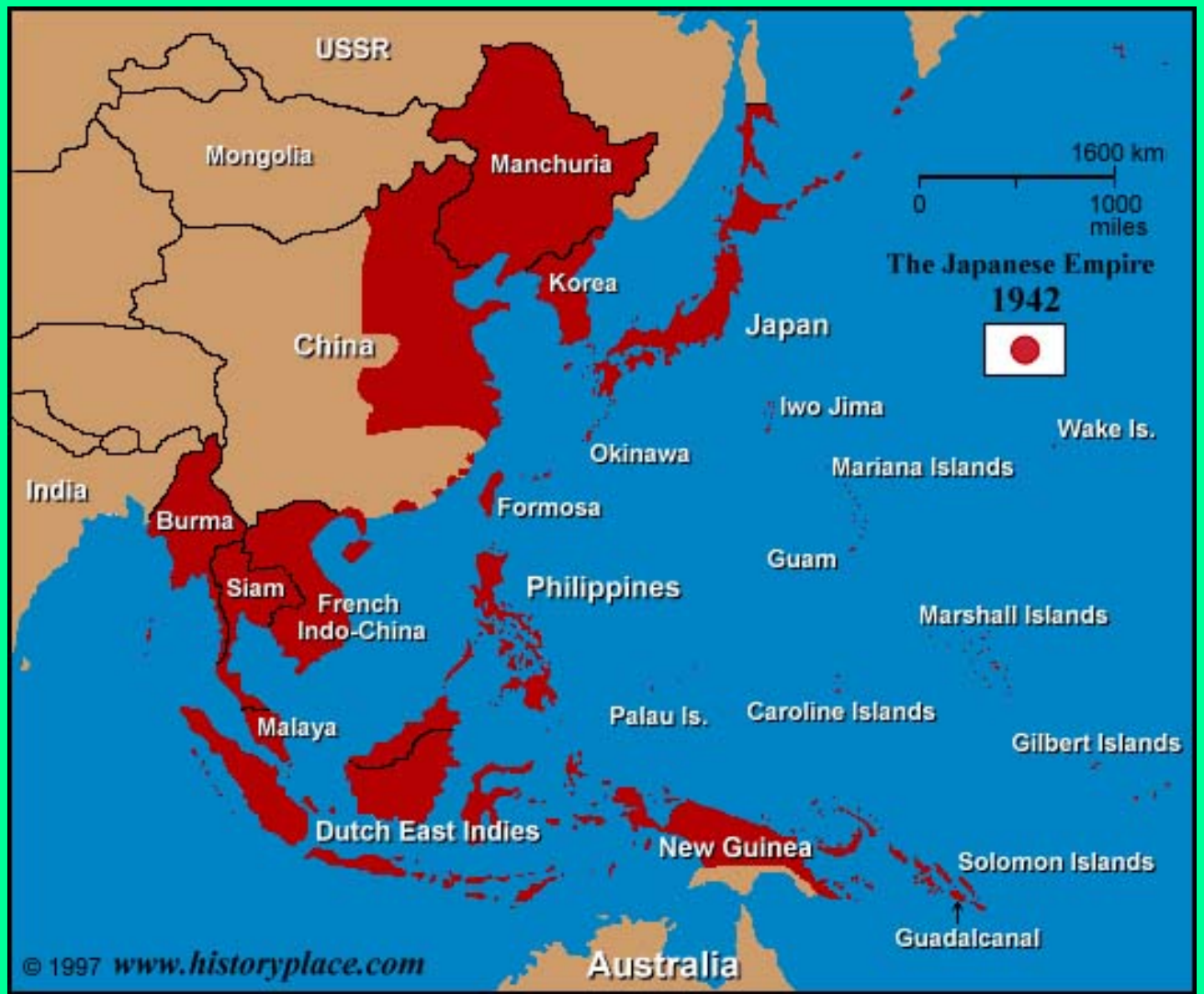
How Slide Rules Won a War.

Slide Rules, The B29 and Nuclear Bombs

- Japanese attack Pearl Harbor
- December 7, 1941 54 warships at anchor

•1942: Japanese launches the greatest war in history soon occupies most of China and most of Southeast Pacific



Boeing's B-29 super fortress

- First flight: August 1942
- Engines: Four
- Length: 99 ft
- Maximum speed: 358 mph
- Ceiling: 31,850 ft
- Range: 4,100 miles.
- Crew: 10.
- 20,000 lb bomb capacity

Arms: 10 machine guns
1 20mm cannon, Turrets with central fire control (CFC)

General Curtis LeMay

- August 20, 1944: LeMay took over the XX Bomber Command.
- Developed lead-crew training school and began debugging the mechanical problems of the B29.
- My first flight over the Hump was with LeMay as command pilot.

B-29 CFC computer
(it solved differential equations)

