Electronics & Computing Technology

of the mid 1950's – late 1960's

The Apollo Vintage

EARLY TRANSISTOR TIMELINE

1925 Lilienfield - FET - Canadian Patent

(Shockley/Pearson built a working FET copy in the 50's)

1947 Shockley team at BELL

Experimental PNP Ge Point Contact Transistor

1948 (June) Shockley, BELL - US patent

PNP Ge Point Contact Transistor

1948 (Aug) Matare', Westinghouse - French patent

PNP Ge Point Contact Transistor

1951 Westinghouse - 1st Limited Production

PNP Ge Point Contact Transistor

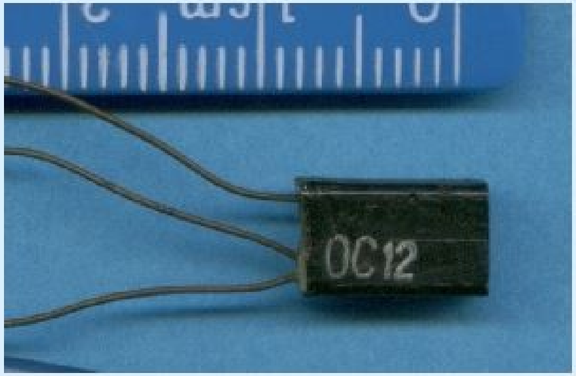
1953 Raytheon - 1st Low Cost Retail Production

PNP Ge Junction Transistor

1954 – TI - First Commercial Silicon Transistors

1958/59 – First Logic IC - (TI Ge/Fairchild planar Si)

1954 – OC71/72 10kHz!



The first (grown?) junction types made by Mullard were the OC10, OC11, and OC12 (shown in the image) from 1953. These were all low-power audio-frequency amplifiers, the first two differing in noise level, the OC12 having a higher gain. Unfortunately, it was soon found that the plastic encapsulation was not hermetic, and moisture crept along the leads and ruined the transistors.

I am seeking examples of the OC10, OC11 and OC12. I also wish to buy original data sheets for these devices. If you have any of these, please [contact me.]

Mullard then developed a unique glass encapsulation, and in 1954 issued three new alloy-junction audio-frequency transistors, the OC70, OC71 and OC72. The image shows the OC71 glass case, painted black, with below it the OC72, a higher power type, achieved by slipping an aluminium can over the glass tube. The OC70 was a low-noise version of the OC71.

This black glass encapsulation, and the version with the aluminium sleeve, both referred to as SO-2, were used by most of the transistor types in the OC series, although a few types used the TO-7 metal can, and power types used TO-3. A correspondent told me that in the early days of the industry, an apprentice at his company was sacked because he had amused himself by crunching the glass capsules under his boot. At the time each transistor cost a week's wages!

MULLARD 1954-60 RANGE

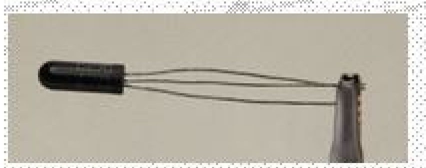
OC44

Type	: OC44, PNP Germanium Transistor (Mixer Oscillator)
Manufacturer	: Philips
Year	: +/-1960
Package, Case style	: TO-1
Spec's	: Vceo=-10V, Vcbo=-15V, Hfe=>100, Ic=-1mA, Icbo=-14uA, Cobo=40pFmax, P=40mW, ft=15MHz(max)
Photo's	: Picture1, Picture2

OC45

Type	: OC45, PNP Germanium Transistor
Manufacturer	: Mullard
Year	: Early sixties
Package, Case style	: Carton box, SO-2 Glass witj plastic tube, in this case orange.
Spec's	: Vceo=-15V, Vbeo=-15V, Hfe=50, Ic=-10mA, Icbo=10uA(max), P=83mW, ft=6MHz, Cobo=10pF
Photo's	: Picture1, Picture2, Picture3, Picture4

OC70



Type	: OC70, PNP Germanium Transistor (Audio Amplifiers)
Manufacturer	: Philips
Year	: +/-1960
Package, Case style	: TO-1
Spec's	: Vceo=-10V, Vcbo=-30V, Hfe=20-40, Ic=-0,3mA, Icbo=-13uA, Cobo=40pFmax, P=125mW, ft=1MHz(max)
Photo's	: Picture1, Picture2

OC72

Type	: OC72, PNP Germanium Transistor (Datasheet)
Manufacturer	: Mullard
Year	: Early sixties
Package, Case style	: Carton box, SO-2 metal can
Spec's	: Vceo=-16V, Vcbo=-32V, Hfe=70, Ic=-125mA, Icbo=10uA, P=165mW, ft=350kHz
Photo's	: Picture1, Picture2, Picture3, Picture4

1953 FIRST LOW COST PRODUCTION

CK722 Ge PNP Junction Transistor $7.60

RAYTHEON

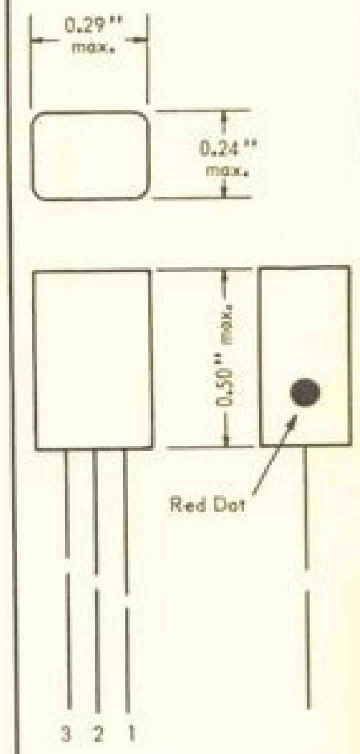
TECHNICAL INFORMATION

Excellence in Electronics

GERMANIUM TRANSISTOR

TYPE CK722

The CK722 is a PNP junction transistor intended primarily for use in audio or low radio frequency applications. The tinned flexible leads may be soldered or welded directly to the terminals of circuit components without the use of sockets. Standard inline subminiature sockets may be used by cutting the leads to a suitable length.



