Analog Devices and Computers

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Analog

- **Analogue** , *n* **[**Gk) *analogos]* , a thing or part that is analogous; that which corresponds with something else in construction, function, qualities, etc.
- **Analogy** *n*. [Gk) analogia , proportion, equality of ratios] 1. a similarity or likeness between things in some circumstances or effects, when the things are otherwise entirely different; 2. In mathematics, an equation between ratios; as, *Napier's* ratios; 3. An explaining of something by comparing it point by point with something else.

Webster's New Twentieth Century Dictionary Unabridged, 2nd Edition

Analog Devices, for example...

- **slide rule**: an instrument consisting of a ruler with a central sliding piece, both being marked with logarithmic scales; used in making rapid mathematical calculations. (Webster's, op. cit.)
- **clock**, *n*., [ME *clock*], an instrument for the measurement of time by the motion of its parts, indicating hours, minutes, and often seconds, by hands which move upon a dial plate. It usually consists of a frame containing a train of toothed wheels operated by springs and weights and regulated by a pendulum or balance wheel. (ibid.)

400 B.C. to ....A.D.?

- Astrolabe: instrument to perform over 1,000 different astronomical observations and calculations

  Ptolemy: Hipparchus of Bithynia, ca.180-125B.C.

  – Position of the sun and principal stars for any hour of a given day of the year

  – find the latitude of the observer (day or night)

  – calculate the number of hours of daylight

  – calculate the number of hours of twilight at both sunset and sunrise

  – find the time (day and night)

Antikythera device:

- Incorporated sophisticated gears, including differential gears
- found in the Aegean Sea by sponge divers in 1900
- vessel was on its way from Rhodes to Rome
- 30 different gears

