

Moorhead Laboratories Inc. Vacuum Tube Contributions - 1915-1925

The purpose of this article is to show the scope of the Moorhead product line in pictures. Most of the history of this company has been covered in previous articles in this newsletter.

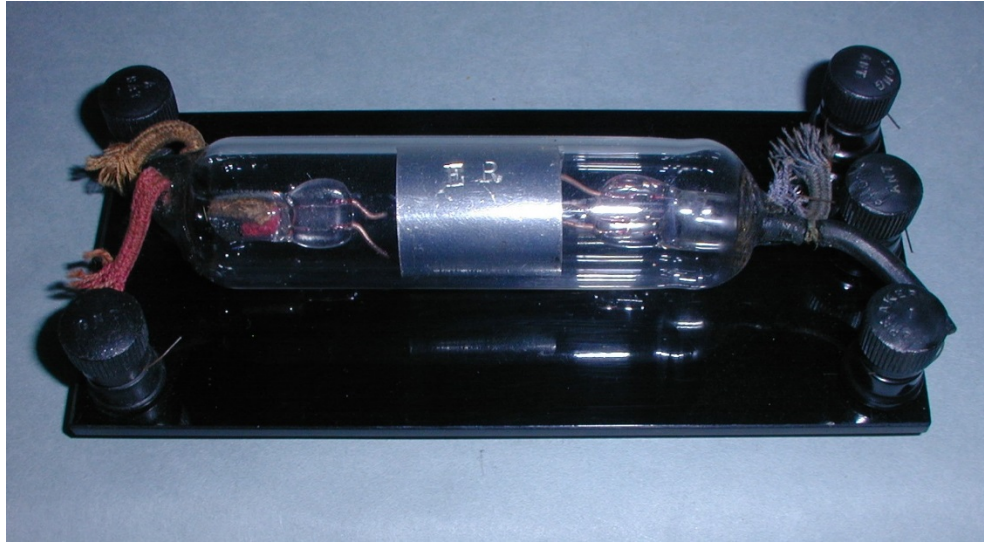
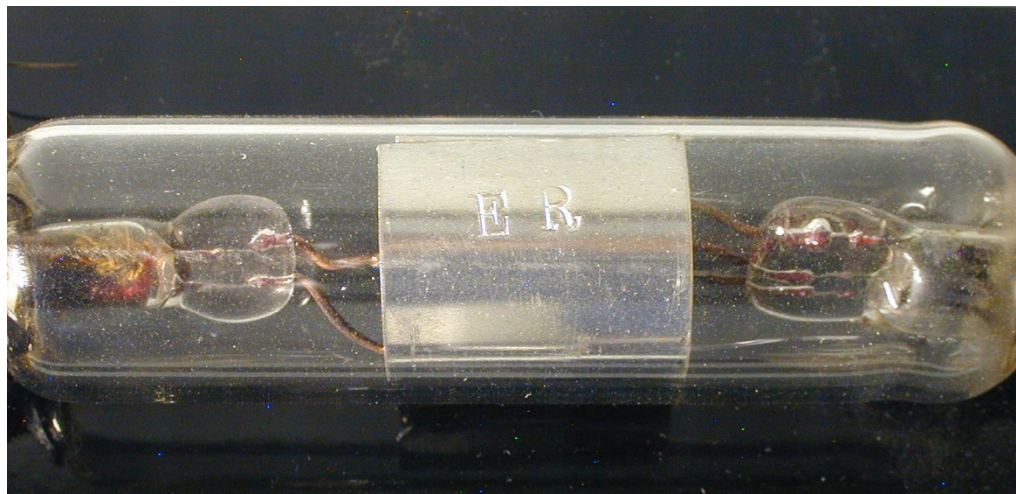


FIG. 1



Moorhead Laboratories Inc. produced this tubular Electron Relay tube shown in Fig.1 and below starting in 1915 in several different forms until well after the US entered World War 1. It can be difficult to determine who made examples of these types of tubular vacuum tubes but there are a few clues to keep in mind to help. The press in the pictured example is more fat than long and narrow as have been observed in Cunningham Audiotron's, for example. DeForest tubular Audion presses have a shape that can be a combination of each the Moorhead and Cunningham tubes. The insulation on the DeForest examples are usually rubber rather than cloth. The Moorhead example above has an ER stamped on the plate which makes an ID easy but this type of stamping is not consistent. This particular tube has a double filament but they were made with a single filament as well.