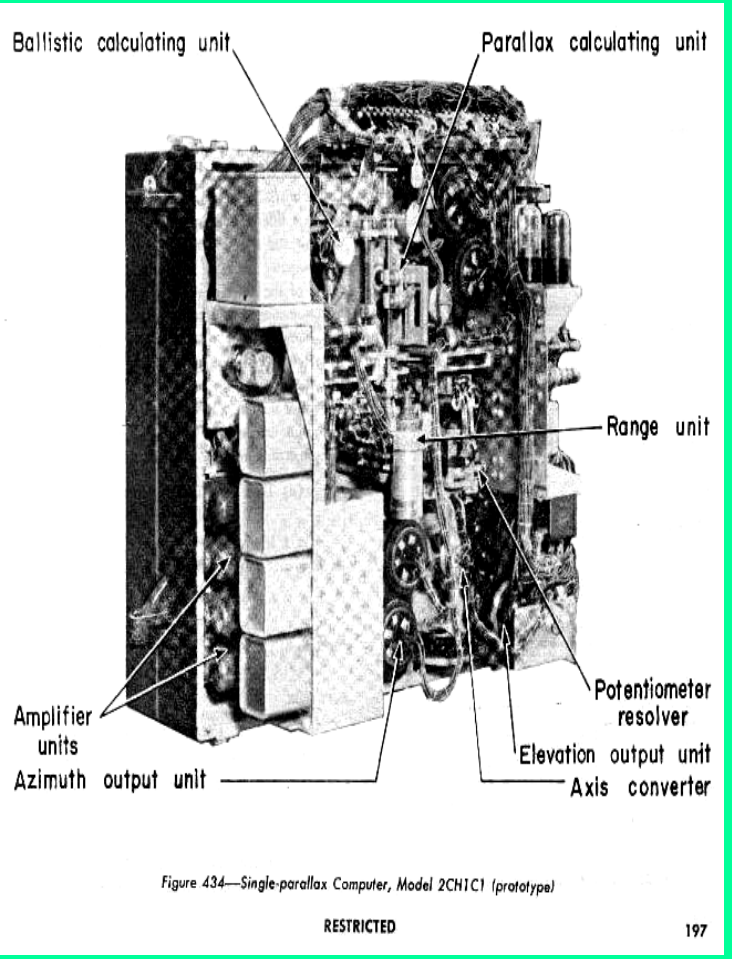


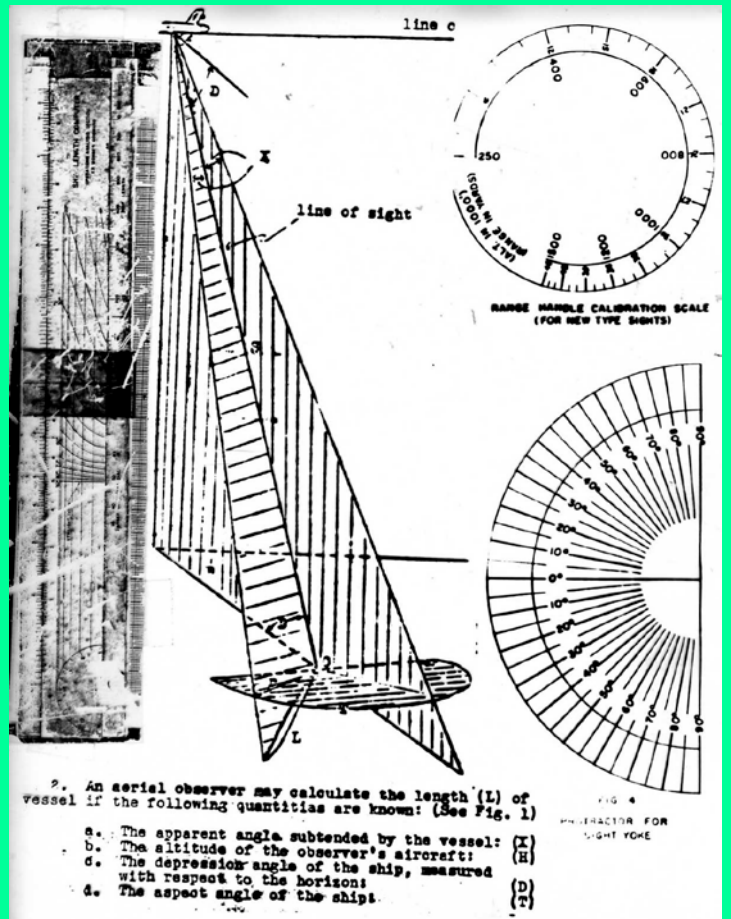
Figure 434—Single-parallax Computer, Model 2CH1C1 (prototype)

RESTRICTED 197

- **AG's major conclusions 12/44**
- 1. The B-29 gunnery system has been moderately effective against frontal attacks, whereas enemy attacks from this direction have been very effective.
- 2. The B-29 gunnery systems has been least effective against side attacks, however enemy attacks from this direction have also been ineffective.
- 3. The B-29 gunnery system has been highly effective against rear attacks whereas rear attacks by enemy aircraft have been ineffective.

2nd OA problem led to Ship length slide rule

- Navy complains about B 29 ship identifications 1/ 45
- AG uses B29 gun sight to triangulate ship length
- Slide rules fabricated from scrap metal in Kharagpur
- Photo-reconnaissance mission assigned for test.



2. An aerial observer may calculate the length (L) of vessel if the following quantities are known: (See Fig. 1)

a. The apparent angle subtended by the vessel: (X)
b. The altitude of the observer's aircraft: (H)
d. The depression angle of the ship, measured with respect to the horizon: (D)
d. The aspect angle of the ship: (T)

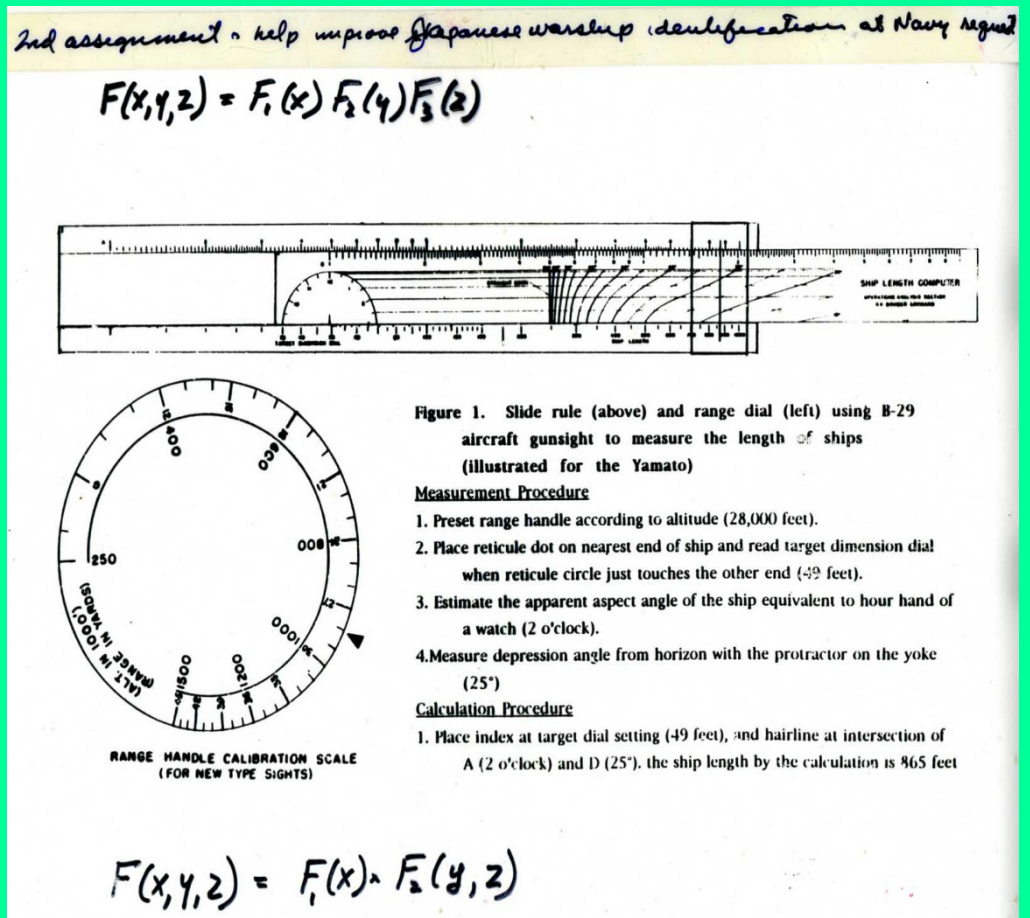


Figure 1. Slide rule (above) and range dial (left) using B-29 aircraft gunsight to measure the length of ships (illustrated for the Yamato)

Measurement Procedure

1. Preset range handle according to altitude (28,000 feet).
2. Place reticule dot on nearest end of ship and read target dimension dial when reticule circle just touches the other end (49 feet).
3. Estimate the apparent aspect angle of the ship equivalent to hour hand of a watch (2 o'clock).
4. Measure depression angle from horizon with the protractor on the yoke (25°)

Calculation Procedure

1. Place index at target dial setting (49 feet), and hairline at intersection of A (2 o'clock) and D (25°). the ship length by the calculation is 865 feet

3/12/45

Our flight discovers lost Japanese fleet

In Kure Anchorage and Hiroshima Bay

.

77 warships anchored for lack of oil

3/12/45

Crew after emergency landing at Xian

Out of gasoline

AG in light jacket

April 2005 Sinking of Yamato

4/1/45 - The final amphi-bious landing of WW II occurs as the U.S. Tenth Army invades Okinawa.