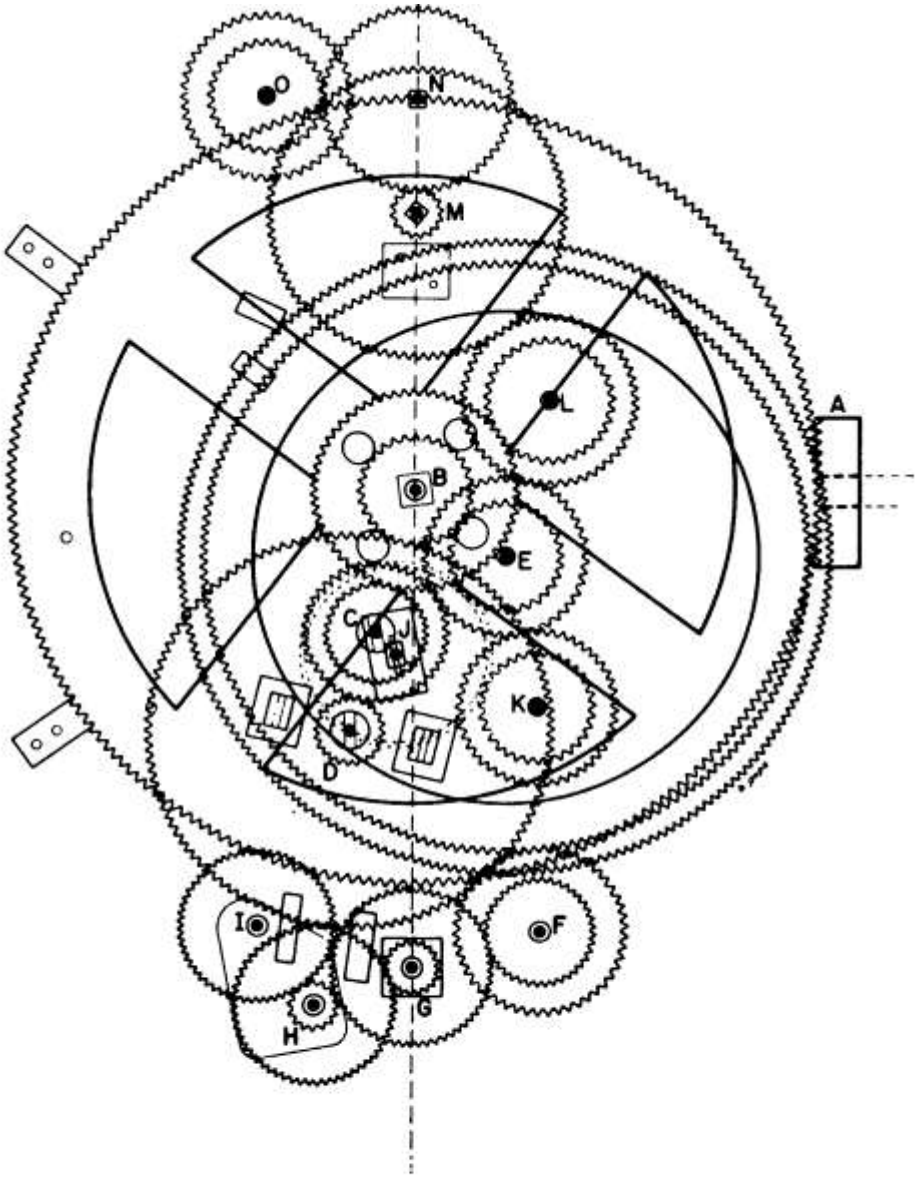
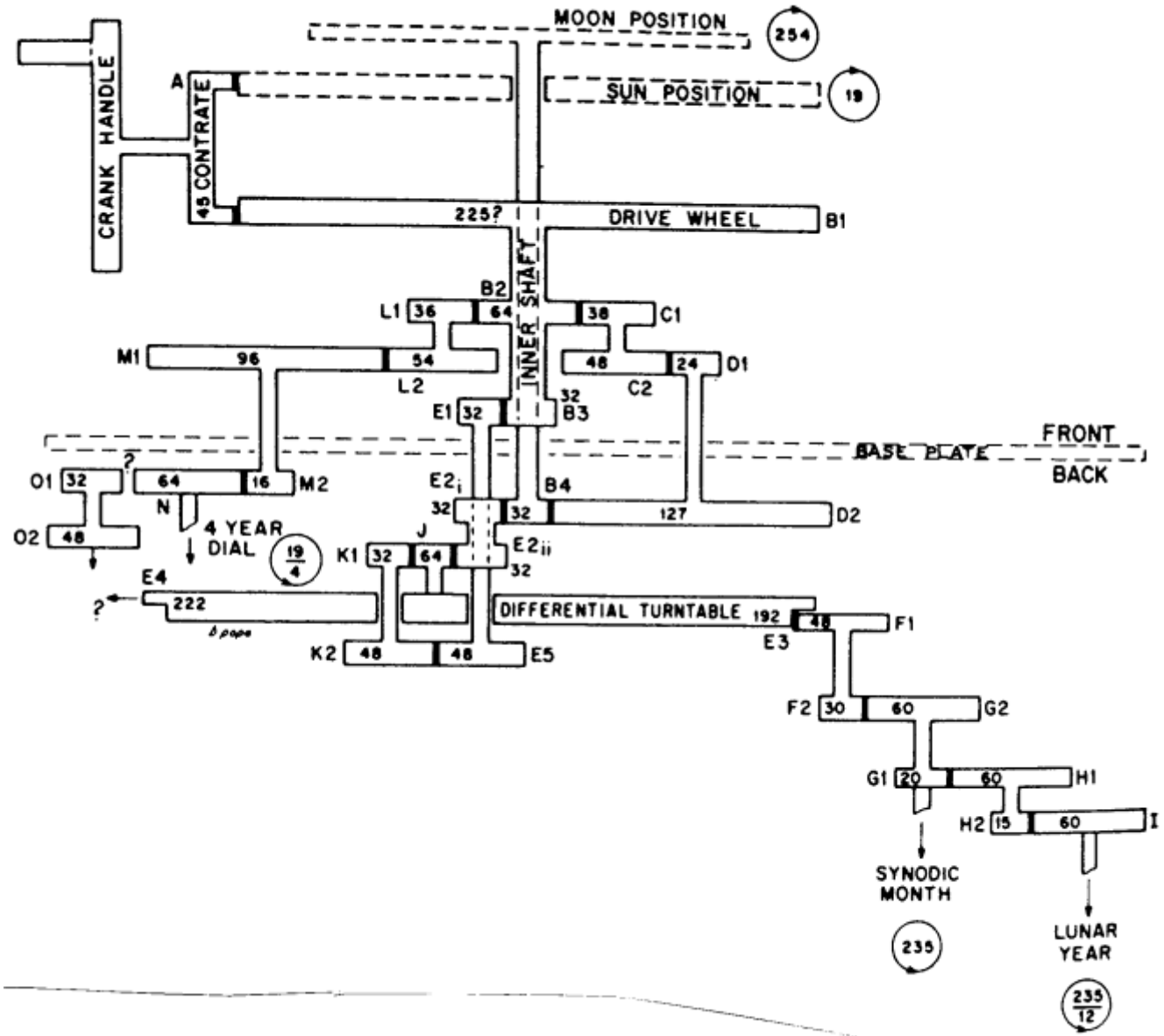


Figure 5–5. The Antikythera Device—two diagrams showing the internal gearing arrangements. (Photographs courtesy of the American Philosophical Society, originally appeared in "Gears From the Greeks," *Transactions, 64*, part 7.)