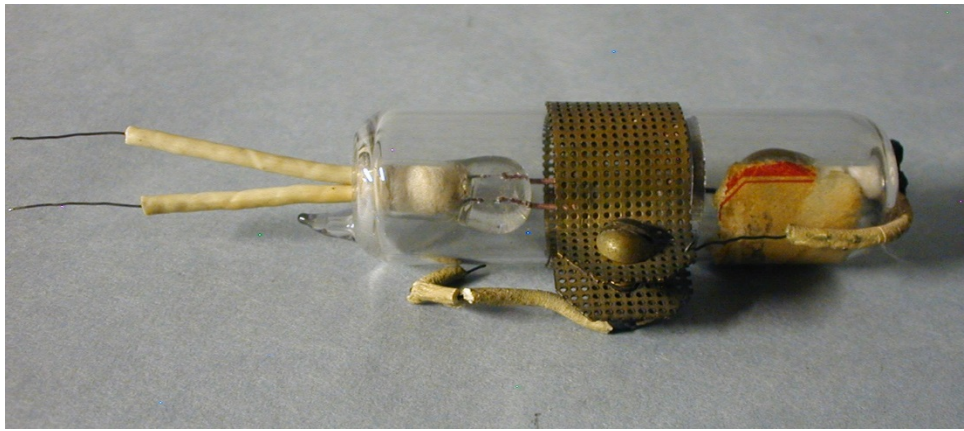


FIG. 2

Moorhead Labs made and started to advertise the external grid Electron Relay, Fig 2, as a replacement for the internal grid E.R. in Fig 1 in 1916 in response to grid patent infringement threats from DeForest and rejections from national magazines he wanted to place ads in because DeForest was threatening them with lawsuits as well. While the threats stopped, tube sales dropped because the external grid E.R. simply did not work. The example above has a short, small loop single filament and a disk plate with Moorhead and patent pending stamped in and of course the brass grid on the outside of the glass bulb held on with a bolt and nut.



FIG. 3

The valve in Fig. 3 is not a Moorhead product but a British Marconi R valve developed for use in WW1 made by GEC, General Electric's presence in England. The companies in England could not meet the production demand called for therefore they contracted Moorhead to supply a direct replacement for their R valve. Moorhead, because of the wartime banning of any patent litigation, was able to produce and sell his tubes to the British and US Governments.



FIG. 4

Moorhead designed and produced his R tube, Fig.4, to be used in place of the British R receiving valve shown in Fig. 3. The R was made according to strict British specs and shipped to England. Moorhead also produced a transmitting tube called the B tube. Both of these tubes were fashioned after the French type TM that had been designed in 1915 for the French military and then adapted to the British military standard. The internal structure is vertical because Moorhead was supplied with only the specs and no drawing.

