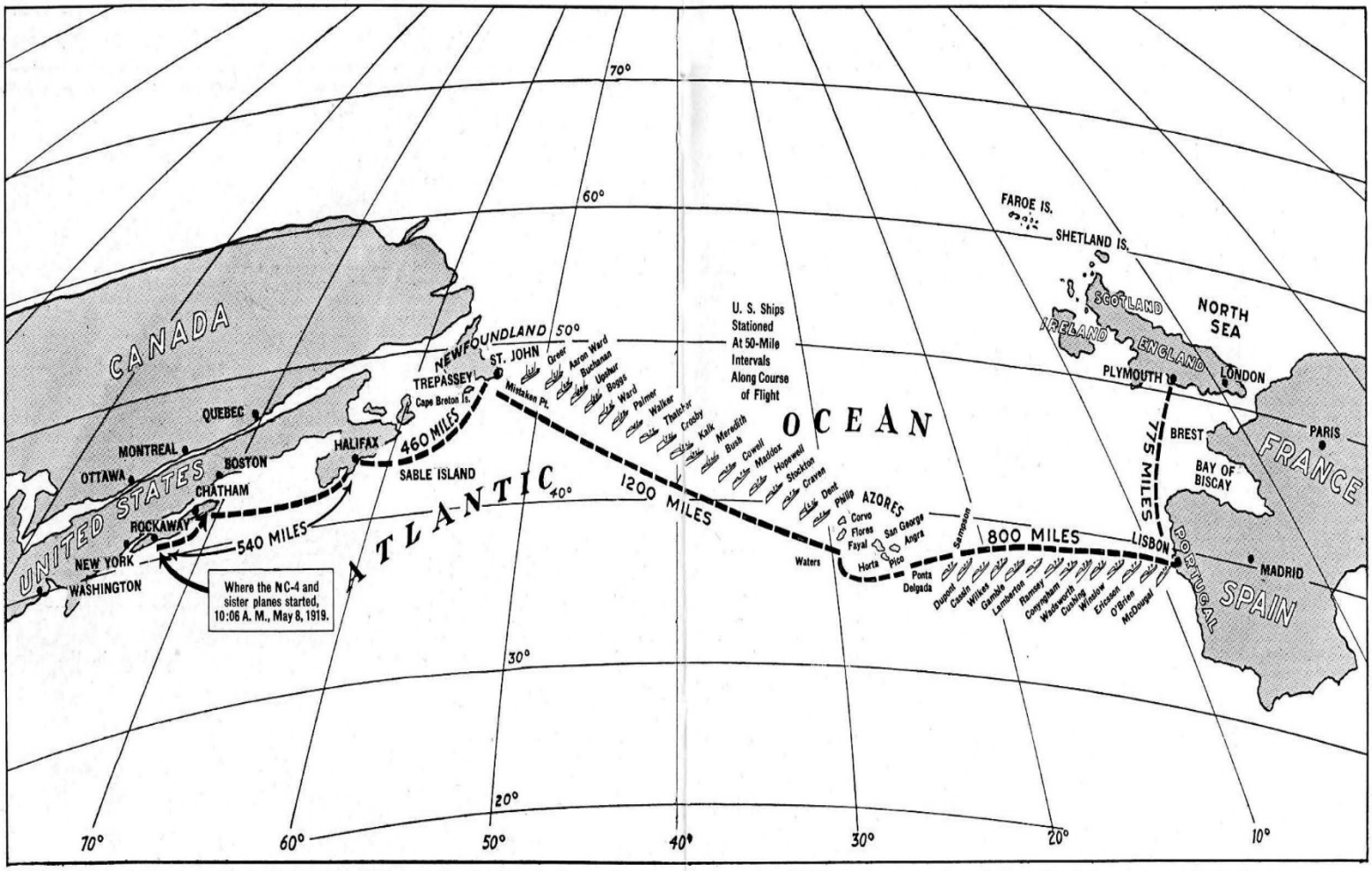
Vacuum Tubes Used in the First Trans-Atlantic Flight

The first trans-Atlantic flight by the US Navy is an often overlooked event in aviation history along with the most important part of the communication equipment necessary to complete that task- the vacuum tube. By orders from the Assistant Secretary of the US Navy, Franklin D. Roosevelt, plans for large, long range flying boats were drawn as early as September, 1917 to combat the German u-boat menace during WW1. Once the war ended, Roosevelt wisely expanded these plans to include the first trans-Atlantic crossing. The Navy choose *The Curtiss Aeroplane and Motor Company, Garden City, Long Island, New York*, to supply the plane design and engines. Holden Richardson, a graduate of the Naval Academy, was also chosen to help with those designs. The Liberty 12 cylinder engine designs were the result of shared patents and were manufactured by many motor car companies such as Buick, Packard, etc. for the war effort. Of course, they had to be altered for use on planes and this was accomplished by Curtiss and Richardson. The name NC (Navy-Curtiss) was chosen. After several years of planning and overcoming difficulties, the NC-1 thru NC- 4 planes were built, tested and ready. By May 8th, 1919, the 4 NC planes started out for their destination, Lisbon, Portugal. [1] [2]



As the NC planes winged their flight from the New World to the Old, each plane was in constant communication with both Continents as well as all ships stationed along the route, with the aid of Moorhead's valve, Type SE 1444.

Fig. 1

Fig. 1 shows the chosen route. [3] 68 US warships were stationed every 50 - 75 miles along the chosen route so the NC planes could keep in constant radio contact and determine if they were veering of course too far. Although each person of the six man crew had an important job, once in the air the radio man's ability to do his job correctly could be called a matter of life and death. The navigator may argue that point. The NC-4 was the only plane to complete the over 4500 mile trip and almost 54 hours of actual flying time on May 30th, 1919. The trip to Plymouth, England was for sentimental reasons alone and is included in the total miles. [2] All four planes were provided a radio direction finding compass but no parachutes.