MOON POSITION
254
SUN POSITION
19
CRANK HANDLE
A
45 CONTRATE
225?
DRIVE WHEEL
B1
INNER SHAFT
B2
L1 36 64
38 C1
M1 96 54
L2
48 24 D1
C2
E1 32
32 B3
FRONT
BASE PLATE
BACK
O1 32
64 16 M2
N
4 YEAR DIAL
19/4
O2 48
E2i
32
B4
32 127 D2
J
K1 32 64
E2ii
32
E4
222
DIFFERENTIAL TURNTABLE 192
48 F1
E3
K2 48 48 E5
F2 30 60 G2
G1 20 60 H1
H2 15 60 I
SYNODIC MONTH
235
LUNAR YEAR
235/12

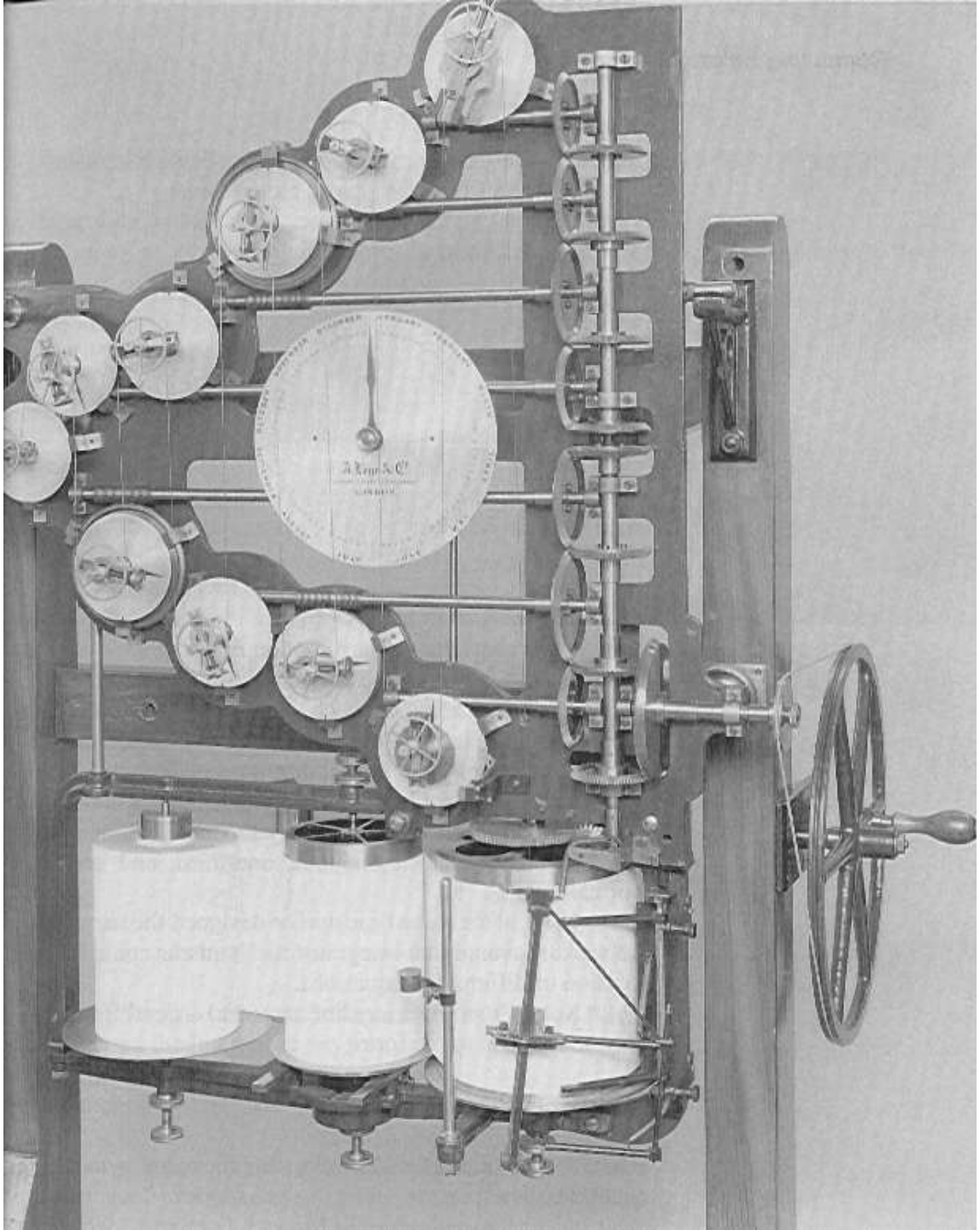
Tide Predictors

- Lord Kelvin (William Thompson, 1824-1907)

  $Y = A\cos(u) + B\cos(v) + C\cos(w) + \ldots$

  up to 12 cosine terms

- U.S. Coastal and Geodetic Survey device was capable of using up to 37 terms; project started in 1905 and completed in 1911.
  - *7 feet high, 11 feet long, 2,500 pound*
  - *calculate the tides to the nearest 0.1 foot for each minute of the year*