MECHANICAL DATA

CASE: Plastic and Glass

BASE: None (0.016" tinned flexible leads. Length: 1.5" min. Spacing: 0.08" center-to-center)

TERMINAL CONNECTIONS: *(Red Dot is adjacent to Lead 1)*

Lead 1 Collector
Lead 2 Base
Lead 3 Emitter

MOUNTING POSITION: Any

ELECTRICAL DATA

RATINGS - ABSOLUTE MAXIMUM VALUES:

Collector Voltage ($\bar{V}c$)	-22 volts
Peak Collector Voltage (Vc)♦ ⊕	-44 volts
Collector Current	-10 ma.
Collector Dissipation *	
Emitter Current	10 ma.
Ambient Temperature ■	70 °C

AVERAGE CHARACTERISTICS: (at 27°C)

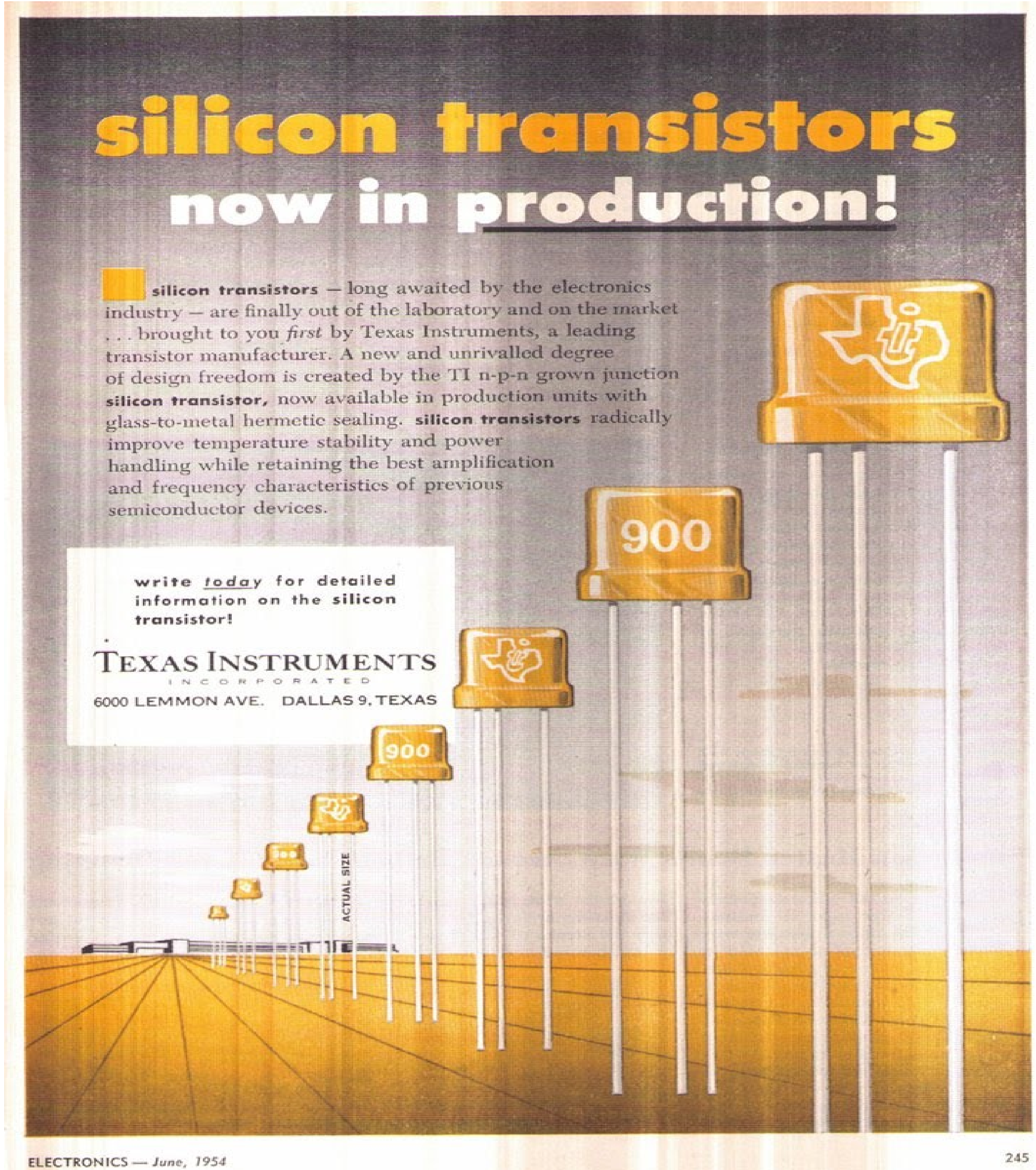
Collector Voltage	-6 volts
Emitter Current	1.0 ma.
Collector Resistance	2.0 meg.
Base Resistance	350 ohms
Emitter Resistance	25 ohms
Base Current Amplification Factor	22
Cut-off Current (approx.)	6 ua.
Noise Factor (max.)●	25 db.

AVERAGE CHARACTERISTICS - COMMON EMITTER: (at 27°C)

Collector Voltage	-1.5	-6 volts
Emitter Current	0.5	1.0 ma.
Input Resistance	1400	800 ohms
Load Resistance	20000	20000 ohms
Power Gain (Matched Input)	37	39 db.

AVERAGE CHARACTERISTICS - COMMON COLLECTOR: (at 27°C)

TI 1960 Si TRANSISTORS



TI 1960 Si PRODUCT RANGE

TI YOUR ONE-STOP SOURCE . . . FOR COMPUTER COMPONENTS!

From economy devices to industry's fastest switchers . . . all of the high-performance computer components you need are immediately available from Texas Instruments! Only TI offers you such a wide line of specifically designed computer components *plus* the ability to supply high-performance devices in mass production quantities . . . *when you need them.*

