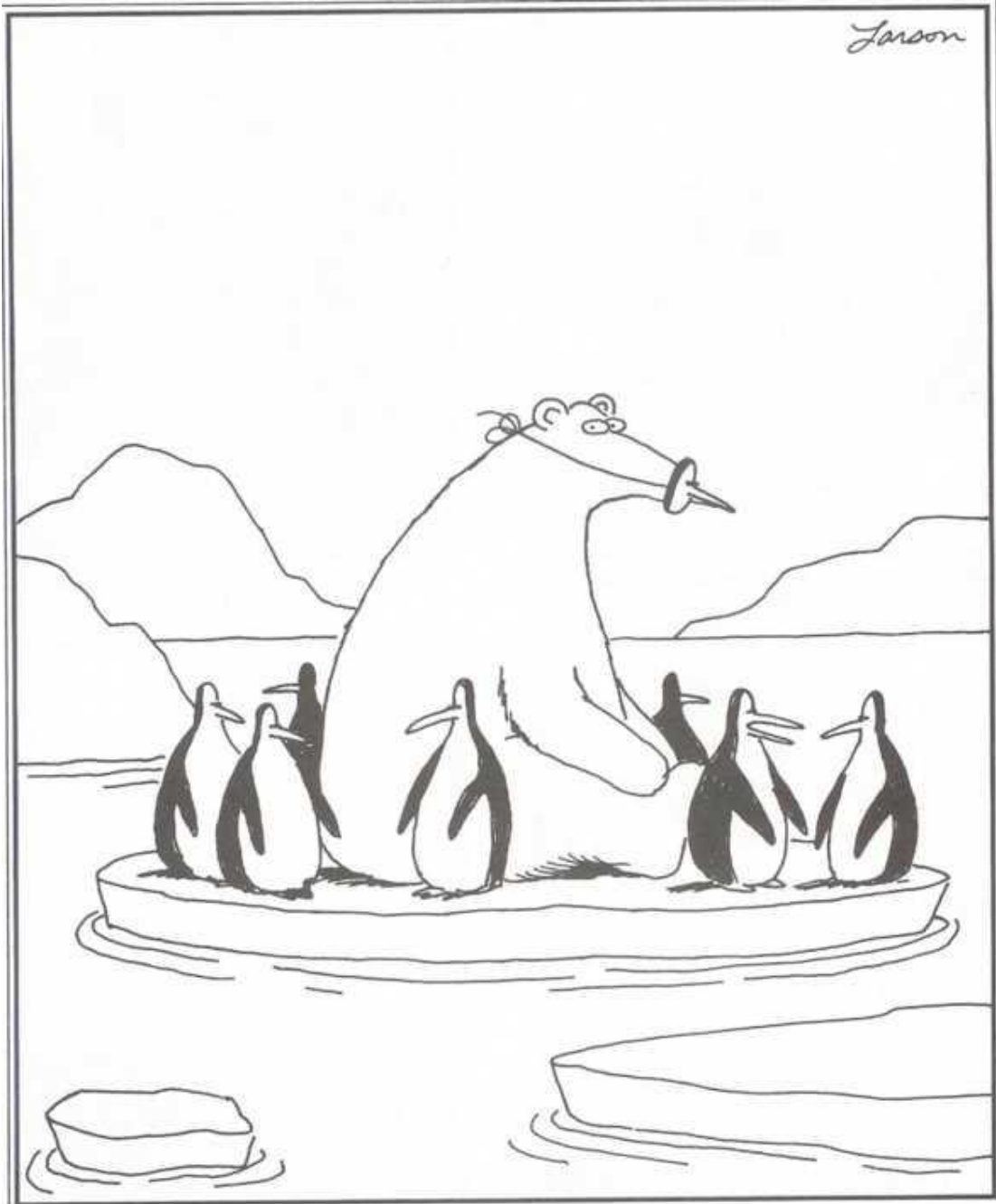
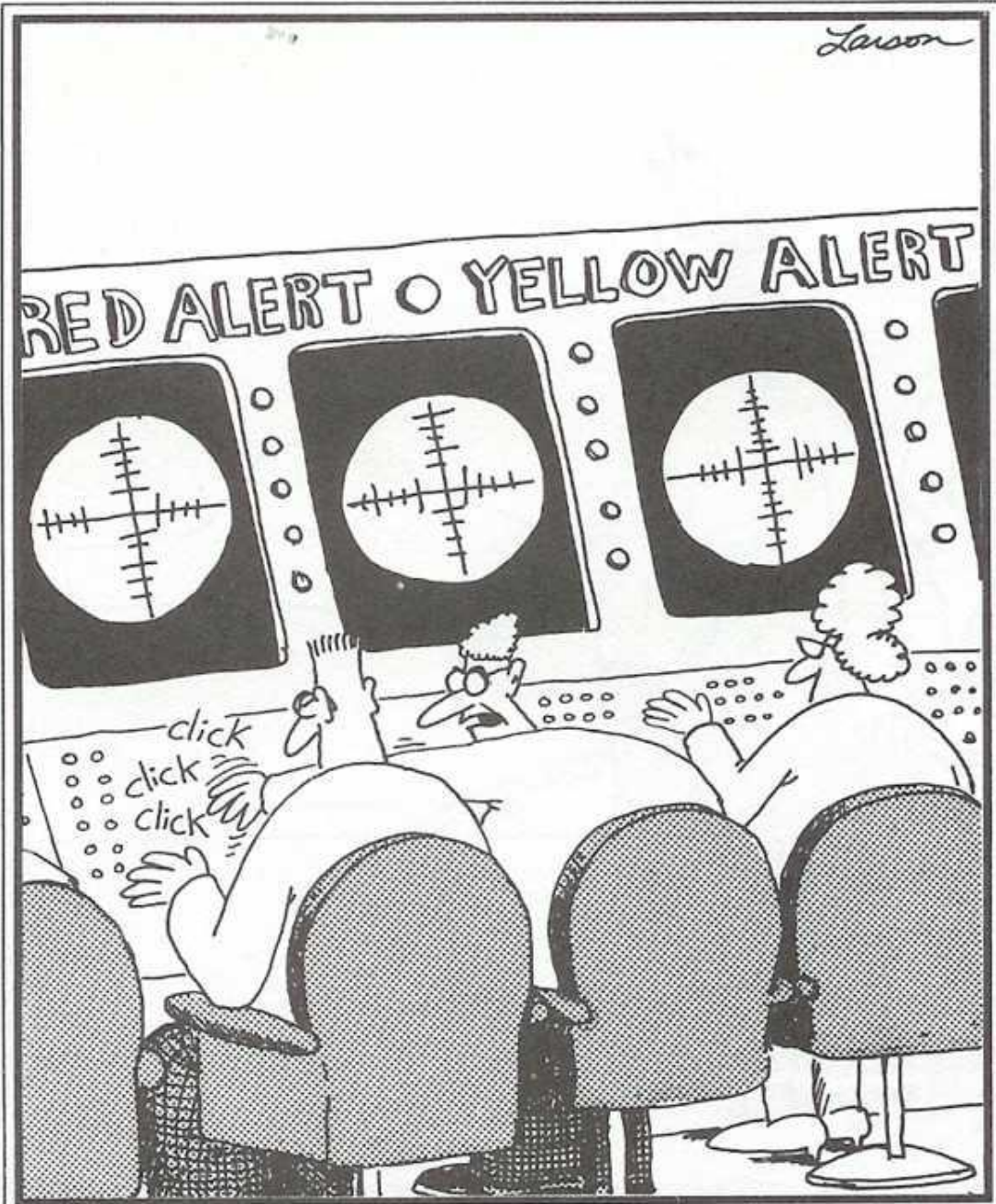


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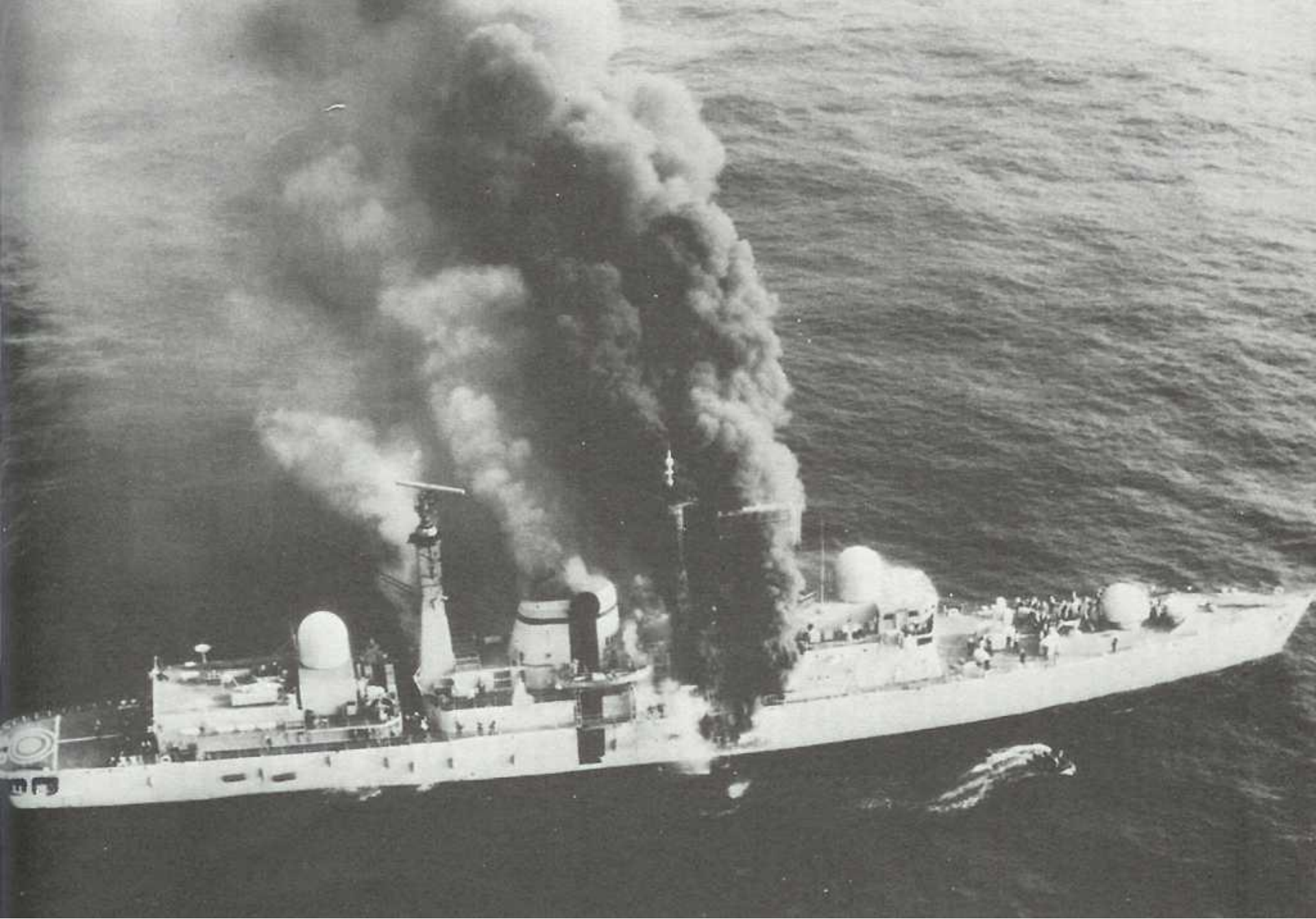


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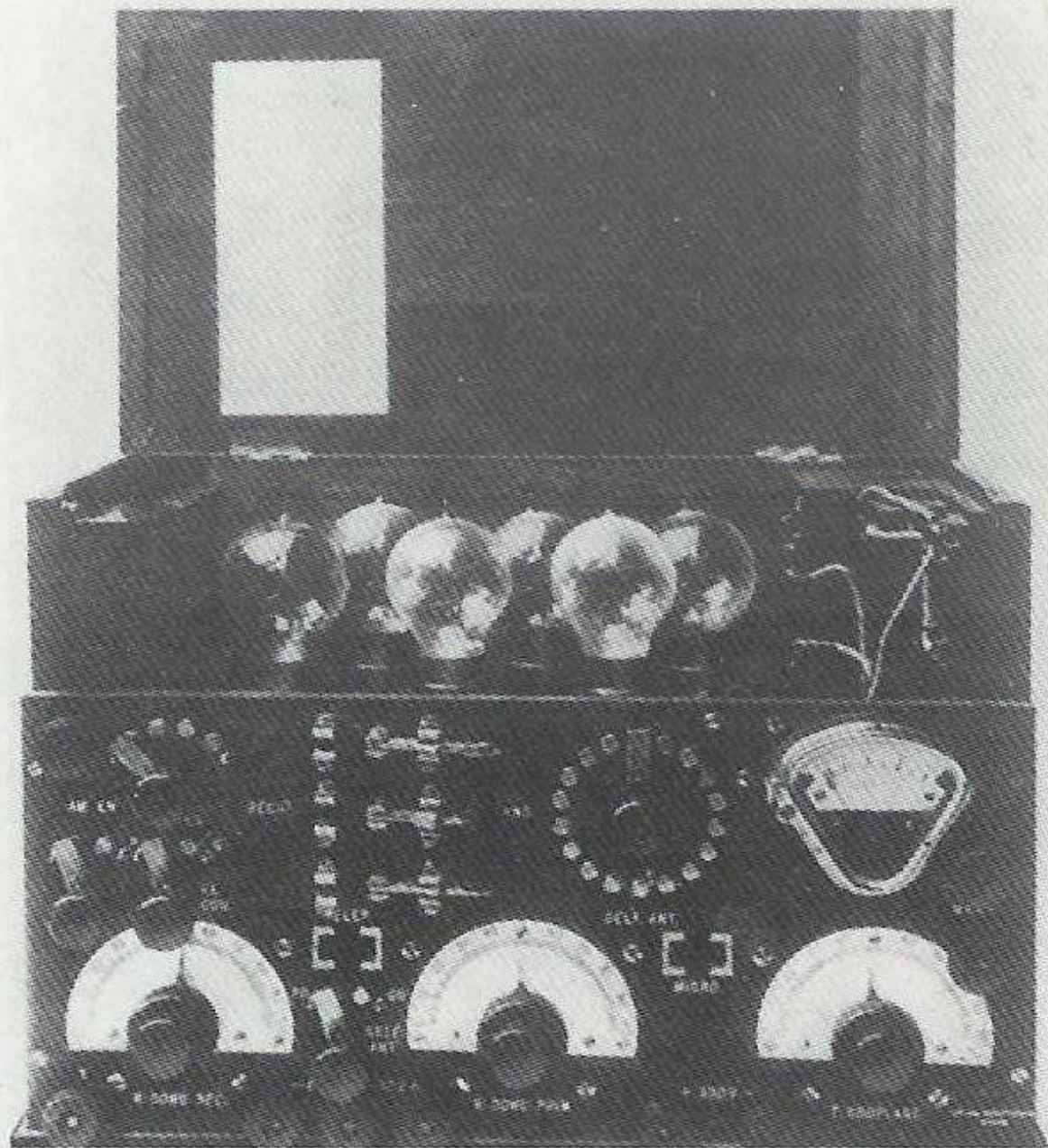
"And now Edgar's gone. ... Something's going on around here."