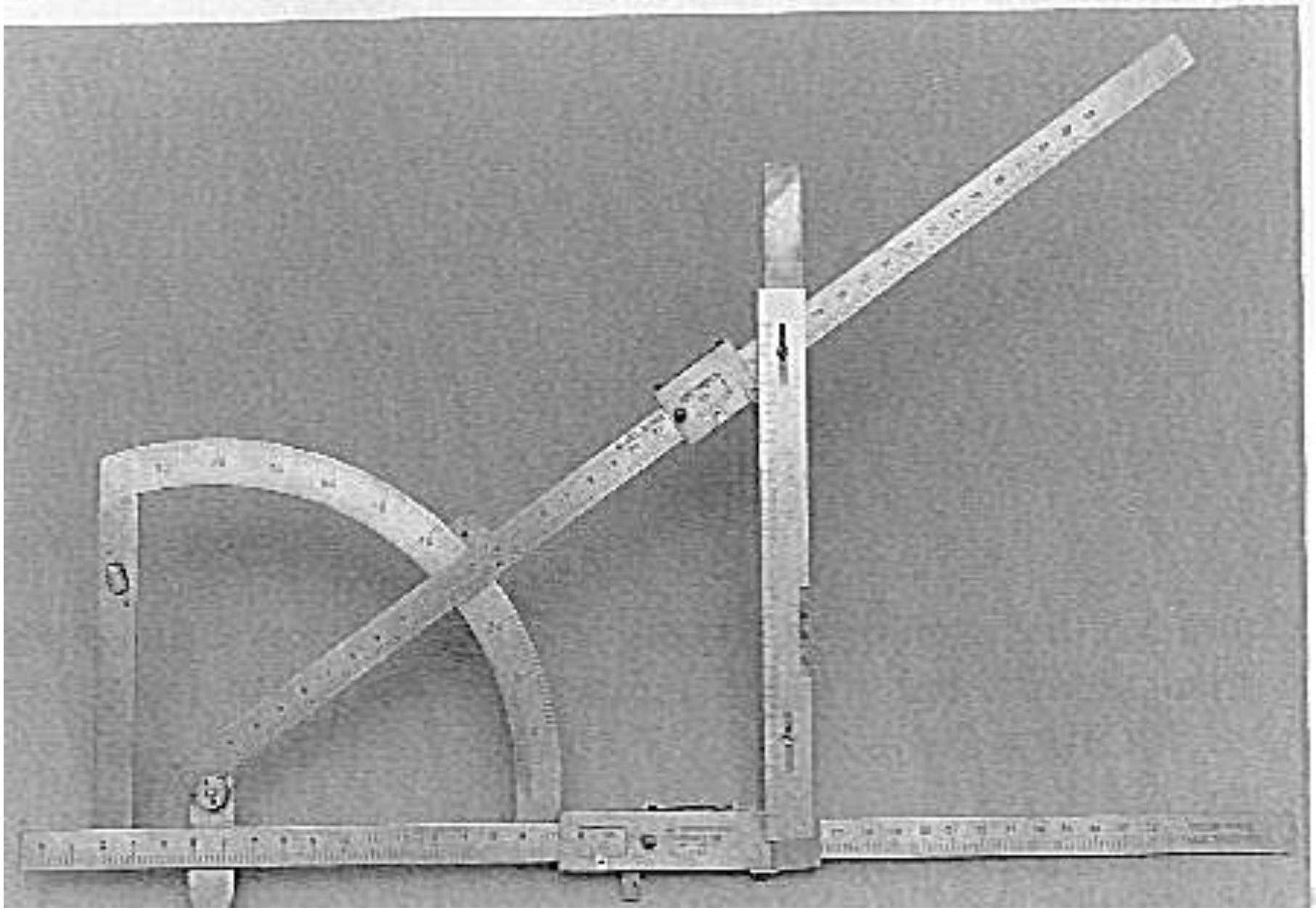
Add Approx. 42 Minutes

These are Ocean City Inlet Tides - Add 2 Hours for Sinepuxe
First time listed each day is early high or early low
Daylight Savings Time April thru October