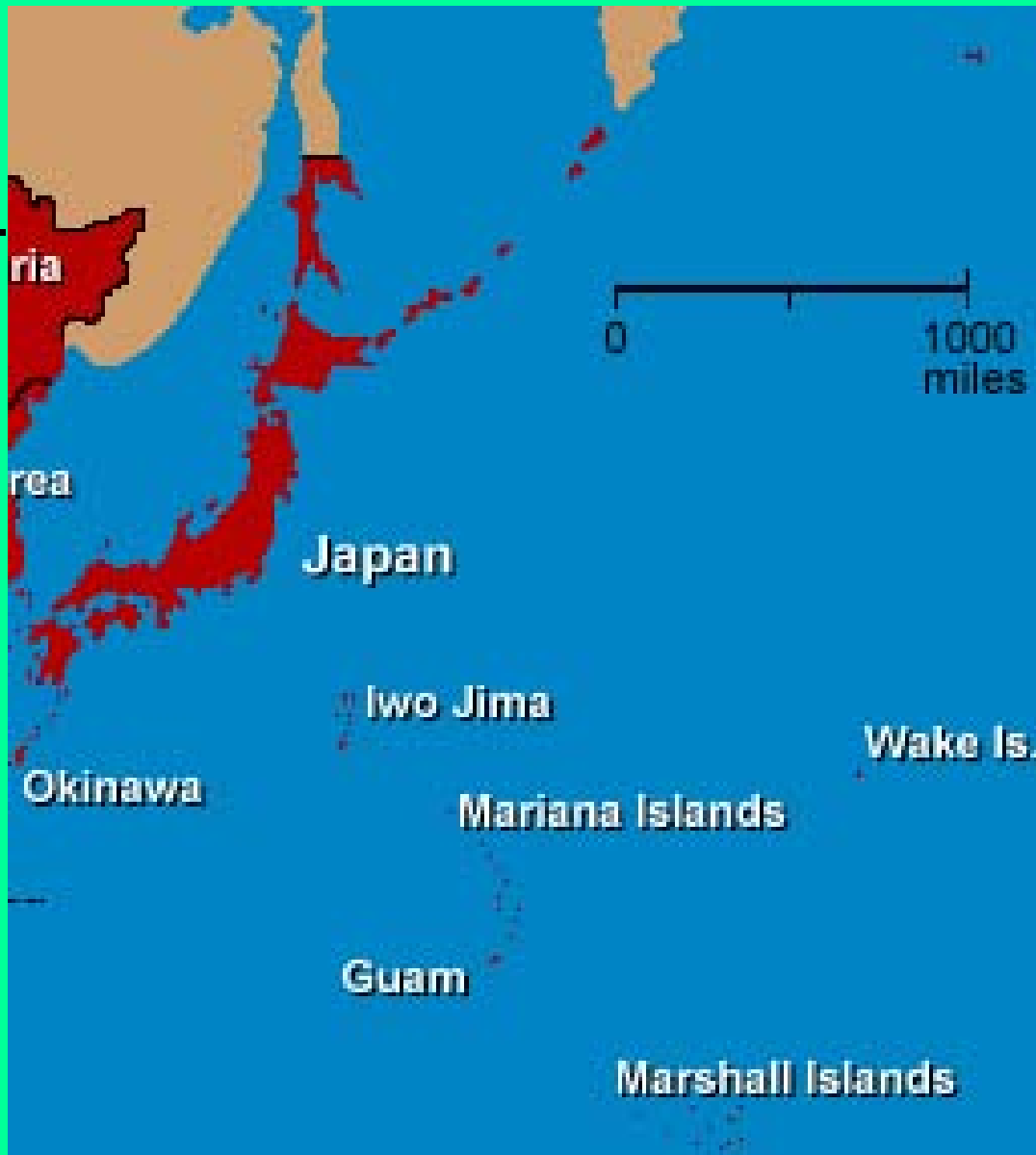
4/7/45 Yamato leaves for Okinawa with one way supply of oil to destroy our troop ships (suicide)

4/8/45 Hornet Wasp fighters sink the super battleship Yamato and several escort vessels

The Yamato, largest naval vessel of World War II and the largest/ heaviest battleship ever built .

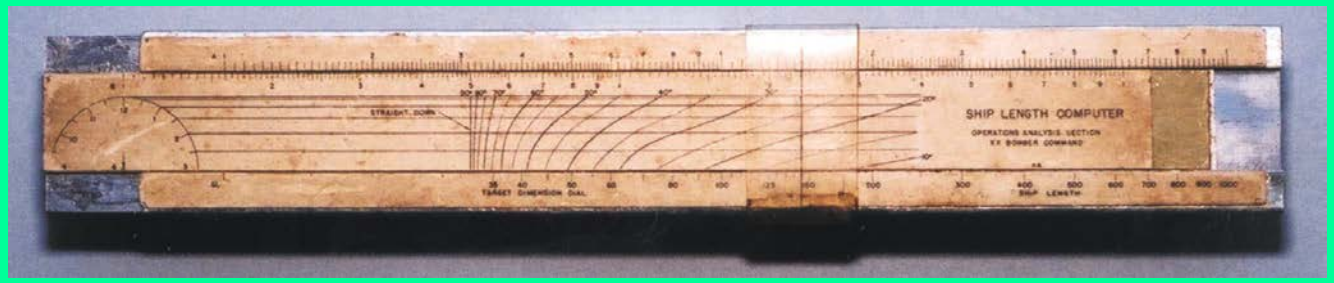
B 29 base of operations shifts to the Marianas

- February 23, 1944 - U.S. attack the Mariana Islands.
- By fall 44 21st BC began ineffective high altitude operations out of Saipan, Tinian and Guam.
- Mar 10, 45 LeMay l fire raids that cause firestorms
- Mar. 25 Iwo Jima secured emergency B29 air strips
- Mar 30 B 29 Aerial mining closes all Japanese ports



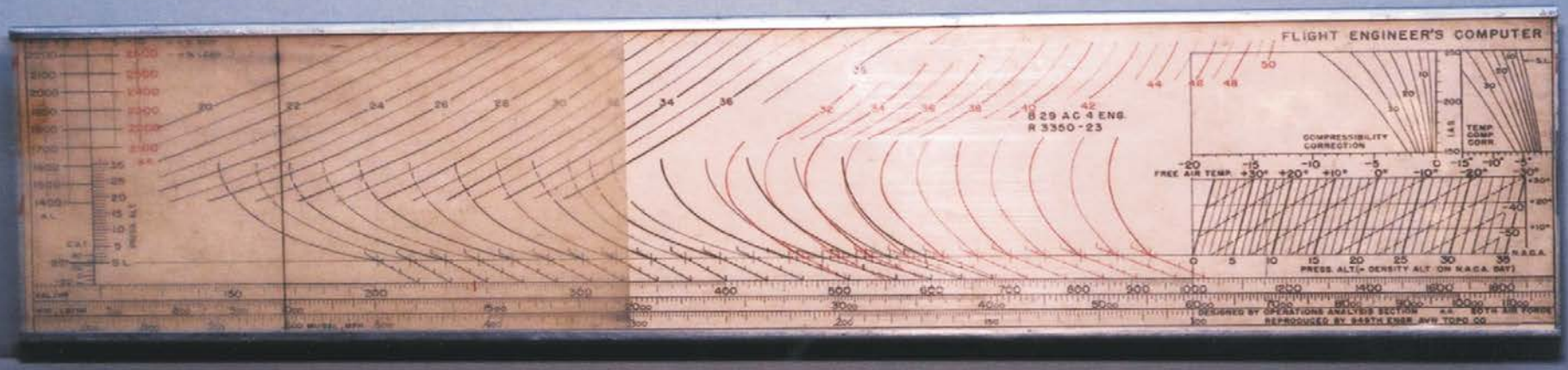
The 20th AF Slide Rule Computers.