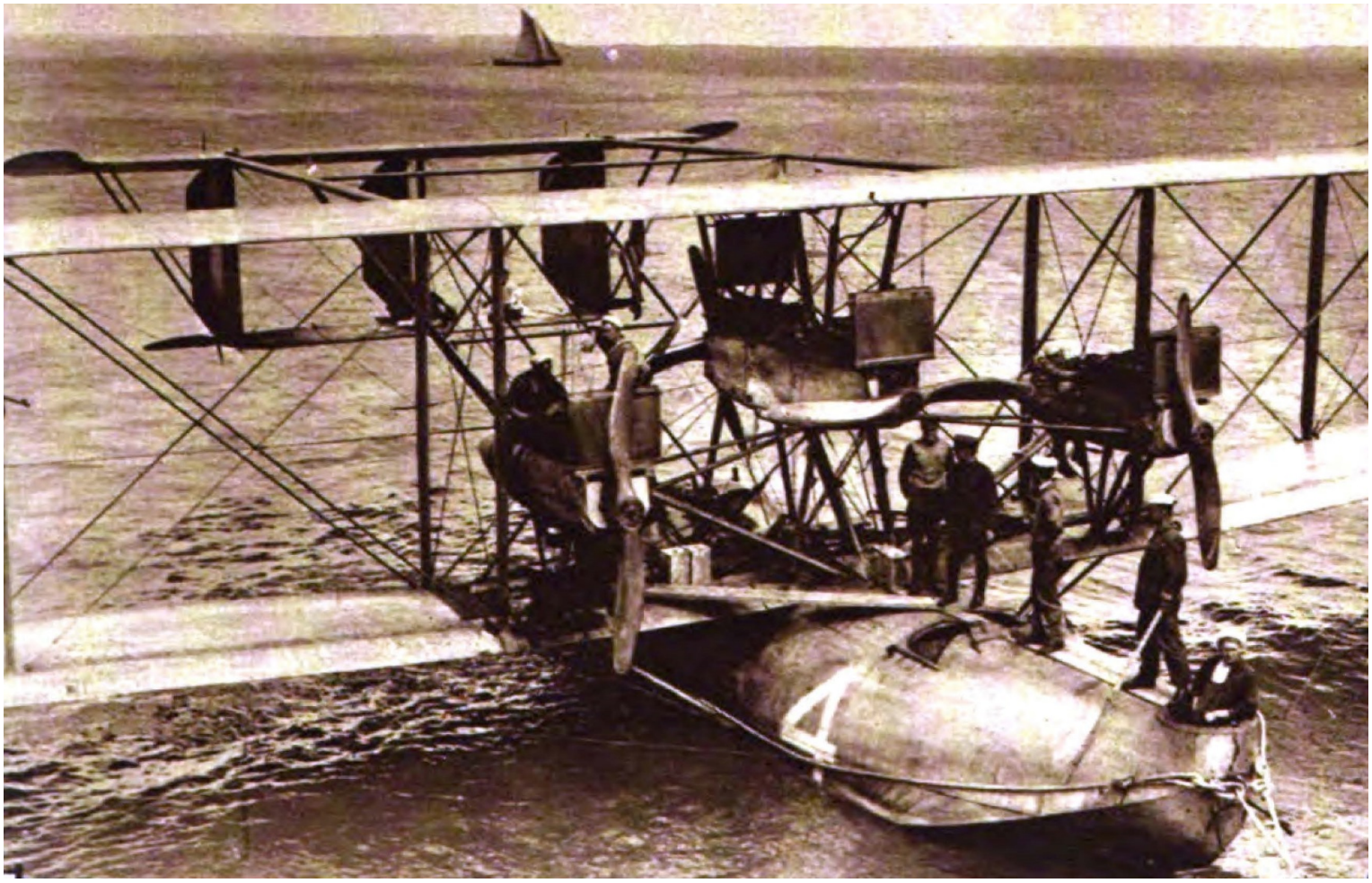
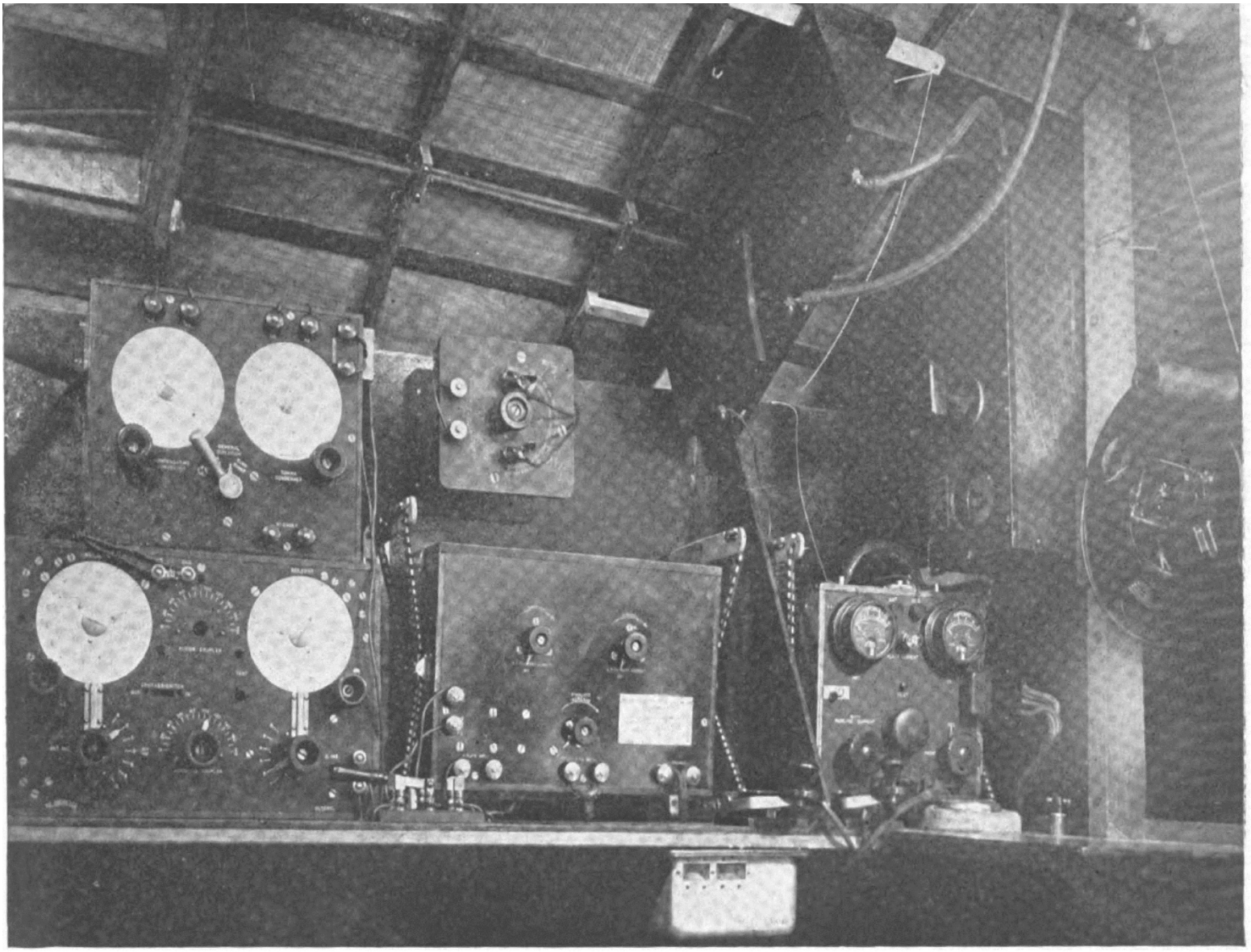