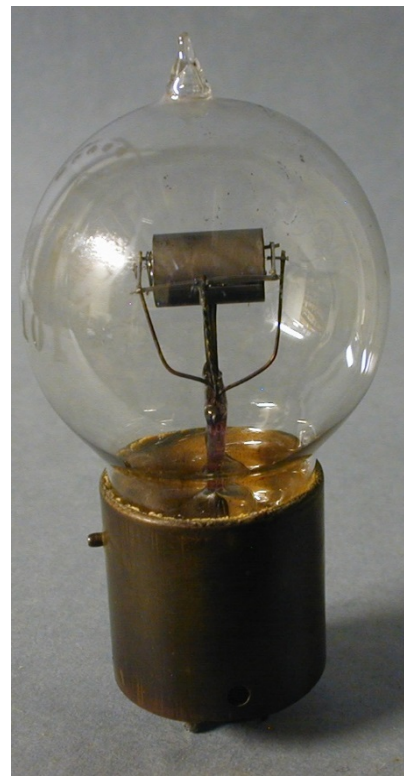


FIG. 5

Shown here in Fig. 5 is a Moorhead B transmitting tube “design in progress” prototype with an American standard Shaw base for ease of testing. The final version would have had a British standard base. Both the Moorhead R and B exceeded British Army expectations and were very well thought of. Note the similarities in the horizontal internal structure of the tubes in Fig.’s 3 and 6. Unlike the R tube, the horizontal structure of the Moorhead B tube was corrected to be exactly in line with the supplied drawing.

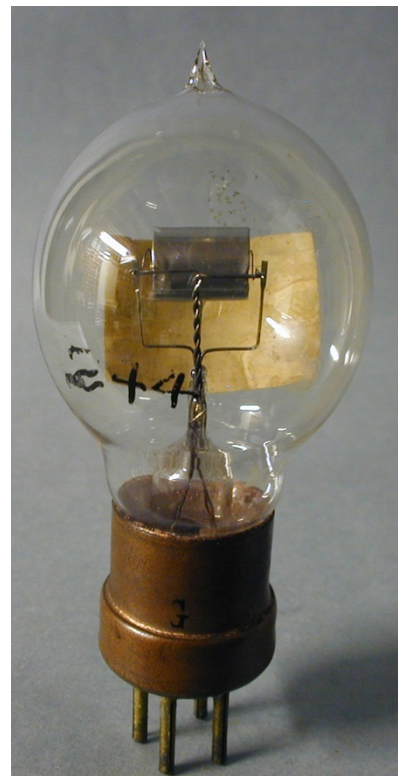


FIG. 6

The French TM Metal valve shown here in Fig. 6 laid the design foundation for both the US and British war time receiving and transmitting tubes for glass shape, structure and electrical properties. The TM Metal, also made by Fotos, was probably the first vacuum tube mass produced in the world. The French method of heating the elements white hot during evacuation to obtain a clean vacuum became the standard for all tube manufacturing from that point on.



FIG. 7

The third tube Moorhead Laboratories Inc. produced for WW1 was named by the US Navy SE 1444 shown in Fig. 7 along with the shipping carton. This tube was designed by the Navy Bureau of Steam Engineering shortened to SE and then given the number 1444. This numbering system was devised by George Clark. It was the only Navy tube that could be used for both receiving and transmitting, testament to a great Moorhead manufacturing process.