Ship Length Computer made at Hdq 20th BC in Kharagpur, India Feb. 45



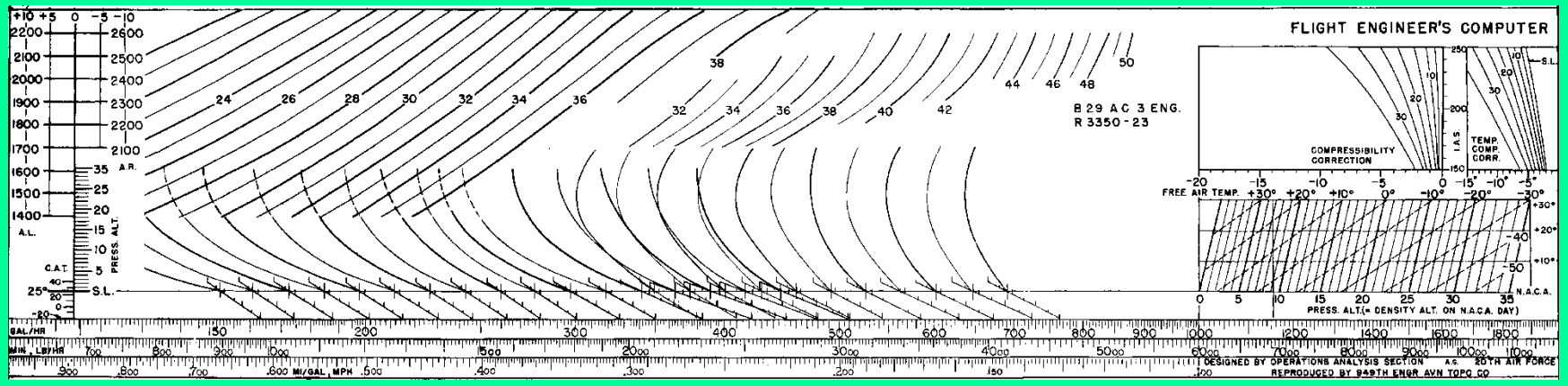
Flight Engineers Computer made at Hdq 21st BC on Guam May 45.

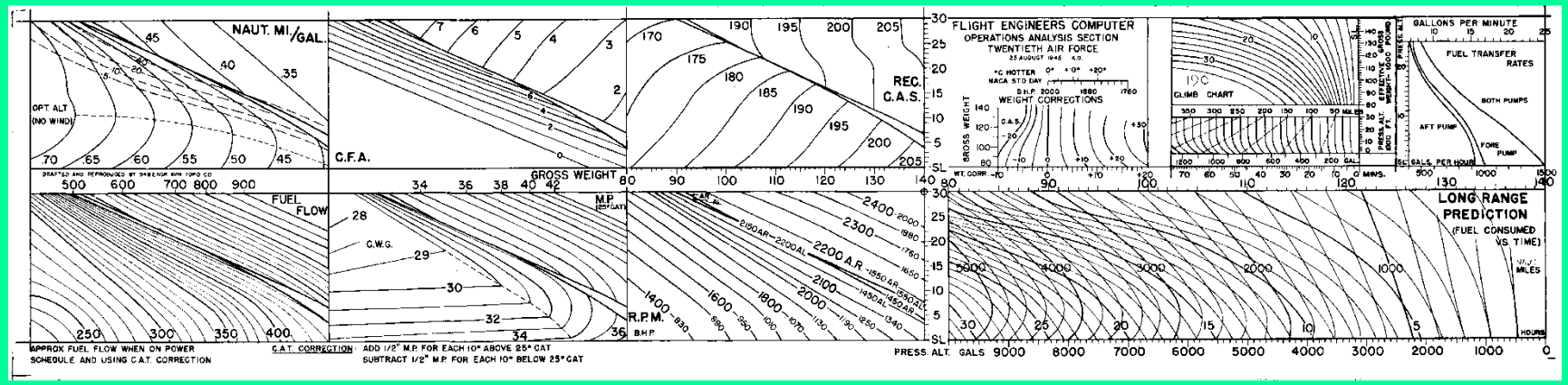
Programmable computer to meet new requests: Uses metal frame with guides, computation chart, plastic cover, glazed plastic slider with hairline, sharp pencil and eraser. Easy to fabricate programmable computer, can store lots of data. Early computer Apps



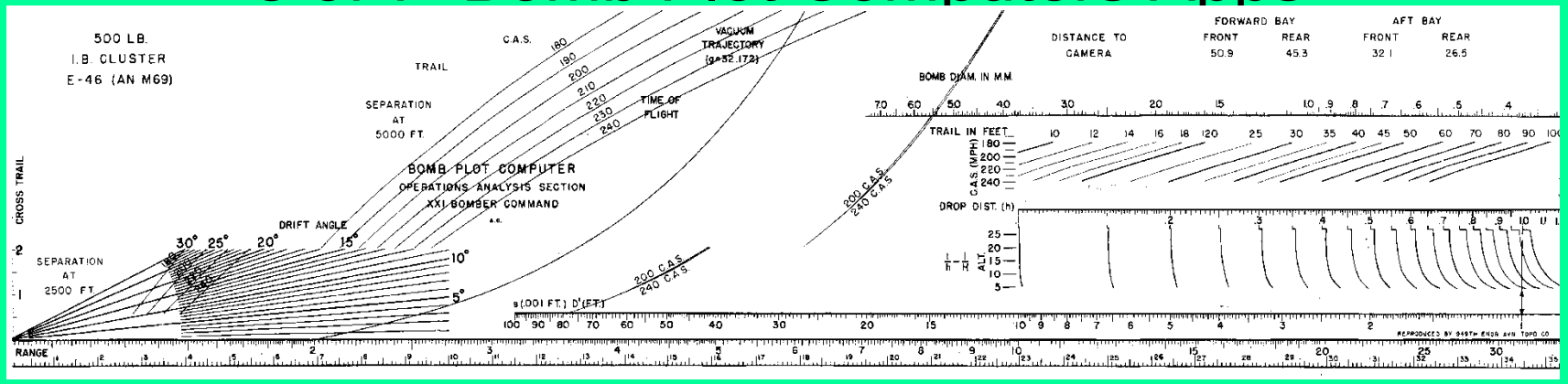
Flight Engineer's Slide Rule (apps)