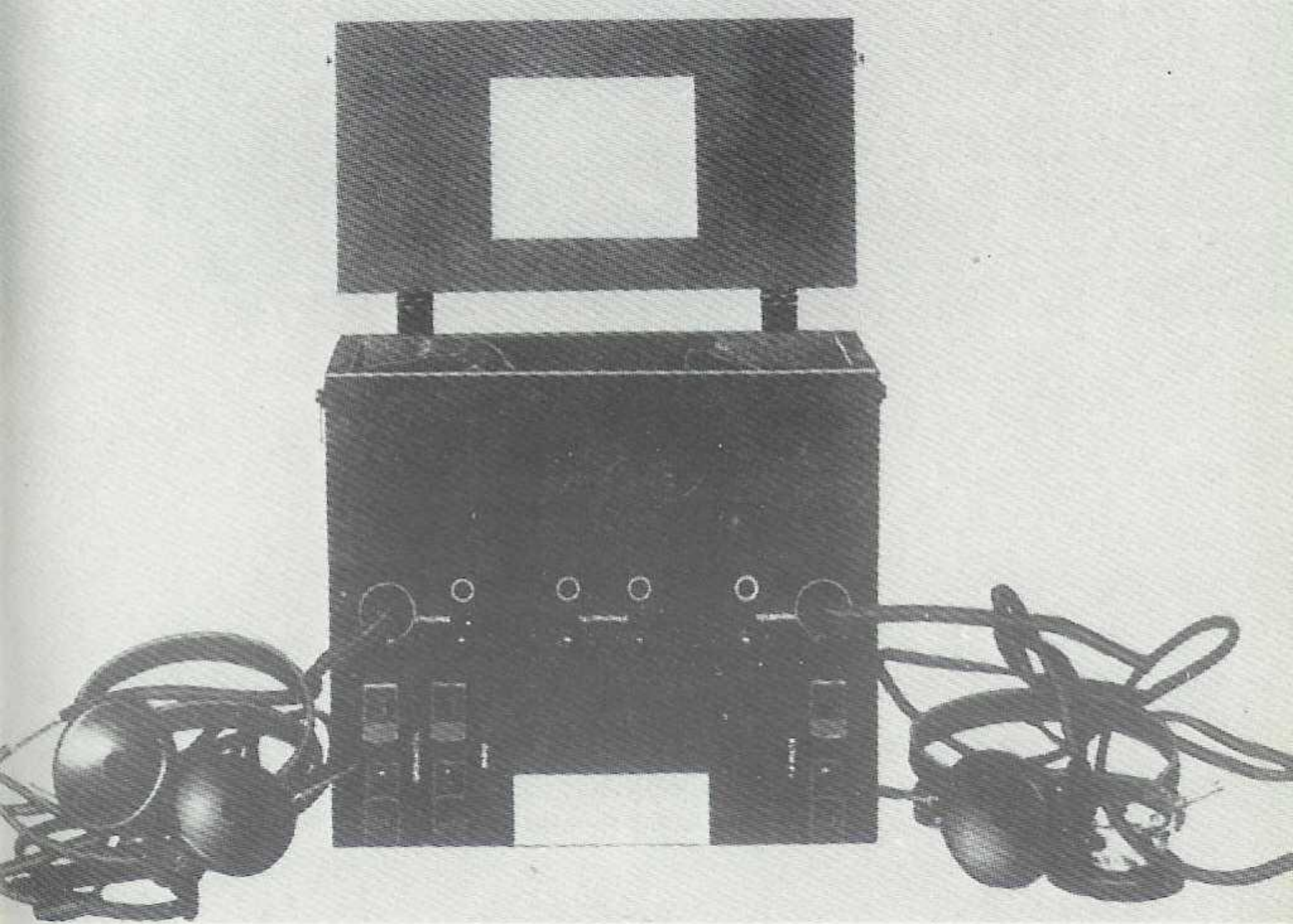


"OK, Baxter, if that's your game, I'll just reach over and push a few of your buttons."

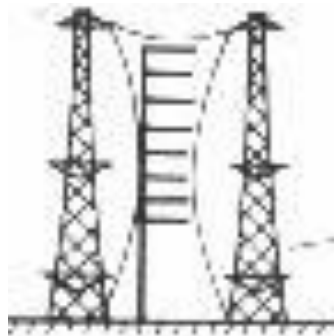








The **BATTLE** of the **BEAMS**



March 1940 – May 1941

Al Penney, VO1NO

Instruments of Darkness

Alfred Price

Electronic Warfare

Mario de Arcangells

Most Secret War

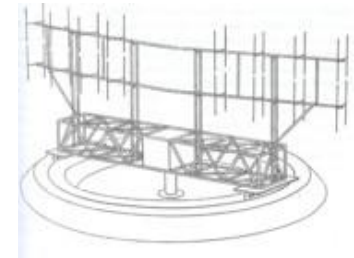
R. V. Jones

The Secret War

Brian Johnson

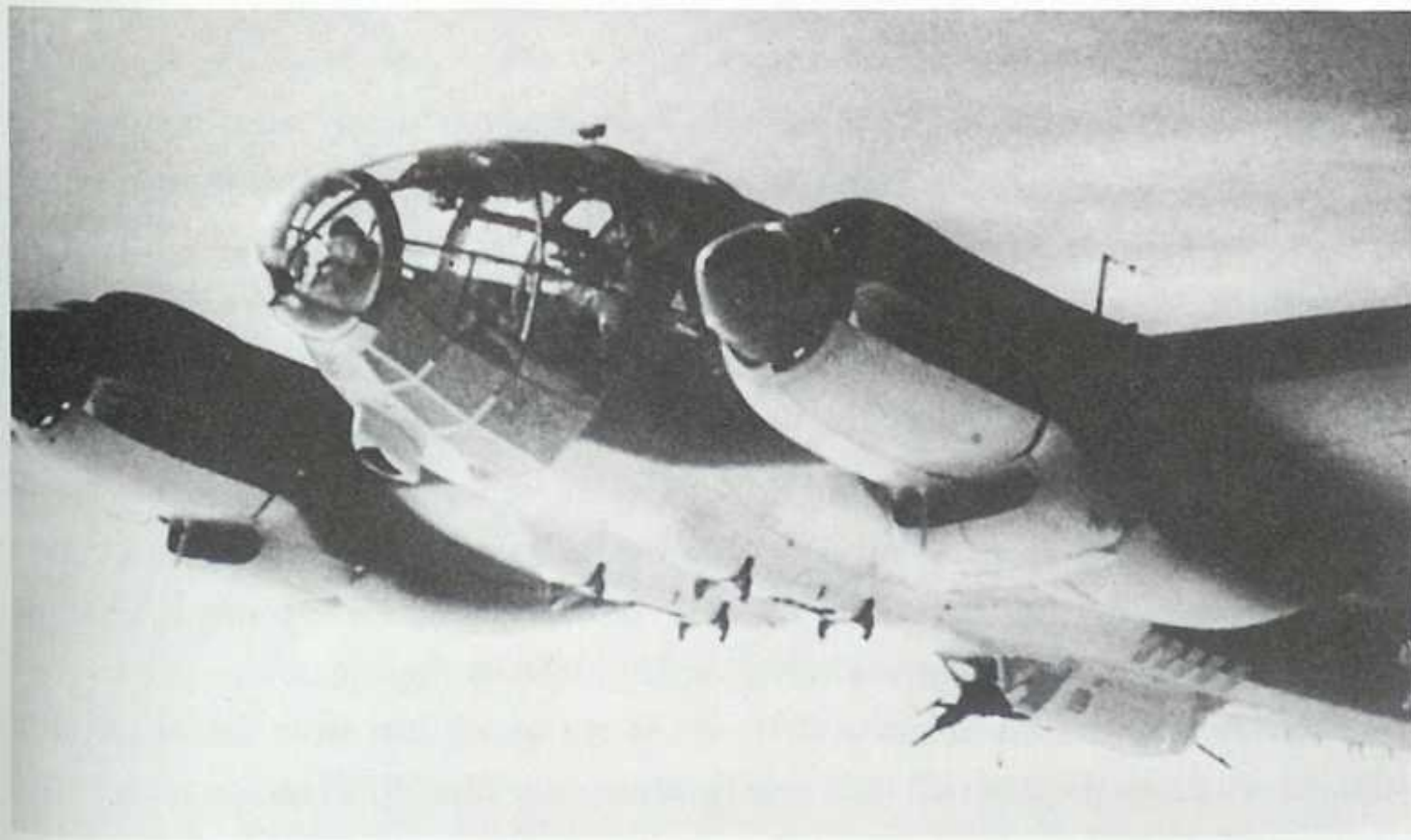
Night Fighters

Bill Gunston





Luftwaffe Heinkel 111 bomber



The glazed nose of a Heinkel 111, the standard German medium bomber. First flown in 1935 as a commercial airliner, it was quickly developed as a bomber and, tested with the Legion Condor in Spain, it became the backbone of the Luftwaffe bomber groups, remaining in service until the end of the war, when the Spanish Air Force built it under licence (with Rolls-Royce Merlin

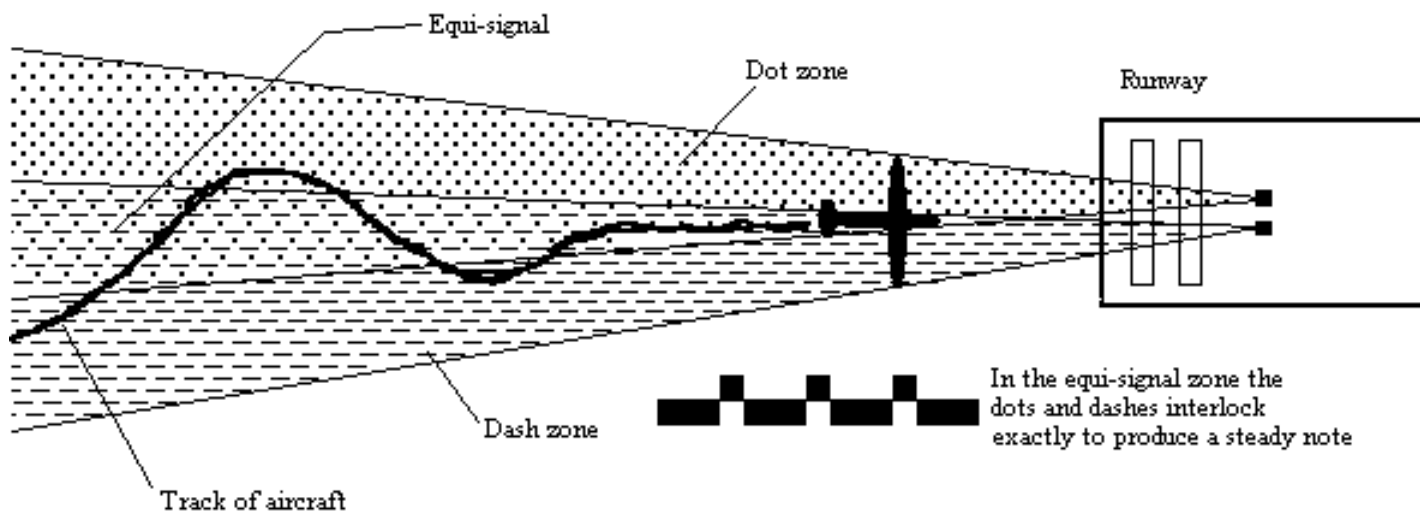
See notes



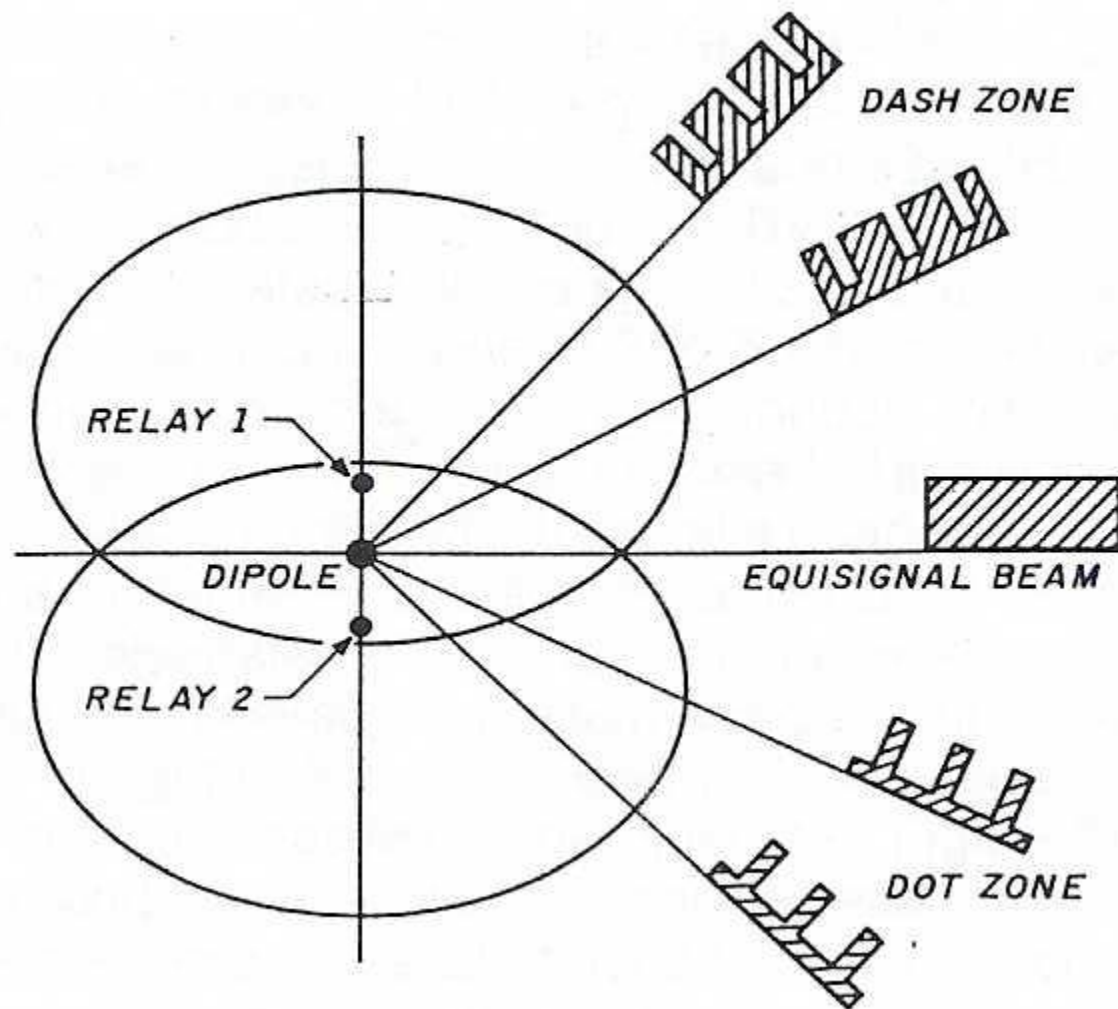
Dr. Reginald V. Jones
1911 – 1997

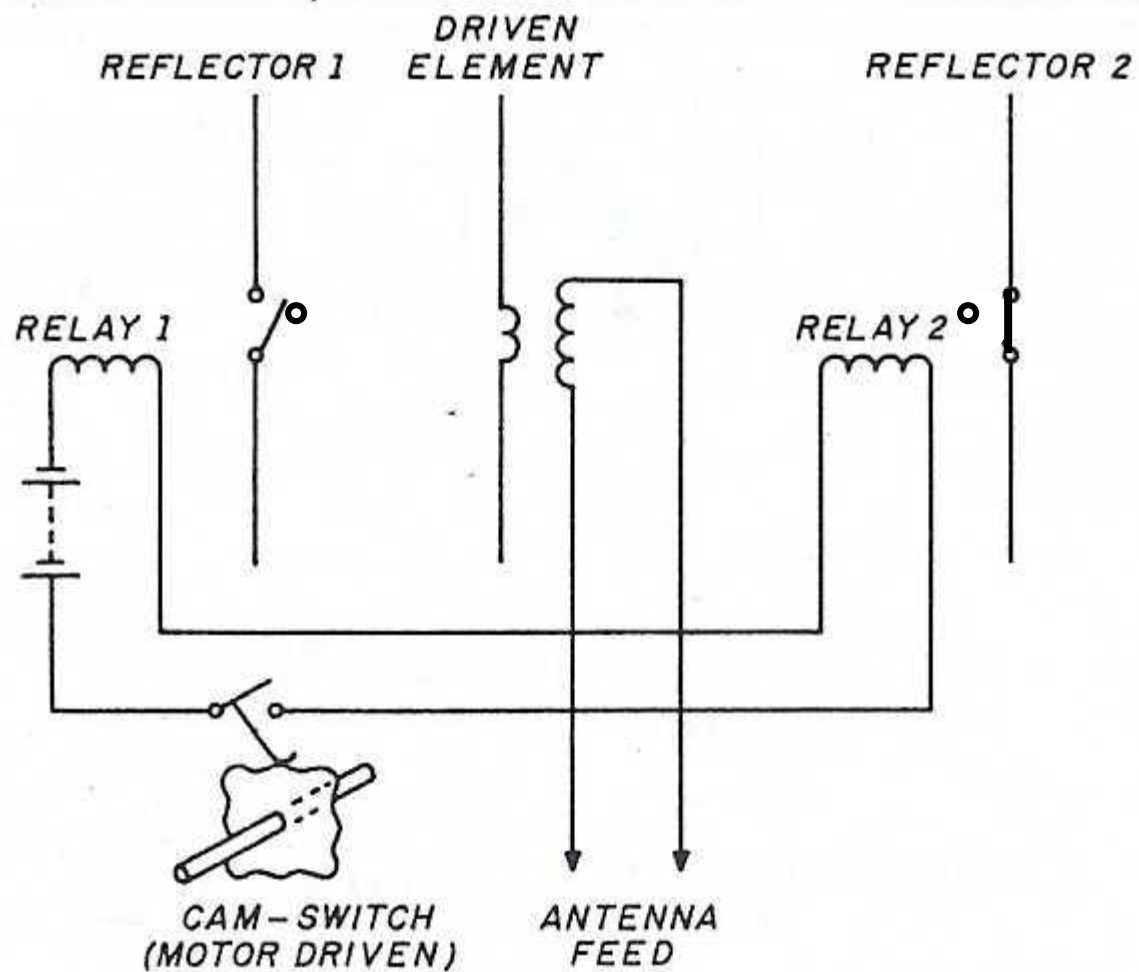
- Commissioned in Officer Training Corps 1928**
- PhD in Physics 1934**
- Assistant Director of Scientific intelligence 1939**
- Outstanding work in all aspects of Scientific Intelligence.**
- Professor Emeritus**
- “Most Secret War” published as “The Wizard War” in United States**