Fig. 2

The four 350 HP “Liberty” engines can clearly be seen in this picture of the NC-4 shortly after its arrival in Plymouth, England, shown in fig. 2. [2] The three front engines were used for lift and the rear engine was used for push. Not so easily seen below the center front and rear engines is the GE wind generator used for the planes power.

Fig. 3 Crew of the NC-4- Left to Right
Stone: Pilot, Rhodes: Machinist Engineer, Hinton: Pilot, Rodd: Radio Operator, Breese: Engineer, Read: Commander and Navigator, Jackson: Navy base ship Melville.



The radio installation on the NC-3, the flagship of the NC squadron, showing the receiving set, radio compass, amplifier, radio telephone set, key and controls for the spark telegraph set, which is mounted on the wing

Fig. 4

Fig. 4 shows the radio equipment aboard the NC-3. [4] The NC- 4 equipment was identical. A very good source to identify the radio equipment along with a complete 3 part narrative of the entire flight was written by the radio operator on the NC-4, Ensign Herbert C. Rodd, US Navy. [5]

The US Navy used three types of vacuum tubes for this trans-Atlantic flight. The CG 1144 for transmitting, the Kenotron TB-1 as a regulator in the wind driven aircraft generator, both made by General Electric, and the Moorhead SE 1444 for receiving. Each of the flying boats including most of the war ships were equipped with the radio gear and these tubes. Rockaway Beach, Long Island, New York, Halifax, Nova Scotia, and St. John, Newfoundland were also equipped with the radio gear and the CG 1144 and SE 1444 tubes. Ensign Rodd used the SE 1444 tubes in a 6 tube amplifier on the NC 4 and it can only be presumed that all the NC's were set up in this manner. Near the end of the journey, Ensign Rodd inadvertently applied 12 volts of filament power to the six tubes for about a half an hour. After discovering his mistake and reducing the power back to six volts he was sure the tubes had been damaged but the messages were coming in loud and clear just as before. The six original Moorhead tubes had lasted the entire trip without fault despite being used a great deal and subjected to vibration and abuse. There had been no need to unpack the two spare tubes he had brought along in case of a loss. [5]

Fig. 5

Fig. 6

Fig. 5 shows the GE CG 1144, also known as the VT-18 or type U Pliotron. Fig. 6 is the GE TB-1 and in Fig. 7 is the Moorhead SE 1444. Over the course of the flight many messages were received and transmitted but the greatest distance of a received message was 1325 miles between the NC-4 and the US Navy Ship USS George Washington, a great achievement by the SE 1444. [5]

