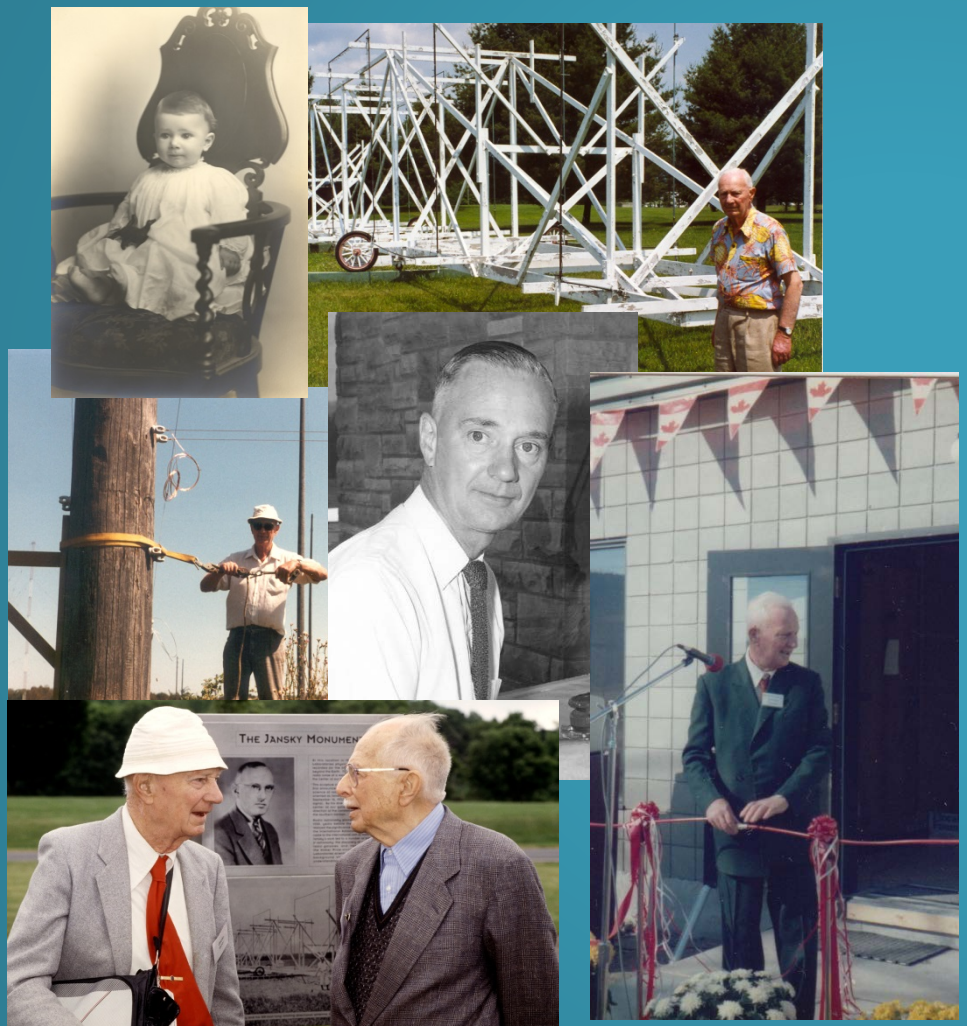
THE PERIPATETIC MR. REBER

Ellen Bouton
National Radio Astronomy Observatory

History of Canadian Radio Astronomy
25-26 July 2016, Penticton

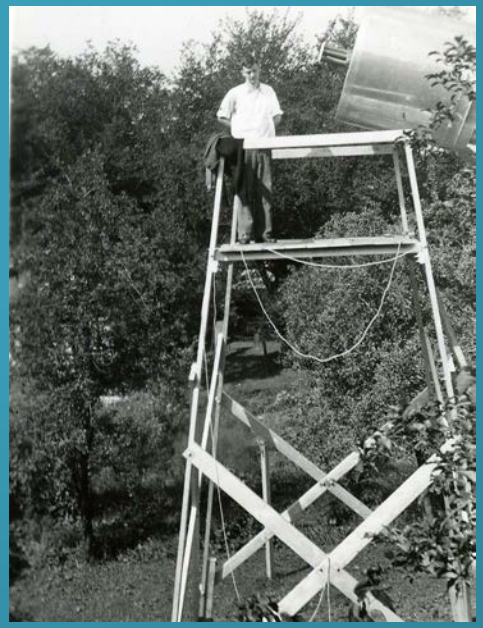
The Peripatetic Mr. Reber



- Geographic and intellectual travels
- Reber in Canada
- The question everyone always asks about Reber

Reber: What we all know

- In 1937 designed and built first parabolic antenna for radio astronomy observations following up Jansky's 1933 detection of cosmic radio emission



Reber: What we all know

- In 1937 designed and built first parabolic antenna for radio astronomy observation to follow up Jansky's 1933 detection of cosmic radio emission
- Detected galactic radio noise in 1939

Reber: What we all know

- In 1937 designed and built first parabolic antenna for radio astronomy observation to follow up Jansky's 1933 detection of cosmic radio emission
- Detected galactic radio noise in 1939
- Published first radio astronomy papers in 1940 (despite dubious reception by the astronomy establishment)

Reber: What we all know

- In 1937 designed and built first parabolic antenna for radio astronomy observations to follow up Jansky's 1933 detection of cosmic radio emission
- Detected galactic radio noise in 1939
- Published first radio astronomy papers in 1940 (despite dubious reception by the astronomy establishment)
- Detected solar radio emission in 1943

Reber: What we all know

- Extended his radio astronomy research to the ionosphere and long hectometer wavelengths

Reber: What we all know

- Extended his radio astronomy research to the ionosphere and long hectometer wavelengths
- Researched and published in a wide variety of other fields: anthropology, archeology, botany, geology, meteorology

Reber: What we all know

- Extended his radio astronomy research to the ionosphere and long hectometer wavelengths
- Researched and published in a wide variety of other fields: anthropology, archeology, botany, geology, meteorology
- Lived in Tasmania the last half of his long life (but traveled many places)

Reber: What we all know

- Extended his radio astronomy research to the ionosphere and long hectometer wavelengths
- Researched and published in a wide variety of other fields: anthropology, archeology, botany, geology, meteorology
- Lived in Tasmania the last half of his long life (but traveled many places)
- Was convinced until his death in 2002 that "The Big Bang Is Bunk!"