See notes

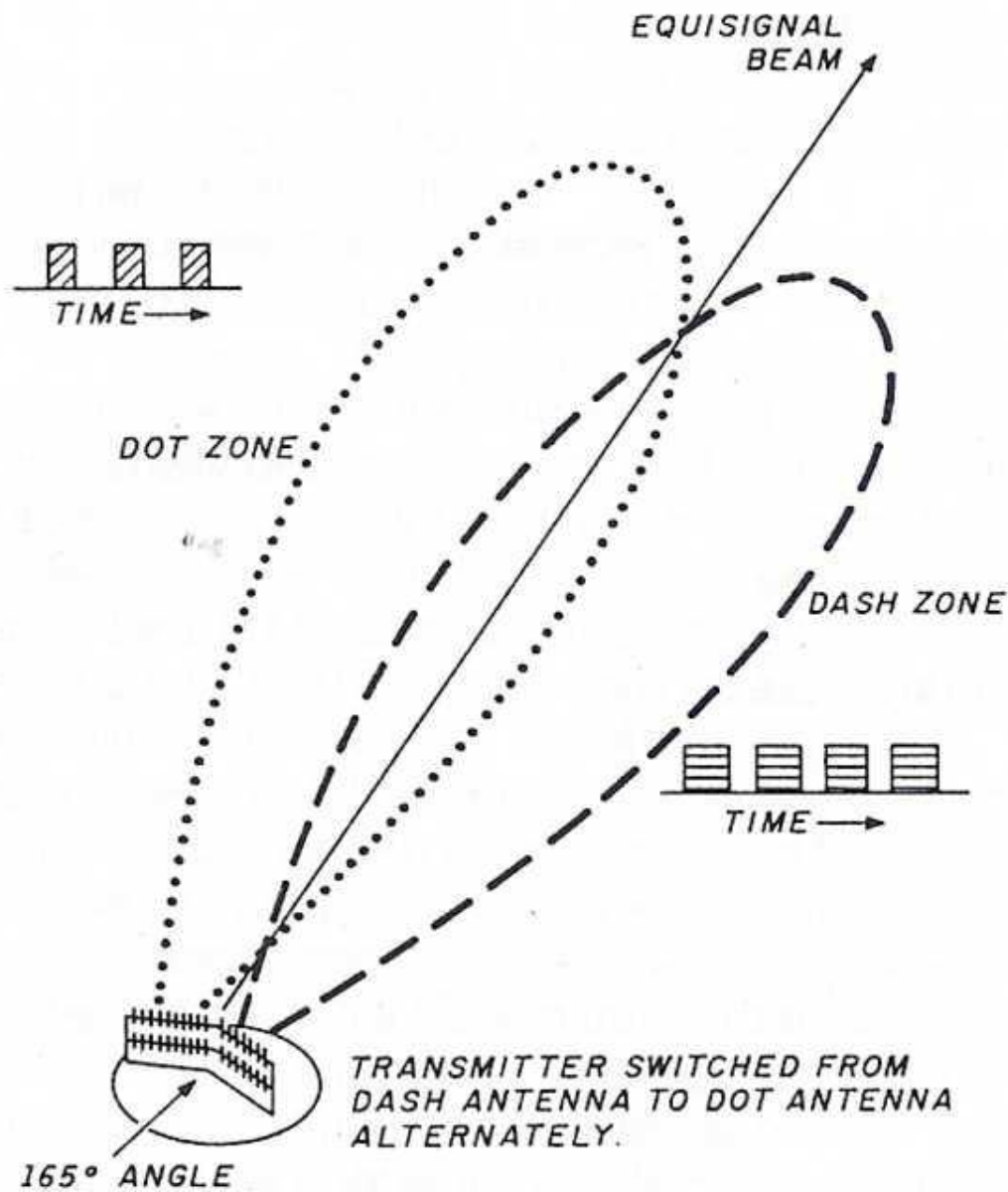


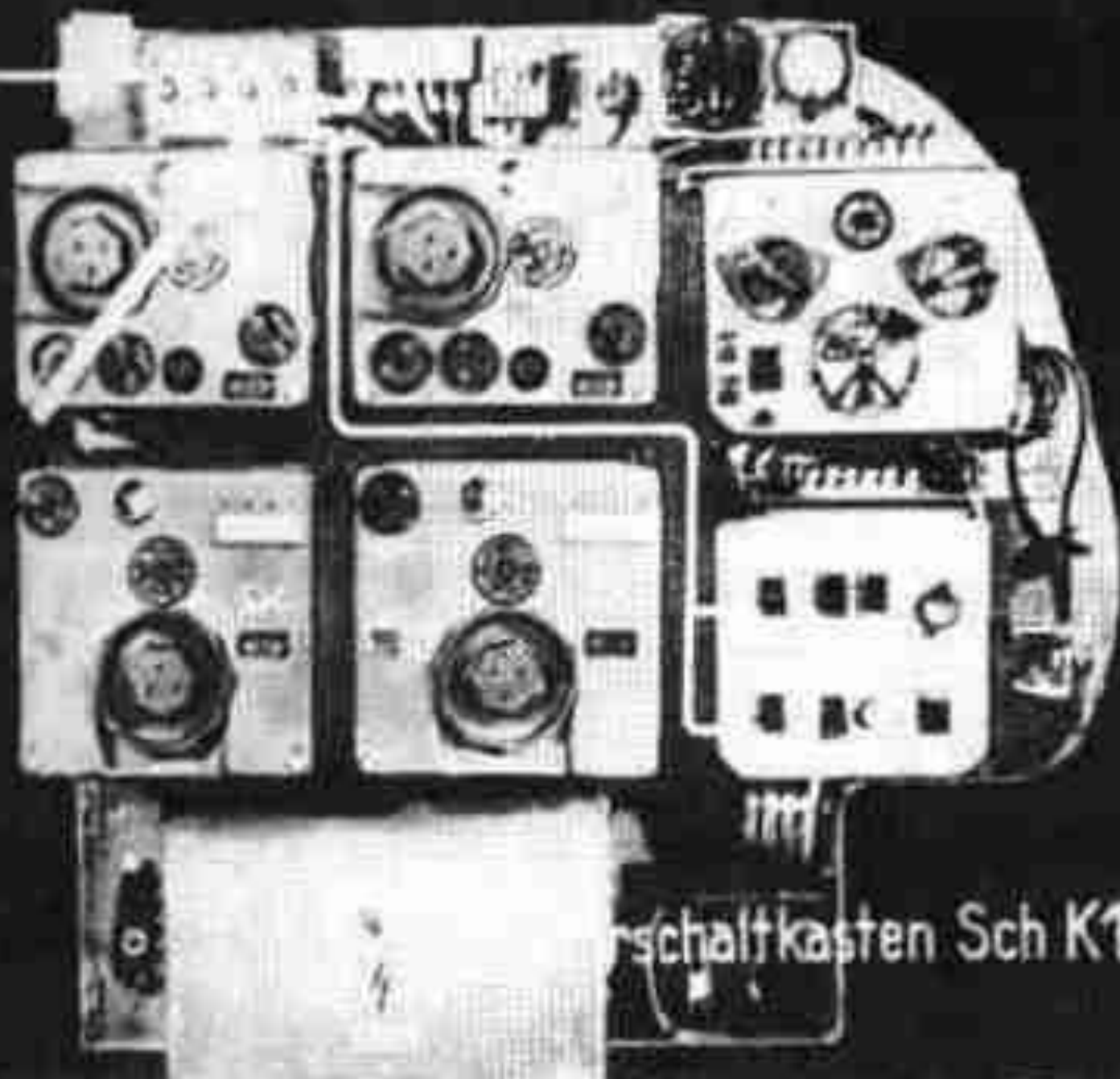
The Lorenz Beam for Blind Landing



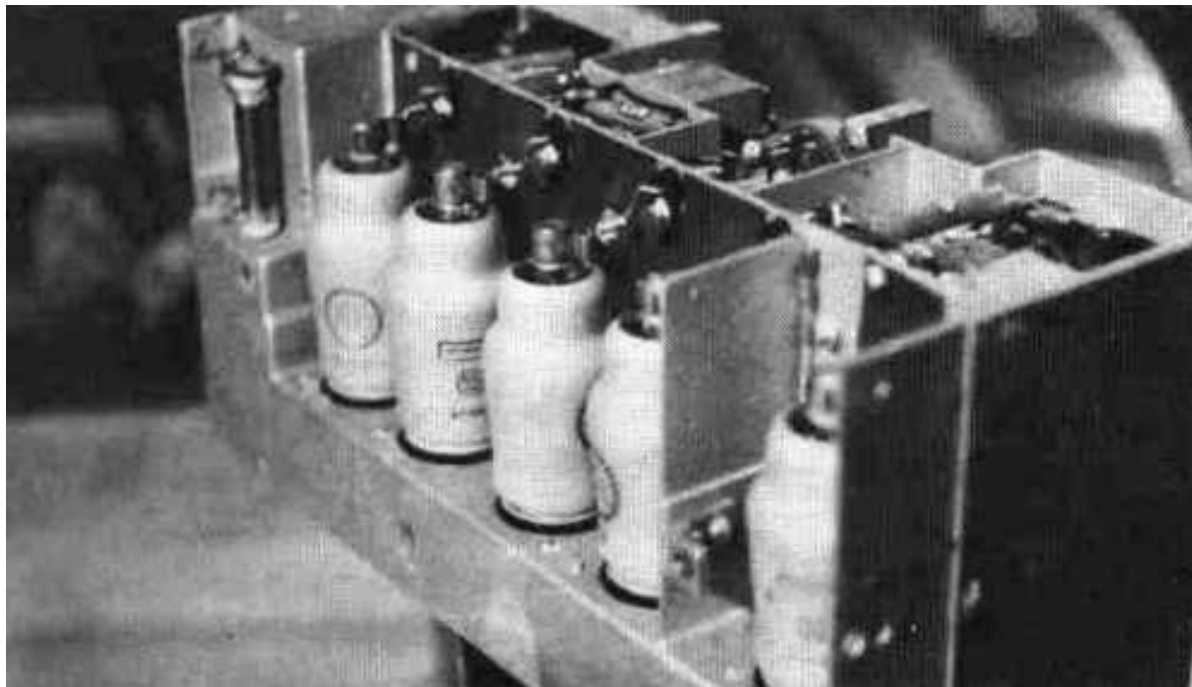


ON THE EQUISIGNAL, DOTS
EXACTLY FILL THE GAPS
BETWEEN THE DASHES, SO
THAT THE PILOT HEARS A
CONTINUOUS NOTE.





Schaltkasten Sch K13

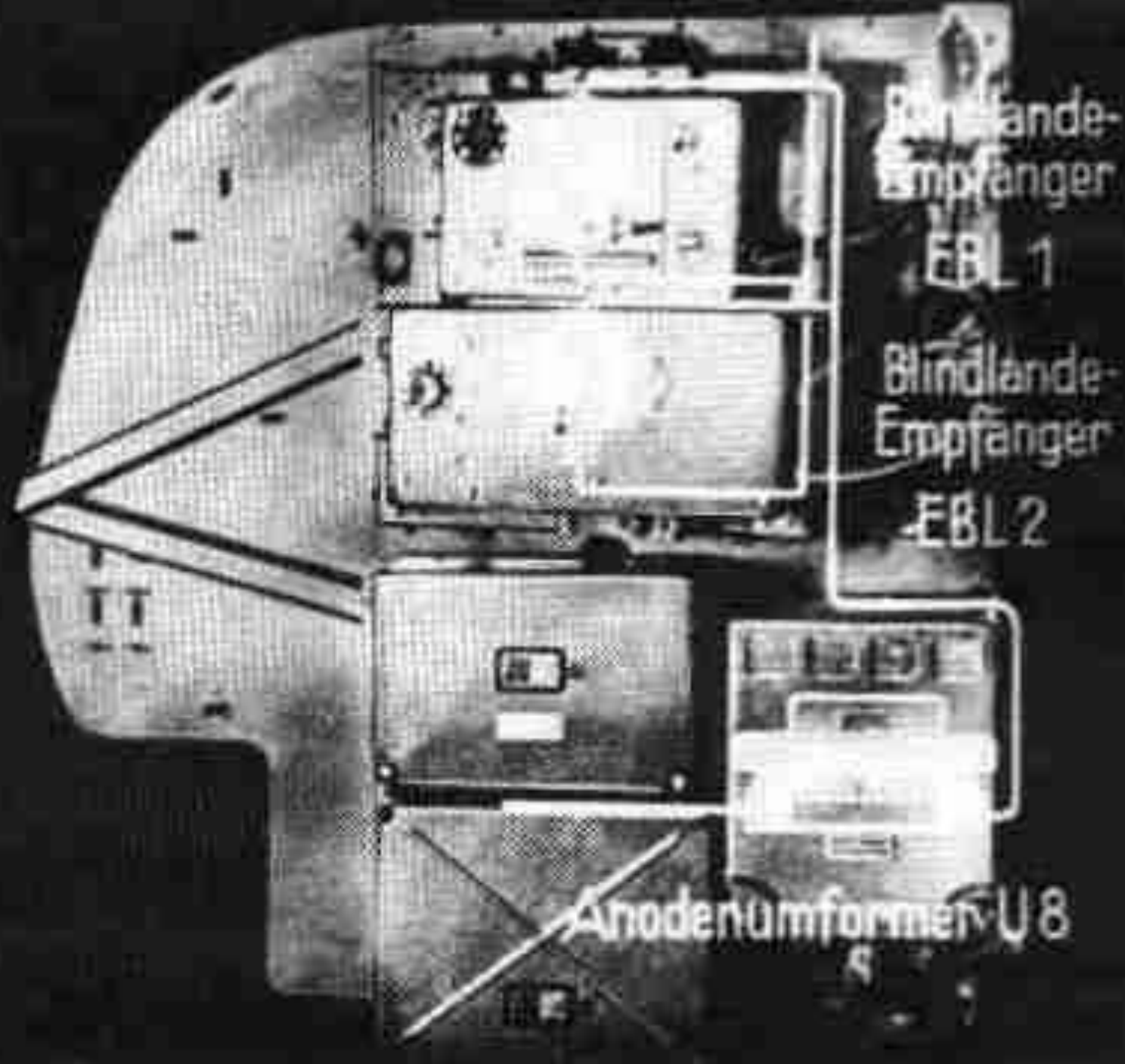


Captured German E Bl 2 Receiver

Five high gain pentode tubes gave it unusual sensitivity – key to its true function.



A typical radio installation in a night bomber (Ju88) c. 1940. A signals mechanic is plugging in a replacement transmitter. This FuG10 equipment was modular and extremely advanced, all the connections being made automatically, thus avoiding vulnerable plugs and cables.



See notes



“There seems to be some reason to suppose that the Germans have some sort of radio device with which they hope to find their targets.”

Professor Lindemann

“This seems most intriguing and I hope that you will have it thoroughly examined.”