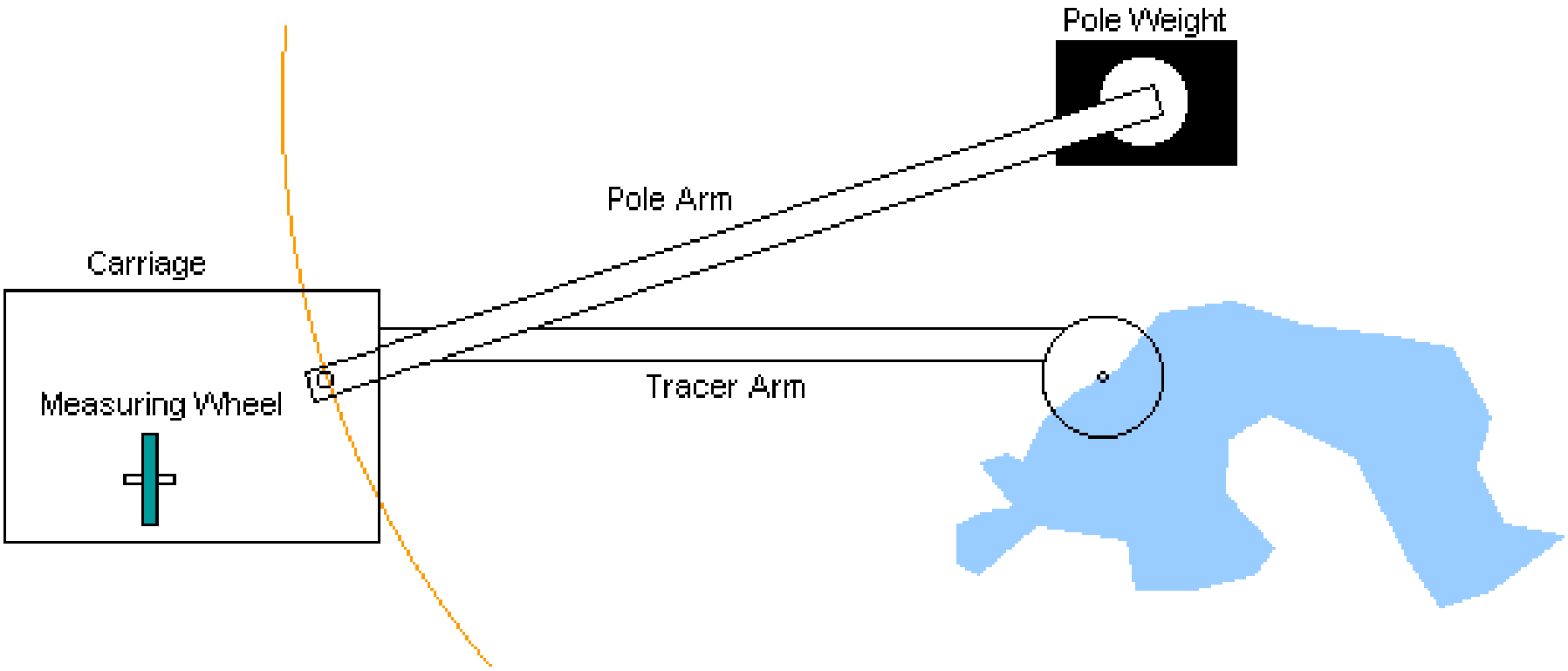
	APRIL		MAY		JUNE		JULY		AUGUST	
	High	Low	High	Low	High	Low	High	Low	High	Low
1	3:31	10:10	4:12	10:34	5:48	11:49	6:28	12:31	7:54	1:56
	4:13	10:31	4:48	11:09	6:14	.....	6:49	12:22	8:05	1:56
2	4:41	11:05	5:13	11:24	6:43	12:43	7:21	1:23	8:37	2:40
	5:16	11:29	5:45	.....	7:04	12:41	7:39	1:18	8:46	2:42
3	5:47	11:56	6:09	12:06	7:34	1:38	8:09	2:15	9:18	3:19
	6:09	.....	6:35	12:14	7:52	1:34	8:23	2:11	9:24	3:23
4	6:35	12:25	7:02	12:59	8:22	2:30	8:56	3:07	9:58	3:56
	6:59	12:46	7:24	1:05	8:39	2:25	9:07	3:00	10:03	4:04
5	7:23	1:18	7:50	1:53	9:13	3:20	9:44	3:45	10:36	4:30
	7:45	1:34	8:10	1:56	9:27	3:16	9:53	3:45	10:41	4:41
6	8:10	2:11	8:09	2:45	10:04	4:07	10:30	4:25	11:18	5:04
	8:31	2:22	8:57	2:45	10:16	4:04	10:35	4:30	11:18	5:20
7	8:58	3:01	9:29	3:34	10:56	4:51	11:15	5:07	11:57	5:34

