26th February 1935

Chain Home & The Daventry Experiment – the 75th Anniversary

Andy Tyler, 26th February 2010

Introduction

- The Daventry Experiment
- 26th February 1935

UK's Air Defense Strategy – 1930 to 1935

- Royal Observer Corps
  – ground spotter networks
  - Optical devices – weather limited
  - Acoustic Detectors – limited range
  - Infrared Detectors – promising but still under development

UK's Air Defense Strategy – 1930 to 1935

- Acoustic Detectors or Sound Mirrors
  - Used since the Napoleonic war
  - Detection range: ≈20 miles
  - Bearing Accuracy: ≈1.5°
  - Gave about 4 min warning of an aircraft approaching at 300mph

- 30' Acoustic locator dish (Dungeness)
- 200' wall (Dungeness)

UK's Air Defense Strategy – 1930 to 1935

- Stanley Baldwin

"The Bomber Will Always Get Through"

UK's Air Defense Strategy – 1930 to 1935

- 1934 RAF Air Exercises
  - Full scale attack on London
  - Observer corps pre-warned of targets
  - 50% of aircraft reached their targets
  - All London targets completely destroyed

- A Radical Rethink of The UK's Air Defense Was Necessary
  - The Committee For The Scientific Survey of Air Defense (CSSAD) formed to look at new technologies

The Death Ray

- Intelligence from Germany indicated the Germans were working on a Death Ray Weapon
- Air Ministry had a Prize of £1,000 for anyone who could build a Death Ray that could kill a sheep at 200 yards
- Some limited studies on intense RF beams
- Robert Watson-Watt asked by CSSAD if a Death Ray was possible

The Death Ray

- Memo From Robert Watson-Watt to Arnold Wilkins

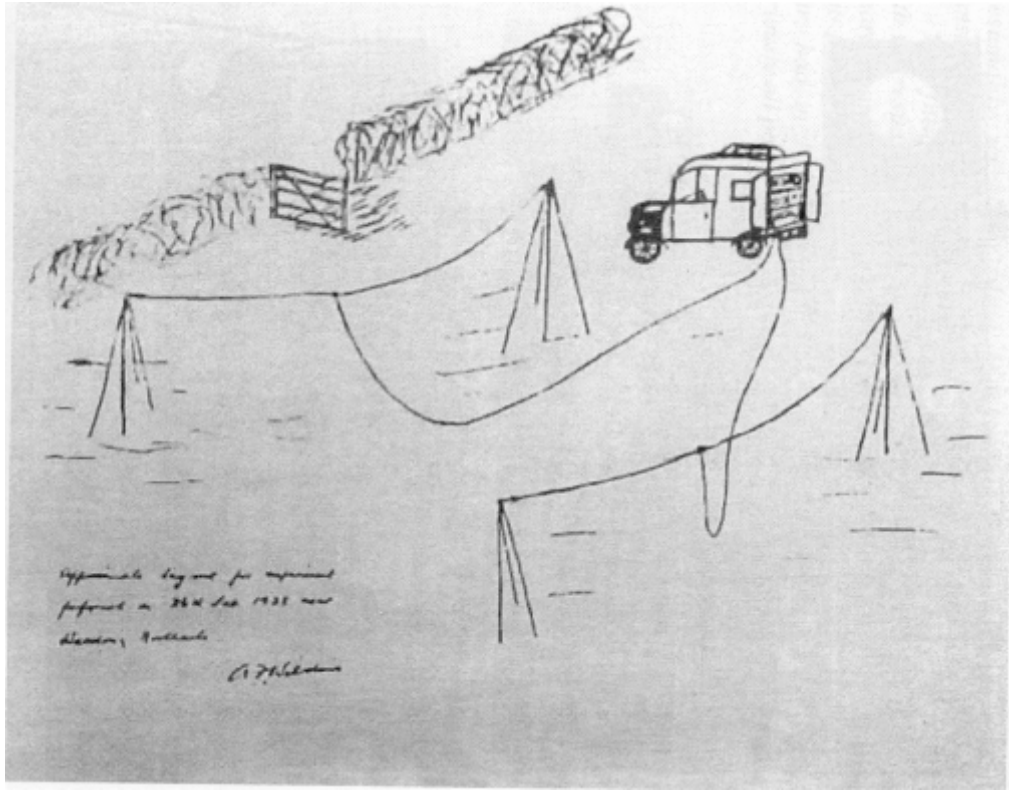
  "Please calculate the amount of HF power which should be radiated to raise the temperature of eight pints of water from 98°F to 105°F at a distance of 5km and a height of 1km"