Prime Minister Winston Churchill

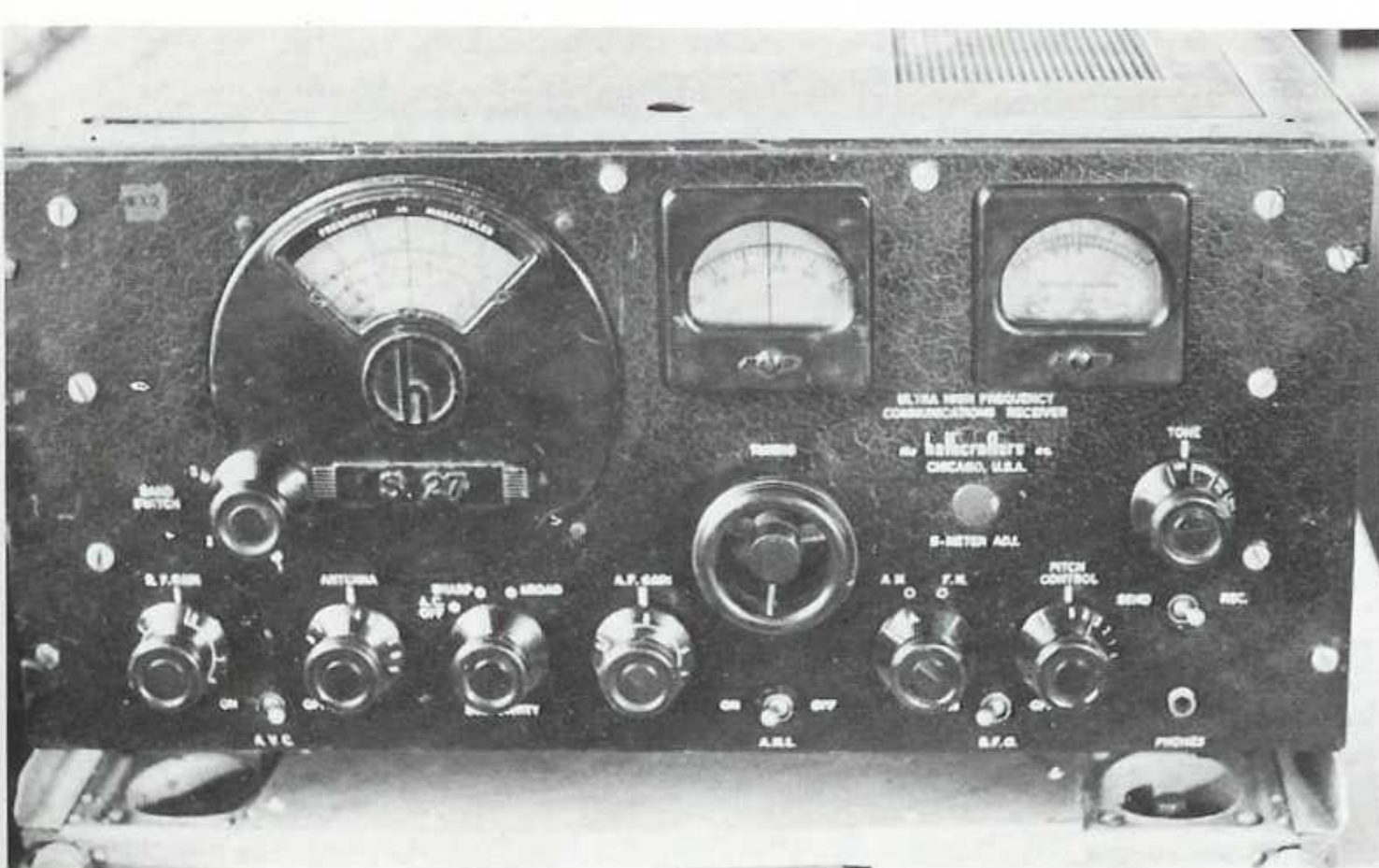




Avro Anson

“Knickebein (Kleve) 31.5”

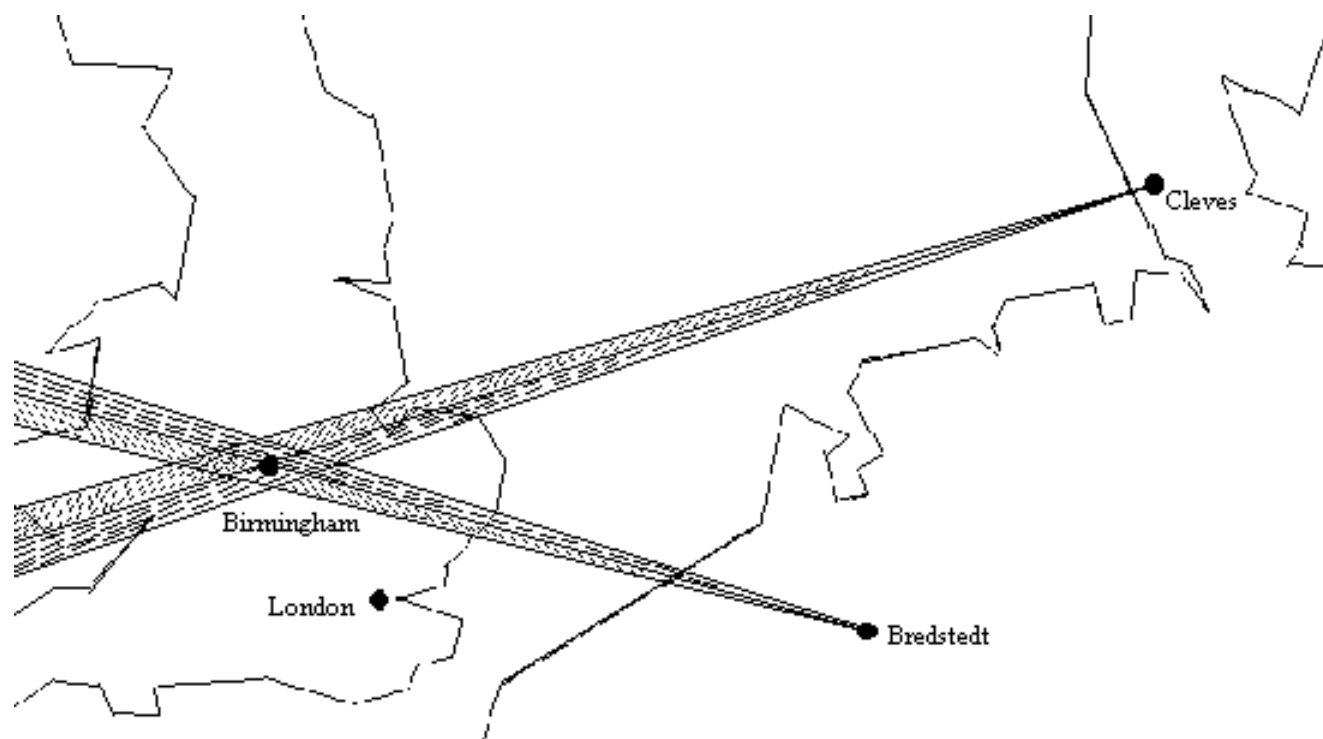
*“VHF. Knicke 54°38’7” N, 8°56’8” E, 51°0’30” N, Eqms.,
Stollberg 30 mc/s. Kleve 51°47’ N, 6°2’ E, 55N, 2° Eqms., 31.5 mc/s.”*



A Hallicrafters S27 VHF receiver. These sets were ideal for intercepting German air-to-ground signals, since they covered all frequencies from 10 metres (28 mHz) to 2 metres (142 mHz). This included Knickebein transmissions and both X- and Y-Geräte. In addition, these sets were used by 'Y' Service to monitor German aircrew radio traffic

See notes

“.. Although I was not conscious of my calmness at the time, the very gravity of the situation somehow seemed to generate the steady nerve for which it called. Although I was only 28, and everyone else around the table was my senior in every conventional way, the threat of the beams was too serious for our response to be spoilt by nervousness on my part.”

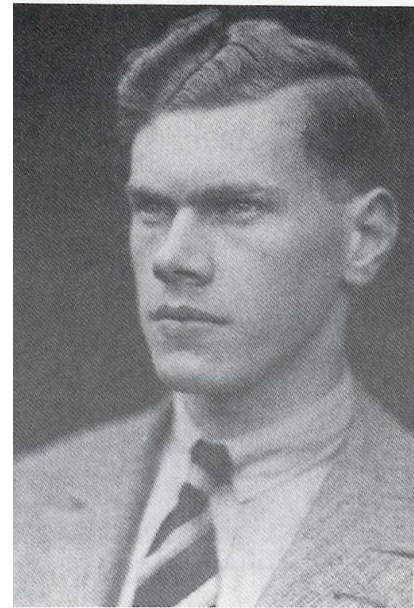


The application of Knickebein in a raid against Birmingham

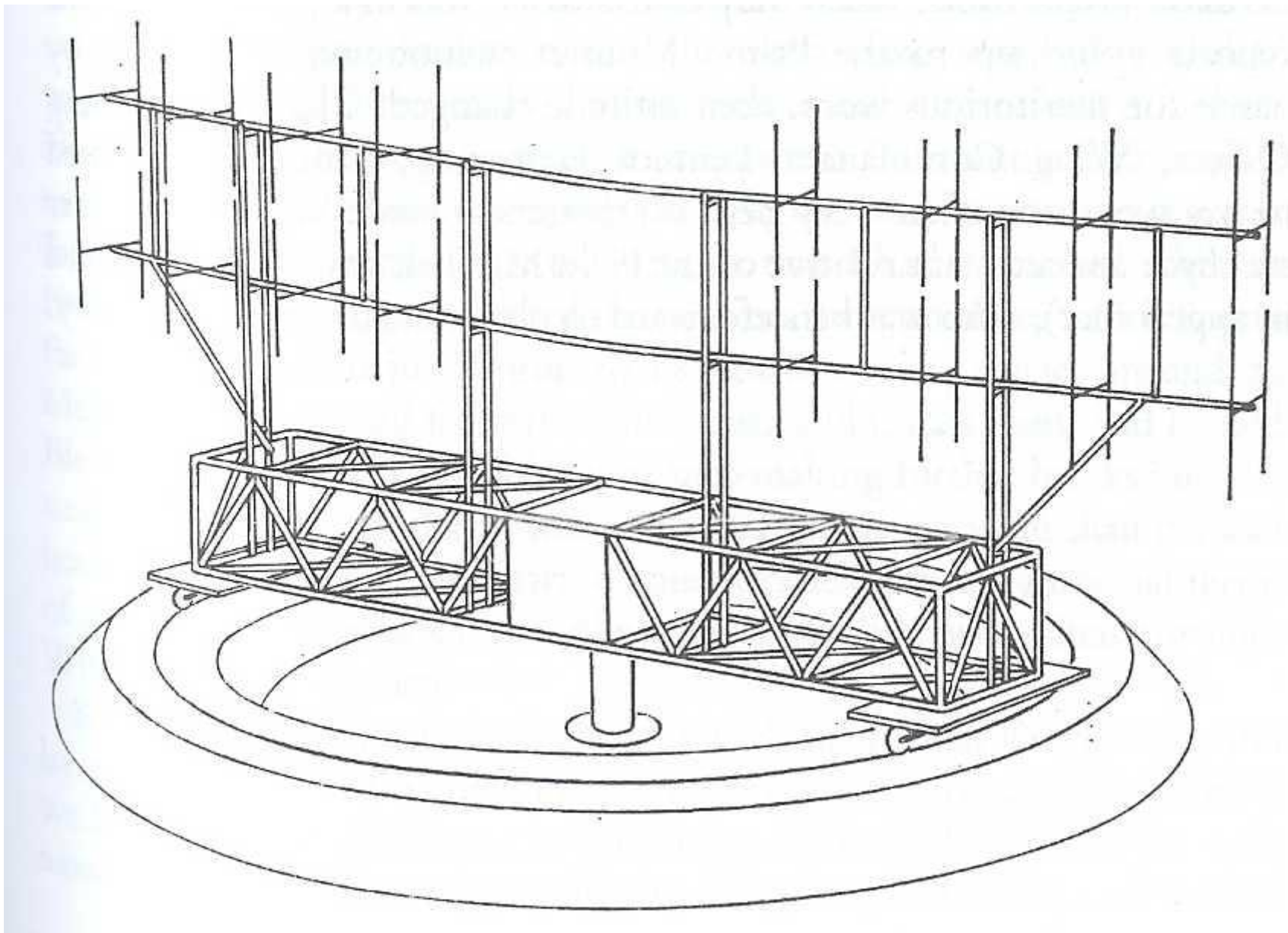
See notes

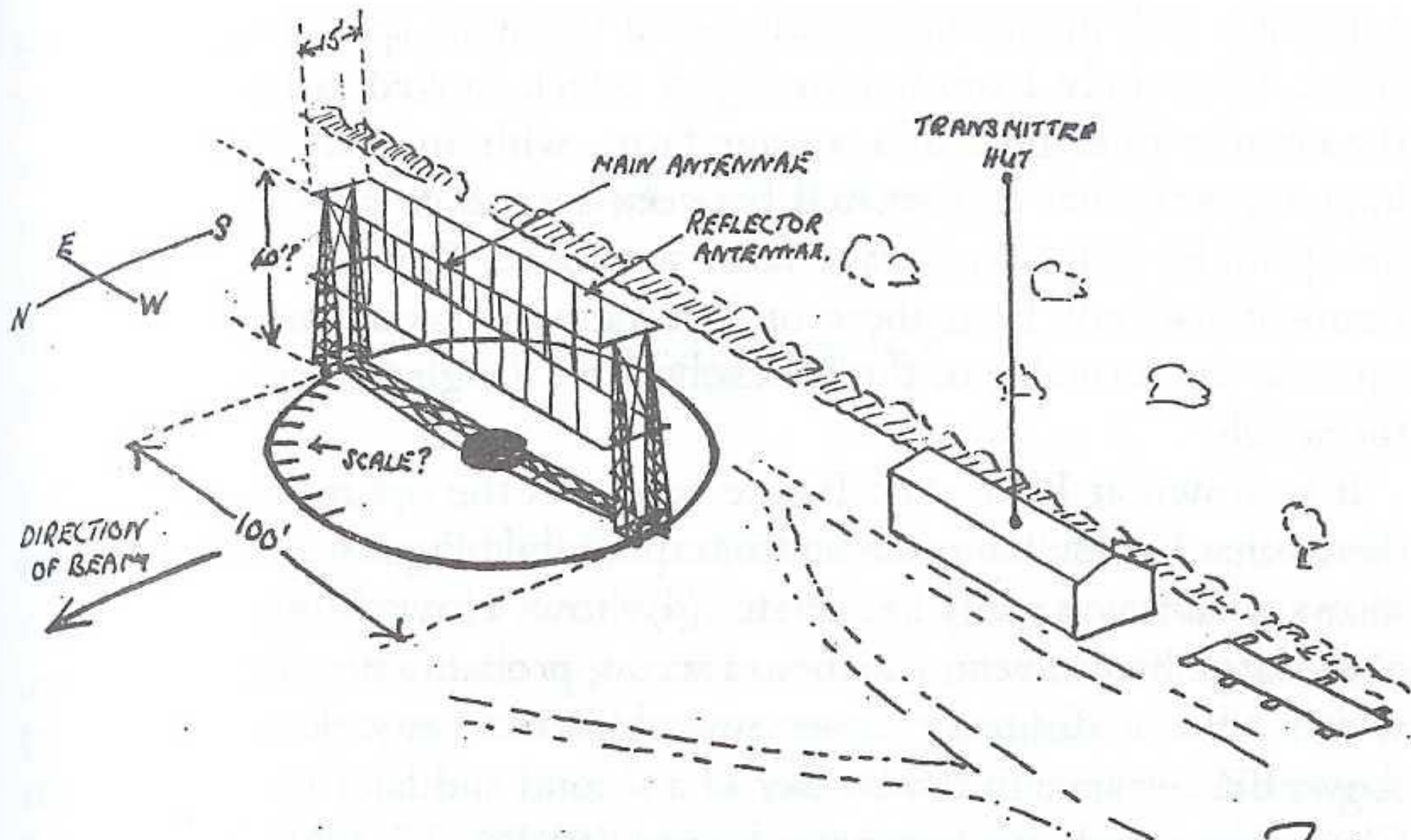
“... jolly well let the Prime Minister know who had countermanded his orders!”

“Had I, after all, made a fool of myself and misbehaved so spectacularly in front of the Prime Minister? Had I jumped to false conclusions? Had I fallen for a great hoax by the Germans? Above all, had I arrogantly wasted an hour of the Prime Minister’s time when Britain was about to be invaded or obliterated from the air?”









KNICKEBEIN INSTALLATION AT BEAUMONT HAGUE

R.Y.J.
S.R.S.
18.9.40.