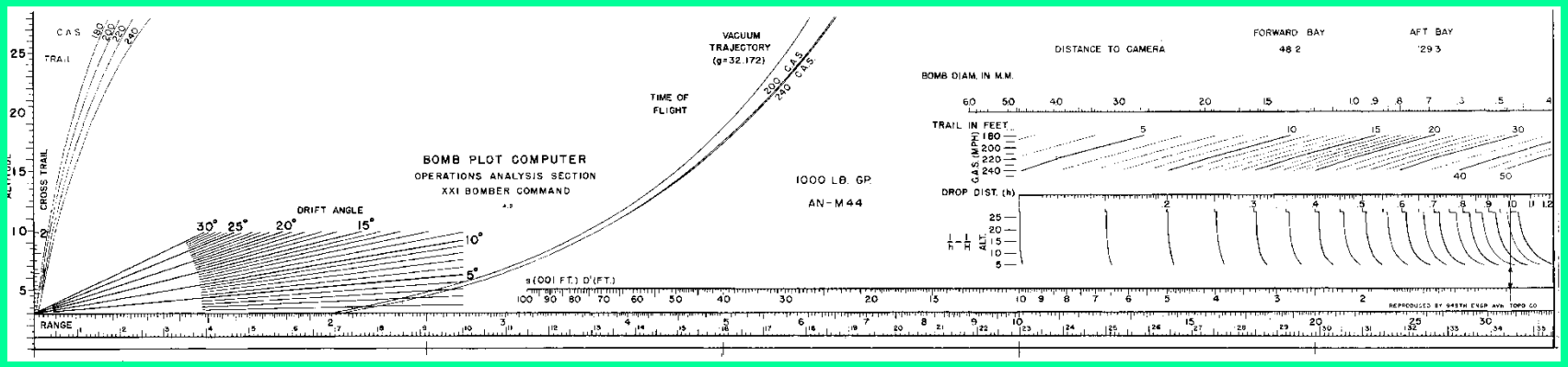
charts for 3 and 2 engine operation were available