TEXAS INSTRUMENTS DEVICES SPECIFICALLY DESIGNED FOR COMPUTER APPLICATIONS

	PERIPHERAL EQUIPMENT	LOGIC	MEMORY	POWER SUPPLY
GERMANIUM TRANSISTORS	2N1038 Series, 2N1046 Series — Driver 2N1302 Series — Logic and Medium Power Driver 2N250 Series, 2N511 Series — Electromechanical Driver	2N797 — Very High Speed 2N705, 2N710, 2N711, 2N1385 — High Speed N100, N101 — Medium Speed 2N1302 Series	2N1046 Series — Driver	2N1038 Series, 2N1042 Series — Medium 2N250 Series, 2N456 Series, 2N1038 Series — High 2N1046 Series — Power
SILICON TRANSISTORS	2N332 Series, 2N497 Series, 2N734 Series, 2N738 Series, 2N1564 Series, 2N1572 Series, 2N1586 Series — Logic and Medium Power Driver 2N389 Series, 2N1714 Series, 2N1717 Series, 2N1722 Series — Electromechanical Driver	TI 450, TI 451 — High-Speed Transistors 2N706A Series, 2N753 Series, 2N1252 Series — High Speed 2N726 — PNP High Speed 2N696 Series, 2N702 Series — Medium Speed J-460 Series, 2N337 Series — Low Speed	2N696 Series, 2N1252 Series, 2N1508 Series — Driver	2N337 Series —A 2N342B Series—D 2N389 Series —P 2N497 Series —D 2N726 —A 2N734 Series —A 2N738 Series —A 2N1047 Series—P 2N1564 Series—A 2N1572 Series—A 2N1714 Series—P 2N1718 Series—P 2N1722 —P A—Amplifier P—Power D—Driver or Medium Power
SOLID CIRCUIT* **Semiconductor Networks**		Type 502 bistable multivibrator and custom designs for logic circuits	Type 502 Set-reset Flip-Flop	
SILICON DIODES	1N2175 (Photo)	C 01 — Low Cost 1N650, 1N651, 1N652, 1N653 — Gallium Arsenide Tunnel Diodes 1N914 Series — High Speed	C 01 — Low Cost 1N650, 1N651, 1N652, 1N653 — Gallium Arsenide Tunnel Diodes 1N914 Series — High Speed	1N746 Series, 1N1816 Series — Reference Power Regulators
SILICON RECTIFIERS	TI-010, TI-025, TI-050 — Controlled Rectifiers			1N253 Series, 1N538 Series, 1N1124 Series, 1N1614 Series — General Purpose Rectifiers 2N1595 to 2N1604 — Controlled Rectifiers
CAPACITORS	*tan***TI***cap** Solid tantalum electrolytic capacitors—type SCM—203 standard ratings — 6v to 35v — 1 μf to 330 μf			
RESISTORS	CG ⅛ Hard Glass Hermetic—Precision Film—Standard Resistance Values from 24.9 ohms to 18.5 K CG ¼ Hard Glass Hermetic—Precision Film—Standard Resistance Values from 24.9 ohms to 82.5 K			
	⅛ watt to 2 watt—MIL-Line—Precision Film—Standard Resistance Values from 10 ohms to 50 meg Ω			
	⅛ watt to 2 watt—Molded—Precision Film—Standard Resistance Values from 10 ohms to 45 meg Ω			

*Trademark of Texas Instruments Incorporated

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TI APPLICATION NOTES AND BROCHURE

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TI FIRST IC SN514 DUAL 3-INPUT NOR

THE VINTAGE TECHNOLOGY ASSOCIATION

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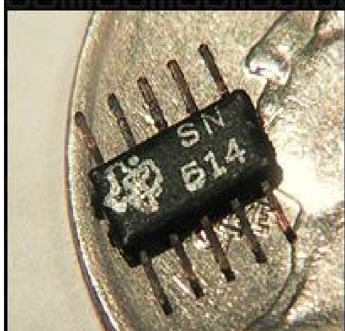
Texas Instruments SN514

Written by AnubisTTP on 2008-11-16

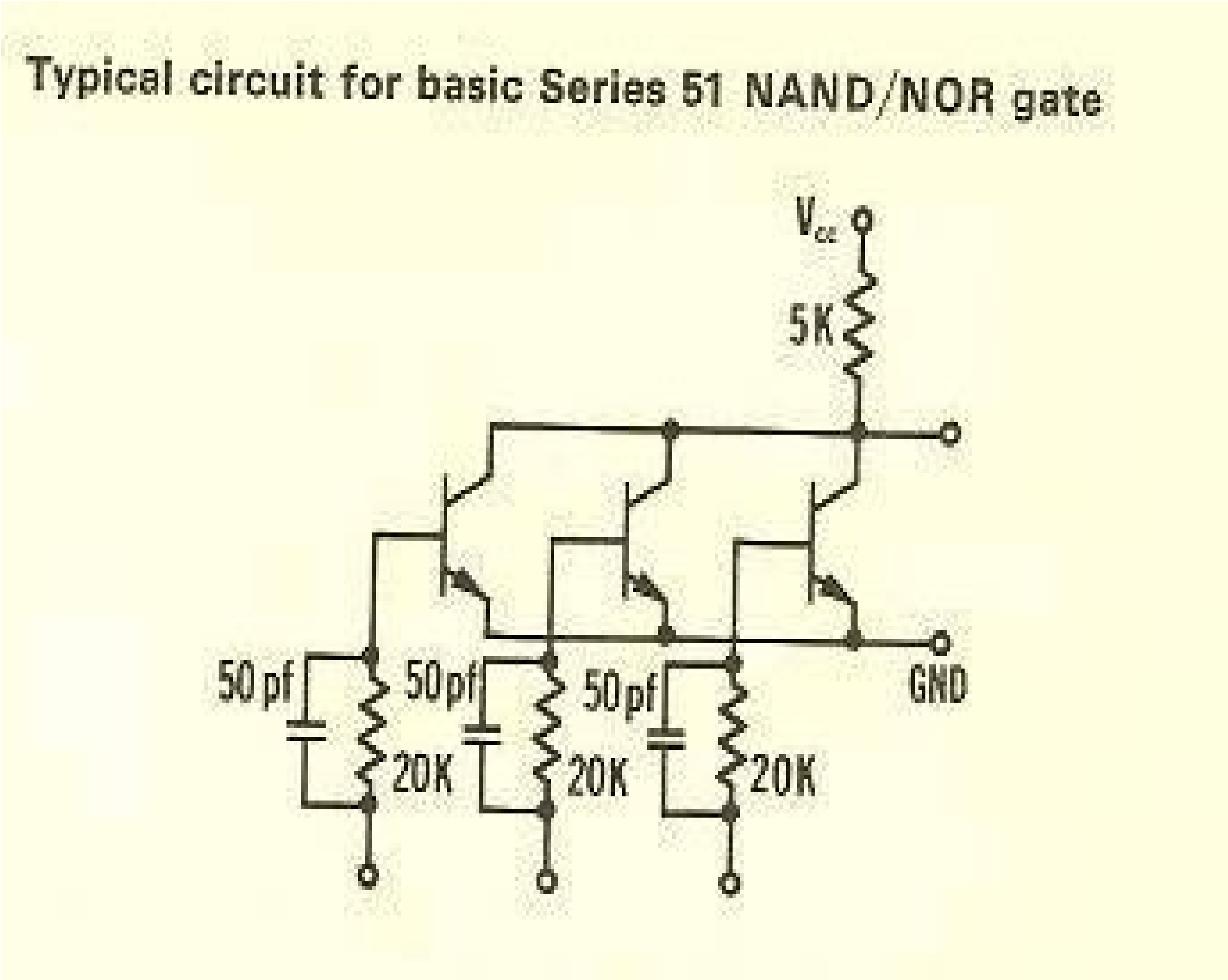


Description

TI's SN51x series of RCTL logic chips, released in 1961, is widely recognized to be the world's first commercially available line of integrated circuits. 'SN' stands for 'Semiconductor Network', TI's nod towards the then-radical idea of combining multiple solid state devices into a single package. The SN51x series chips were manufactured from multiple transistor and diode dies, which were hand-wired together with thread-like interconnect leads inside the package. Constructing chips in this manner was both labor-intensive and expensive: early SN51x series chips sold for over $400 when first released.