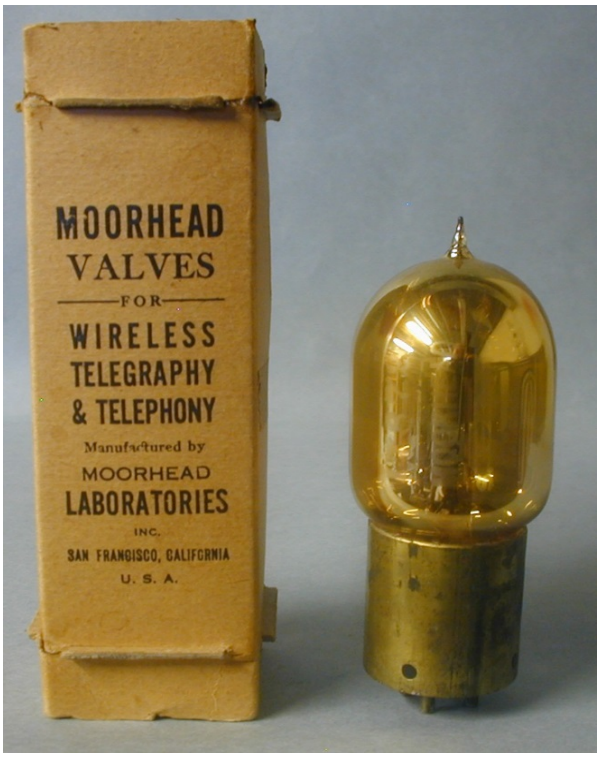


Fig. 7

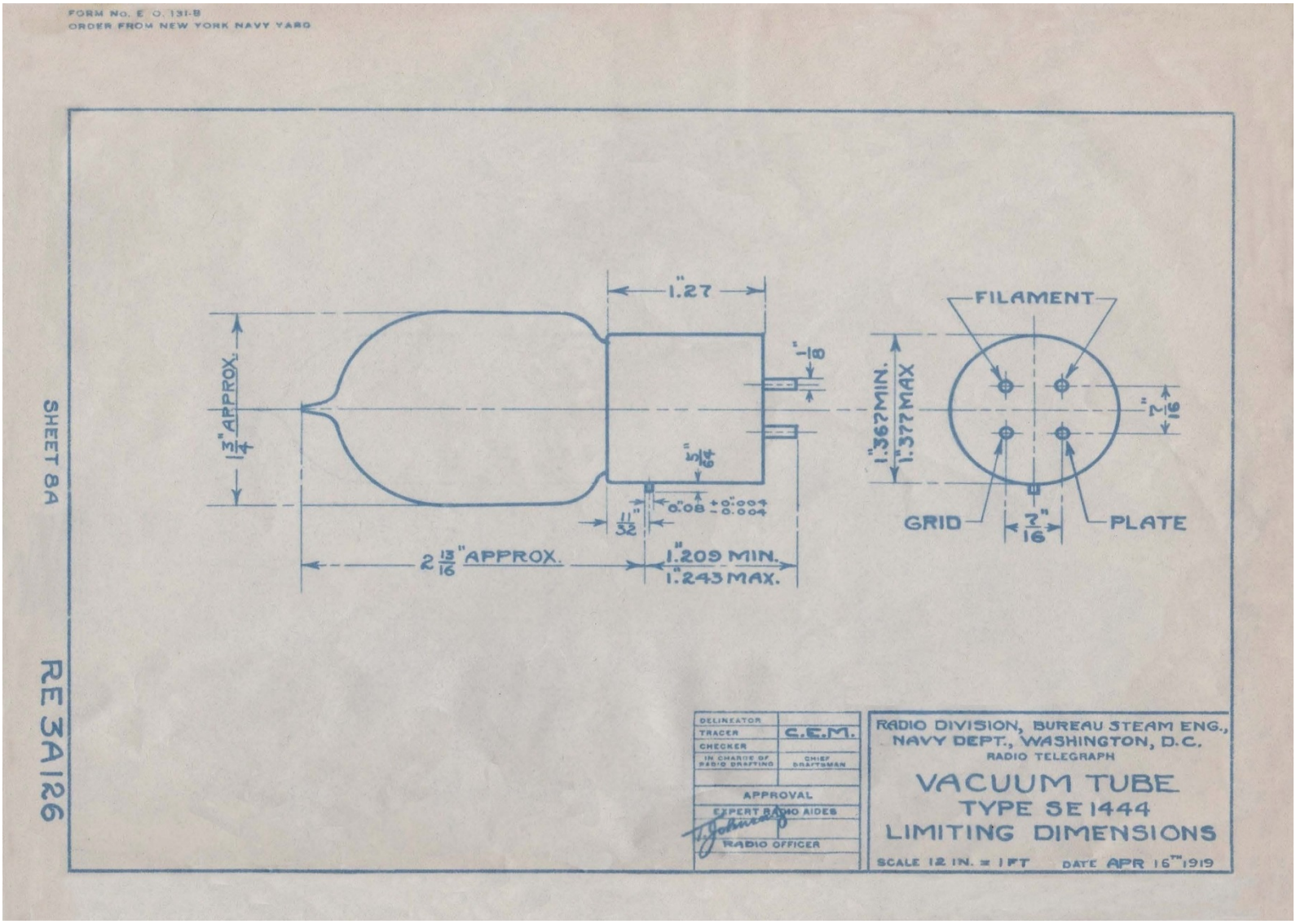


Fig. 8

Shown in Fig. 8 is the US Navy limiting dimensions outline drawing for the SE 1444 dated April, 1919. Earlier versions of this drawing must have been provided to Moorhead to manufacture the SE 1444 as they were made for the US military during WW1. George Clark devised the numbering system for the US Navy. SE 1444, for instance, would be a tube designed by the Navy: SE = Bureau of Steam Engineering, and 1444 would be a consecutive number assigned according to the number of sets and components made up to that point. The CG 1144 tube would be a commercially designed tube: CG = C for commercial, G for General Electric and assigned the number 1144. [6] The TB-1 was a US Army (Signal Corps) tube and their numbering system is unknown to this author at this time.

Appendix I. The U.S. Navy Type Number System

In 1916 the Navy adopted a Type Number System to identify radio equipment by the designing agency's assigned designation as listed below:

CA	American Radio Research Corp.
CB	Crocker Wheeler Co.
CD	Dubilier Condenser Co.
CE	E. J. Simon
CF	de Forest Radio Telephone & Telegraph Co.
CG	General Electric Co.
CH	Electrose Insulator Co.
CK	Kilbourne and Clark
CL	Fritz Lowenstein
CM	Marconi Wireless Telegraph Co. of America
CN	National Electric Supply Co.
CO	Copely Manufacturing Co.
CP	Cutting and Washington
CQ	International Radio Telegraph Co.
CR	Wireless Specialty Apparatus Co.
CS	Sperry Manufacturing Co.
CT	Federal Telegraph Co.
CU	Miller Resse Hutchinson
CV	Weston Instrument Co.
CW	Western Electric Co.
CY	Wireless Improvement Co.
CAB	Baldwin Telephone Co.
CAC	Central Telephone Co.
CAD	Domestic Manufacturing Engineering Co.
CAE	Cutler Hammer Manufacturing Co.
CAF	John Firth
CAG	General Radio Co.
CAH	Cutter Manufacturing Co.
CAJ	Holtzer Manufacturing Co.
CAK	William J. Murdock
CAL	Locke Insulator Co.
CAM	Manhattan Electrical Supply Co.
CAN	Sagame Electric Co.
CAD	Ward Leonard Co.
CAP	Frank B. Perry
CAQ	Robbins and Meyers
CAR	Roller Smith
CAS	Chloride of Silver Co.
CAT	American Transformer Co.
CAU	Triumph Electric Co.
CAW	C. & C. Electric Co.
CAX	Metropolitan Electric Co.
CAV	Industrial Controller Co.
CAY	West Electric Controller Co.
SE	Bureau of Engineering

Fig. 9

The George Clark US Navy numbering system is shown in Fig. 9. [7]

NAVY NUMBERING SYSTEM

Corrections and explanation of Navy Type Designations on page 576 of the book titled "History of Communication-Electronics in the U.S. Navy".

Designations:

CAJ-- Holtzer-Cabot Electric Co.
CAN-- Sangamo Electric Co.
CAY-- Westinghouse Electric Manu. Co.
SE -- Bureau of Steam Engineering, U.S.N.

The "number system" started in 1916 but it was mid 1917 or later before fully applied. The above changes brings the list up to 1919. The system was continued at least through WWII with numerous other changes.

All numbers were originally assigned by the Bureau of Steam Engineering as they were in charge of furnishing radio equipment for the Navy in the early days. All numbers for equipment made from Navy drawings had the prefix SE before the number.

All numbers assigned to private companies for manufacture with their designs had the letter "C" and an additional letter or two designating the company. As an example: early condensers made by Dubilier Company could be marked CD-53.

All type numbers ran in one continuous series numerically whether assigned to Navy Yards or to private companies.

The fact that a certain number assigned to one company appears on a name plate does not necessarily mean that this company actually made the piece of equipment, but that the original design was made by that company and accepted by the Navy. After that, when bids were asked for construction and furnishing the equipment, some other company may be the low bidder. So once the type number was assigned, it was used on that particular apparatus no matter who actually made it. This has been confusing to many present day collectors of old gear

In the case of sub-contractors, it was customary that the prime contractor's number be used and on one corner of the name plate an additional letter be stamped so as to identify the sub-contractor.

If a modification of the original drawing was made, the letter "A" was added immediately after the number. Thus, a name plate for a ½ Kw. submarine transmitter for which Emil Simon was prime contractor and Kilbourne and Clark the actual manufacturer and there had been one major change on the blue print, the Type Number would be: CE 606A and in one corner of the plate would be stamped "K" for Kilbourne & Clark.

Fig. 10

Bob Palmer wrote several corrections and an explanation to George Clark's numbering system some years later, shown in Fig. 10. This is an unknown source file in the authors' collection.

U. S. NAVY YARD, DATE

TYPE SE-1444

This tube is being manufactured by several manufacturers from Navy drawings. It has a pear-shaped bulb and is equipped with a four-prong base.

Overall length: 3-1/4"; diameter: 1-3/4".

The plate is an open nickel cylinder, 0.4" in diameter and 0.6" long. The grid is helical, of 11 turns of 0.01 nickel wire, and 0.6" long. The filament is tungston, designed to operate at 4 volts and a current of 0.65 amperes. It gives best operation at a plate voltage of about 40, with a bias of 1.3 volts.

This tube compares very favorably with the CW-933 in its characteristics, although it is not quite as good an oscillator, but is quite as good in the reception of spark signals and is especially useful in radio-frequency amplifiers. It is expected that this type of tube will become standard in Navy service. At present the cost of these tubes is $3.05.

In addition to its use in receiving, this tube may be used with a plate voltage as high as 750 volts for transmission. When so used, it is capable of developing a power output of 10 watts. This makes it suited for telephone work and for low-power undamped transmission.

It is to be noted that this is the only bulb in Navy service which combines the functions of the transmitter and receiver.