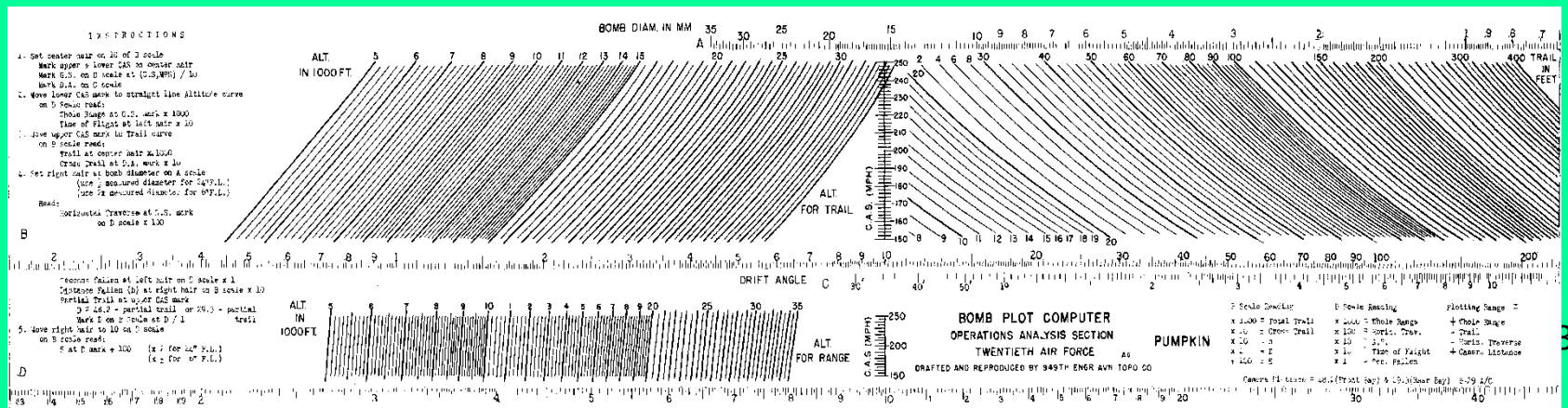




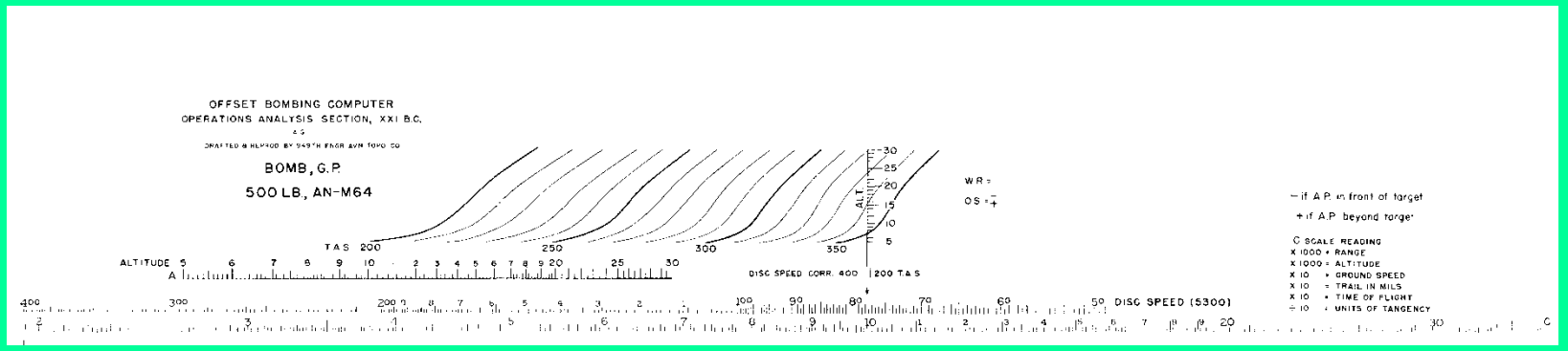
3 of 7 Bomb Plot Computers Apps

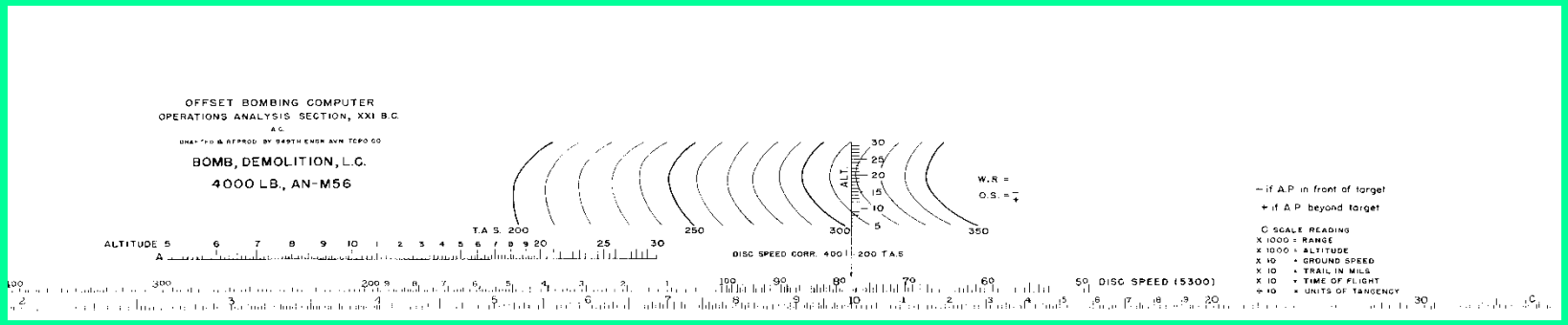


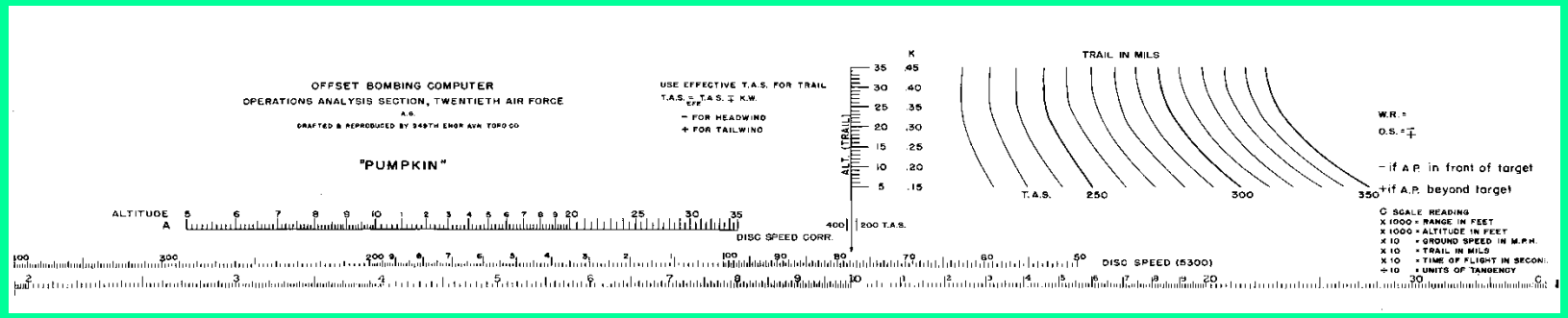




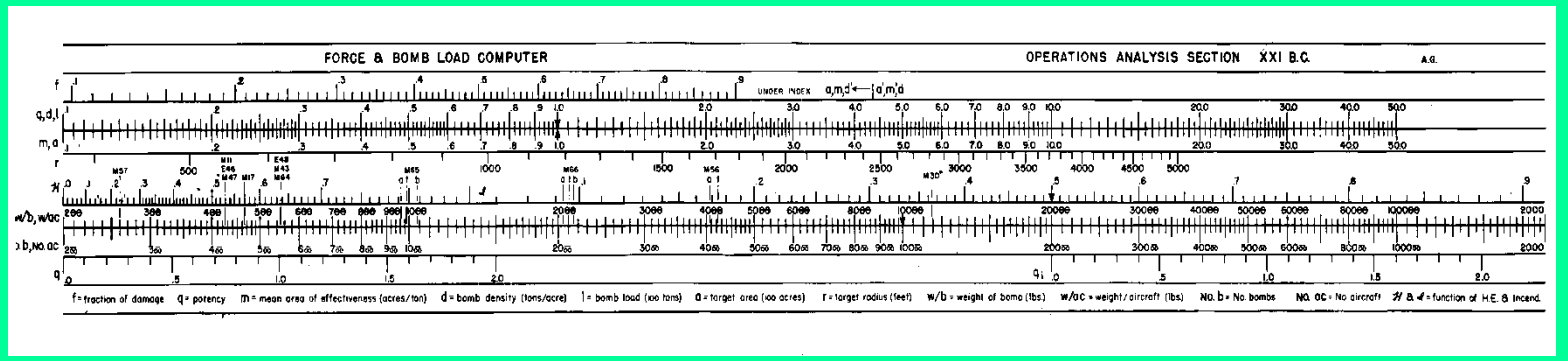
3 of 7 Offset Bombing Slide Rule Apps

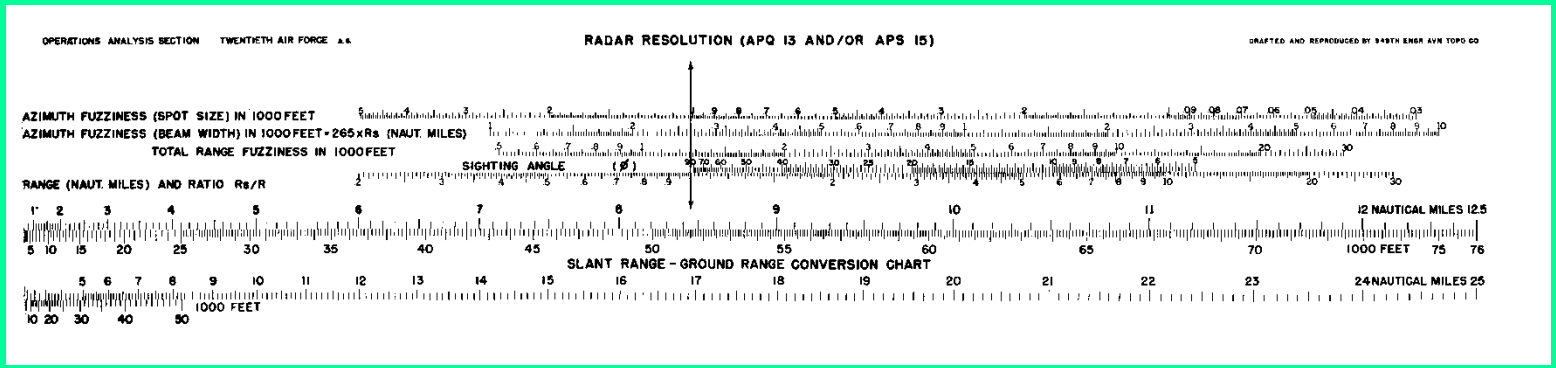


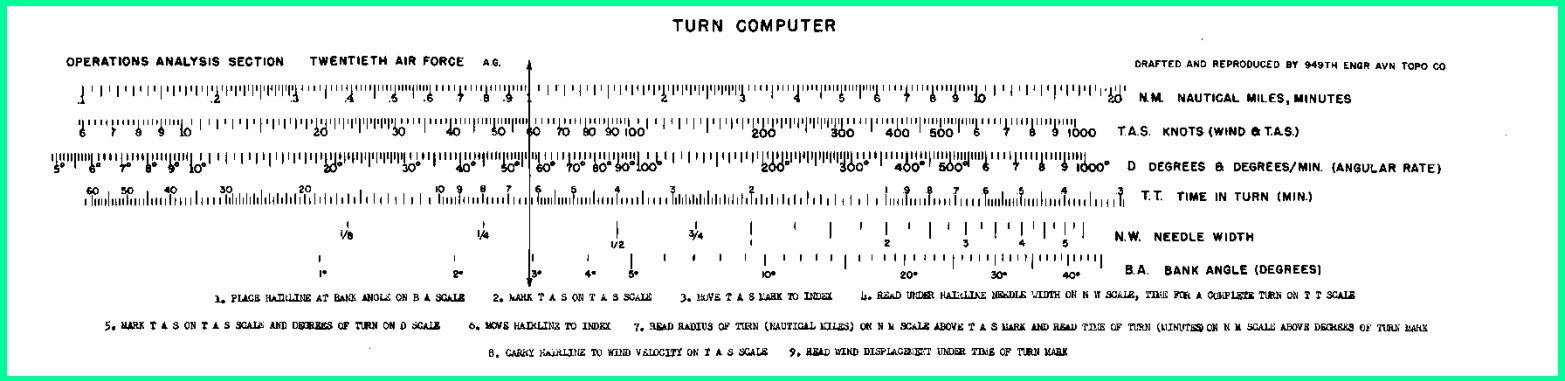




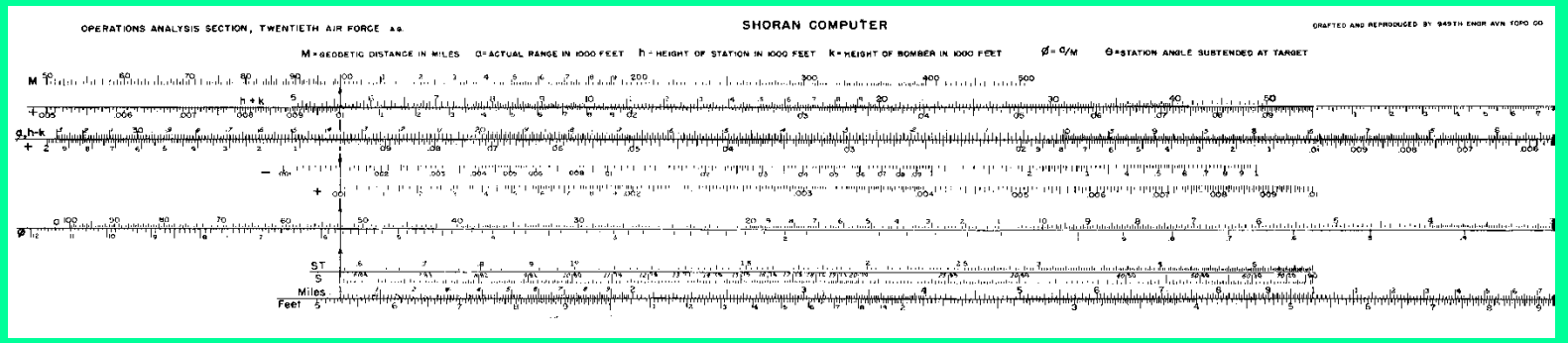
3 other computers







Shoran Bombing System to enable B-29 fleet to give close support to planned invasion of Japan



Shoran to be used like GPS

William Shockley posed weather correction problem to AG. Result AG became operational calculator

Didn't like AG's slide rule, went back to Bell Labs, invented transistor

Put slide rules out of business and launched the cyber age

It changed the way we bank, drive, cook, communicate, listen to music and watch television. BY SHARON BEGLEY

THE TRANSISTOR

Creating the Future Bardeen (left), Shockley and Brattain's invention laid the foundation for the cyber-revolution

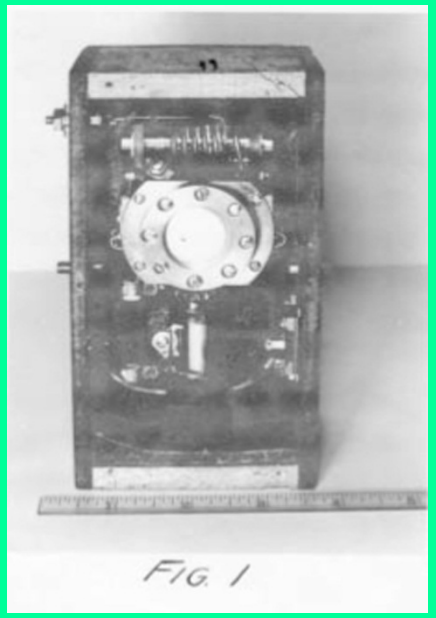
riddled with cul-de-sacs, he suggested, making it possible for electrons to enter but not to leave. The surface seemed to be positively charged on the outside, attracting electrons in, but negative on the inside, repelling them when they start to move. The electrons were stuck. As a result the flow of electrons—which is all a current is—could not increase. Applying an electric field did nothing.

For the next 20 months Bell's team turned to the most basic of research—the quantum properties of solids—as it sought ways to liberate the electrons in the semiconductor. "Without understanding solids from a quantum mechanical point of view," says William F. Brinkman, vice president of R&D at Bell Labs, "the transistor could