Solving Differential Equations

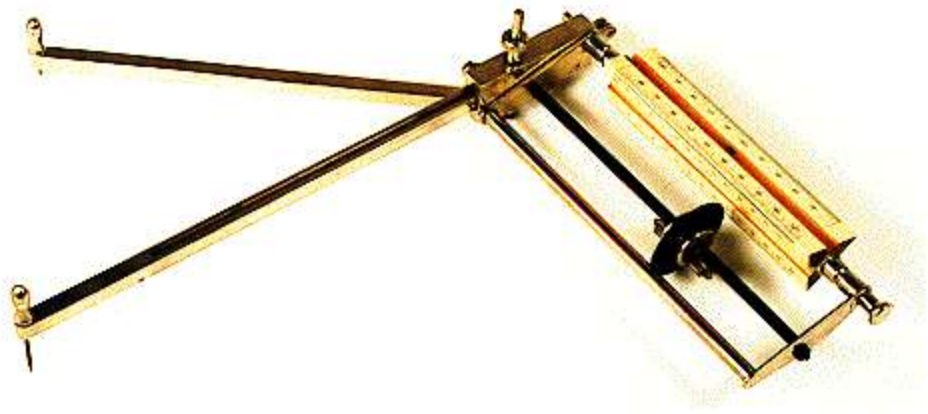
- Problem: to calculate the area under a given curve, i.e., the integral of the function $f(x)dx$.
- Professor James Thompson, using a rotating disk, a sphere and a cylinder, devised an arrangement which would perform elementary integration through *mechanical integration*.
- Planimiters
- Weapons control devices such as the Norden Bomb Site and other aiming devices for weapons



Courtesy: HP Calculator Museum



Willis Polar Planimeter (1901)



Lasico Standard Planimeter

Skokkia Planix 7 ($895)

Differential Analyzer

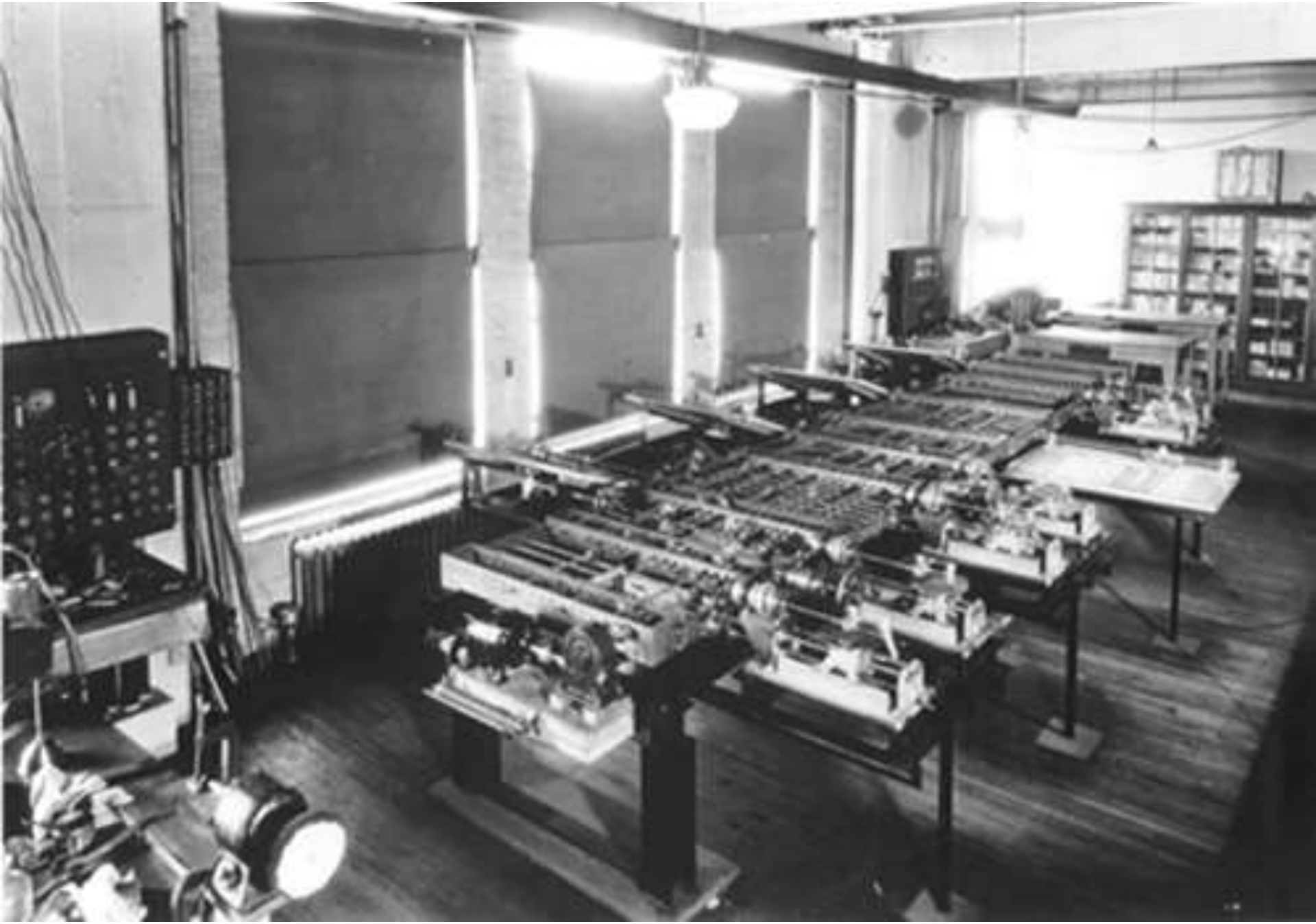
- Vannevar Bush at MIT 1930
  - **F(x) = *f(x)g(x)dx*.**