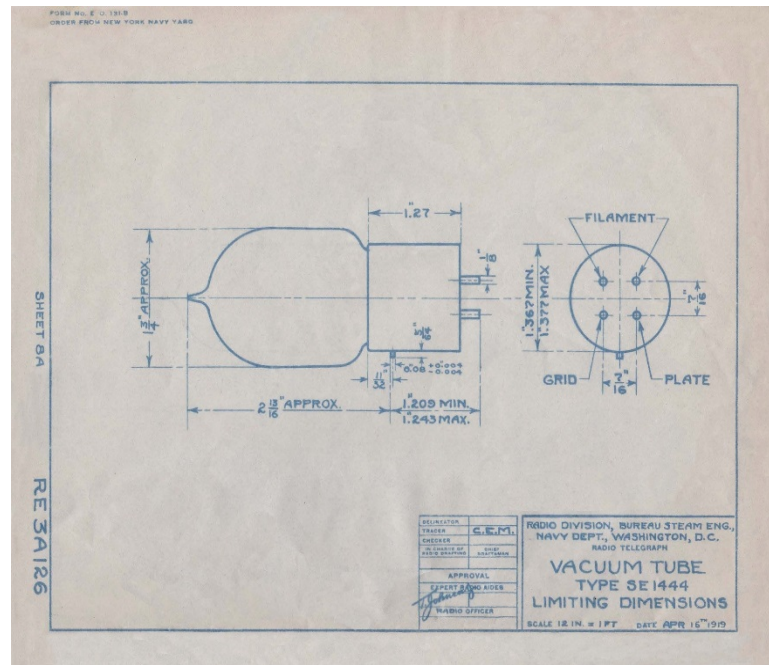


FIG. 8

In Fig. 8 is the original Navy line design drawing for the SE 1444. Several manufacturing companies were given this line drawing and asked to submit examples, several were chosen but the tube Moorhead supplied would have become the Navy standard had his factory and financial practices been more stable. This drawing states “Navy Bureau of Steam Engineering” and the date 1919. This latter date must mean that the drawing had been updated after the war as Moorhead supplied the US Government with the SE 1444 as early as 1917.

PACIFIC RADIO NEWS

*Pioneer Journal of
Western Radio News and Development.*

A-P TUBES CROSS WITH NC-4

USE THE TUBE THE NAVY USES

So efficiently did these A-P VT tubes serve on this flight, so much did they contribute to the success of this great achievement, that voluntarily the Bureau of Engineering of the U. S. Navy wrote our Laboratories a letter of appreciation. Descriptive Pamphlet Free on Request.

AMATEURS—"Use the Tube the Navy Uses"—the A-P VT Amplifier Oscillator—equipped with the SHAW standard four-prong base—price \$7. Order from your dealer.

*A-P tubes manufactured under the De Forest Audion and Fleming patents.
Other patents applied for and pending.*

PACIFIC RADIO SUPPLIES CO. **ATLANTIC RADIO SUPPLIES CO.**
638 Mission St., San Francisco, Cal. 8 Kirk Place, Newark, New Jersey
Distributors for Moorhead Laboratories

READ THE EXTRAORDINARY OFFER ON PAGE 61

FIG. 9

N. S. E. Co.
ADDRESS BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT,
AND REFER TO NO.

NAVY DEPARTMENT
BUREAU OF STEAM ENGINEERING
WASHINGTON, D. C.

July 6, 1919

Moorehead Laboratories,
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 hold 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 NC 4 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 U S Seaplane Division 1.
Trans-Atlantic Flight.

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

FIG. 10

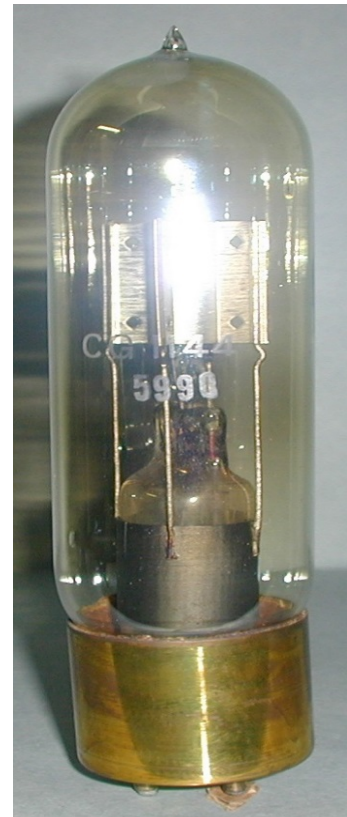



FIG. 11

Shown in Fig. 9 is an ad for the A-P VT Amplifier-Oscillator tube the Navy was using in 1919 on their Navy NC flying boats. The NC-4 was first airship to cross the Atlantic. Keep in mind the A-P VT and the SE 1444 were the very same tube, the VT being the Moorhead name and the SE 1444 the Navy's name. The US Navy sent the letter in Fig.10 to Moorhead Laboratories Inc. to congratulate them on the VT tube that performed exceedingly well. The NC flying boats and the Navy ships used the Moorhead SE 1444 tubes to receive the spark signals they sent and the General Electric CG 1144, Fig. 11, transmitting tubes to send the spark signals. The Navy had ships stationed every 50 miles moving along a path to the NC-4's destination keeping in constant contact. The lives of the crew of the NC-4 literally depended on the Moorhead VT and GE CG-1144 performing flawlessly on this very risky flight. The US Navy built 4 NC (Navy Curtiss) flying boats to make this historic journey but only the NC- 4 made the complete journey. The longest message received by the NC-4 plane was an intercepted message from the USS George Washington to the shore near Breast, France estimated to be 1800 miles away and easily the record for receiving a message for any plane in flight up to that time.