- Wilkins Replied
  - That his calculations showed that a huge power would be required for such a weapon, however it might be possible to detect the reflected radiation from an aircraft

- Watson-Watt reports back to CSSAD
  - Requests £12,000 to begin research
  - CSSAD release just £2,000 for a proof of principle demonstration

The Daventry Experiment

- 26th February 1935
- Located 10km from the BBC Empire transmitter at Daventry near the village of Weadon
- Two horizontal ½ wave dipoles spaced 100’ apart and aligned with the Daventry transmitter
- Connected to a two channel Receiver which in turn was connected to a CRO
- A Phase Shifter in one channel to cancel the Ground Wave
- A Heyford bomber was flown at 10,000’ between the receiver and transmitter



The Daventry Experiment

The Birth of RDF

Top Secret

- Orfordness
  - Separate ½ wave dipoles for Tx and Rx at about 25m high
  - 25µS Pulse
  - Pulse triggered from national grid
  - Peak Power 20kW
  - Targets detected at 27 Km
  - TX Power raised to 100kW
  - Targets detected at 100 Km

The Move to Bawdsey

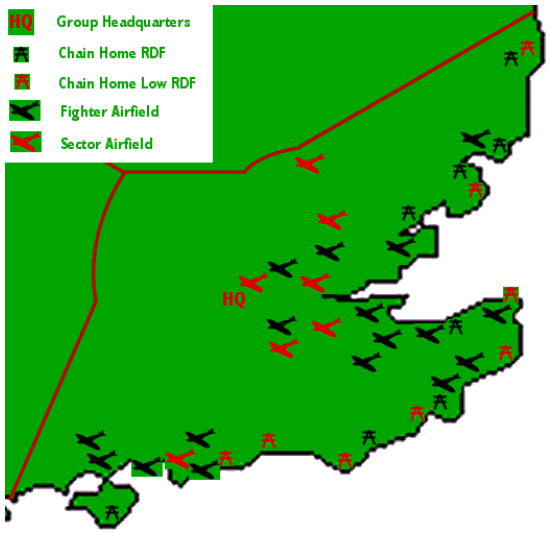
- Bawdsey Manor
  - Purchased early 1936 for £23,000

The Birth of RDF

- The Thames Estuary Chain
  - 5 Stations built to test principle
  - Bawdsey Manor (1936)
  - Gt Bromley (1937)
  - Canewdon (1936)
  - Dunkirk (1937)
  - Dover (1936)

Chain Home RDF

- Air Exercises in late 1937 and early 1938
  - Control and Command, Filter Rooms and Plotting Tables
- £10m released to complete a chain of 20 stations
  - Good Friday 1939 all CH stations start 24/7 watch



Chain Home

- Chain Home Specification (AMES1)
  - Four Frequencies between 20MHz and 55MHz
    - Later just two between 20MHz and 30MHz
  - Horizontal Polarisation
  - Peak Power 350KW
    - Later 750KW and 1MW
  - PRF 25 and 12.5Hz locked to the National Grid
  - Pulse length 20μS
  - Long interpulse period 40mS to mask long range scatter