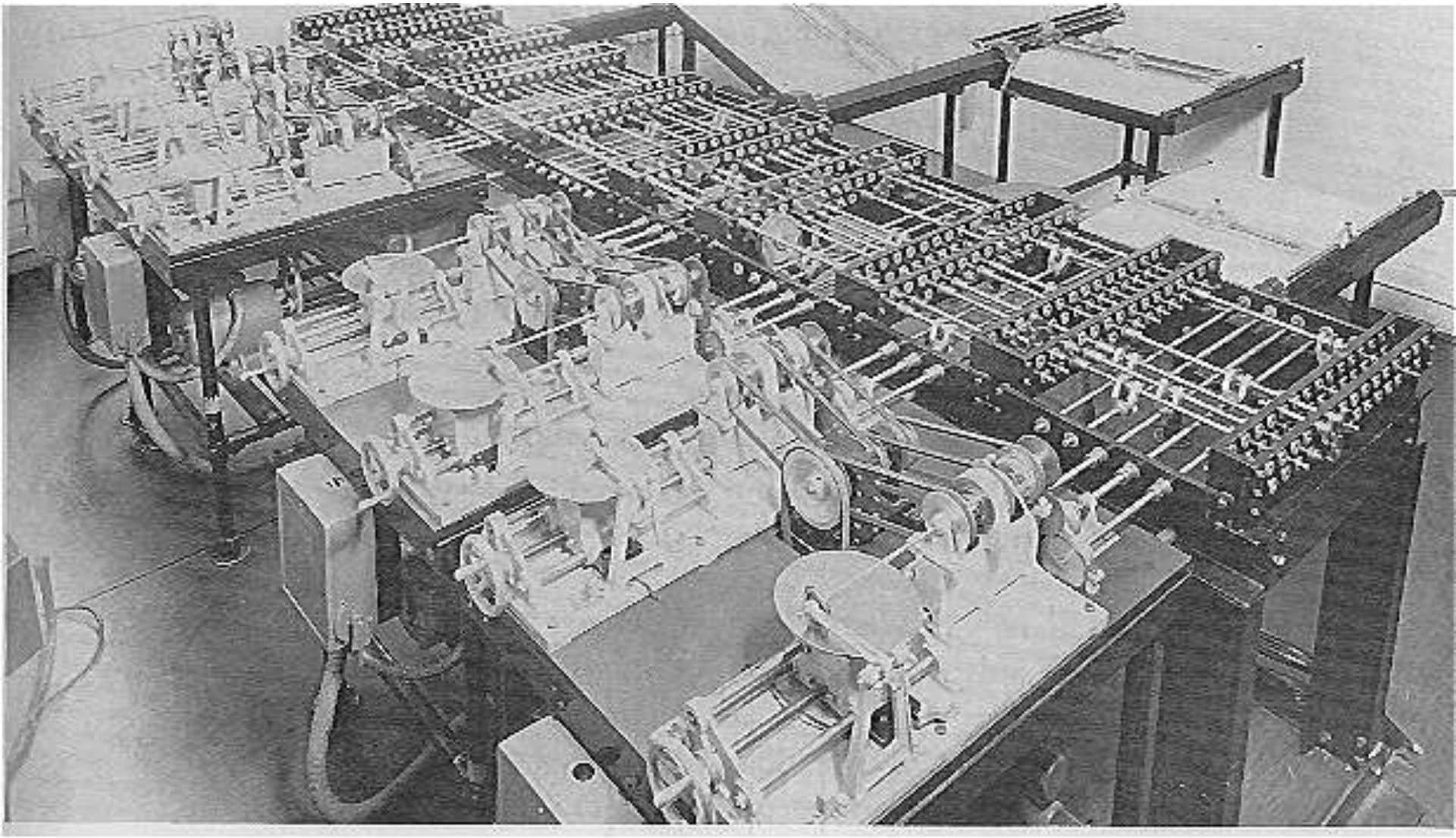
  Used mechanical integrators, gears for constant multiplication, and differential gears for addition and subtraction; long rotating shafts to move values to another part of the analyzer
- Moore School, U.of Pennsylvania 1934
- Army Ballistics Research Laboratory 1935