These early ICs were primarily targeted towards the military and aerospace industry, and the SN514 (along with the SN510) were the first integrated circuits to orbit the earth. The earliest SN51x series chips were packaged in gold plated flat-packs. This example, a SN514 NOR/NAND gate made in November 1962, abandons the military gold package in favor of a more primitive looking 'block of carbon'-style enclosure.

TI SN514 INTEGRATED CIRCUIT



Apollo GUIDANCE (NAV) COMPUTER

(2 used on Apollo 11 Moon Landing, 1 in CM, 1 in LM)

1 cubic ft, 70 Watts at 24V, 1 MHz clock (plus multiple control panels)

ROM 6 modules of fixed core rope 36KW (72kB), 11.72uS (85kHz)

RAM 1 segment of erasable core 2kW (32kb), 11.72uS (85kHz)

16-bit words data = (14+ 1 sign + 1 overflow)

address = 12 bits (with bank switching)

16 I/O channels

2880 10-pin flatpacks -> 5760 x 3-input NAND/NOR, RTL/RCTL gates

Set-up with 4 x 16-bit main registers, Accumulator, Program Counter,

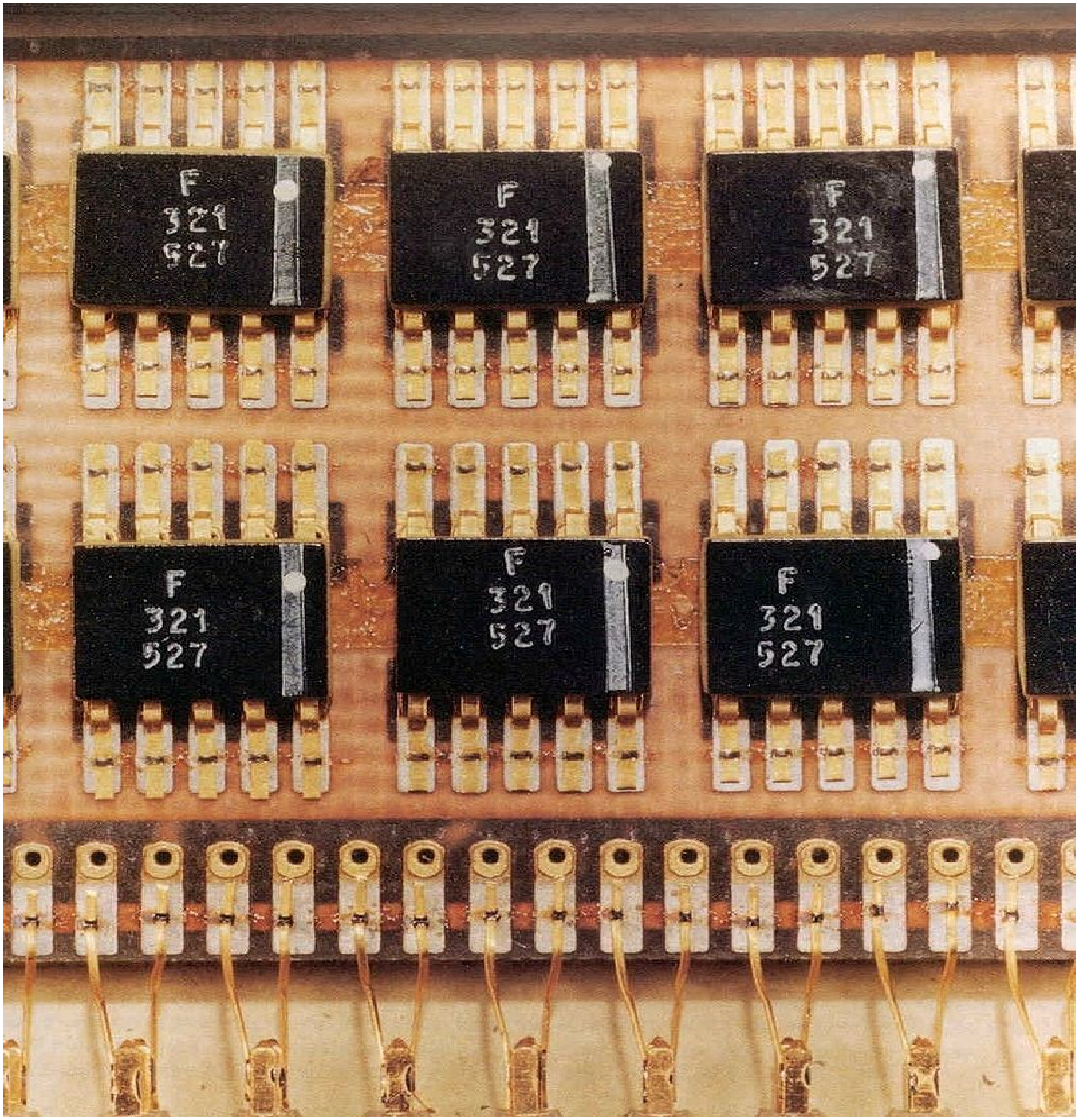
Remainder Register and Product Register and 13 more Registers

