Gustafson**, Iowa State University
- "easier to build in 1995 than 1939...."
- 6-foot steel frame; 32-inches wide, 34-inches high
- control panel of toggle switches
- resin cylinder with copper pegs for binary conversion unit
- 300 vacuum tubes

Reconstruction (1997-99)

References

- J.V. Atanasoff, "Computing Machine for the Solution of large Systems of Linear Algebraic Equations," (August 1940) in Randell (Ed.), *The Origins of Digital Computers, Selected Papers*, Springer-Verlag, Berlin, 1973

- J.V. Atanasoff, "Advent of Electronic Digital Computing," *Annals*, Vol..6, No.3 (July 1984)

References

- Saul Rosen, "The Origins of Modern Computing, *ACM Computing Reviews*, Sept. 1960

- Joel Shurkin, *Engines of the Mind, The Evolution of the Computer from Mainframes to Microprocessors*, W.W. Norton, 1984

- Allan R. Mackintosh, Dr. Atanasoff's Computer," *Scientific American*, August 1988

- Allan R. Mackintosh, "The First Electronic Computer," *Physics Today*, March 1987

Biography

- Clark R. Mollenhoff, *ATANASOFF, Forgotten Father of the Computer*, Iowa State University Press, 1988.

- Alice R. And Arthur W. Burks, *The First Electronic Computer: The Atanasoff Story*, U. of Michigan Press, 1988

Show and Tell

- R.K. Richards, *Electronic Digital Systems*, New York, Wiley (1966)

- *ACM Computing Reviews*, September 1990