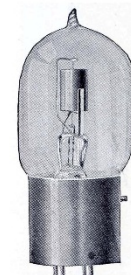
It is well known to the Radio Art that no one tube can be both an amplifier and an efficient detector of spark signals. This is because the detector tube must be operated at a higher stage of ionization and consequently must not be exhausted to as great a vacuum. Only a combination of tubes can give complete efficiency and provide all necessary operating characteristics without the sacrifice or subordination of desirable features. In the new *Moorhead Electron Relay* and *Moorhead VT Amplifier-Oscillator* the Moorhead Laboratories offer amateurs and experimenters the one such perfect combination on the market to-day. Both types of tubes are rugged in construction and unqualifiedly guaranteed.

THE MOORHEAD ELECTRON RELAY



Retail Price Six Dollars

THE MOORHEAD VT AMPLIFIER-OSCILLATOR



Retail Price Seven Dollars

LICENSED UNDER THE DE FOREST AUDION AND FLEMING PATENTS

Originated by the Moorhead Laboratories in 1915, the Moorhead Electron Relay was the first tubular vacuum valve ever manufactured. For the sake of convenience in operating, it is now supplied with the standard four-prong base, but retains the copper grid and aluminum plate of the old type relay. The Electron Relay has the familiar hissing point and low B battery potential requirement characteristic of the efficient detector tube.

This is the Navy SE 1444 tube, designed for amplification and undamped wave reception by the regenerative method. It is highly exhausted to insure efficient performance as a generator and amplifier. It may be used singly for receiving continuous waves or in cascade as a two or more step amplifier. Recent Navy tests show that this tube has a higher amplification constant than any other tube known to the radio art.

A combination of two or more VT Tubes as Amplifiers with an Electron Relay as the Initial Detector or Oscillator is the Ideal receiving combination for long distance amateur or long wave reception

FIG. 12

Moorhead Laboratories Inc. tube insert ad for the SE 1444, left, Fig. 12



FIG. 14

Once the war ended, no one could legally make a 3 element vacuum tube until Moorhead negotiated a contract with Marconi and DeForest. Marconi was to become the sole distributors of this new organization. One of the first products was the Moorhead type A class 2 shown in Fig.14 along with the carton. The A was a hard tube used for both amplifying and detecting. Moorhead must have shipped and or sold some of his A tubes before the properly prepared Marconi boxes were available as this A tube was still sealed in the box when found.

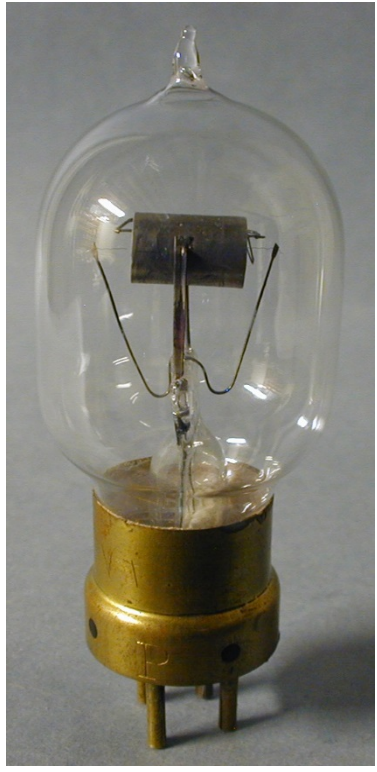
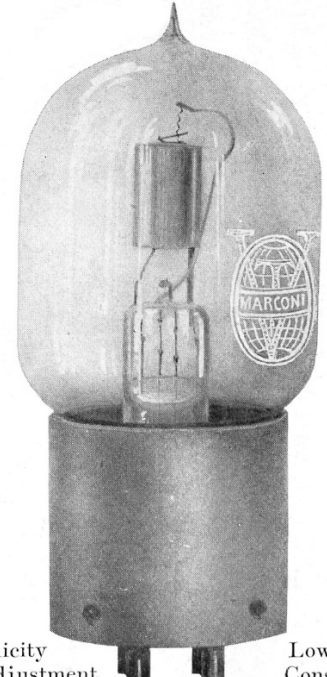