Peripatetic:

- "traveling from place to place, especially working or based in various places for relatively short periods"

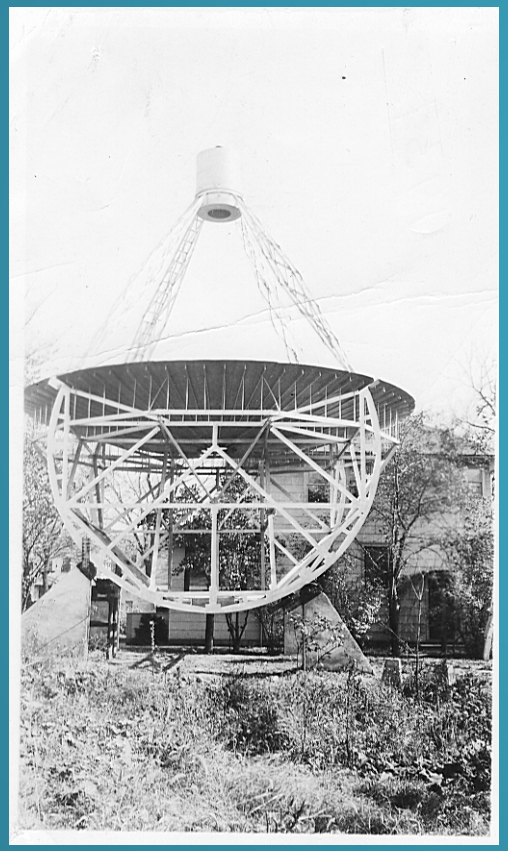
Peripatetic:

- "traveling from place to place, especially working or based in various places for relatively short periods“
- Geographically: Wheaton IL, DC, Alaska, Hawaii, NRAO (Green Bank), The Netherlands, Canada (Ottawa, Penticton), Tasmania, Sydney/CSIRO, New Zealand

Peripatetic:

- "traveling from place to place, especially working or based in various places for relatively short periods“
- Geographically: Wheaton IL, DC, Alaska, Hawaii, NRAO (Green Bank), Canada (Ottawa, Penticton), Tasmania, Sydney (CSIRO)
- Intellectually: lava flows, botany, archaeology, solar power, energy efficiency, electric cars

Wheaton Years



- 1933 degree in electrical engineering (electronics & communications)
- Ham radio, 1928-1938
- 1933-1946: series of jobs at Chicago area companies, including military-related work during WW II

National Bureau of Standards in Sterling, Virginia, 1947-1951

- Accepted 1947 offer to set up radio program at NBS
- Possibility of building 75-100 foot dish
- Wheaton dish and instrumentation sold to NBS and moved to Sterling
- Only time Reber received salary for radio astronomy work

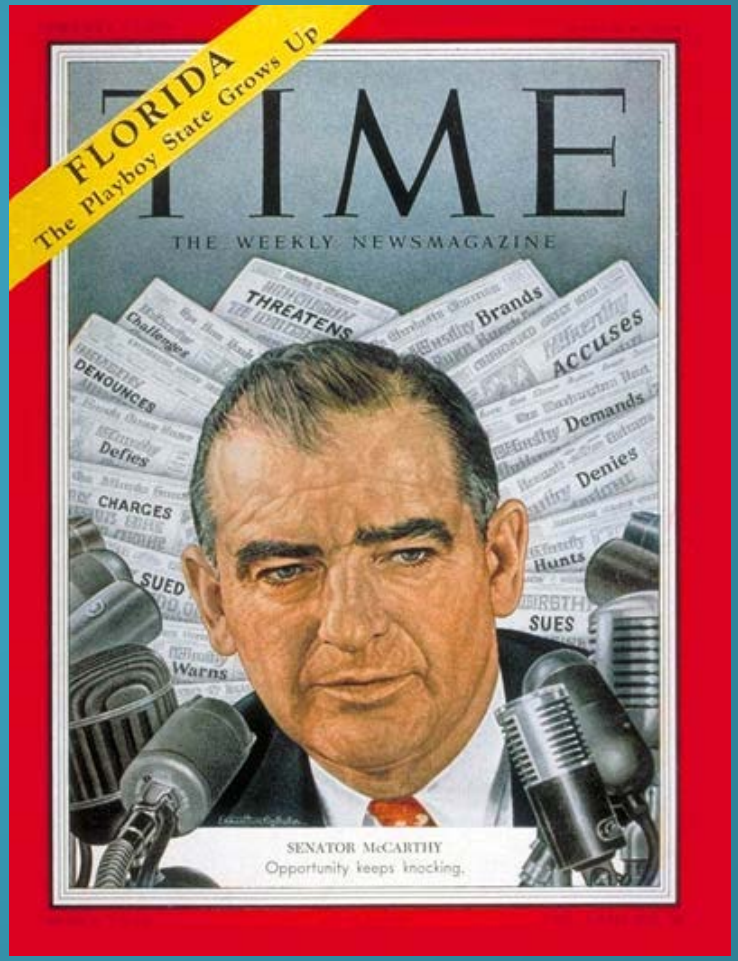
Attu, Alaska, 1950

While at NBS, participated in NRL solar eclipse expedition, Attu, Alaska, Aug-Sept 1950

"This was probably the first total eclipse which was successfully observed during a torrential downpour of rain in a gale!" [letter to Oort, 5 Nov 1950]

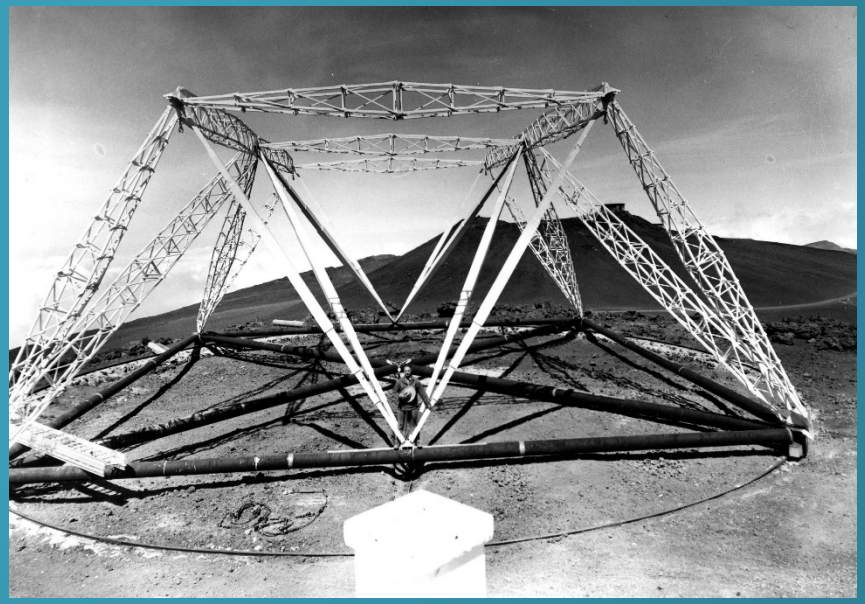
Increased frustration in DC

- Lack of support for planned telescope
- Hated politically suspicious atmosphere fostered by McCarthy
- Hated working under bureaucracy