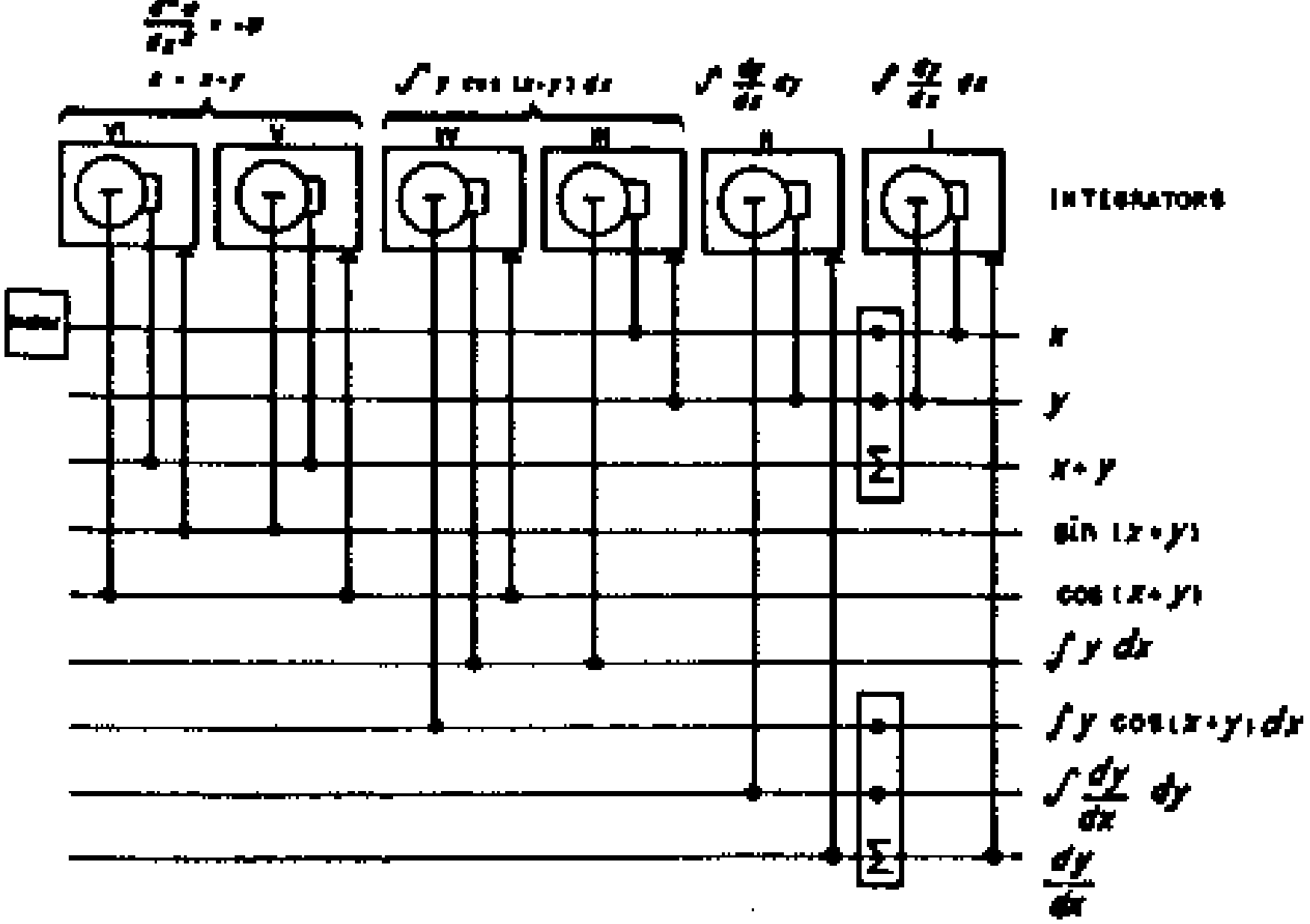
  Aberdeen Proving Ground, MD

  calculate ballistics trajectories and firing tables
  - *electrical integrators, other improvements*

Vannevar Bush (1890-1974)






INTEGRATORS
x
y
x + y
sin (x + y)
cos (x + y)
∫ y dx
∫ y cos (x + y) dx
∫ dy/dx dy
dy/dx

Vannevar Bush

- National Defense Research Committee
- Office of Scientific Research and Development
- "As We May Think," *Atlantic Monthly*, July 1945

described the "Memex" a desk which provided instant access to micro-photographed books, periodicals and documents (*a precursor to www*).

President, Carnegie Institution (1939-1955)

Electr(ical/onic) Analog Computers

- Flight Simulators, including *Whirlwind* at MIT
- Weapons analysis and operation
- Electrical engineering problems
- Telephone engineering problems

- See analog textbooks

References

- "Analog Computing Devices," by Allan G. Bromley in William Aspray, ed. *Computing Before Computers*, Iowa State U. Press, 1990
- "The Analog Animals," in Michael R. Williams, *History of Computing Technology*, IEEE Press, 1997
- J. Crank, *The Differential Analyzer*, Longmans, Green, 1947
- D.R. Hartree, *Calculating Instruments and Machines*, U. Of Illinois Press, 1953

Show and Tell

- Astrolabe
- Time Gadget
- Aircraft thing
- Other dial gadgets
- Palimpsest
- Analog books.....