FIG.13

The fourth and last tube made for the war effort by Moorhead Laboratories Inc. was the VT-32 and is shown in Fig. 13. This tube was made to be identical to the Moorhead B except for the shape of the glass bulb. The designation, VT-32, does not fit into either the British or US numbering system so they were probably made after the war had ended and never shipped to England in any great quantity, if at all. It is possible that change in glass bulb size would make the tube easier to ship and thus reduce costs but that is just a guess on the author's part.

Ruggedness Reliability Long Life
Extreme Sensitiveness



Simplicity of Adjustment Low Current Consumption

The Marconi V. T. Oscillation Detector

FIG.15

Marconi VT shipping carton insert, Fig. 15. No Moorhead tubes were made with the Marconi logo etched on the glass as shown in the picture but rather were pressed into the base along with the DeForest information.



FIG. 16

The Moorhead type A class 2 was also made with a spherical glass bulb, Fig 16. No explanation has been found for this different glass shape. It did mean, however, that a larger shipping carton and shock insert needed to be purchased to insure that the tube arrived safely. Moorhead contracted an egg crate manufacturer to make all his shipping containers, the Wallace Egg Carrier Company, who's name can be seen on the shock preventer. The A and B types were almost always marked as such.

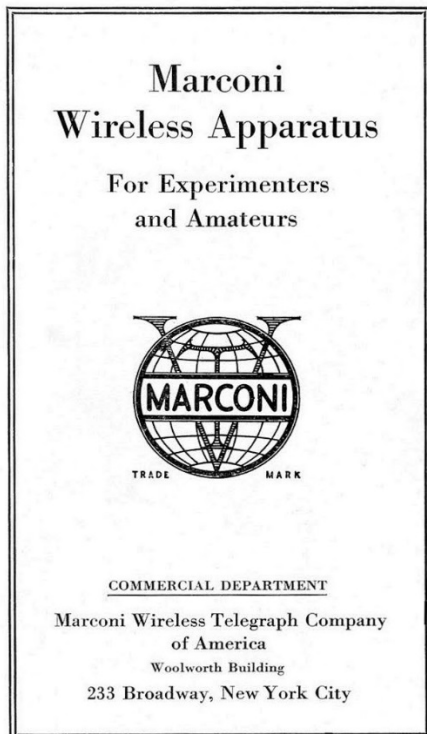


FIG. 17

This twelve page brochure was included in every shipping carton with tubes sold by Marconi along with the insert in Fig. 17.



FIG. 18

Moorhead also made the type B class 1 soft tube to be used as a detector shown in Fig. 18. Marconi preferred to sell the hard A tube they claimed was the best all-around tube for general radio use but armatures really preferred the soft type B as it was much more sensitive.



FIG. 19

As with the A tube, the B class 1 tube was also made in the spherical version which is shown in Fig. 19. Moorhead was quite good at marking the early contract tubes with a B etched on the glass, a B or 1 on the press or class 1 in ink on the base. Moorhead Laboratories often times followed those markings with patent and warning notices. Serial numbers were also added quite consistently. I will add the serial numbers observed by collectors at some point in this article to aid in the identification of most of the Moorhead tubes.