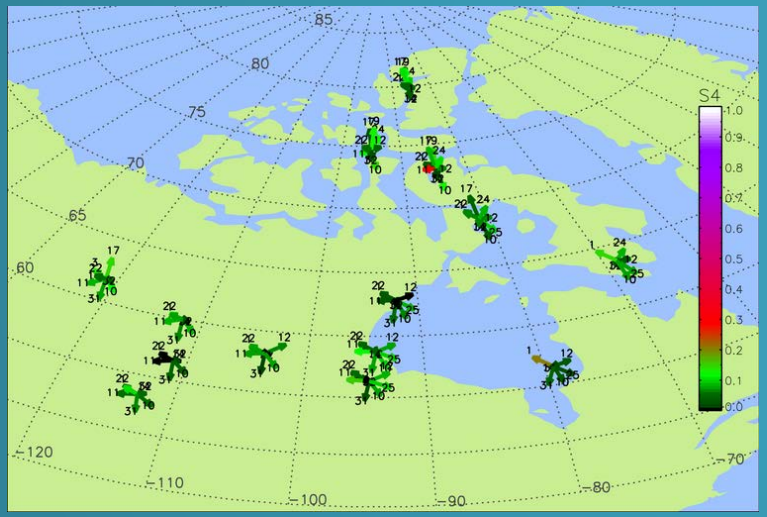
Hawaii, 1951-1954

- Rotating antenna to do interferometry (inspired by Australian sea interferometry)
- Plagued by ionospheric refraction and terrestrial interference
- Moved to Tasmania in 1954

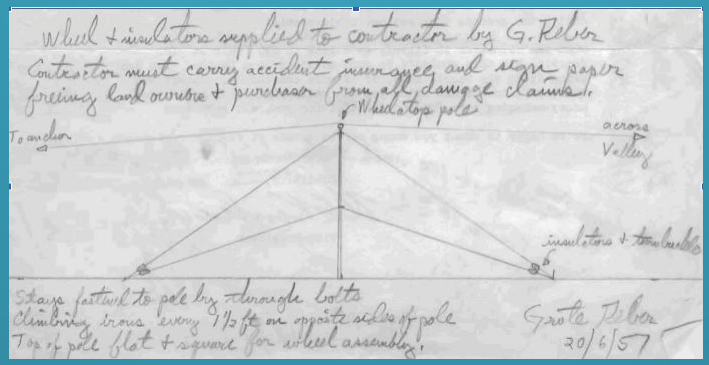


Ice damage, February 1957

Long wavelength work is best with minimum of ionospheric disturbance: Northern Canada or Tasmania?



Built two dipole arrays in Tasmania: First in Kempton…



…then in Bothwell

Reber built antennas … literally

Travels from the bottom of the world

Ice skating in Leiden in February 1956

Travels from the bottom of the world

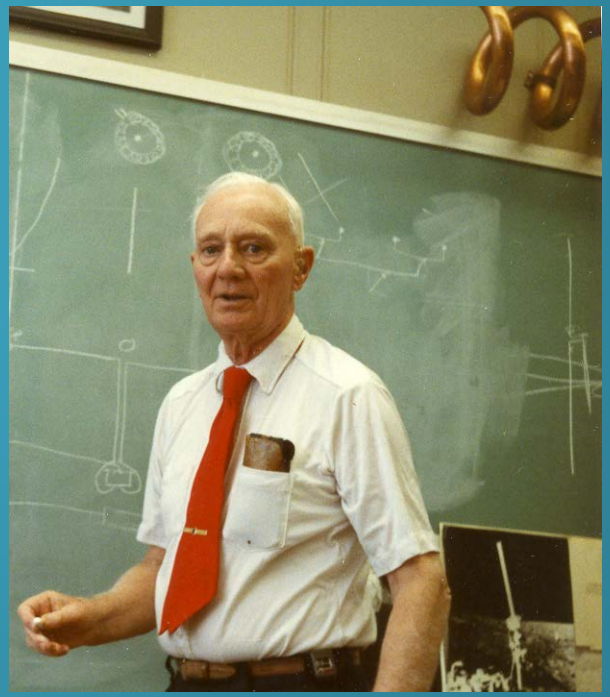
Green Bank 1958-1960 – reconstruct antenna

Travels from the bottom of the world

Other trips to Green Bank in summer 1978, spring 1983, winter 1988, spring 1995

Travels from the bottom of the world

Ohio State University honorary doctorate, 1962



Travels from the bottom of the world

Reber and Greenstein, Jansky Monument Ceremony, Holmdel NJ, 8 June 1998

Travels of the inquiring mind

- Publications:
  - 1957-1959: 4 papers on Hawaiian meteorology
  - 1959, 1962: 2 papers on age of lava flows on Haleakala, Hawaii