TRANSMITTING VACUUM TUBES

TYPE CW-931

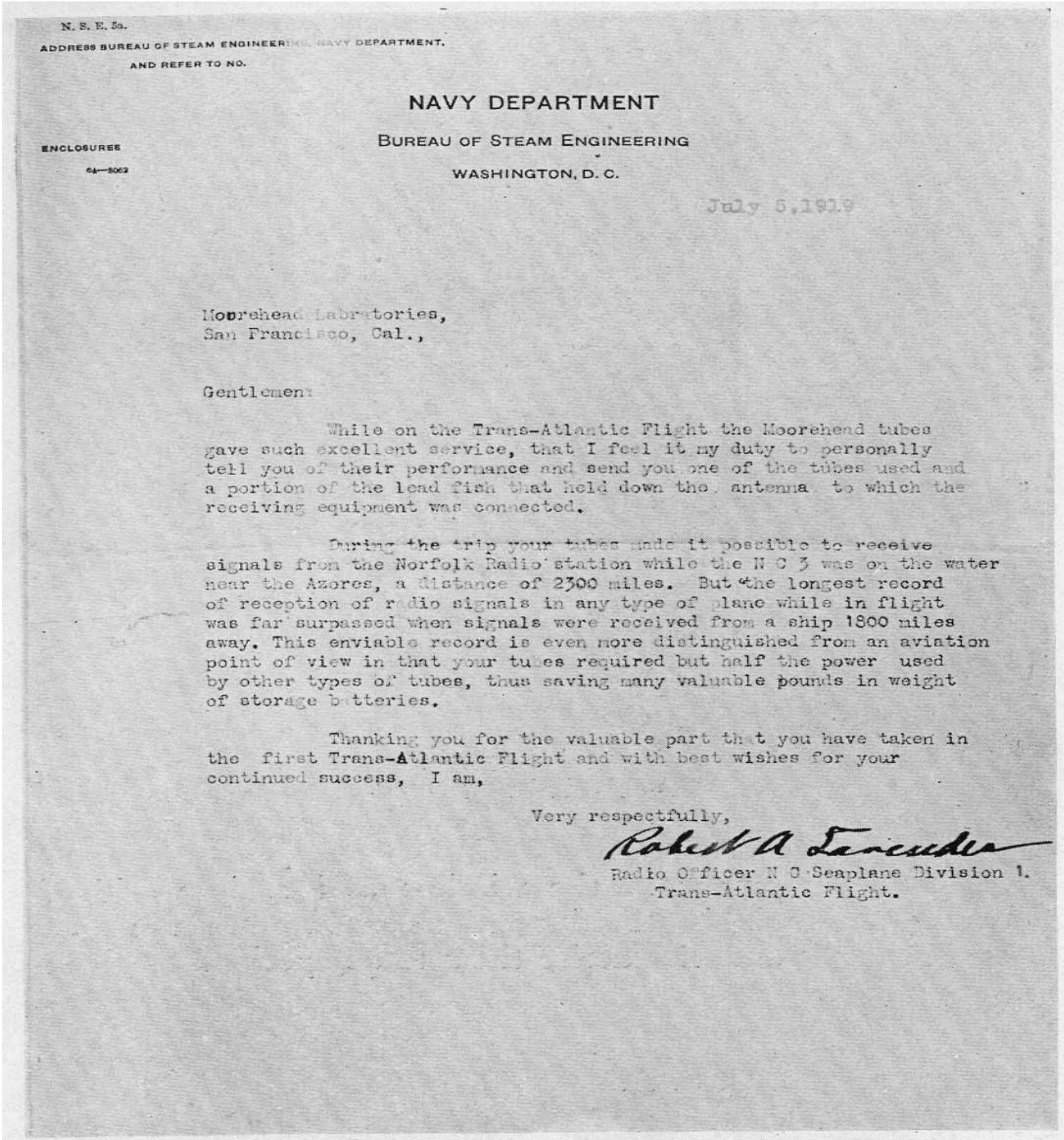
This tube is otherwise known as the Western Electric type E. It is used in airplane and other low-power sustained-wave transmitters. This tube has a spherical glass bulb and is provided with a four-point base; the pins are arranged somewhat differently from the Navy standdard base so as to eliminate the possibility of using any other tube in the socket designed for this type bulb.

Overall length is about 4-1/4";; diameter is 2-5/16". The grid elements are spaced 1/16" on each side of the filament.

SHEET 3 RW50A254

Fig.11

The Navy Bureau of Steam Engineering was responsible for suppling tubes for US Navel use. Some of these types were assembled into an example collection after the war. Lieutenant W.A. Eaton, US Navy, was given the task of assembling and describing the now famous Eaton Navy tube collection. Shown in Fig. 11 is a scan of sheet three of the appendix of that report, dated February, 1919. [8] The SE 1444 is described in great detail and said to be the only vacuum tube in use by the US Navy that could be used as transmitter and a receiver.[9][10] The first sentence in the document also states several tube manufacturers were making their version of the SE 1444 from the US Navy drawings. From that sentence one could assume that some unmarked Moorhead SE 1444 *lookalikes* seen in collections today may have been legitimate contributions by other manufacturers.



N. S. E. 3a.

ADDRESS BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT,
AND REFER TO NO.

NAVY DEPARTMENT

BUREAU OF STEAM ENGINEERING

WASHINGTON, D. C.

ENCLOSURES

64—5062

July 6,1919

Moorehead Labratories,
San Francisco, Cal.,

Gentlemen:

While on the Trans-Atlantic Flight the Moorehead tubes gave such excellent service, that I feel it my duty to personally tell you of their performance and send you one of the tubes used and a portion of the lead fish that held down the antenna to which the receiving equipment was connected.

During the trip your tubes made it possible to receive signals from the Norfolk Radio station while the N C 3 was on the water near the Azores, a distance of 2300 miles. But the longest record of reception of radio signals in any type of plane while in flight was far surpassed when signals were received from a ship 1800 miles away. This enviable record is even more distinguished from an aviation point of view in that your tubes required but half the power used by other types of tubes, thus saving many valuable pounds in weight of storage batteries.

Thanking you for the valuable part that you have taken in the first Trans-Atlantic Flight and with best wishes for your continued success, I am,