See notes



Diathermy set

See notes

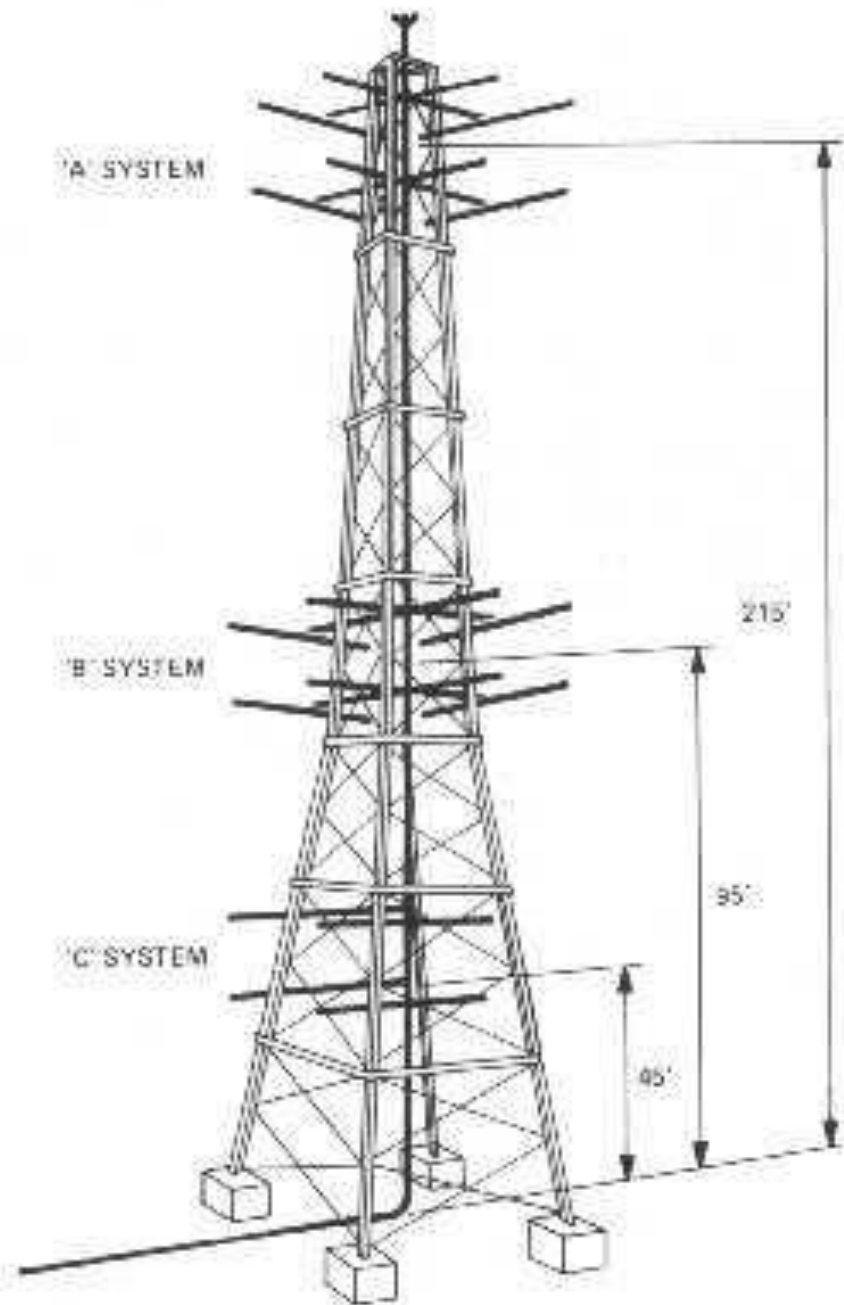
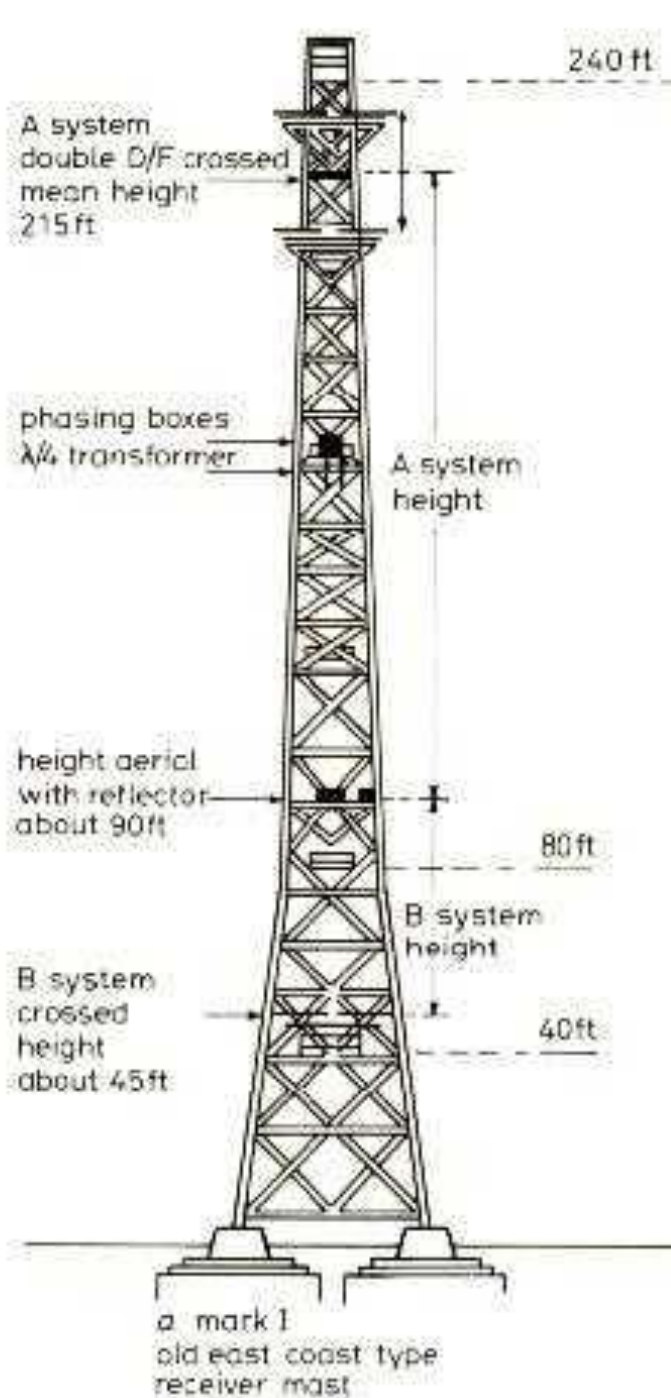


Fig. 8. Dipole arrays on a receiver tower



Fig. 2. Typical East Coast CH station

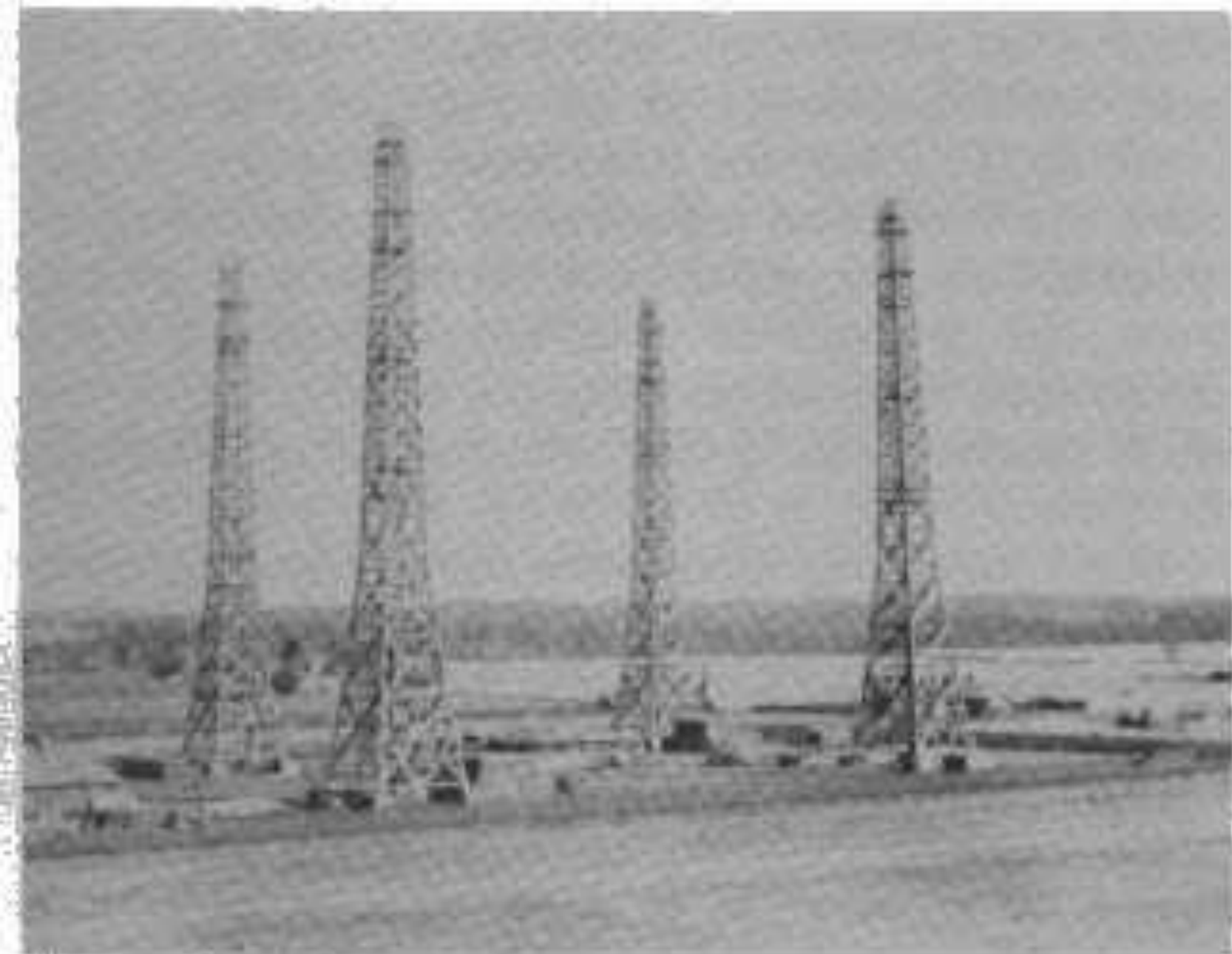
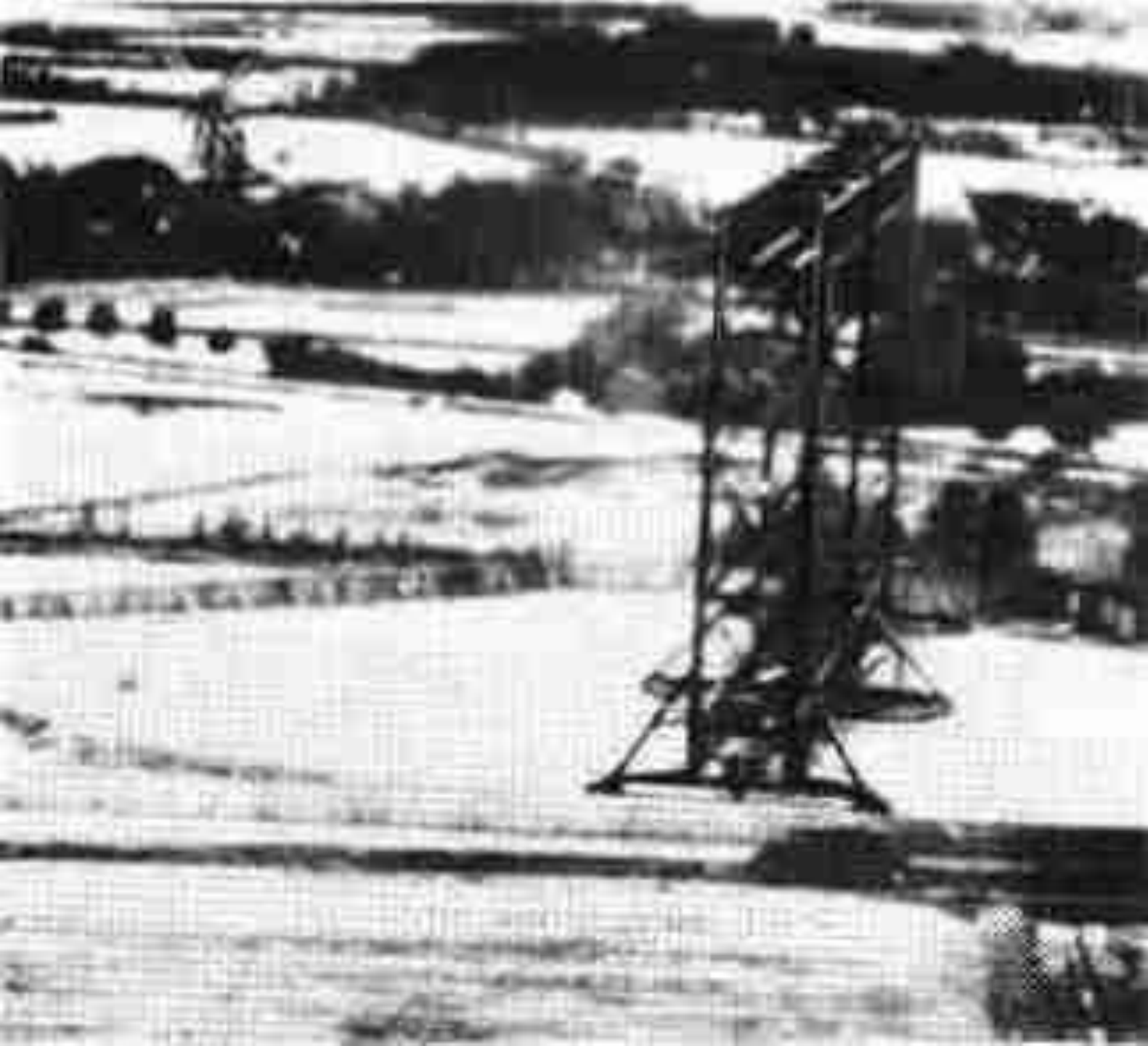
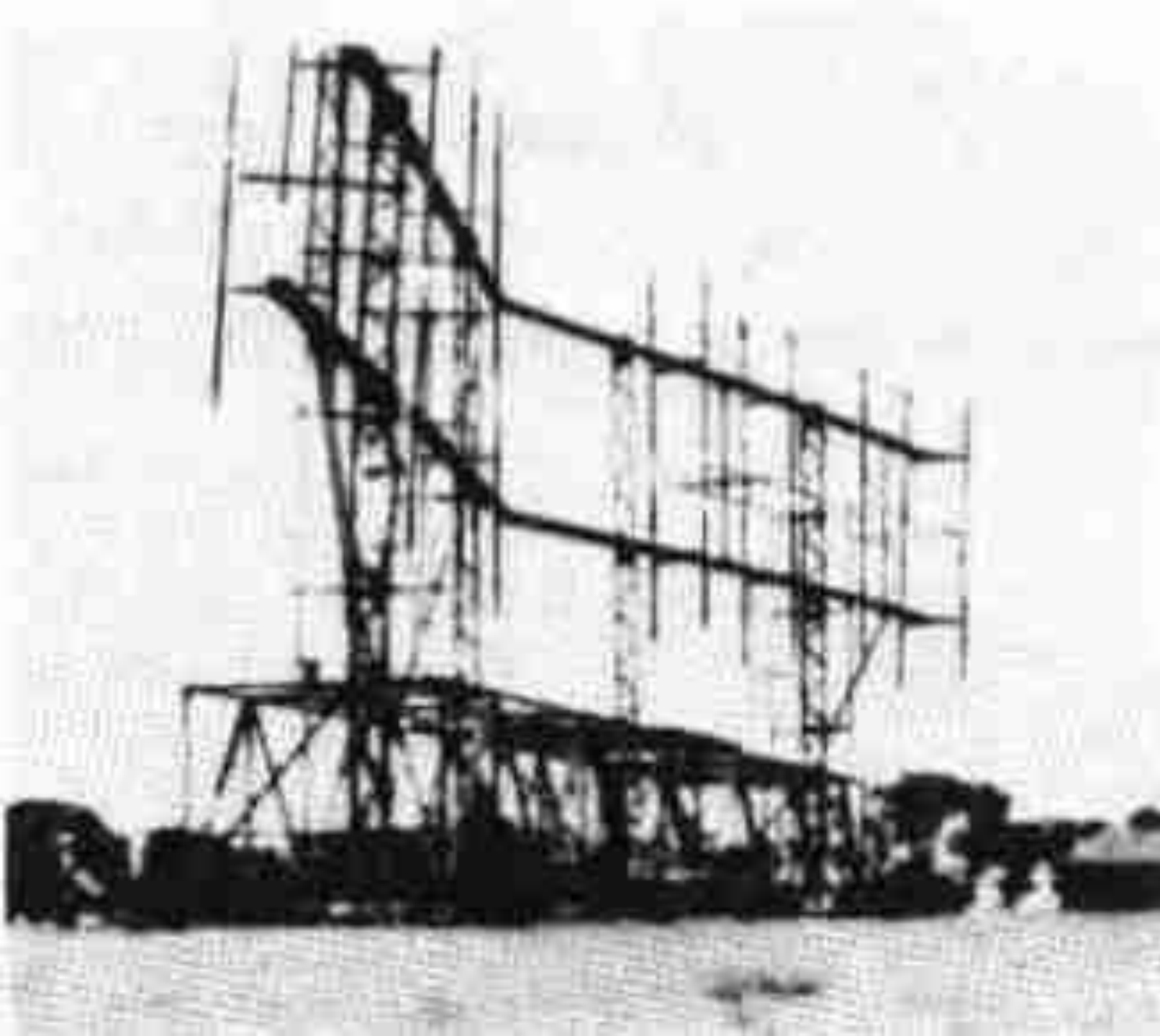
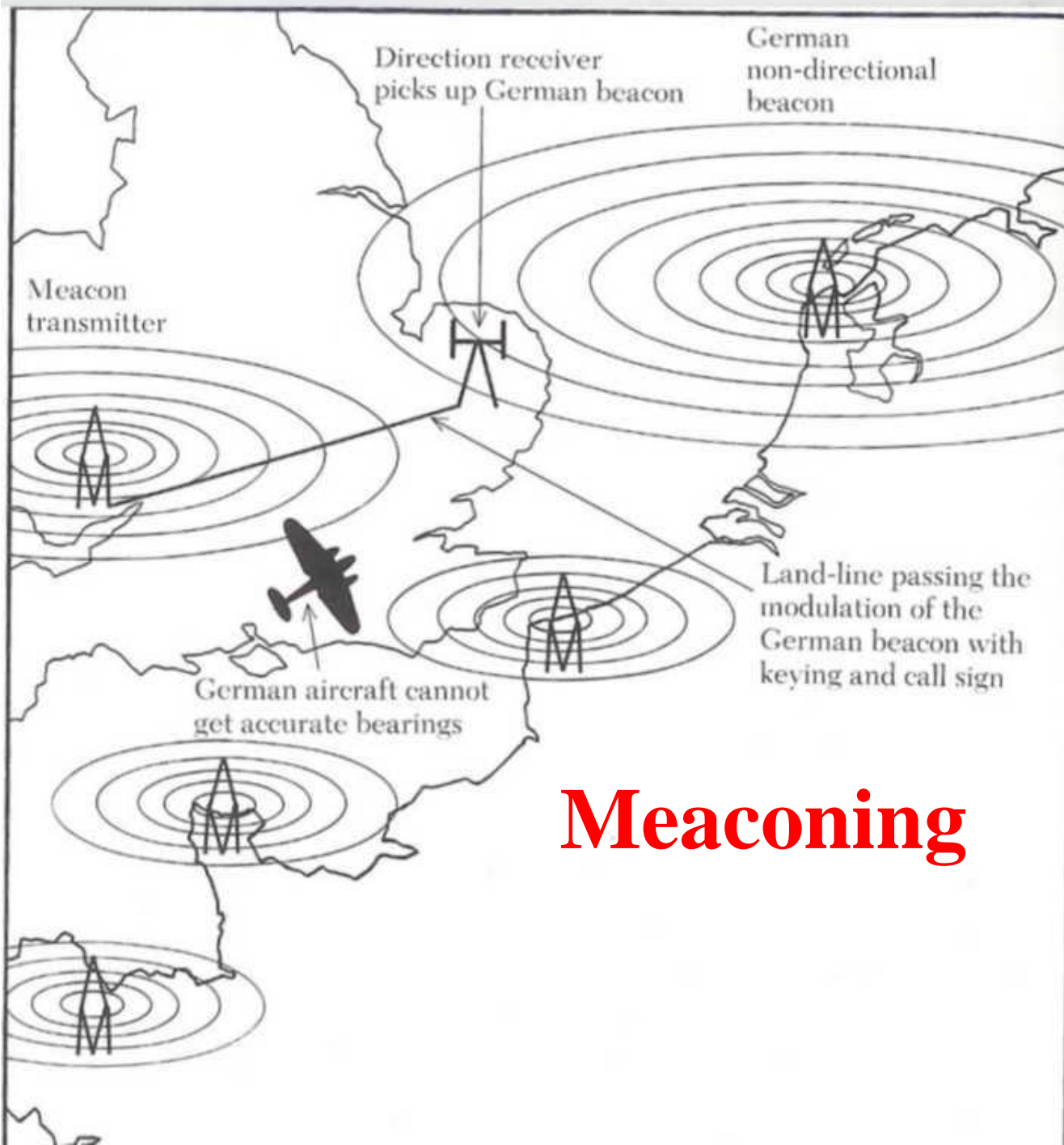