Lava flows in Hawaii

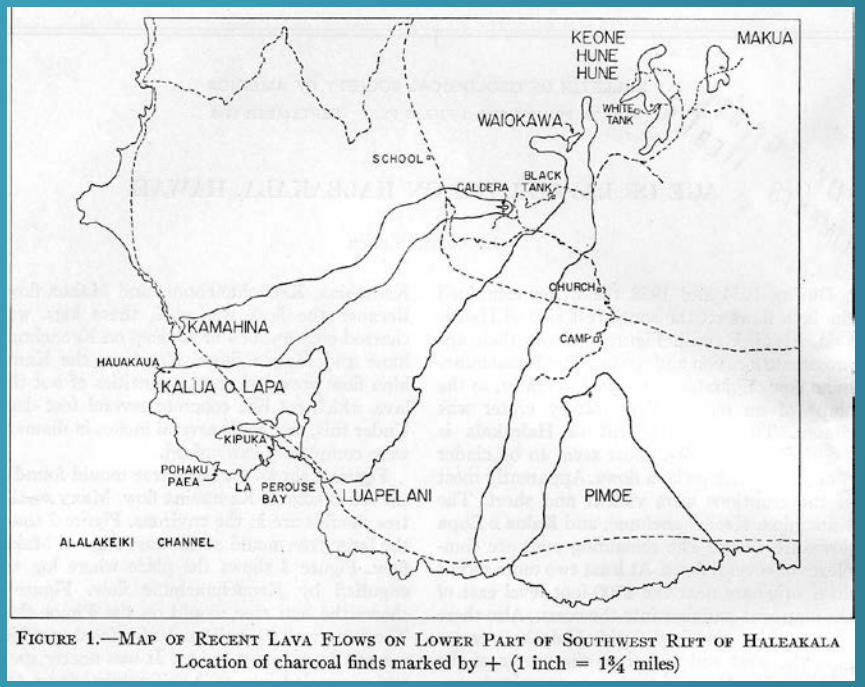


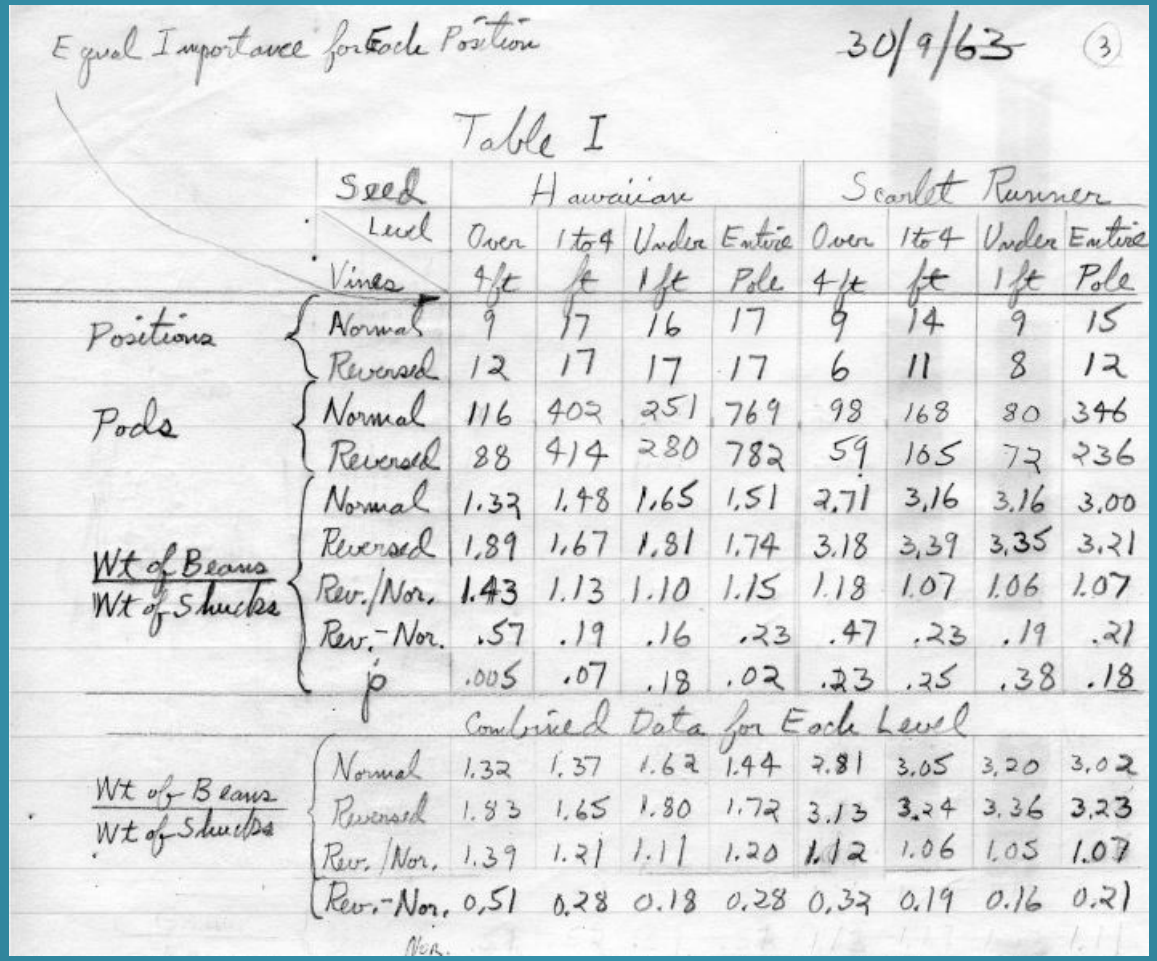
FIGURE 1.—MAP OF RECENT LAVA FLOWS ON LOWER PART OF SOUTHWEST RIFT OF HALEAKALA
Location of charcoal finds marked by + (1 inch = 1¾ miles)

Travels of the inquiring mind

- Publications:
  - 1957-1959: 4 papers on Hawaiian meteorology
  - 1959, 1962: 2 papers on age of lava flows on Haleakala, Hawaii
  - 1960, 1964, 1967: 3 papers on reversed bean vines

Research on twining beans, Green Bank, summer 1960

Twining bean data



Equal Importance for Each Position 30/9/63 (3)

Table I

	Seed	Hawaiian				Scarlet Runner			
	Level	Over	1 to 4	Under	Entire	Over	1 to 4	Under	Entire
	Vines	4 ft	ft	1 ft	Pole	4 ft	ft	1 ft	Pole
Positions	Normal	9	17	16	17	9	14	9	15
	Reversed	12	17	17	17	6	11	8	12
Pods	Normal	116	402	251	769	98	168	80	346
	Reversed	88	414	280	782	59	165	72	236
Wt of Beans / Wt of Shucks	Normal	1.37	1.48	1.65	1.51	2.71	3.16	3.16	3.00
	Reversed	1.89	1.67	1.81	1.74	3.18	3.39	3.35	3.21
	Rev./Nor.	1.43	1.13	1.10	1.15	1.18	1.07	1.06	1.07
	Rev.-Nor.	.57	.19	.16	.23	.47	.23	.19	.21
	p	.005	.07	.18	.02	.23	.25	.38	.18
		Combined Data for Each Level							
Wt of Beans / Wt of Shucks	Normal	1.32	1.37	1.62	1.44	2.81	3.05	3.20	3.02
	Reversed	1.83	1.65	1.80	1.72	3.13	3.24	3.36	3.23
	Rev./Nor.	1.39	1.21	1.11	1.20	1.12	1.06	1.05	1.07
	Rev.-Nor.	0.51	0.28	0.18	0.28	0.32	0.19	0.16	0.21

NCB.

Travels of the inquiring mind

- Publications:
  - 1957-1959: 4 papers on Hawaiian meteorology
  - 1959, 1962: 2 papers on age of lava flows on Haleakala, Hawaii
  - 1960, 1964, 1967: 3 papers on reversed bean vines
  - 1965, 1967: 2 papers on carbon dating of aboriginal kitchen middens in Tasmania

Travels of the inquiring mind

- August 1965 in New Zealand: Reber presented 4 papers in 4 days at the 38th Congress of the Australian and New Zealand Association for the Advancement of Science

Travels of the inquiring mind

PROGRAMME

MONDAY, 16th AUGUST

9.30 a.m. SYMPOSIUM: Galactic Radio Astronomy. Phys. Th. 2.
Chairman — B. J. Bok (Australian National University).
Neutral hydrogen in the galaxy — F. J. Kerr (Division of Radiophysics, C.S.I.R.O., Sydney).
Distribution of ionised hydrogen in the galaxy — G. R. A. Ellis (University of Tasmania).
OH radicals at the galactic centre — B. J. Robinson (Division of Radiophysics, C.S.I.R.O., Sydney).

11.15 a.m. Concurrent Sessions:
1. SYMPOSIUM: Galactic Radio Astronomy (continued).
Radio continuum emission from the local spiral arm— D. S. Mathewson (Division of Radiophysics, C.S.I.R.O., Sydney).
Some observations of the southern sky at 75 c.m. using a one and a half minute fan beam — A. G. Little (University of Sydney).
Hectometer radio astronomy — G. Reber (Division of Radiophysics, C.S.I.R.O., Hobart).

20

Travels of the inquiring mind

MONDAY, 16th AUGUST

3.45 p.m.

Concurrent Sessions:

1. PAPERS (G.S.A. and Section D): Molecular Genetics (continued).
   Mechanism of genetic recombination during transformation in *Bacillus subtilis* — C. Kidson (Baker Medical Research Institute, Melbourne).
   Cotransduction of analogue-resistance- Judith A. Waltho (University of Melbourne).
   Genetic control of recombination between linked genes in *Neurospora crassa* — B. R. Smith (Australian National University).