Chain Home - Transmit Antennas

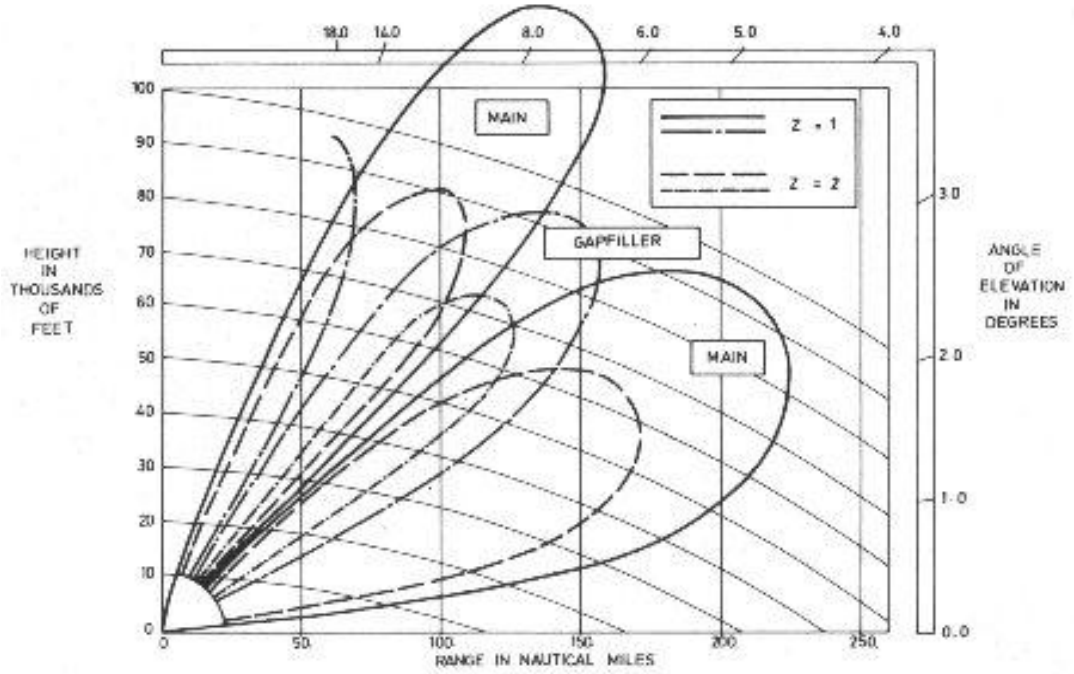
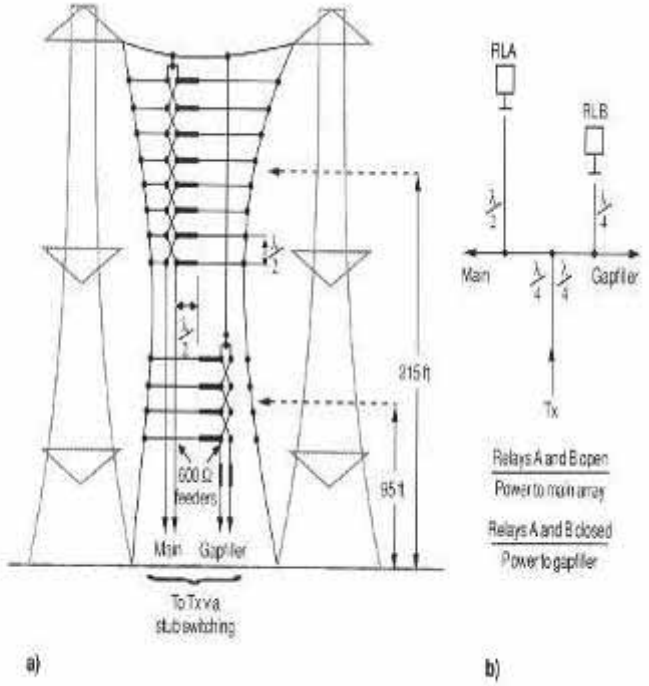


Fig. 6. Typical CH performance diagram



) CH transmitter array, and b) stub switching

Chain Home - Receiver Antennas

- Receiver Antennas
  - Four wooden towers 240’ high
  - Three antenna stacks identified as A, B and C
  - A and B system, crossed half wave Dipoles aligned N-S and E-W with switched reflectors
  - C system, two single dipoles used for height finding in Gapfiller mode
  - Feed with 72Ω, pressurised, solid copper Coaxial cables