not have been invented." On Nov. 17, 1947, Brattain launched the experiments that would bring success. He began with a splash—literally: he bathed silicon in various electrolytes (liquids that contain electric charges), such as acetone and distilled water. The electrolytes changed the electrical properties of silicon's surface. When Brattain shined a light on the treated silicon, a larger current flowed than from untreated silicon (silicon was known to produce a current in response to light; today that is the basis for solar cells). Apparently, the electrolytes set up an electric field that bulldozed the cul-de-sacs, allowing the electrons to escape.

On Nov. 21

20TH AIR FORCE PROJECT PARTY
1891 G 35PTU 18 AUG 45 B-29 SHORAN PROGRAM

Nuclear Bomb = 20,000 tons TNT
(from shock wave measured by second B29)



FEI instrument to measure miss distance of a bullet by its shock wave. It had FM transmitter and a condenser microphone. A. Green, W. Panofsky, J. DuMond co-inventors,

Instrument with condensor microphone and FM transmitter dropped on 8-6-45 by 2nd B29 at Hiroshima to measure Little Boy's shock wave-energy

(in Hiroshima museum)

AG and Air to Air Gunnery

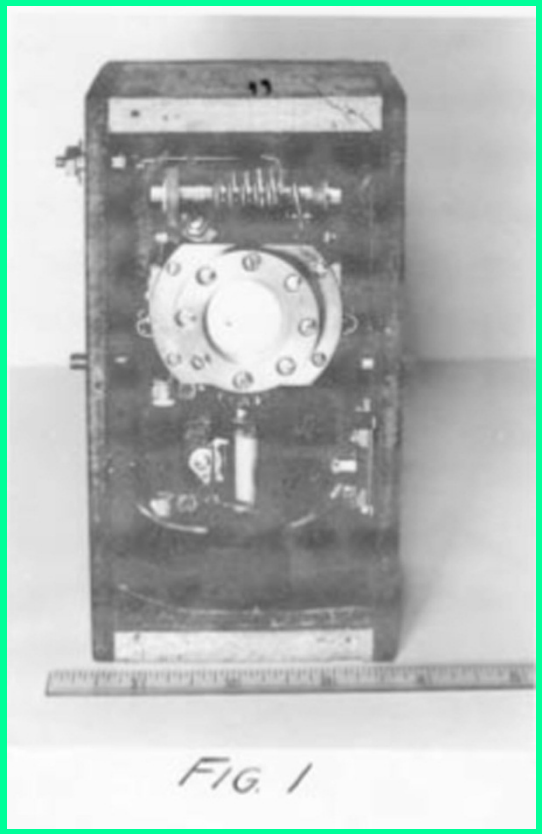
6/41: California Institute of Technology (Caltech): Completes MS, starts PhD in atomic physics under Jesse DuMond

1/42:WWII, DuMond's group joins Caltech's rocket development project (now Jet Propulsion Laboratory).

3/42: In rocket tests at Goldstone lake AG sees UK target rocket. Suggests a firing error indicator (FEI).

7/42: FEI evolves from a magnetic sensor to acoustic based on bullets shock wave. AG tests at military bases.

11/43 AG Joins, FGISRD Ft Myers FL to introduce FEI in gunnery training & work on urgent AAF gunnery tasks. 2/44 FGISRD moved to Laredo Texas.