Mainly from Fairchild, some from TI

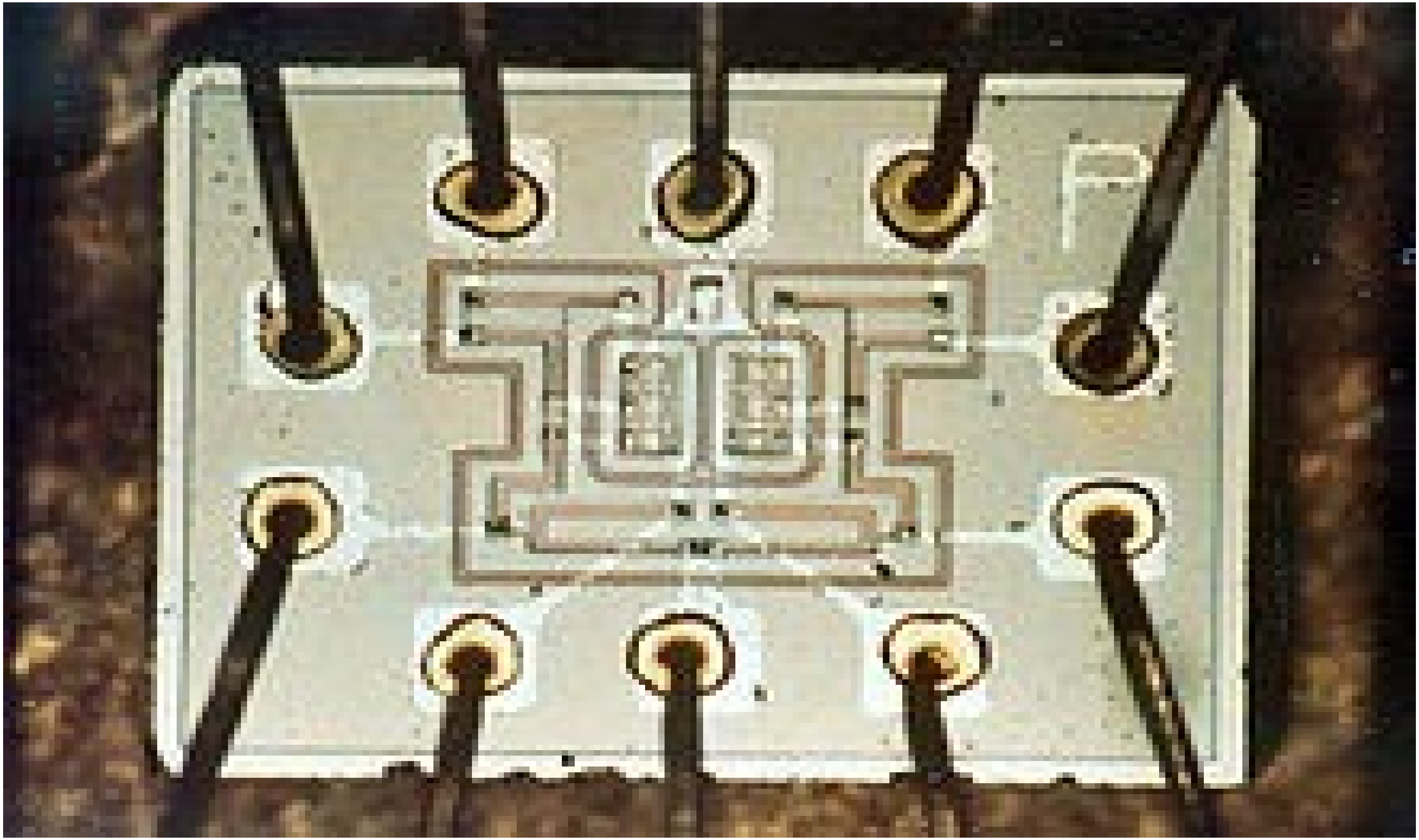
(priced about $40 -> $10ea) .. [2016 inflation multiplier x8]