Fig. 7. East Coast CH receiver towers





See notes

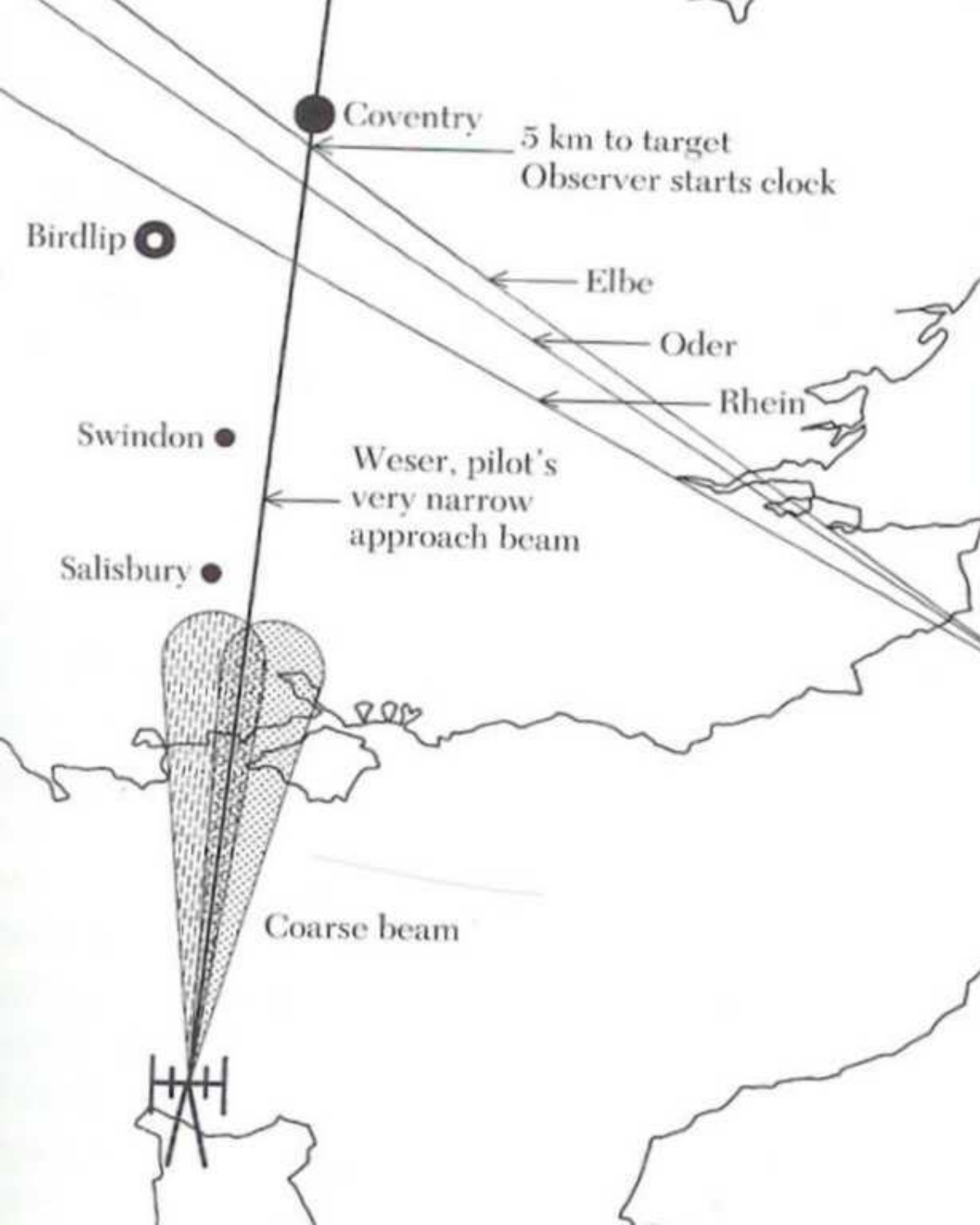


Meaconing

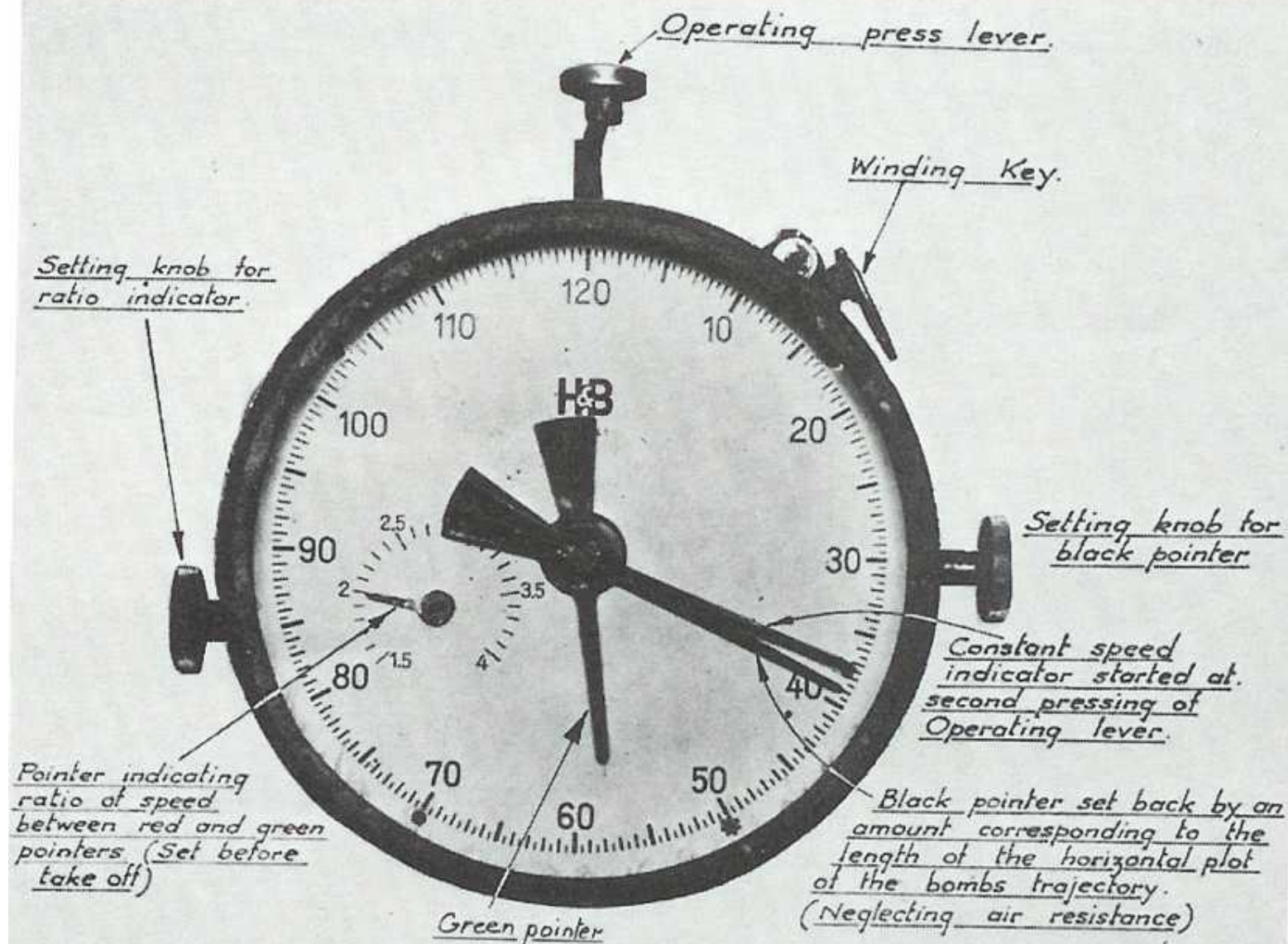
See notes

“Our community of Radio Amateurs in Britain was to prove an invaluable reserve, both in Signals Intelligence and Signals proper, as well as furnishing many of the staff for our rapidly increasing number of radar stations.”

Dr. R. V. Jones



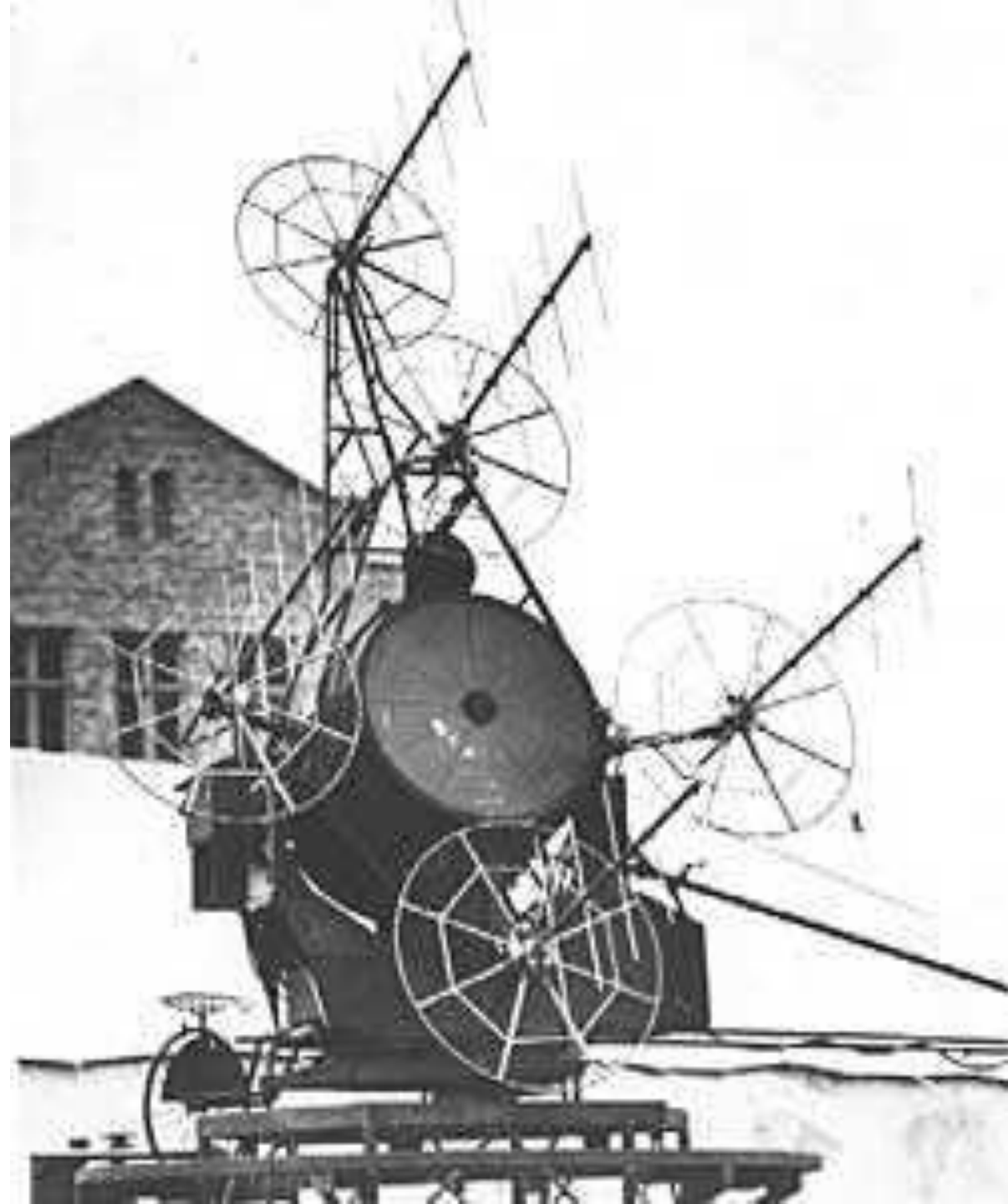
X-Gerate



FACE OF CLOCK : SHOWN JUST PRIOR TO RELEASE OF
BOMBS.