2. PAPERS: Lecture Room 1, Life Sciences Building.
   Chairman — I. F. Wardlaw (Division of Plant Industry, C.S.I.R.O., Canberra).
   Reversed bean vines — G. Reber (Division of Radiophysics, C.S.I.R.O., Hobart).

Travels of the inquiring mind

TUESDAY, 17th AUGUST

11.15 a.m. Concurrent Sessions:

1. SYMPOSIUM: Cosmic Ray Astronomy. Phys. Th. 2.
Chairman — P. G. Law (Antarctic Division, Department of External Affairs, Melbourne).
Evidence for a two-way sidereal anisotropy in the charged primary cosmic radiation — R. M. Jacklyn (Antarctic Division, Department of External Affairs, Hobart).
Solar diurnal variations of cosmic rays — J. E. Humble (University of Tasmania).
Solar and sidereal protons — G. Reber (Division of Radiophysics, C.S.I.R.O., Hobart).

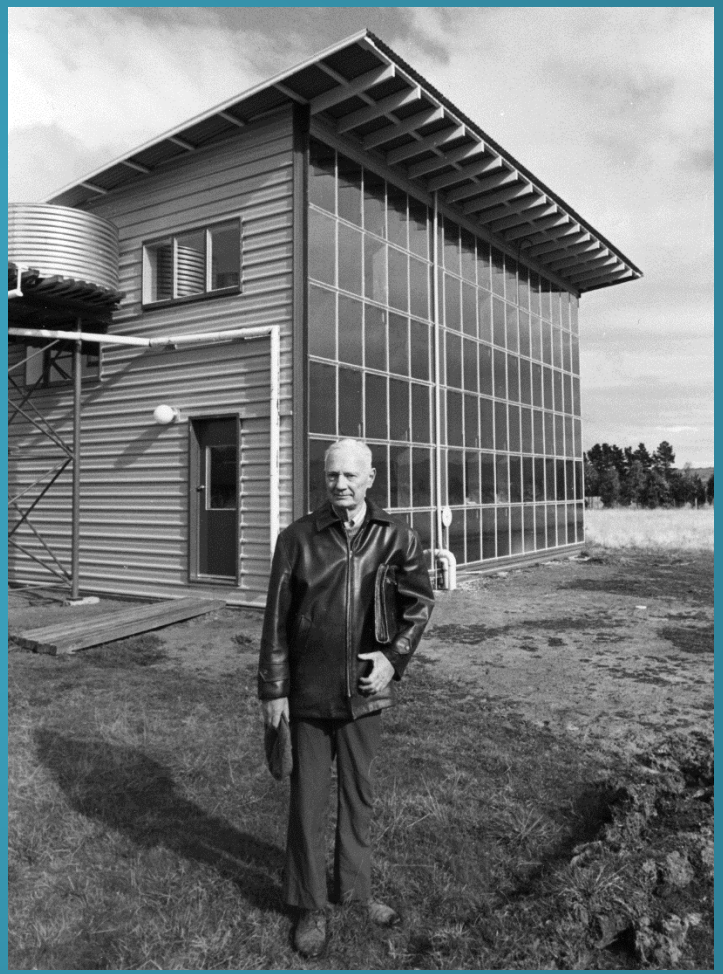
Travels of the inquiring mind

THURSDAY, 19th AUGUST

9.30 a.m. SYMPOSIUM: The Twmianian Aborigine.
Arts Lecture Theatre.
Chairman-W. Bryden (Tasmanian Museum and Art Gallery).
The post-settlement history of the Tasmanian aborigines — W. F. Ellis (Queen Victoria Musuem, Launceston).
French manuscripts referring to the Tasmanian aborigines — N. J. B. Plomley.
The age of the Tasmanian aborigines-
G. Reber (Division of Radiophysics, C.S.I.R.O., Hobart).

Travels of the inquiring mind

- Concerned about growing energy crisis and the increased use of fossil fuels – built an energy efficient house



Travels of the inquiring mind

- In a March 1981 letter to John Galt, writing about the house into which he had recently moved, Reber said, “So far, it has been quite pleasant. However, proof of performance will be next winter.”

Travels of the inquiring mind

In 1990 received an energy efficiency award

Travels of the inquiring mind

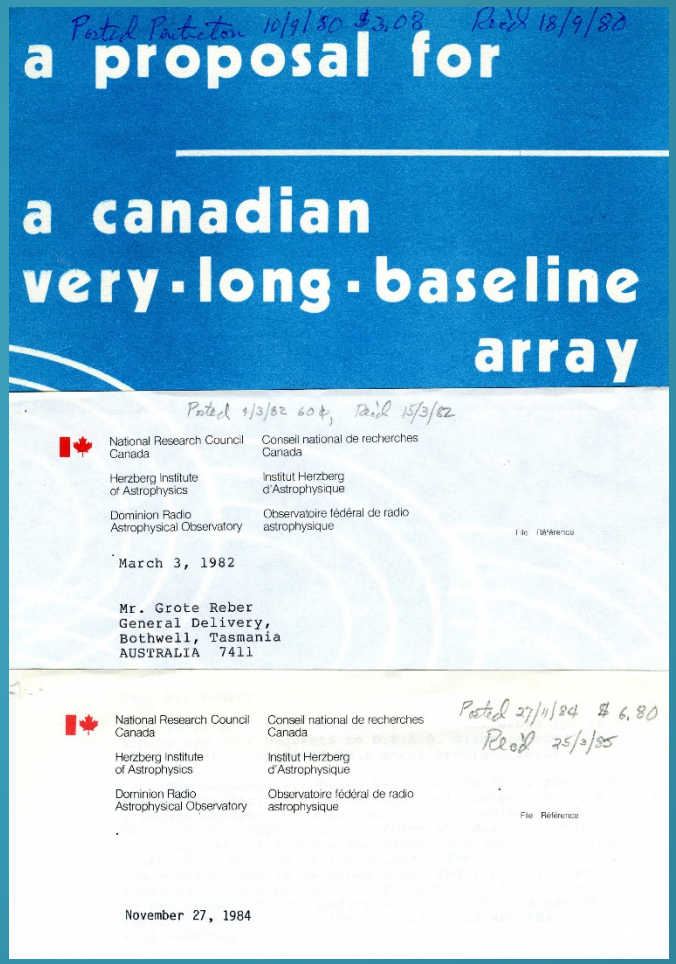
Built Pixie, a battery powered car he used to travel around Bothwell and Hobart

