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University, refusal to grant a permit to build an Arab polytechnic near Jerusalem, the closure of Palestinian universities in the West Bank, banning books, and the destruction of the Arab University in Beirut during last summer's invasion. Ideally, nothing of this can justify what can be taken as an anti-Jewish policy, but does it make it a bit more understandable?

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6/83

Development of radar

The letters by John DeWitt, Ernest Linder, and Luiz Alvarez (June, page 101) on the early history of radar call for comment.

I was the engineer at the Signal Corps Laboratories who invited Irving Wolff and Linder to demonstrate the utility of their 9-cm microwave equipment at Sandy Hook in 1934. This was part of a program at SCL to determine the usefulness of microwaves for target detection. Alvarez compares the 13 watts of power generated by the RCA equipment unfavorably with the 50 kW of peak power available from British magnetrons in 1940, which he views with awe. The radar range equation as used in 1942 and later shows that the range attainable with a given target, in view of the noise figure of the receiver and its required bandwidth, is a function of average rather than peak transmitter power. Thus if 1-microsecond pulses are used, spaced at 1000-microsecond intervals, to yield a 100-mile-range scale permitting high-range resolution, the average power is 50 watts, or about 4 times the power available from the RCA equipment. The latter used tone modulation with a narrow-band receiver, so the range of a little less than one mile observed on a small vessel in the Ambrose channel is not surprising. Doppler and cw radar have their uses even today.

The method described to me by William Blair, Director of SCL during the 1930s and during the period when work was initiated at Fort Monmouth in 1933, envisioned the use of one tone-modulated microwave transmitter together with several narrow-band receivers to detect microwave power reflected from an airplane and thus determine its position. This method is an outgrowth of the method employed in 1933 and earlier that used a searchlight to illuminate a target and then determined its position using several receivers with good angular resolution to detect the reflected light.

One of my contributions at SCL was to persuade Blair, with most effective

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help from Roger Colton (who succeeded Blair as director at SCL), to abandon the use of microwaves in 1936 and go to the pulse-echo method at 110 MHz where more power and effective receivers could be developed.[1] I described a complete pulse-echo system in a memorandum dated 21 September 1936, based in part on an earlier memorandum of November 1933 in which I suggested the use of the pulse method. This method was not viewed with favor at that time, and work was limited largely to Blair's simpler ideas from 1933 to 1936.

Alvarez also cites as the official history of the MIT Radiation Laboratory a book with the title "Five Years (The MIT Rad Lab Memory Book)." I believe that a more balanced and objective work is that of Henry Guerlac, who wrote his history to accompany the 26-volume Rad Lab Series. Guerlac identifies himself on the title page as "Historian, Radiation Laboratory, MIT." In his history, Guerlac mentions the first airborne radar equipment developed at RCA and flight tested in 1937 and 1938. The first development of this kind of gear is sometimes erroneously attributed to the British. I was hired at RCA primarily to work on the development of this equipment; it operated at first at 500 MHz with 1-microsecond pulses. It embodied both an altimeter and an obstacle detector that displayed echoes from the Blue Mountain in Pennsylvania out to a range of 5 miles.

Reference

1. McKinney, "Radar: A Reluctant Miracle," Signal Journal of the Armed Forces Communications and Electronics Assn., November 1968, **21**, page 34.

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THE AUTHOR COMMENTS: In answer to W. D. Hershberger's criticism of my letter, I'll quote a sentence from that letter. "If I had been describing the history of the US radar" (instead of recounting the life story of Alfred L. Loomis), "I would not have mentioned the Loomis or Hansen devices, or that of RCA, because in my opinion, *none of the three had any appreciable effect on the development of microwave radar, as it was practiced by the Allies in WWII.*" (Emphasis added.) A careful reading of Hershberger's letter shows nothing that is in disagreement with that statement. For example, Hershberger tells of the potential usefulness of the RCA magnetron in cw and Doppler radars, techniques that weren't *practiced* to any appreciable extent by the Allies in WWII; cw radar is now useful in apprehending speeders, and Doppler radar was used extensively after the war to assist commercial airliners in navigating their way across the oceans. The microwave radar that was used almost exclusively in WWII was high peak powered pulsed radar, and not the nearly continuous wave microwave sets that were later used in automobile traffic control and air navigation, and to which RCA-developed techniques did contribute substantially.

The final paragraph in Hershberger's letter refers to a 500-MHz pulsed airborne radar set tested by RCA in 1937 and 1938. I believe his account, but I don't see what it has to do with a *militarily useful microwave* radar set. I am sure it was useful as an altimeter and as an obstacle detector, but 500 MHz is by no stretch of the imagination in the microwave range, and the ground—or a mountain—has a cross section enormously larger than that of an airplane. So I also recommend the radar equation to the reader. How far could such a set see an airplane, if it could see a mountain "out to a range of 5 miles"?

I'm sorry that my "insistence on historical accuracy" makes me sound negative about some really admirable achievements by RCA and other organizations engaged in the development of radar in the 1930s. But the facts in the case are quite clear: Microwave radar as practiced by the Allies in WWII sprang almost full-blown from the invention of the pulsed cavity magnetron, by John Randall and Henry Boot, in Birmingham, England, in early 1940.

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Poetic desecration

Lovers of poetry cannot fail to have noticed that the Elizabethan drama that unaccountably serves as your June Guest Comment (page 9) fails regrettably to scan in the final two lines of A's first speech to F about B ("Which I here have called Lorentz's Rules/and number one through five.")

Such readers should know that this jarring breach of form is an interpolation in the original text, contrived without the poet's knowledge or consent in the editorial offices of PHYSICS TODAY, presumably to replace a technical footnote in the original text (of flawless iambic pentameter) which would have made little sense in the new setting.

I urge those planning amateur performances for graduations, weddings, Christmas parties or other festive occasions to delete the above-mentioned spurious lines. The purpose for which they seem to have been designed can be