Very respectfully,

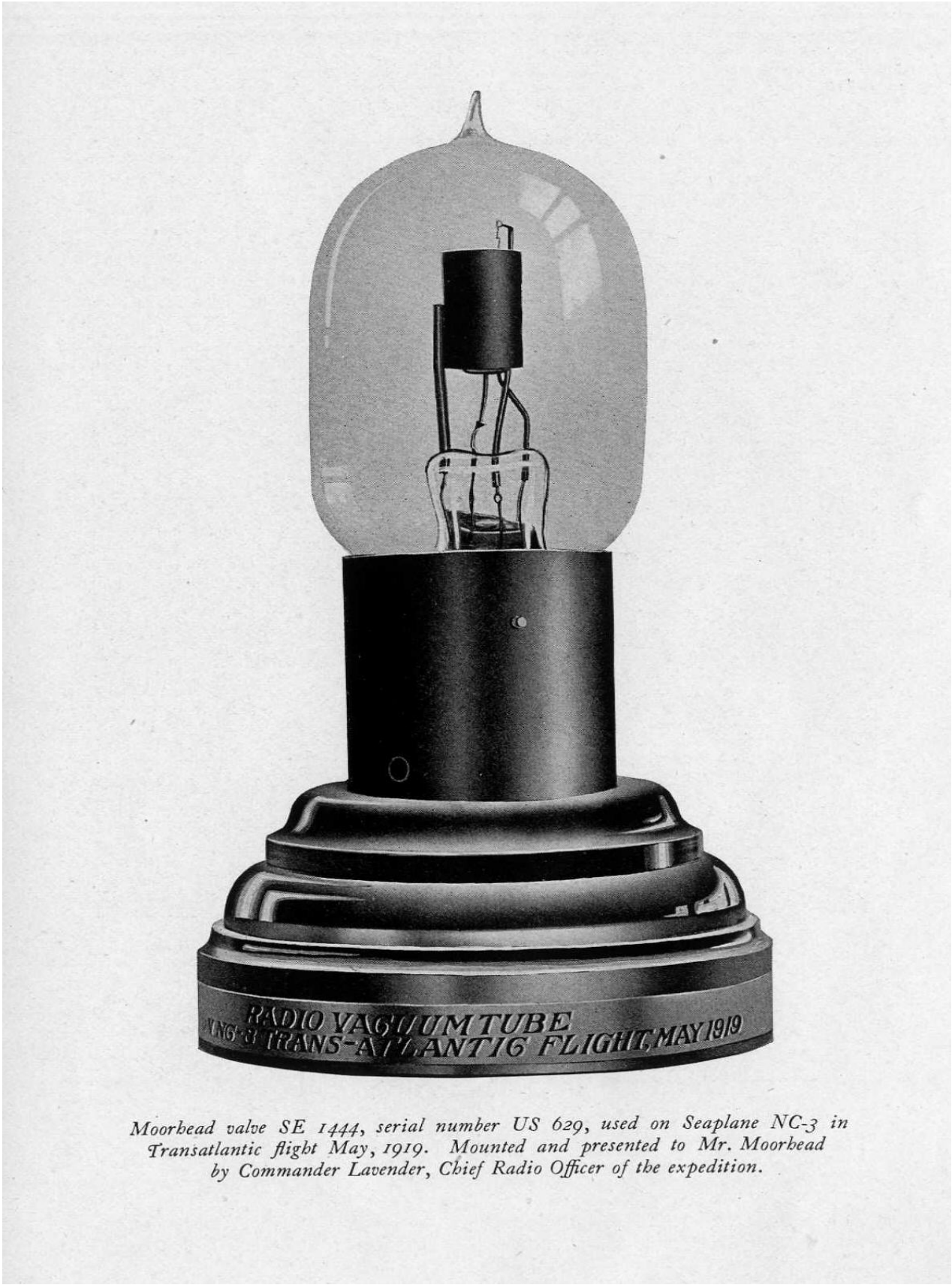
Robert A Lavender

Radio Officer N C Seaplane Division 1.
Trans-Atlantic Flight.

Facsimile of letter from Radio Officer Robert A. Lavender to Mr. Moorhead after Transatlantic flight.

Fig. 12

The US Navy was quite impressed with the performance of the SE 1444 and subsequently wrote a letter to Moorhead thanking him for the valuable part he played in the first trans-Atlantic flight. They included with the letter one of the SE 1444's used on the NC 3 during the flight and an antenna part. Fig. 12 is a scan of that letter as it appeared in a company brochure. [3] The letter was signed by Lieutenant Commander Robert A. Lavender, US Navy, the radio operator on the flagship NC 3 and the radio officer in charge of the entire NC fleet.



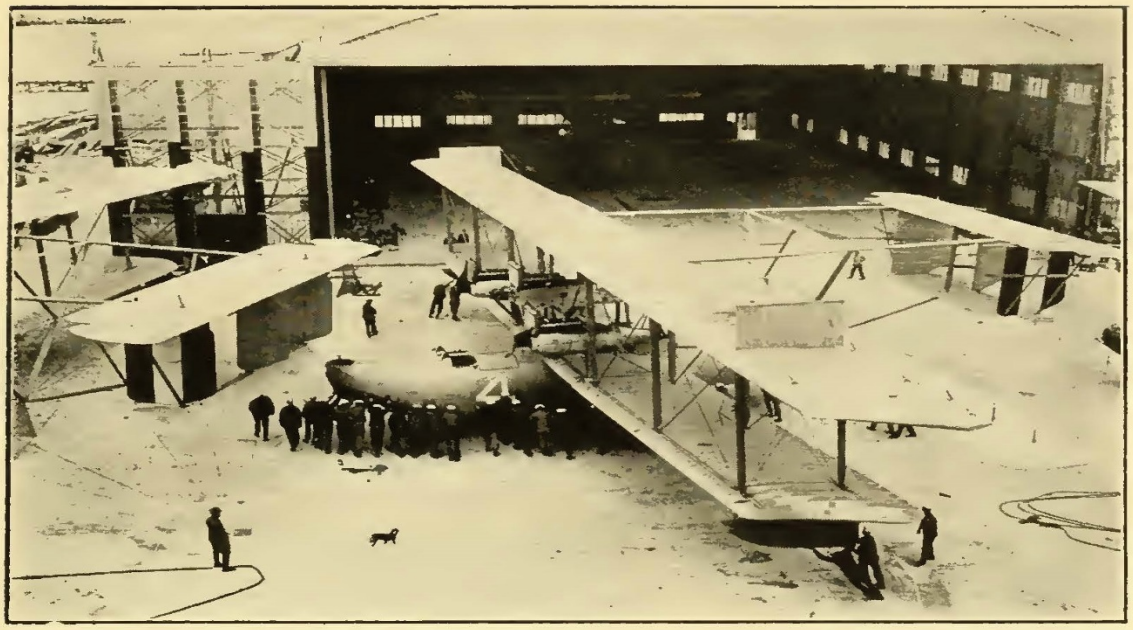
Moorhead valve SE 1444, serial number US 629, used on Seaplane NC-3 in Transatlantic flight May, 1919. Mounted and presented to Mr. Moorhead by Commander Lavender, Chief Radio Officer of the expedition.