Good Reference <http://history.nasa.gov/computers/Ch2-5.html>

FLATPACK NOR GATE ARRAY

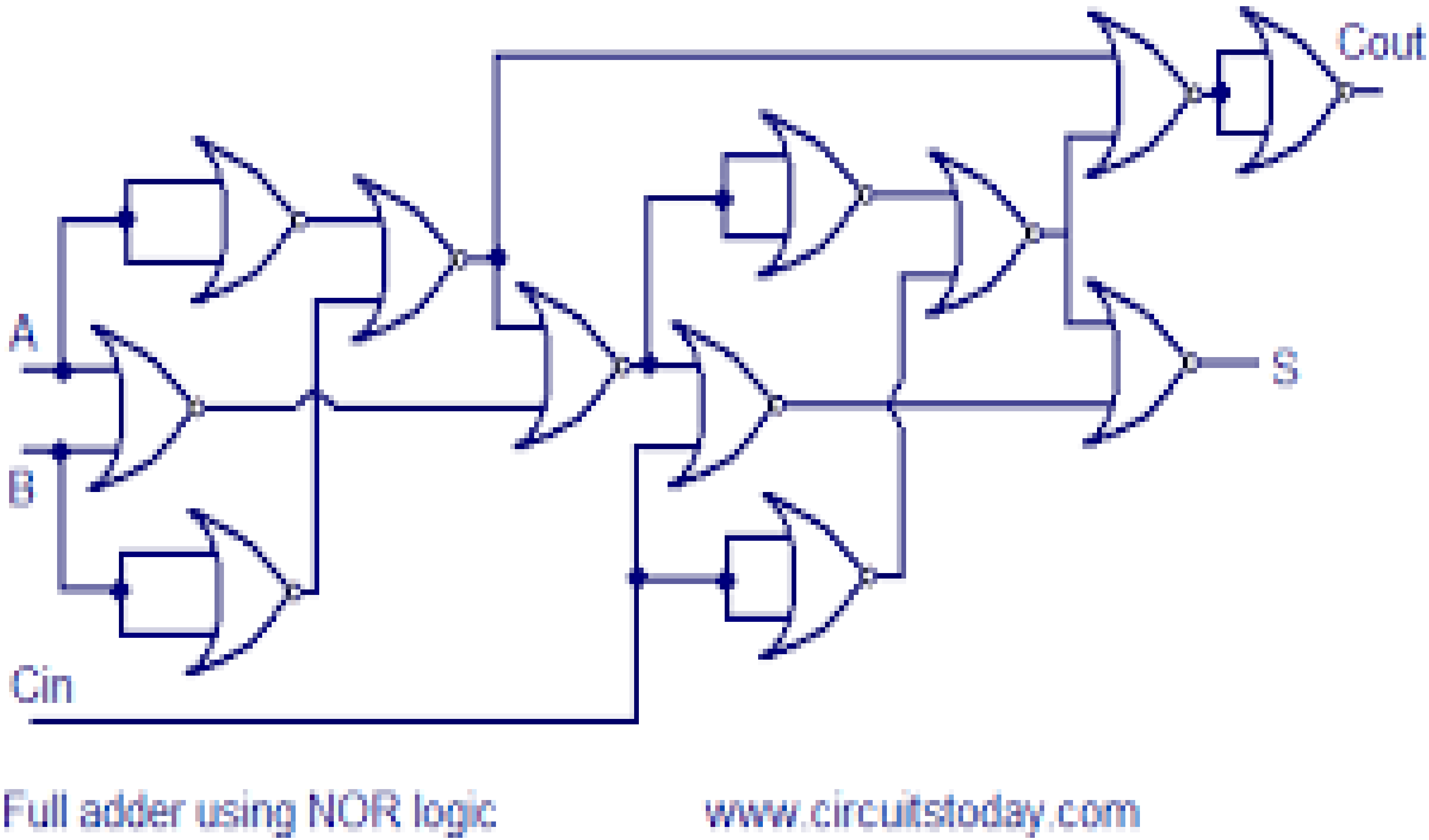


FAIRCHILD 60's PLANAR Si TECHNOLOGY

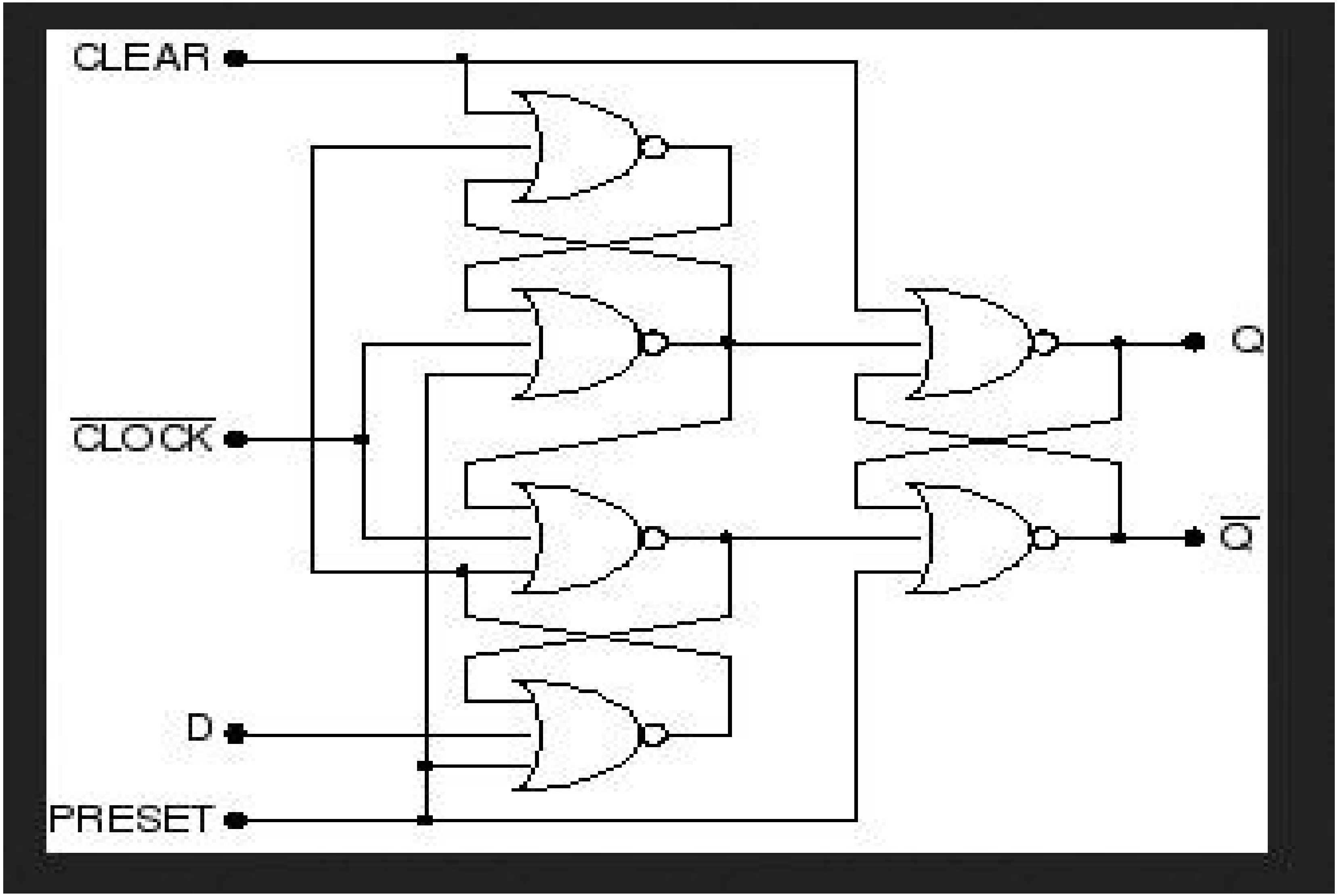


12 NOR GATES → FULL ADDER

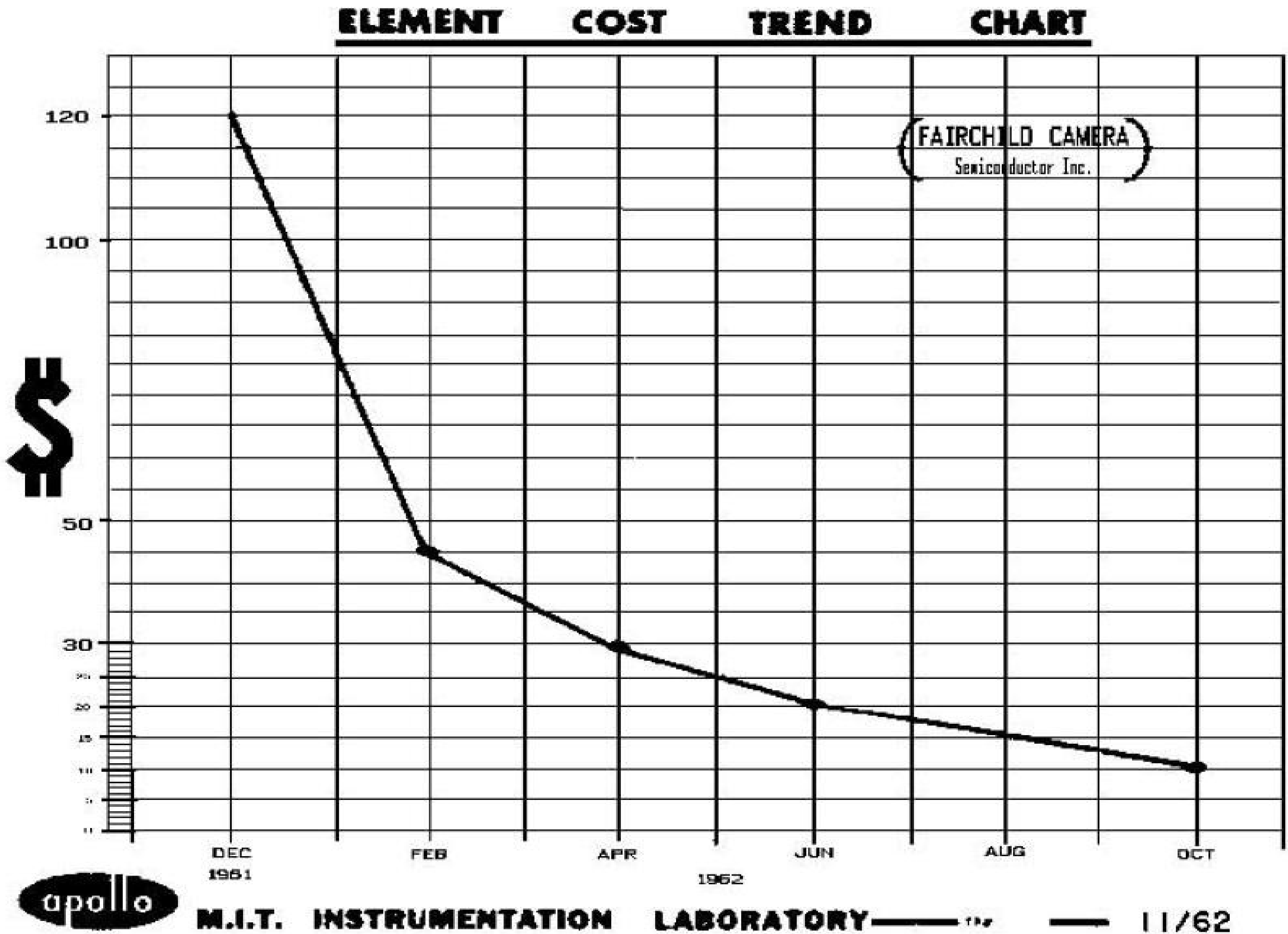
Adds A and B and Carry In → Sum and Carry Out