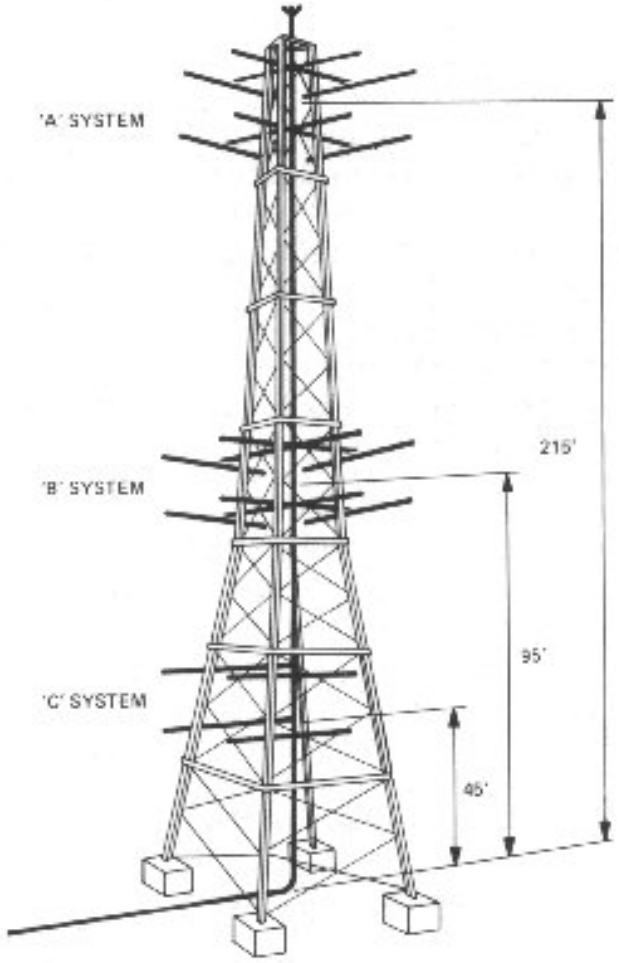


Fig. 8. Dipole arrays on a receiver tower

Chain Home - Transmitter

- Transmitter
  - Metropolitan-Vickers
  - T3026
  - 750kW peak, later 1MW

Fig. 9. East Coast CH transmitter room

Chain Home - Transmitter

- Transmitter
  - SW5 Pulse Oscillator
  - Type 43 Class C Doubler Driver + Dummy Valve
  - 2 x Type 43 Class C Push-Pull Power Amplifier
  - Output and driver stages, continuously evacuated demountable tetrodes, Type 43

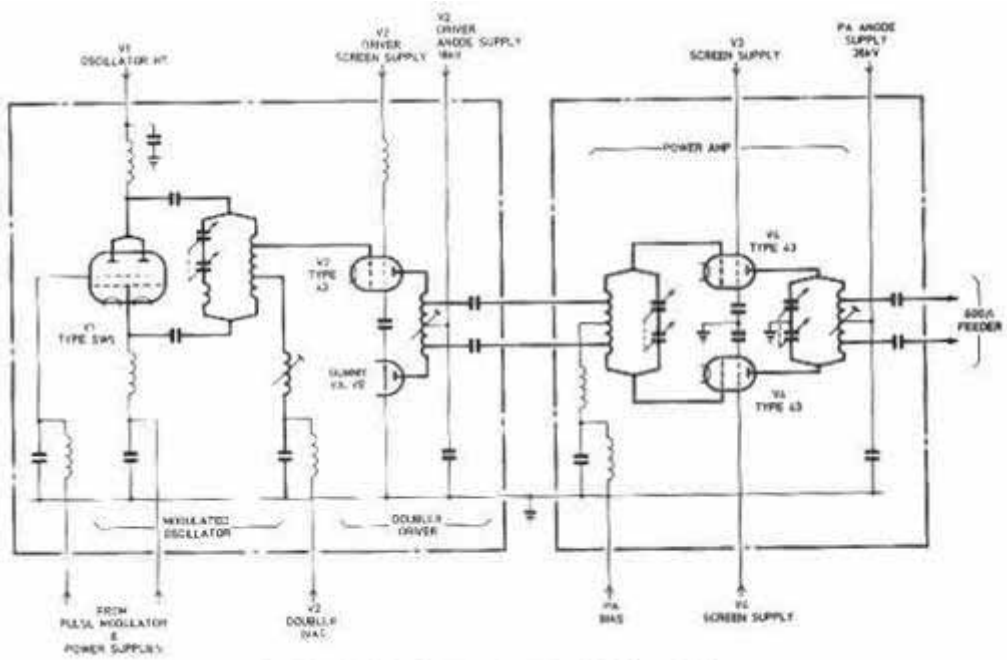


Fig. 10. Simplified circuit diagram of CH transmitter

Chain Home - Transmit Valves

- Transmitter Type 43 Valve
  - Demountable
  - Water cooled Anode
  - Filament Control and Screen Grids could be replaced
  - Filament 18V/140A
  - Anode Voltage 35kV
  - Output Power 750kW
  - Transmitters had inbuilt vacuum pumps