Travels of the inquiring mind

Inveterate record keeper: how far he walked in a day

Travels of the inquiring mind

Speed of the mail

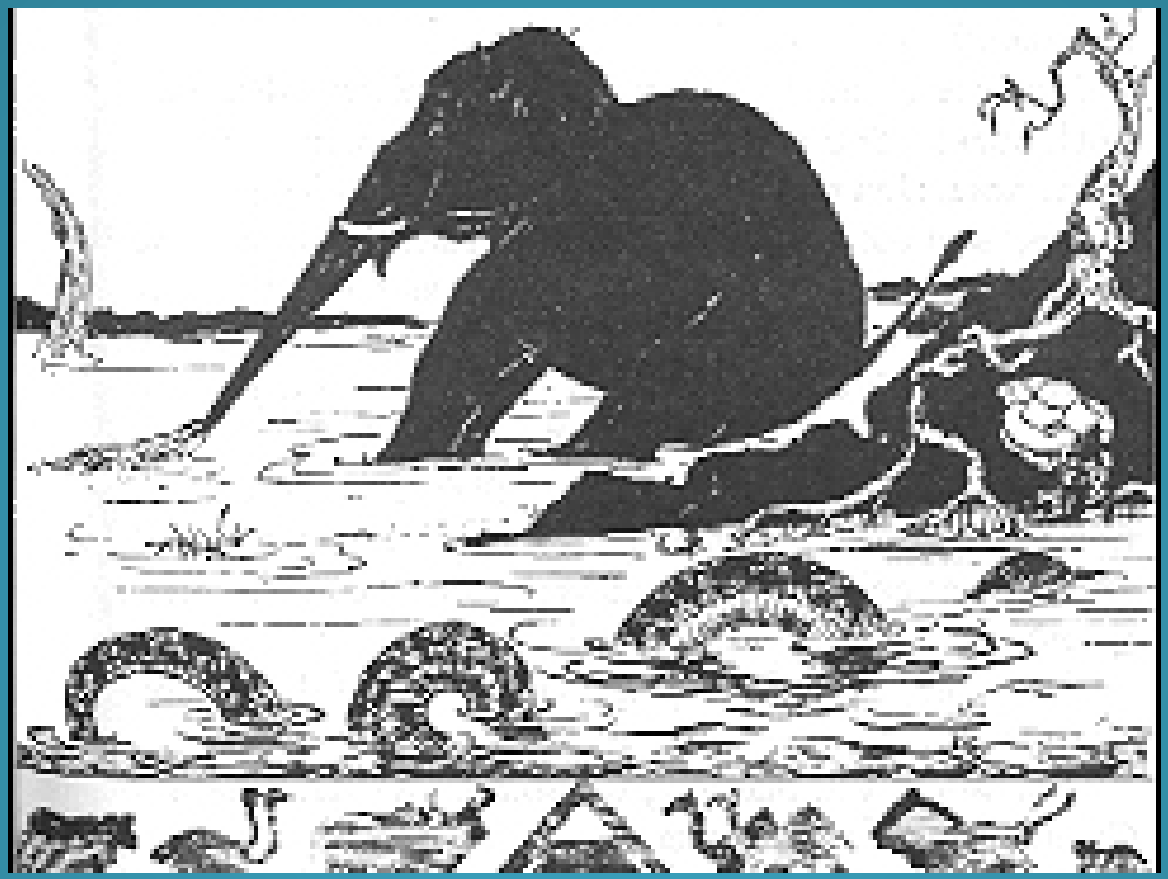


Travels of the inquiring mind

- Life span of fluorescent light tubes

Travels of the inquiring mind

- Sent away for what ended up being hundreds of pounds of catalogs and brochures



Rudyard Kipling's The Elephant's Child

who had "'satiable curtiosity"

Reber in Canada: 2800 mc radiometer at Ottawa 22 June 1949 (the AAS met in Ottawa)

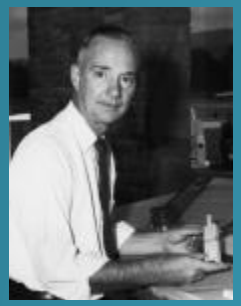
Meeting on “sun-earth-relationships,” Ottawa, 20-21 July 1959

- Reber was in Green Bank working on reconstruction of his telescope there
- Letter to Charles Schauer (Research Corporation): “The trip to Ottawa was a success both as to the meeting and other activities. It is good to see how others do things from time to time.”

Penticton, 1962

The radio astronomy installation at Penticton was very good and well worth seeing. I had a pleasant and profitable few days there. The wavelength of observation is only about one tenth mine so the two are in no way competitive. However it struck me that they are already well underway on an elaborate installation which is nearly identical to what Menon proposes to start in India about 6 years from now.

Penticton 1975

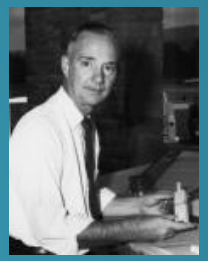


- Reber: 22 Sept letter to Galt saying he wants to see progress made since 1962 "and particularly the 10 mc antenna."

- Galt on 26 September: "The 10 MHz array has recently been dismantled but we have a new project afoot to map the north polar region by synthesis at 22 MHz."

1979 Correspondence

- Nov 28 letter to Galt (CC to DRAO): "About four years ago I visited your establishment. The telescope was in process of construction. Please send me single copies of whatever results are now available including details and descriptions of the apparatus."
- Galt sent Peter Dewdney's thesis on an aperture synthesis radio telescope and deep sky survey at 22 MHz.



21/8/80

Dr. John Galt, Director
Dominion Radio Observatory
P.O. Box 248
Penticton, B.C., Canada
V2A 6K3

Dear John:

Your letter of 13/12/79 and Dewdney's thesis arrived on 7/1/80. Thanks. I've read it all and reread parts several times. It is truly a herculean effort for one man. He carried it to a magnificent end in a very thoro manner. I'm greatly impressed.

I've decided to gradually disperse my assets in Canada while I'm still here, instead of waiting until I'm gone. As a modest start, you will receive early September, a check for $30,000 and note from David Ozmond of Midland Doherty, Toronto.

This sum is to be used as seed money entirely at your discretion. When it has been expended, please send to me a brief run-down on its use. More will probably be available later. If some visibility is given to this sun, it may attract donations from other people.

Until you hear from me to contrary, I wish to remain anonymous on financial matters.

Best wishes,

Grote

Grote Reber
General Delivery
Bothwell, Tasmania
Australia 7411

Galt's 10 September 1980 response

- "I have just returned from a Pulsar Conference in Germany and was most surprised to receive your letter and the cheque from Midland Doherty Limited. Needless to say we are pleased to accept your most generous donation and I can assure you that the money will be put to good use. Immediately it will be placed in a separate Trust Account until we have determined the most appropriate (and visible) way to spend it."