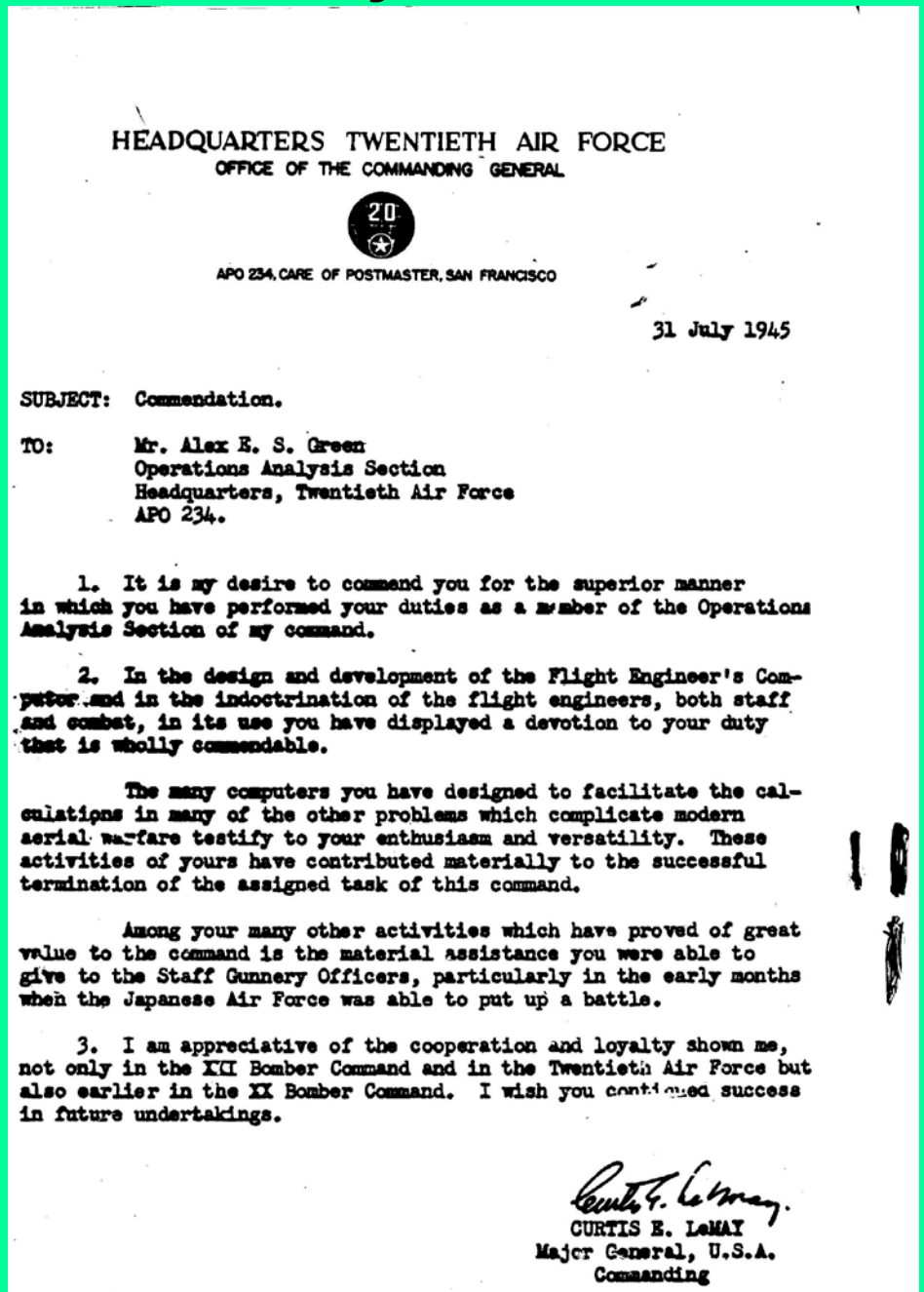
FEI instrument with FM transmitter and a con-denser microphone to measure miss distance of a bullet by its shock wave.

LeMay's Commendation July 31, 1945

The many computers you have designed to facilitate the calculations in many of the problems which complicate modern aerial warfare testify to your enthusiasm and versatility. These activities of yours have contributed materially to the successful termination of the assigned task of this command.*

Appreciate the cooperation and loyalty not only in XXI BC and Twentieth AF but also earlier in the XX BC.

- ***"To destroy the capability of Japan to wage war"***



HEADQUARTERS TWENTIETH AIR FORCE
OFFICE OF THE COMMANDING GENERAL

APO 234, CARE OF POSTMASTER, SAN FRANCISCO

31 July 1945

SUBJECT: Commendation.

TO: Mr. Alex E. S. Green
Operations Analysis Section
Headquarters, Twentieth Air Force
APO 234.

1. It is my desire to command you for the superior manner in which you have performed your duties as a member of the Operations Analysis Section of my command.

2. In the design and development of the Flight Engineer's Computer and in the indoctrination of the flight engineers, both staff and combat, in its use you have displayed a devotion to your duty that is wholly commendable.

The many computers you have designed to facilitate the calculations in many of the other problems which complicate modern aerial warfare testify to your enthusiasm and versatility. These activities of yours have contributed materially to the successful termination of the assigned task of this command.

Among your many other activities which have proved of great value to the command is the material assistance you were able to give to the Staff Gunnery Officers, particularly in the early months when the Japanese Air Force was able to put up a battle.

3. I am appreciative of the cooperation and loyalty shown me, not only in the XXI Bomber Command and in the Twentieth Air Force but also earlier in the XX Bomber Command. I wish you continued success in future undertakings.

CURTIS E. LeMAY
Major General, U.S.A.
Commanding

Truman's Medal of Freedom presented November 1947

REFER TO:

WAR DEPARTMENT
THE ADJUTANT GENERAL'S OFFICE
WASHINGTON 25, D. C.

11/11

CITATION FOR THE MEDAL OF FREEDOM

Mr. Alex E. S. Green, Operations Analyst, Twentieth Air Force, performed meritorious service while participating in combat operations and in connection with air operations against the enemy, 25 October 1944 to 5 September 1945. He was a member of the crew of a B-29 photo airplane on one of the longest and most hazardous reconnaissance flights of the war. On this mission Mr. Green used a ship-length computer he had devised in helping to identify major units of the Japanese fleet lying in the Kure anchorage. As a result of this flight the U. S. Navy made a highly successful attack on the enemy fleet. His diligence, sound judgment, skill and devotion to duty contributed materially to the success of the Twentieth Air Force in carrying out its assigned mission.

Local CBIVs celebrating AG's 90th birthday with slide rule birthday cake

left to right

- Bill Morgan,
- Bud Maloney,
- Alex Green,
- Deane Hodge,
- Joe Busby

5 of 10 of 42 members since 1992 of local University Basha

Alternatively come to Florida Museum of Natural History Collectors Day, January

AG's SR collection included

- **His 20th AF SRs (left)**
- **It included Other military SRs**
- **Commercial & engineering SRs (K&E, Dietzgen, Post, Hemmi …)**
- **Industrial/equipment SRs**
- **Instructional SRs, 9 ft, 4 ft, student**
- **Books and proceedings on SRs**
- **Journals of the Oughtred Society**

For more info

- aesgreen@ufl.edu
- http://physicstoday.org/resource/1/phtoad/v54/i8/p40_s1?bypassSSO=1