A Heinkel 111 KGr100, probably photographed in Norway where the unit was stationed before their attacks on England. The Viking ship emblem of KGr100 can be seen on the side of the cockpit. The aircraft is equipped with X-Geräte and the additional aerial mast is clearly visible.



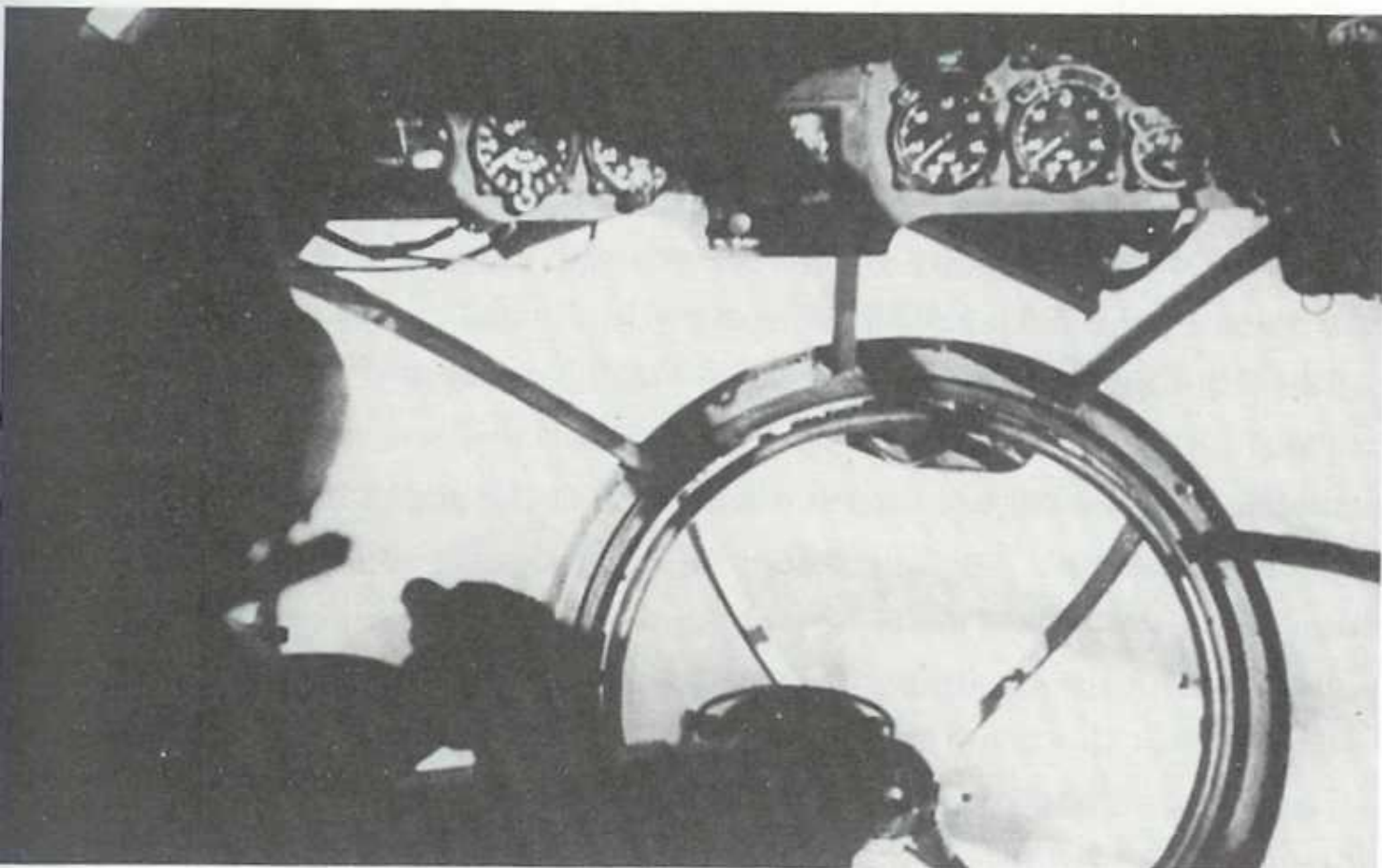


Control Bunker for “decoy fire city”.

“These it transpired, were due to bad measurement of the frequencies of the German beams on the part of the countermeasures organization, a feature that was to plague us through the whole battle. The fault in this case probably lay not with the observers, but with the calibration of our receivers which were not up to the German standard of precision.”



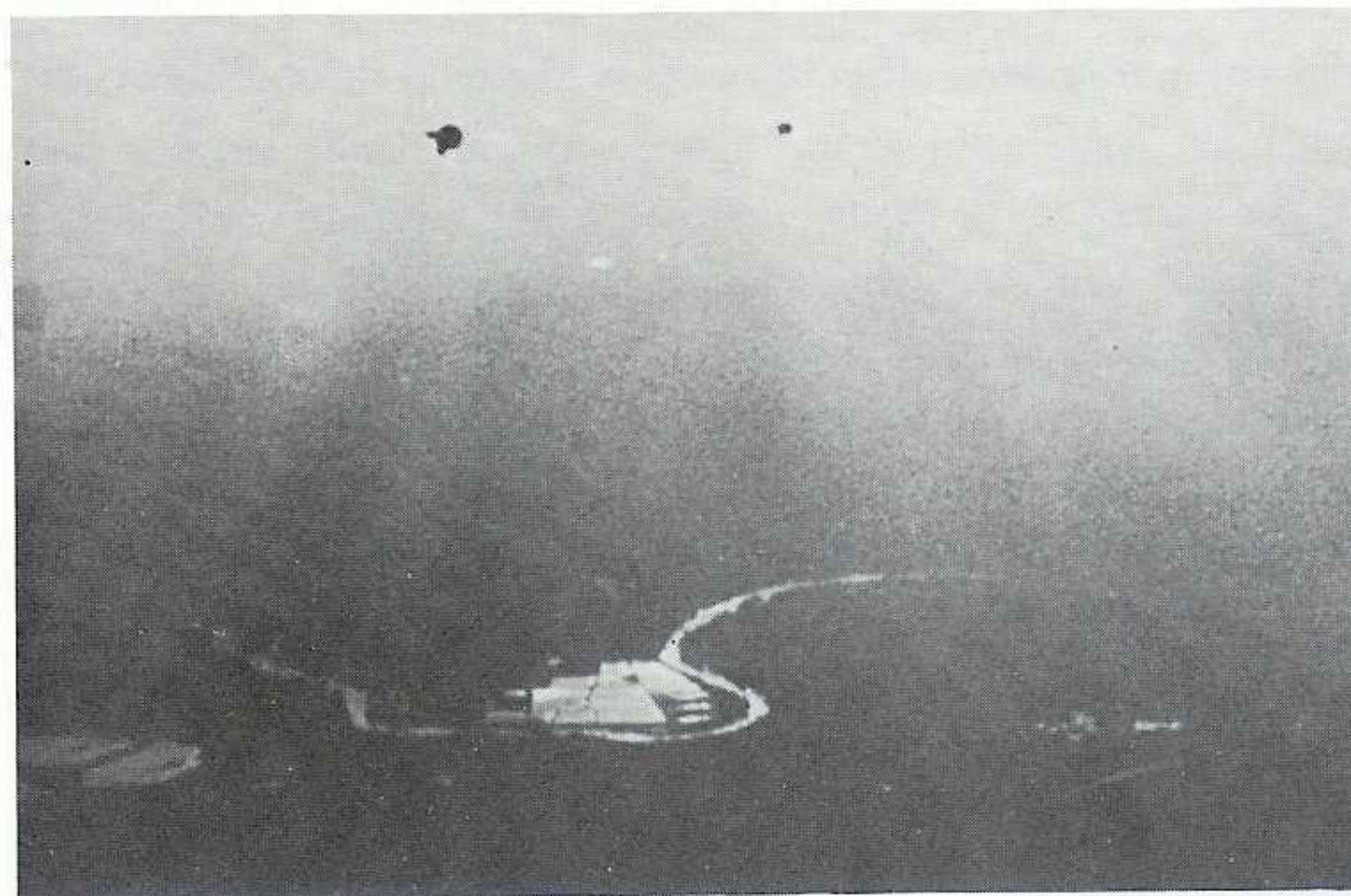
An observer in an
He111 map-reading
by moonlight.
Although it is not
possible to say that
this photograph was
taken on the actual
Coventry raid,
conditions were
perfect that night
and the full moon
was bright enough
for map-reading.



The cockpit of an He111.

Surprisingly, not one of the 499 bombers in the raid on Coventry was attacked by night fighters.







See notes

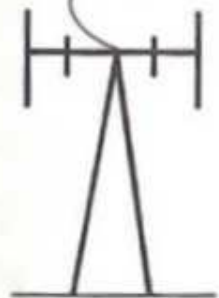


See notes

Aircraft's Y-Geräte equipment picks up signal from ground and retransmits it

300 ~
modulation
to aircraft

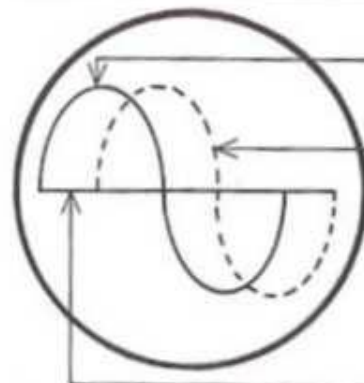
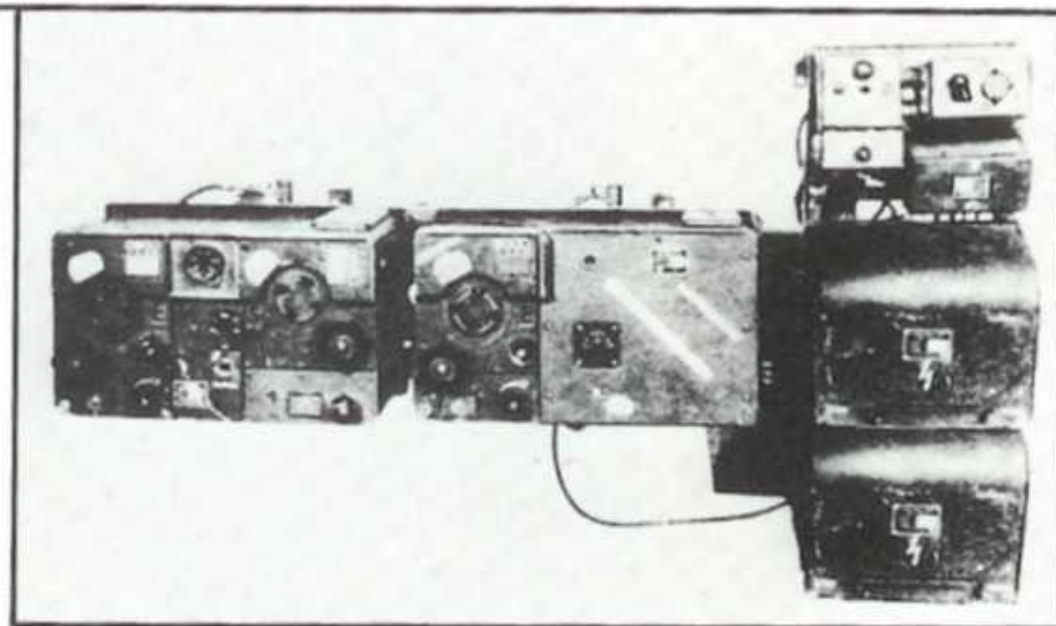
300 ~
from aircraft



Transmitter



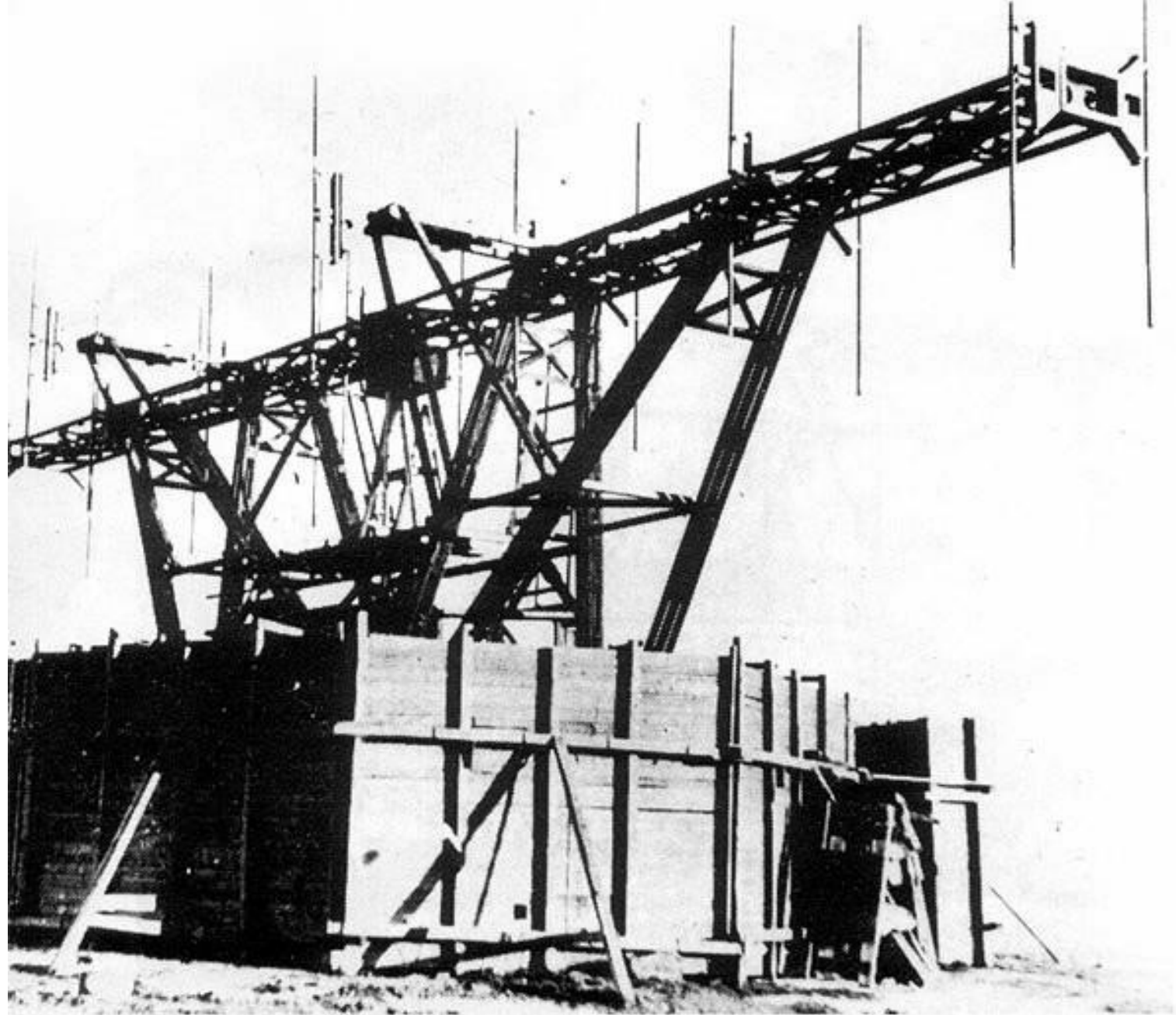
Receiver



Waveform of transmitted tone

Waveform of received tone

Time difference to compute range



Wotan II or Y (or Benito) beam transmitter near Stavanger,
photographed by a Norwegian patriot

Flaws of the Y-GERATE

- **The aircraft was required to transmit.**
- **The system was automatic and could be more easily deceived.**
- **Only one bomber could be controlled at a time.**

**BBC TV station
at Alexandra Palace,
London.**







How bad could it have been without the electronic countermeasures?

In the words of Dr. R. V. Jones...

“If one thinks of what could have happened if with Knickebein, all the German Air Force could have bombed accurately. Well, we saw what happened when things went wrong as at Coventry... That could have happened every night.”