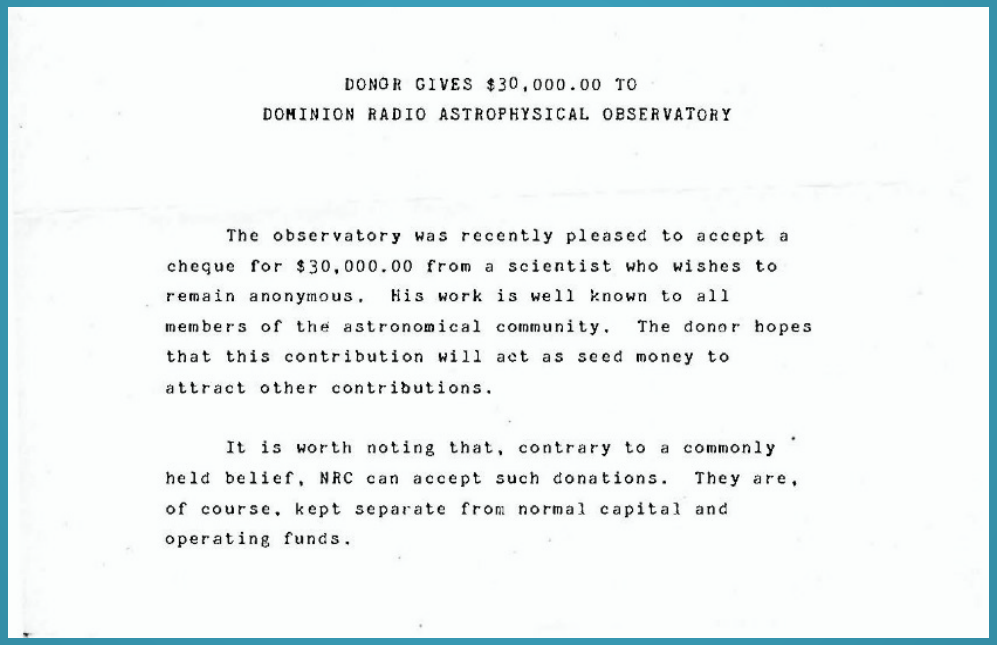
Possible uses for money

- 1) To pay expenses for visiting scientists to work at Penticton in circumstances where NRC is unable to provide a position
- 2) To assist in the design study (Phase II) of the Long Baseline Array.

Possible uses for money

- 3) To design and build a prototype of a Foucault Pendulum of unprecedented accuracy. This suggestion originated with Ed Argyle who performed considerable analysis of the problem but has since retired from the Observatory staff.
- 4) To purchase apparatus required immediately when regular funds have been exhausted.

Notice in Cassiopea



DONOR GIVES $30,000.00 TO
DOMINION RADIO ASTROPHYSICAL OBSERVATORY

The observatory was recently pleased to accept a cheque for $30,000.00 from a scientist who wishes to remain anonymous. His work is well known to all members of the astronomical community. The donor hopes that this contribution will act as seed money to attract other contributions.

It is worth noting that, contrary to a commonly held belief, NRC can accept such donations. They are, of course, kept separate from normal capital and operating funds.

Reber to Galt, 23 Nov 1981

- "Some more money has come to hand. Toward end of month you will receive a check for $30,000 made out to DRO from Midland Doherty. It is to be used for benefit of DRO as you and your associates see fit. All I ask is a short run down on how it was expended."

Higgs to Reber, 2 Dec 1981

- Using funds to add 408-MHz facility to existing 1420-MHz synthesis telescope
- Will provide 3.5 arcmin beam and image 7° in diameter. Allowing simultaneous observations at 2 frequencies so that spectral information for extended galactic objects will be easily obtained.

Higgs to Reber, 2 Dec 1981, cont.

- "Within the observatory we are already referring to this as the "Reber Facility" - currently the lowest frequency instrument that we are building"
- "It is being constructed principally by two graduate students from the University of Alberta and the equipment is being financed from your bequest."

Higgs to Reber, 2 Dec 1981, cont.

- "We are delighted that you have been so kind as to offer us a further donation of $30,000, which of course we will be pleased to accept. I expect that it will be directed in some fashion towards the CLBI"
- "John Galt joins with me in sending our kindest regards, and thanking you for your generosity."

Finally … October 1985

- 3 October: at DRAO for 25th anniversary celebration, formal opening of 408 MHz Reber facility

October 1985

- 10 October – Herzberg colloquium
- 11 October – Shirleys Bay
- 12-13 October – Algonquin Park

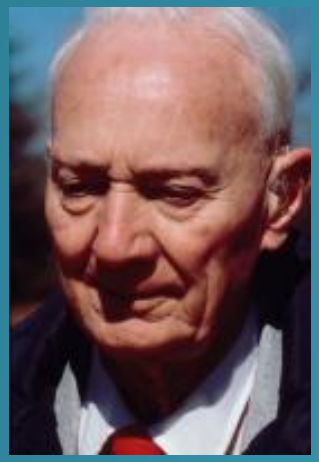
Fall and winter 1986

- Apparently worked at Ashton for several months (40 km SW of Ottawa)
- Remotely operated observations continued
- 1987-1988 file about purchasing equipment for ionosonde work at Ashton, corresponding mainly with Jean Bastien
- In 1993 correspondence with Paul Feldman Reber requests a sample of galvanized iron tuner boxes he had built at site

22 December 1987

- One day symposium in Ottawa honoring
  - Reber's 76th birthday
  - 20th anniversary of Canadian-US VLBI
  - 50th anniversary of first discoveries of interstellar molecules.

2 February 1988



- Gave talk at Communication Research Centre, Shirleys Bay, Ottawa
- Flyer for talk says Reber is "visiting research scientist at NRCC's Herzberg Institute of Astrophysics. He is modifying CRC's old partial-reflection antenna at Ashton in order to measure radio noise near 1.8 MHz."