D-TYPE FLIP-FLOP MADE FROM 6 NOR GATES



IC COSTS LATE 1959- EARLY 1963



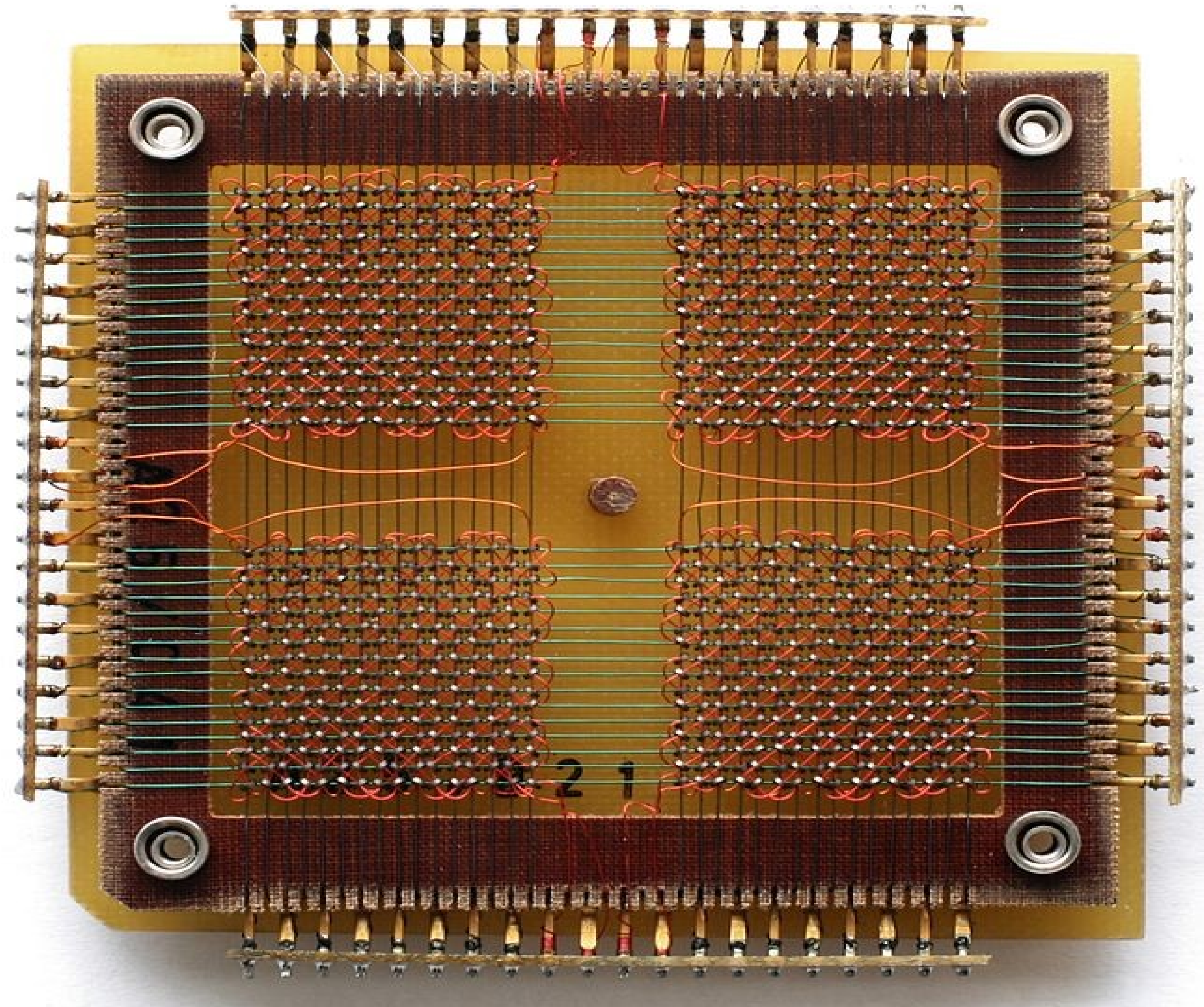
1955-75 VINTAGE RAM – CORE MEMORY

Magnetic-core memory was the predominant form of random-access computer memory (RAM) for 20 years between about 1955 and 1975. Such memory is often just called core memory, or, informally, core.
Core uses tiny magnetic toroids (rings), the cores, through which wires are threaded to write and read information. Each core represents one bit of information.
The cores can be magnetized in two different ways (clockwise or counterclockwise) and the bit stored in a core is zero or one depending on that core's magnetization direction.
The wires are arranged to allow for an individual core to be set to either a one or a zero and for its magnetization to be changed by sending appropriate electric current pulses through selected wires.
The process of reading the core causes the core to be reset to a zero, thus erasing it. This is called destructive readout.
To read and retain the original stored data requires a read/re-write operating sequence.