FIG. 20

With the initial contract with Marconi now fulfilled with A and B tubes, the second contract called for the tubes to be renamed VT as the marking on the tube and box in Fig. 20 indicate. The VT was the same as the hard type A with very little difference. At some point during the production of the VT, because of financial difficulties, Otis Moorhead was now working for the company he had started and Henry Shaw was president. Moorhead's name was removed from all company literature. Shaw set up a new sales agency called the Atlantic-Pacific Radio Supplies Company. This change is shown as A-P on the box. Notice the Marconi logo on the tube socket, their own production.



FIG. 21

This VT with an odd shaped glass bulb was found in a collection in Canada, Fig. 21. It has all the necessary markings to be a genuine Moorhead VT. The seller claimed his grand- father worked in a Moorhead factory in Victoria B.C. and that they produced some VT's in this way. The story seems unlikely as Moorhead had enough difficulty maintaining one company, let alone two. After conferring with many collectors, this example is the only known VT to be made in this manner

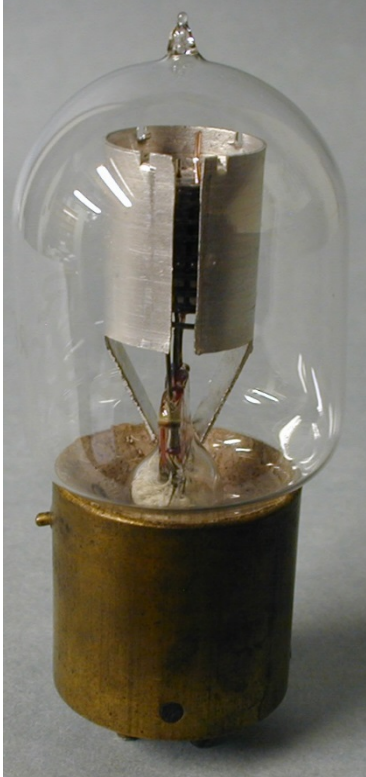


FIG. 22

A new Moorhead Laboratories Inc. tube was announced in June 1920, the based Electron Relay as shown in Fig. 22. It has a very similar construction to the un-based E.R. shown in Fig. 1 except the plate tabs were extended down to the press for stability. The first construction series of tubes proved to be micro phonic so an extra disc of mica was added to the top of the plate. This helped but the design still needed improving. The next tube in the series attempted to correct this problem. These tubes were marked E.R. on the glass and with numbers as well.



FIG.23



FIG. 24

The next tube made was the improved version of the based E.R. in Fig. 22 and is shown in Fig. 23 along with the shipping carton. The plate was shortened but did little to prevent the looped filament from moving about. Placement in the right type of socket helped considerably. This version is known among collectors as the short dull plate E.R. About the time these first E.R.'s were shipped out to Marconi, they cancelled all contracts.

Another version of the based E.R. along with the newly designed shipping carton is shown in Fig. 24. The plate on this tube is made of nickel and is known as the short shiny plate E.R. Henry Shaw convinced RCA, who had absorbed the British and American Marconi Companies along with all their patent rights, to extend the contract as they had a great deal of money tied up in materials. Moorhead Laboratories Inc. had bought some time to liquidate their material assets.



FIG. 25

The VT and Electron Relay ads appearing in Pacific Radio News, Sept., 1920, Fig.25.



FIG. 26

at the Moorhead factory. DeForest is etched around the top of the tube which is very unusual.

This article would not be complete without mentioning the DeForest type 20 shown in Fig. 26. It is not known who actually made this tube. It certainly looks like a DeForest product but it may have been made by Moorhead Labs. Some suggest that it is actually the DeForest type DV-6 but that tube was not introduced until 1923. It is this authors belief that the type 20 was its own type but that neither DeForest or Moorhead Labs got around to producing them in a great enough quantity considering the turmoil that was happening

THE PERFECT VACUUM TUBE COMBINATION

PRESENTING TWO NEW TYPES OF VACUUM TUBES FOR EXPERIMENTERS

—the De Forest 20 Audion Detector and the Moorhead VT Amplifier-Oscillator: perfected to meet the increasing demand for tubes of superior efficiency, wherein all desirable characteristics are combined without subordinating any essential elements.