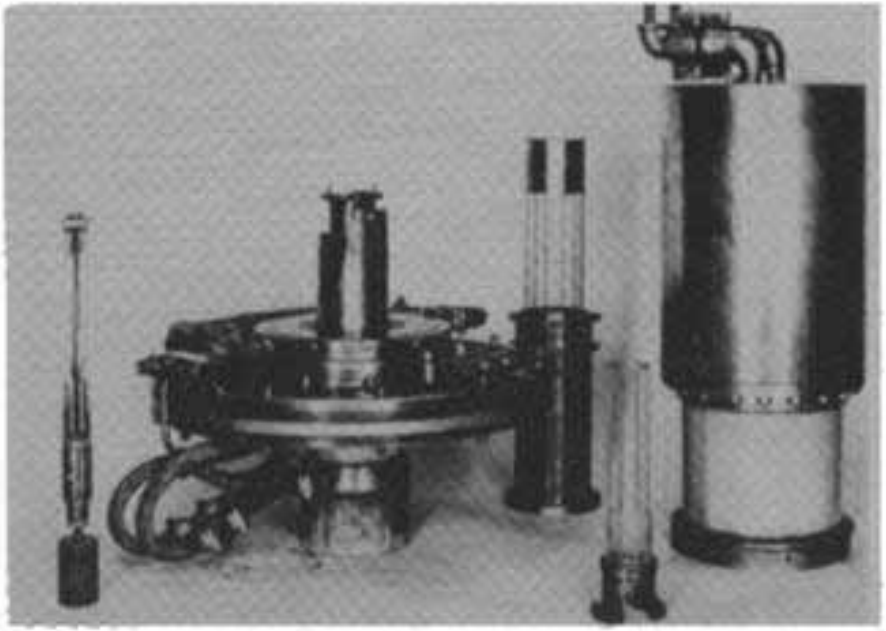


Fig. 11. Components of demountable valve type 43

Chain Home - Receiver

- Receiver
  - A C Cossor Ltd
  - Three stage balanced RF amplifier using EF8's
  - Balanced mixer
  - 1st IF 2MHz
  - IFRF
  - 5 stage single ended IF amplifier with choice of 3 bandwidths
    - 500kHz
    - 200kHz
    - 50kHz