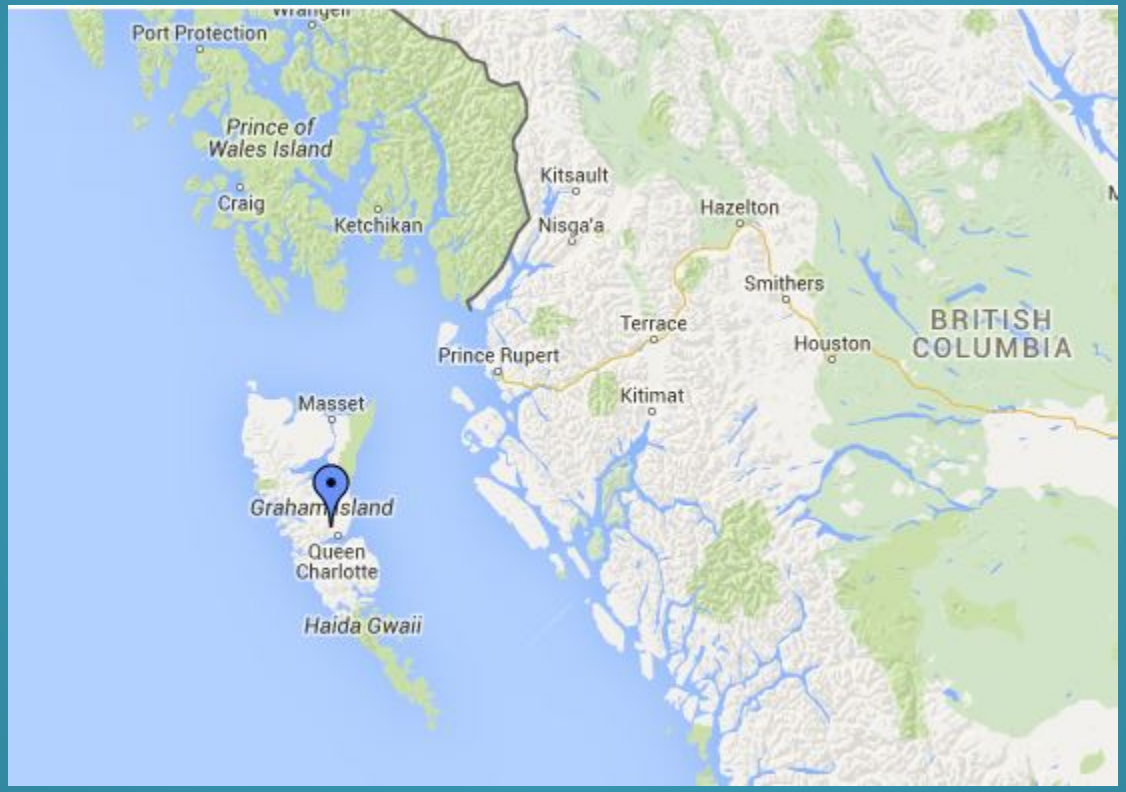
Georgian Bay, 1989

- Plans to do reconnaissance and surveying 21 Aug - 8 Sept 1989
- Arrangements made in Canada for truck, equipment, and lodging
- Reber cancelled trip in 6 July 1989 letter

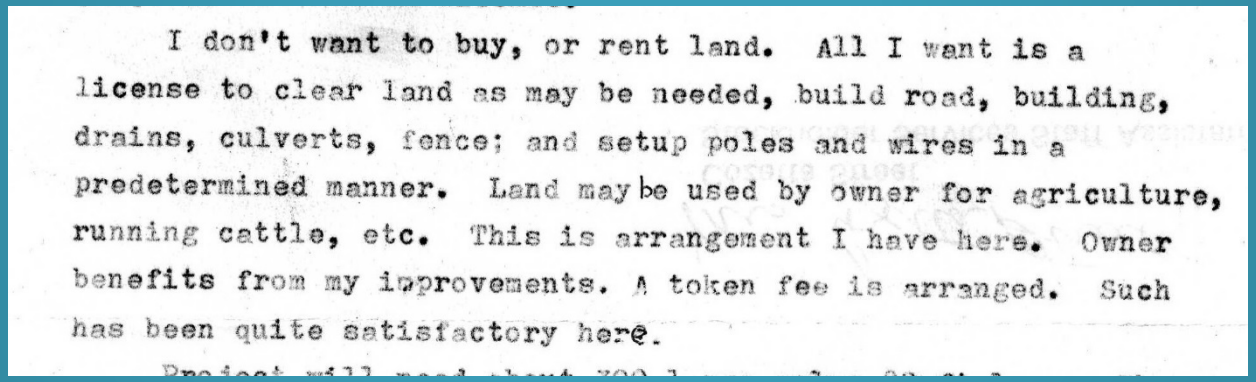
Continuing interest in Canadian ionospheric data

- 1988-1991 correspondence with Jack Landry and Paul Campbell
- Discusses comparisons of Prince Rupert, St. Johns, and Ottawa data to get a "good quantitative understanding of transparency of ionosphere across Canada. This will allow finding a best location to do low frequency radio astronomy. My present thinking is Prince Rupert."

Graham Island



A reasonable request?



I don't want to buy, or rent land. All I want is a license to clear land as may be needed, build road, building, drains, culverts, fence; and setup poles and wires in a predetermined manner. Land may be used by owner for agriculture, running cattle, etc. This is arrangement I have here. Owner benefits from my improvements. A token fee is arranged. Such has been quite satisfactory here.

Observatory to measure hectometer radio waves

- Can’t acquire land unless he is a Canadian citizen or a Canadian corporation
- Applies to set up corporation
- BUT….

Observatory to measure hectometer radio waves

- 95% of land in B.C. is owned by Crown Land
- Any large flat parcel in Queen Charlotte Islands is owned by Crown Land
- “If you want land you will deal under the laws, regulations and procedures set down by Crown Lands, not what YOU want…. What is done in Tasmania has nothing whatsoever to do with what is done here.”

Reber on 4 November 1992

- “I’ve gotten cold feet on this project.”
- Would be “spending half my time up there, and half down here. A lot of long distance travel would be involved. I find this very wearing.”
- “It looks to me this project falls in the foolish category. Accordingly, I’ve decided to bow out.”

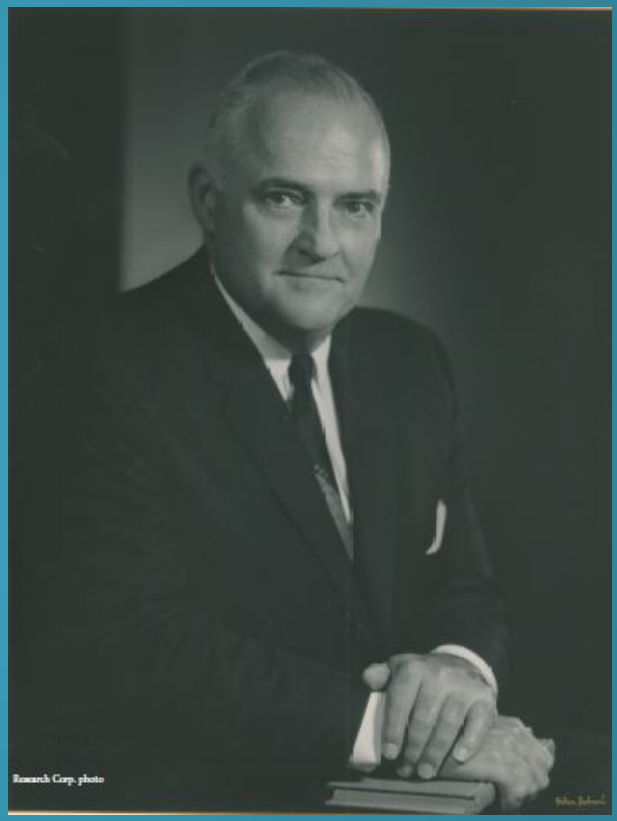
The Big Question:
Where did the money come from?

$$$

- Inherited from his father (but probably not a large amount)
- He made astute investments in the 1930s
- Guest appointments (support but no salary)
- Frugal - kept track of every penny he spent
  - Used back of old reports for carbon copies
  - Drew circuit diagrams on backs of bank statements
  - Used neighbors' sheep to "cut" grass
  - Reused postage stamps

$$$

- Financial support from the Research Corp, 1951-1981 (over $200K - ~$6.6K/yr)
- "…Research that strikes out from the known boundaries of knowledge rather than that which adds to and fills in the blank spaces within known boundaries."



$$$

- He donated generously to charity and to support young radio astronomers
- Donated generously to worthy astronomy projects and institutions

Final travels….