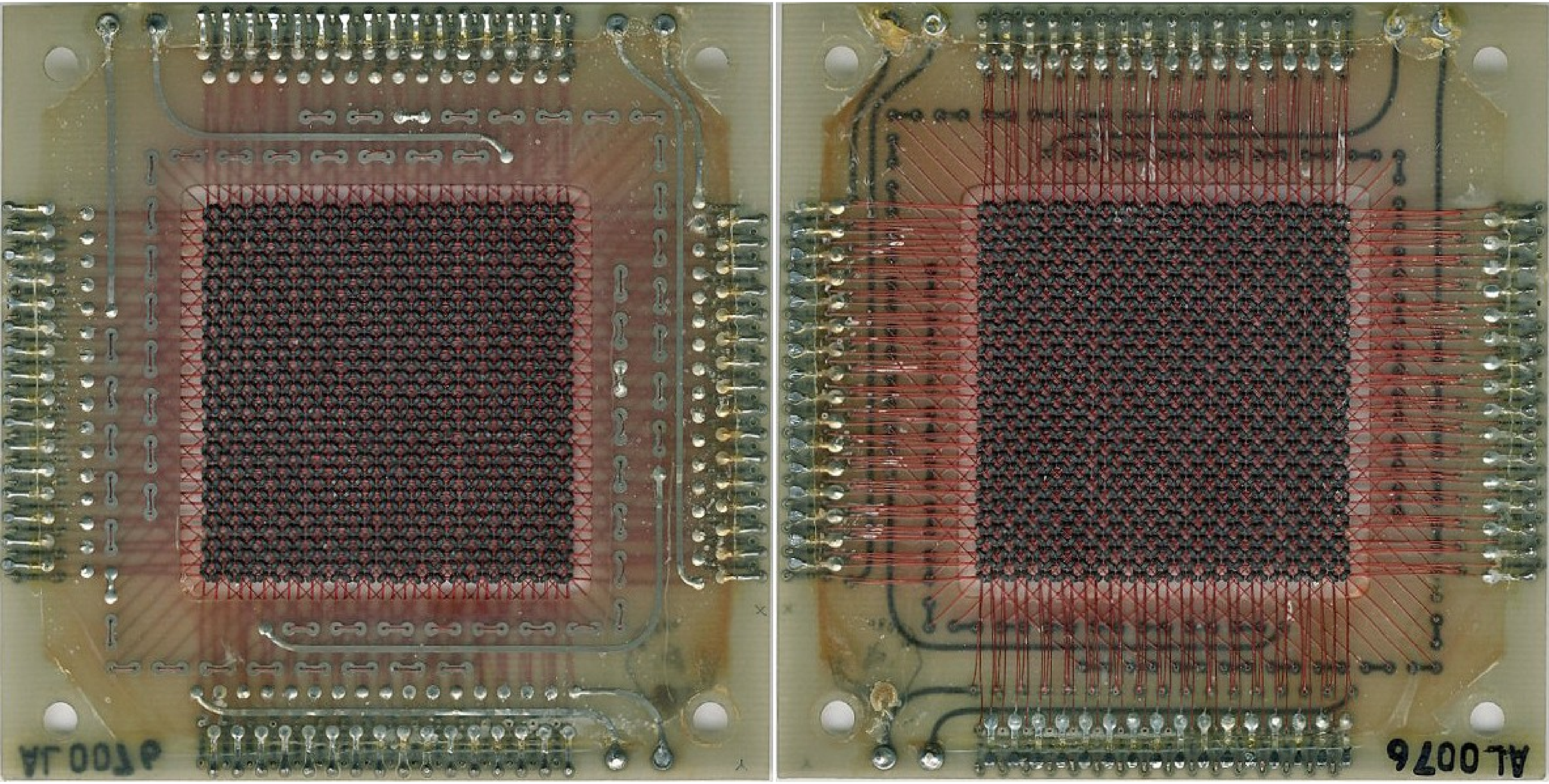
When not being read or written, the cores maintain the last value they had, even when power is turned off. This makes them nonvolatile.

Using smaller cores and wires the memory density of core slowly increased, and by the late 1960s a density of about 32 kilobits per cubic meter was typical.
However, reaching this density required extremely careful manufacture, almost always carried out by hand in spite of repeated major efforts to automate the process.
The cost declined over this period from about $1 per bit to about 1 cent per bit.

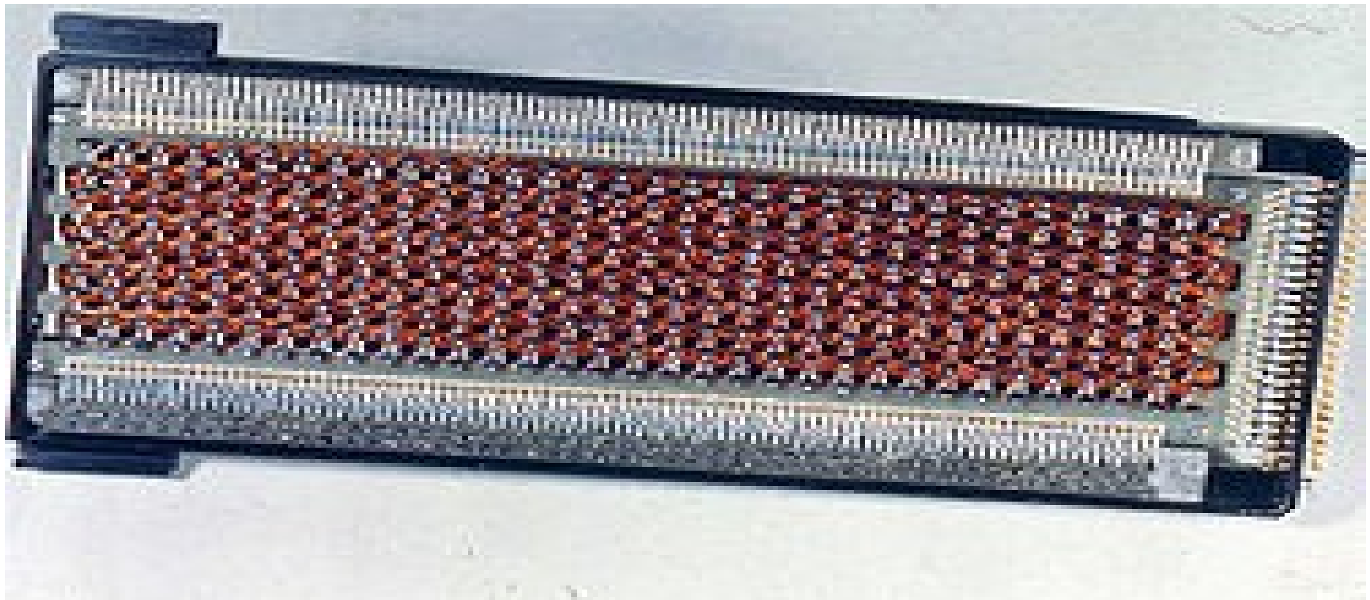
32x32 1024 bit CORE RAM



Apollo 32x32 bit RAM (FRONT & BACK)



Apollo ROPE ROM MODULE
(1 toroidal core holds 1 bit)



Core rope memory is a form of read-only-memory (ROM), first used in the 1960s by early NASA Mars probes and then in the Apollo Guidance Computer designed and programmed by the MIT Instrumentation Lab and built by Raytheon.
Contrary to ordinary coincident-current magnetic core memory, which was used for RAM at the time, the ferrite cores in a core rope are just used as transformers.
The signal from a *word line* wire passing through a given core is coupled to the *bit line* wire and interpreted as a binary "one", while a word line wire that bypasses the core is not coupled to the bit line wire and is read as a "zero". In the AGC, up to 64 wires could be passed through a single core.
Software written by MIT programmers was woven into core rope memory by female workers in factories. Some programmers nicknamed the finished product *LOL memory*, for *Little Old Lady* memory.

Apollo HAND WOVEN ROPE ROM

(As many as 64 wires through some cores!)