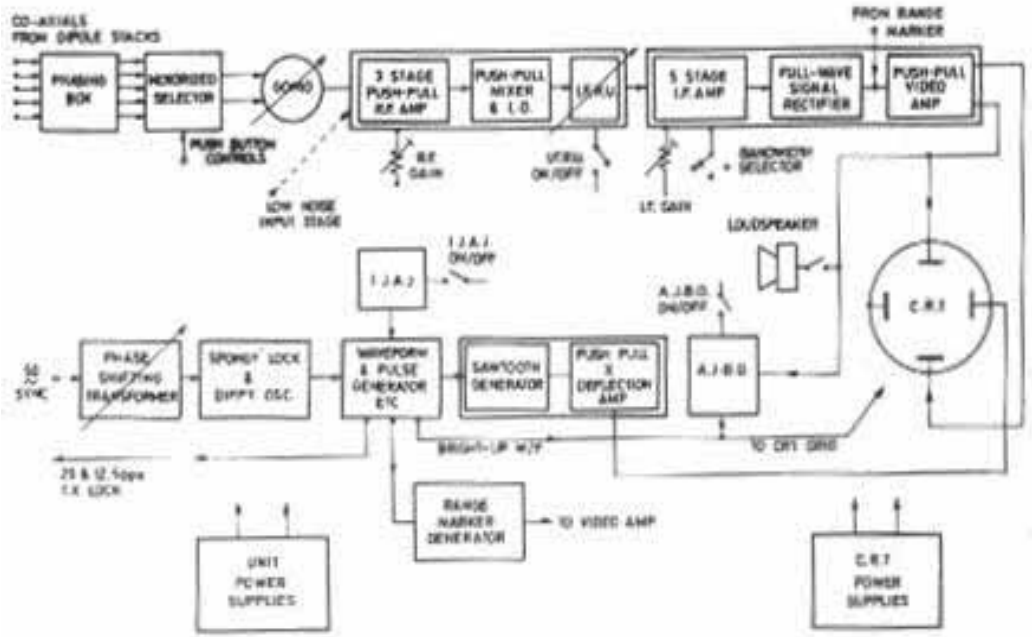


Fig. 12. Schematic diagram of receiver and display console

Chain Home - Receiver

- Receiver
  - A C Cossor Ltd
  - Three stage balanced RF amplifier using EF8's
  - Balanced mixer
  - 1st IF 2MHz
  - IFRF
  - 5 stage single ended IF amplifier with choice of 3 bandwidths
    - 500kHz
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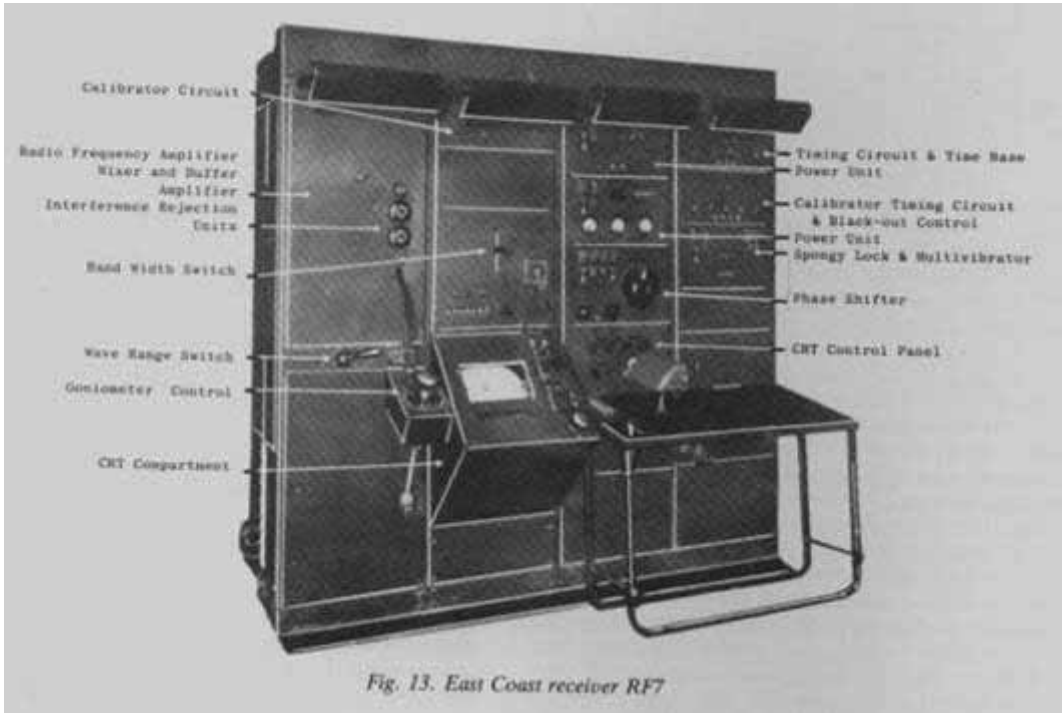


Fig. 13. East Coast receiver RF7

Chain Home - Calculator

- The Calculator
  - Each Station calibrated by aircraft or autogyro
  - Inputs
    - Target range
    - Target bearing
    - Target height
    - Earths Curvature
  - Output
    - Corrected Target Height