See notes

Lessons Learned...

- Timely intelligence is vital in Electronic Warfare – Delays cost lives.

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- Don't always believe the scientists!

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- Countermeasures don't have to be electronic.

Lessons Learned...

- Timely intelligence is vital in Electronic warfare – Delays cost lives.
- Don't always believe the scientists!
- Don't transmit if you don't have to.
- Countermeasures don't have to be electronic.
- Sometimes wrong assumptions lead to the right conclusion.

Lessons Learned...

- Don't blindly trust black boxes *and...*
- Don't automatically assume the other guy has an equipment failure if something isn't working.

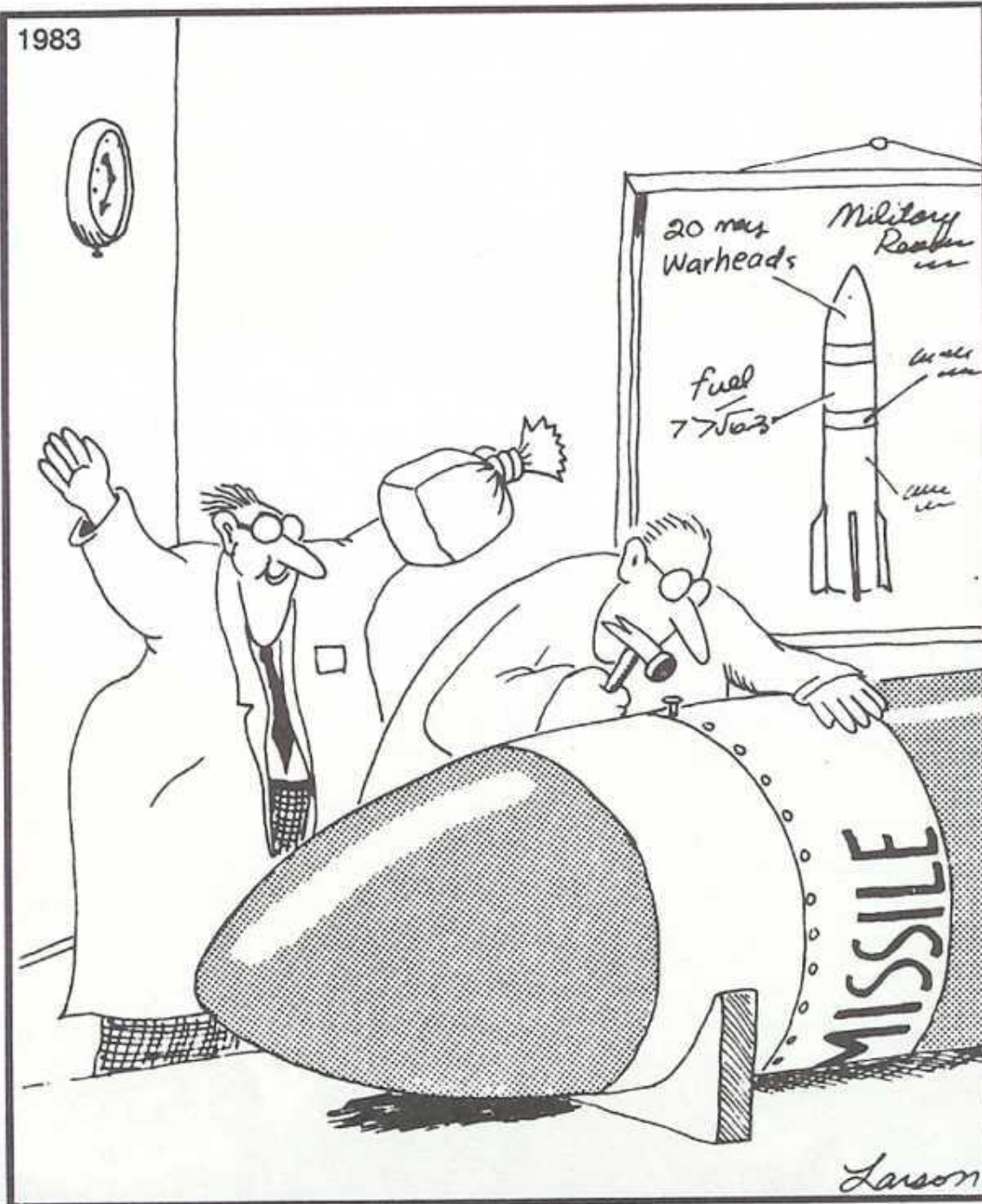
Lessons Learned...

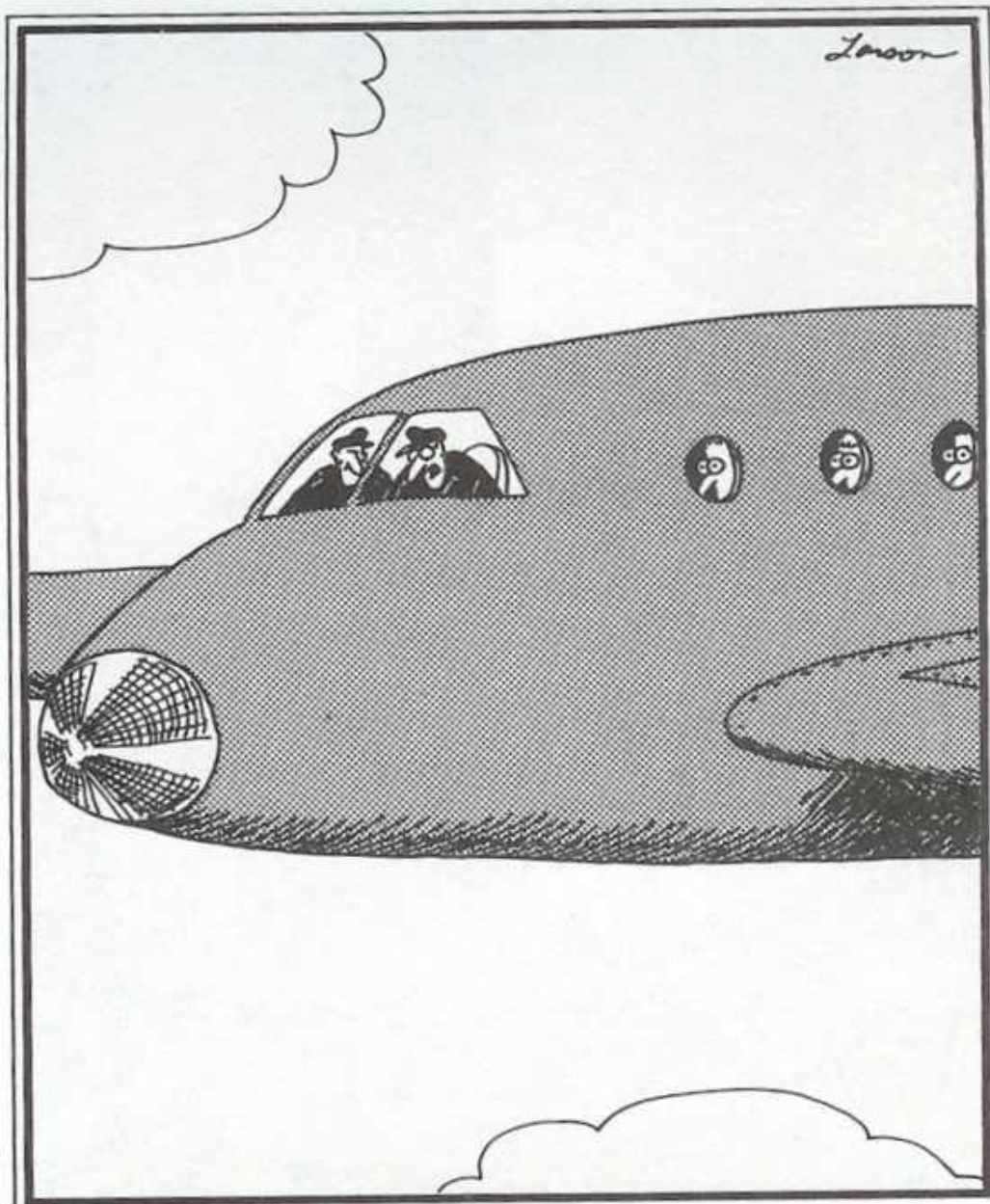
- Don't blindly trust black boxes *and...*
- Don't automatically assume the other guy has an equipment failure if something isn't working.
- Use all available means to fix your position.

Lessons Learned...

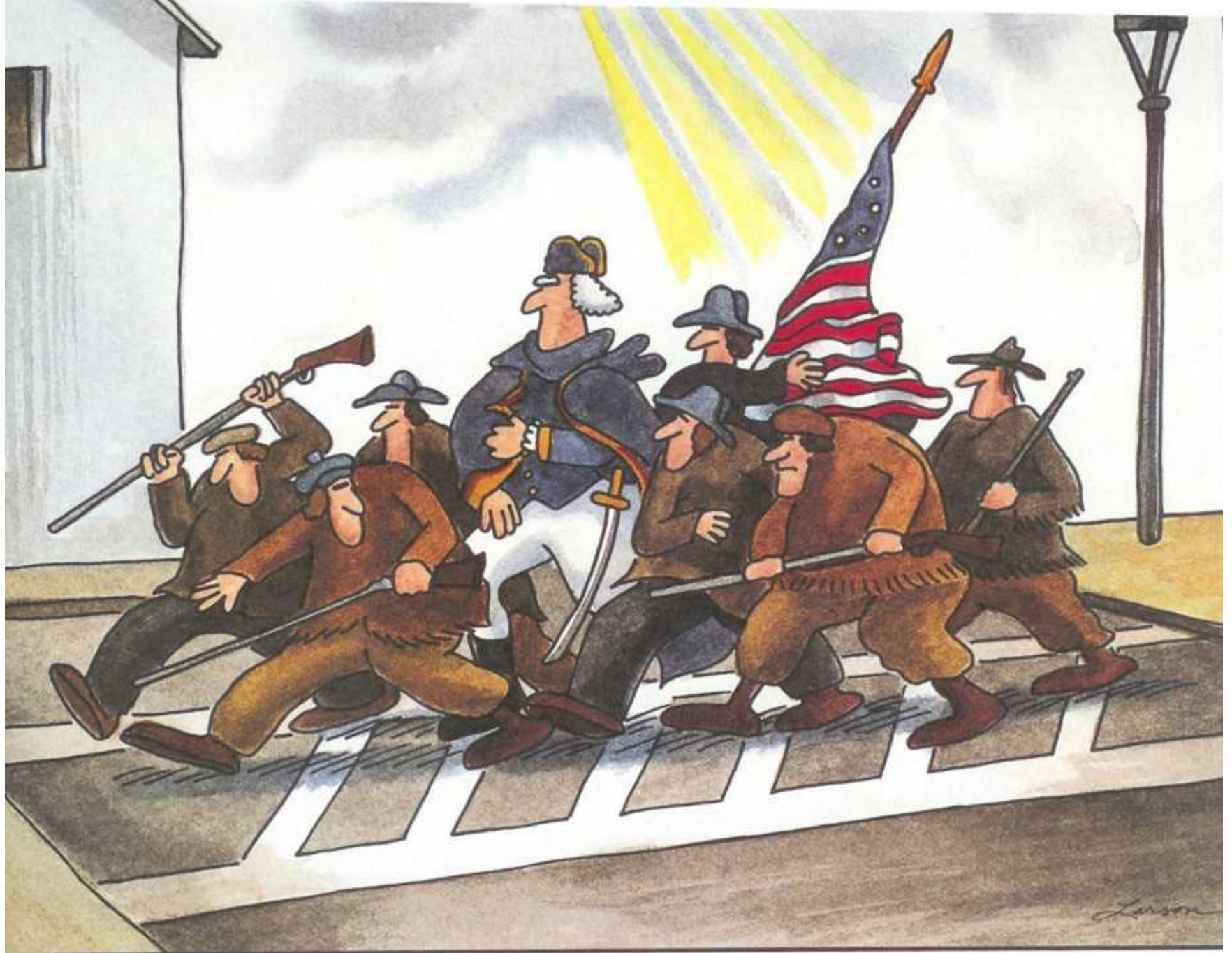
- Don't blindly trust black boxes *and...*
- Don't automatically assume the other guy has an equipment failure if something isn't working.
- Use all available means to fix your position.
- When trying to salvage an aircraft on the beach, *don't tow it into the ocean!*

1983

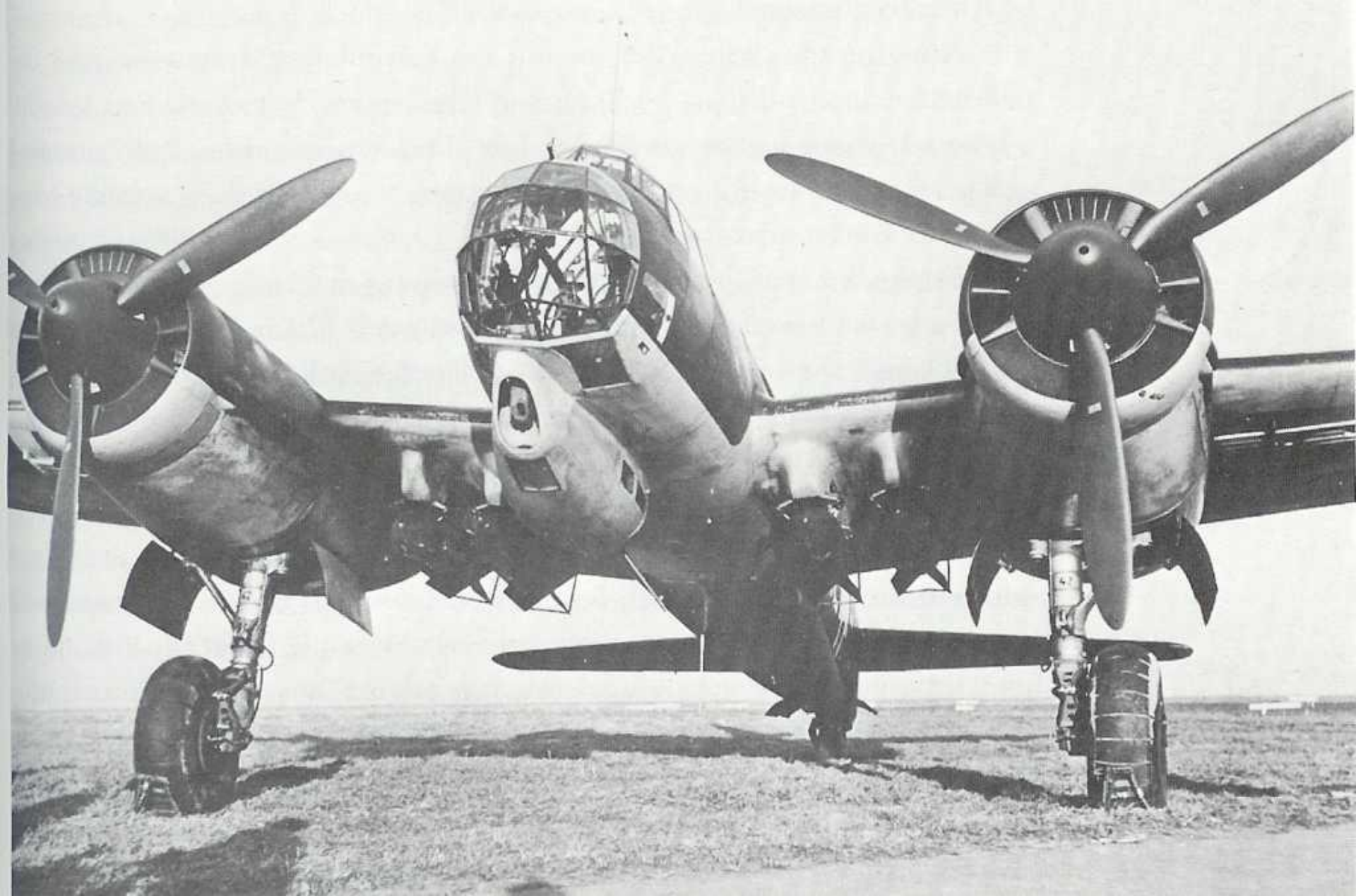




"The fuel light's on, Frank! We're all going to die! ... We're all going to die! ... Wait, wait. ... Oh, my mistake—that's the intercom light."



Washington crossing the street



Luftwaffe Ju 88 bomber



Pilot and observer side by side in a Ju88 A-1. The lack of any dual controls is obvious.