Fig. 13

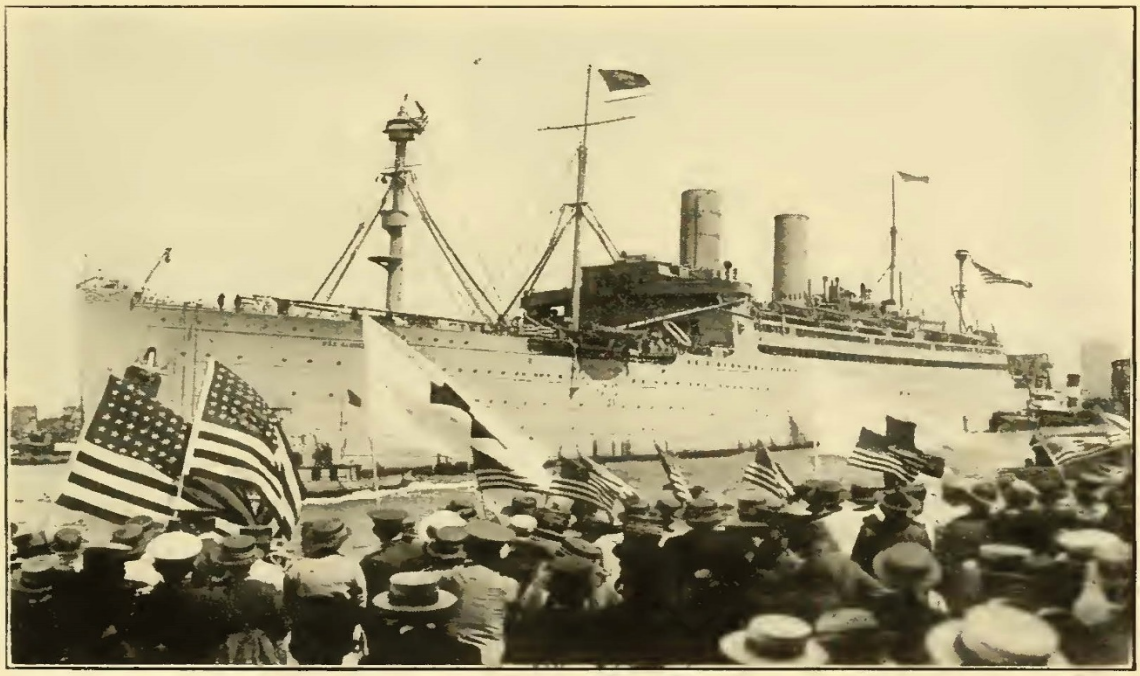
Shown in Fig. 13 is a scan of the US Navy presentation tube as it appeared in a Moorhead company brochure. [3]

Fig. 14

Otis Moorhead was working for the company he had started and Henry Shaw was president at the time the A-P advertisement shown in Fig. 14 appeared in the October, 1920 Pacific Radio News. The tube shown in the ad was called the Atlantic-Pacific VT but in fact was the renamed SE 1444. [11]



The famous Flying Boat NC-4 which was the first trans-Atlantic plane. Using CG-1144 Vacuum Tubes, the NC-4 maintained communication with the George Washington until 50 miles away.



The U. S. Naval Transport George Washington which carried President Wilson to and from the Peace Conference. CG-1144 Vacuum Tubes were very successfully used in both Wireless Telephony and Wireless Telegraphy sets on board this ship.

Fig. 15

The communication distances of 50 miles using CG 1144 tubes referred to in the top picture in Fig. 15 [12] were preliminary tests made in 1918 after the completed assembly of the NC 4. Much greater distances were achieved in the 1919 expedition. Oddly, the SS George Washington (original name), lower picture, was a German (1908) built ocean liner seized by the US Government when we entered WW1. It was also one of the first ships to send wireless reports to the Titanic regarding a particularly large iceberg seen off the Grand Banks of Newfoundland on April, 14th, 1912. That reported area is exactly where the Titanic struck an iceberg and sank.

Footnotes:
All material used in this article are in the Joe Gruber collection.
Very good youtube video on the NC 4: http://www.youtube.com/watch?v=K6E696hr420

References:

1. Smithsonian Institution, National Air and Space Museum, Washington, DC. "The First Flight Across the Atlantic", 1968.

2. Russell, James and Moore, William, "The United States Navy in the World War", 1921, pages 207-222

3. Moorhead, Otis, "Moorhead and His Valve", 1919.

4. Flying Association, Inc., "Flying Magazine", monthly magazine, June, 1919.

5. Wireless Press Inc., "The Wireless Age", "Across the Ocean on the NC- 4" by radioman Ensign Herbert C. Rodd, 3 articles appearing in the Aug., Sept., Nov., 1919 issues.

6. Howeth, Capt. L. S. US Navy, "History of Communications- Electronics in the United States Navy", 1968, pages 218, 219.

7. same as 6, page 576

8. scan of document in the authors collection.

9. Eaton, W.A., US Navy, Radio Test Shop, US Navy Yard, Washington, DC., appendix to: "Description of Vacuum Tubes in Navy Service", February 3rd, 1919, in a report coded RW50A254.

10. Clark, George H., "Radioana Collection", Archives Center, National Museum of American History, Smithsonian Institution, Washington, DC.

11. scan of magazine cover in authors collection.

12. General Electric Company, book, "The National in the World War, April 6th, 1917- November 11th, 1918", between pages 244 and 245.