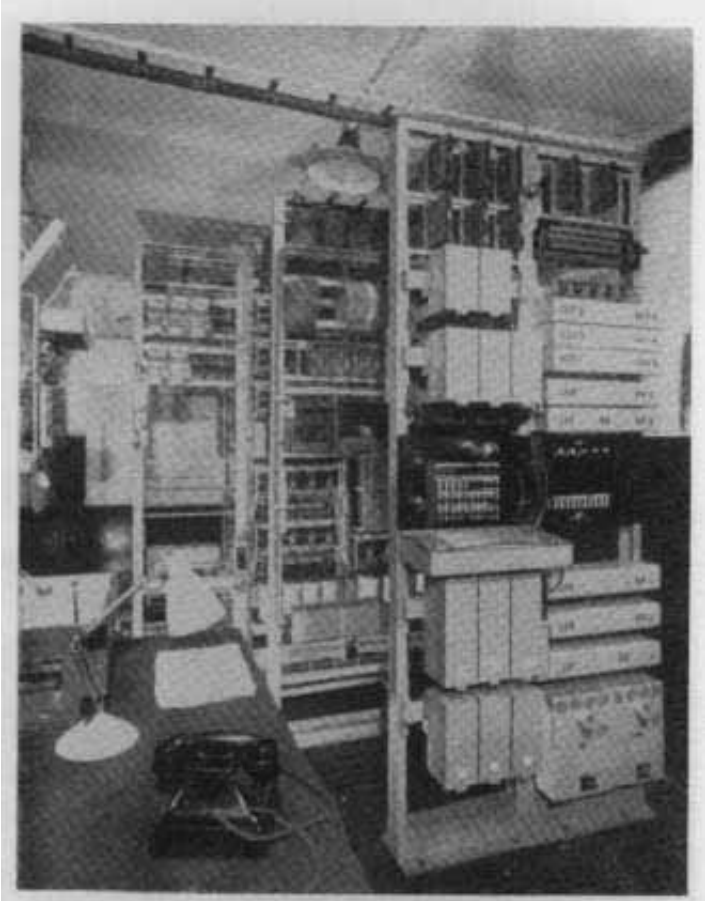
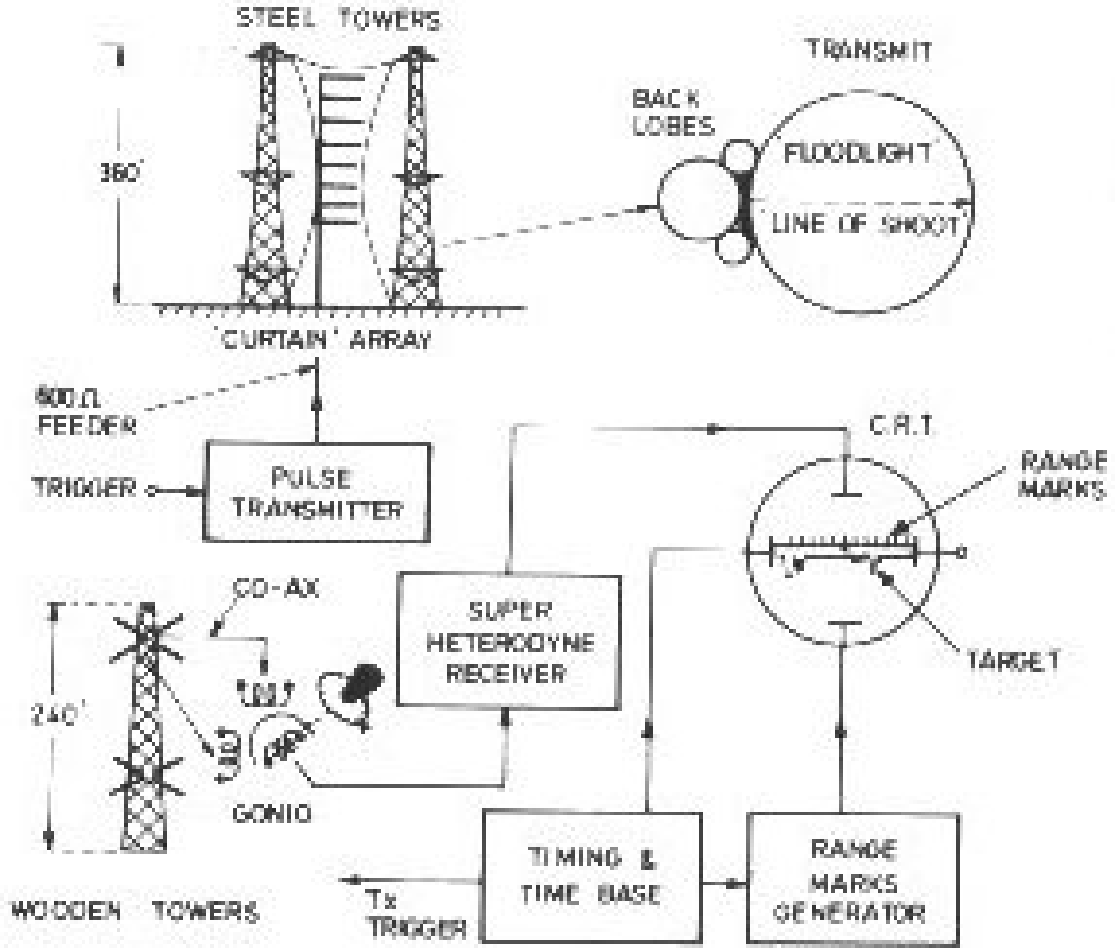


Fig. 15. CH electro-mechanical calculator

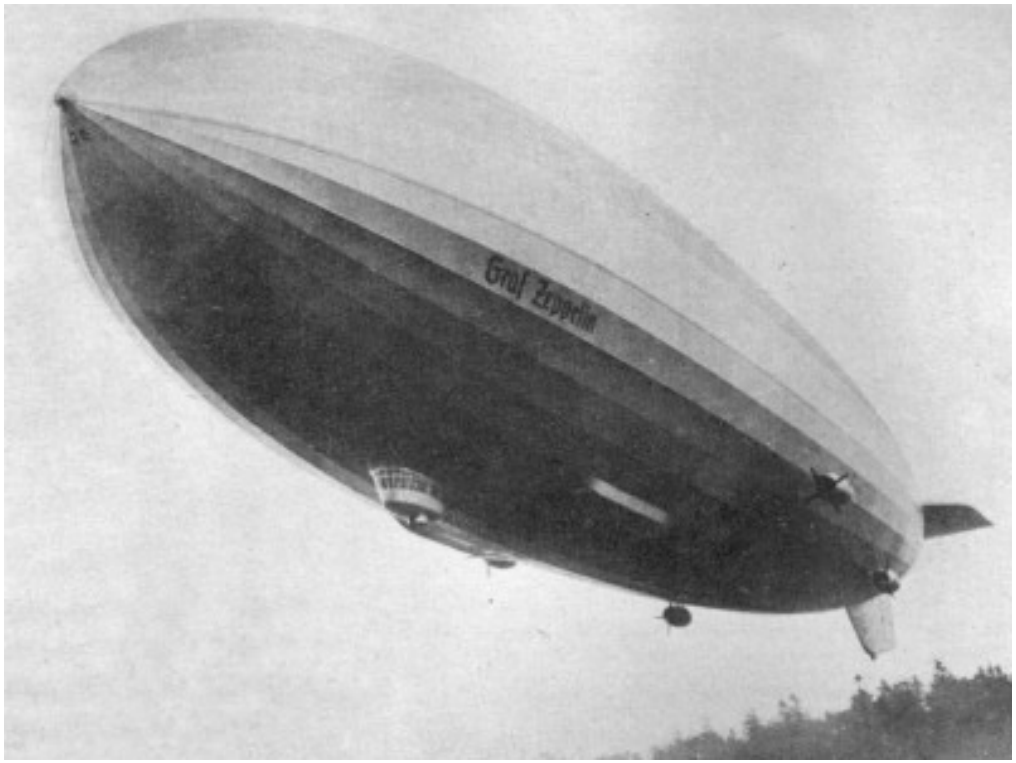
Chain Home Operation

- Chain Home – The general principle of operation



Chain Home RDF

- Did the Germans know what we were doing ?
  - Chain Home – one of the best kept secrets of WW2
  - Graf Zeppelin – LZ130

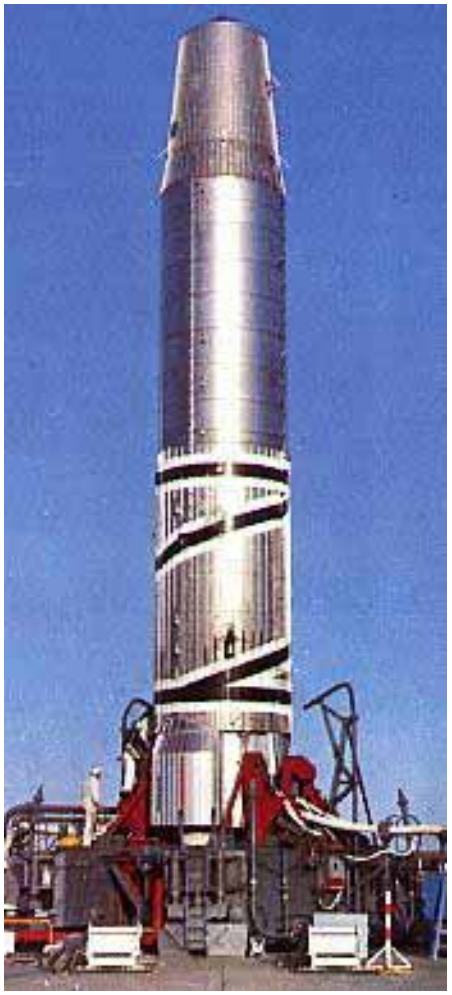


The Battle of Britain

- Chain Home played a major role in the Battle of Britain
  - Existence of RDF disclosed to the public in 1942
  - Project Big Ben

A New Lease of Life

- The Blue Streak Project
  - Medium range Intercontinental Ballistic Missile (ICBM)
  - Range 2,000 miles
  - Powered by liquid fueled Rolls Royce rocket motor
  - Delivery vehicle for UK's independent nuclear deterrent
  - Cancelled in 1960
  - Rocket was used as the first stage for the European Launch Vehicle



CH Mast at Baddow - A New Lease of Life

- Projects
  - Radio wave Propagation
  - High Speed Radar Data Link
  - National One
  - 805SW Tracker Antenna for SWMLU

The Future

Gt Bromley

Dover

Great Baddow

Stenigot

Stoke Holy Cross

Questions and Answers