THE DE FOREST 20 AUDION DETECTOR

Type 20 combines all the advantages of the tubular type De Forest audion, in its extreme sensitiveness as a detector, with those of the Navy standard base. This tube is of the so-called "soft" type, requiring relatively low B battery potential, and is unexcelled as a detector.

Both types of tubes are of unusually rugged construction.

These Tubes are Licensed under the De Forest Audion and Fleming Patents.

THE MOORHEAD VT AMPLIFIER-OSCILLATOR

The VT Amplifier-Oscillator is similar to the Navy "hard" tube, and is designed and manufactured expressly for amplification and oscillation purposes.

A combination of two or more Moorhead tubes as amplifiers with a De Forest tube as the initial detector or oscillator is the ideal receiving combination for long distance amateur or long wave reception.

PRICE \$7 EACH

Specify full names of tubes when ordering. Orders may be placed through a dealer or sent direct, with check, draft, or money order, to the Laboratories. Immediate delivery.

Dealers—write for prices and particulars.

PACIFIC RADIO SUPPLIES CO., SAN FRANCISCO

SOLE SALES AGENTS FOR MOORHEAD LABORATORIES, Inc.

REFERENCES, THE AMERICAN NATIONAL BANK, SAN FRANCISCO.

FIG 27

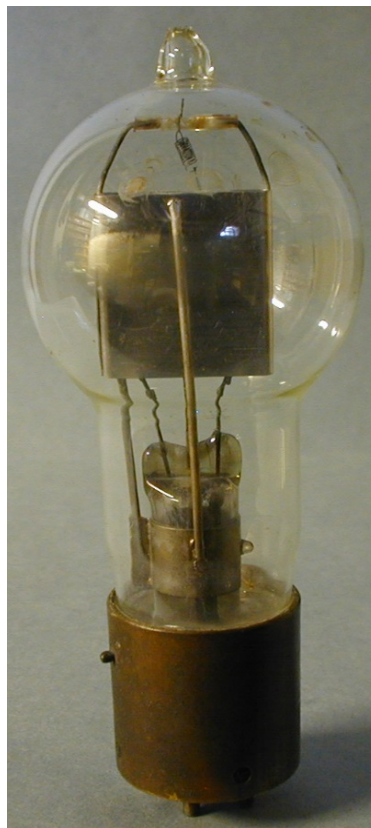


FIG. 28

One of the final products of the Moorhead Laboratories Inc. company was the A-P Rectifier shown in Fig. 28. This tube is clearly a DeForest design and some collectors believe that Moorhead also made the DeForest Singer tube as well. Henry Shaw and his lawyer, W.F. Willianson, had managed to string RCA along for quite a while before ceasing operations in May, 1922. This was not quite the end for the company that Otis Moorhead had started, however.

Here is the only ad known ad, Fig. 27 for the DeForest type 20 tube from the Electrical Experimenter magazine, May, 1920. Why would Moorhead Labs and or DeForest make this tube, etch DeForest on the glass, announce it unless it actually existed. A great mystery.



FIG. 29

Henry Shaw was not involved with Moorhead Laboratories Inc. when the A-P Solenoid tube, Fig. 29 was developed by Henry Huppert for the new president of Moorhead Laboratories, Willis Deming. It was meant to circumvent the DeForest patents by using the base an extra connection to the grid, while the solenoid winding is similar to a filament. The paper tag states that it is #5 in a series of tests conducted by William Hanscomb, then an employee. It was never put into production in great numbers because of its shortcomings and for financial reasons. Timeline is mid 1923.



FIG. 30

In mid- 1924, A-P Radio Laboratories with D.C. Seagrave as president emerged as a newly formed company trying to market what they called the new A-P Two In One Tube shown in Fig. 30. Producing this type tube was a bit of a legal mistake in that Seagrave thought the DeForest grid patent would have expired by the time the Two In One was to be released, however, the patents on the grid placement were not set to expire until mid-1925.

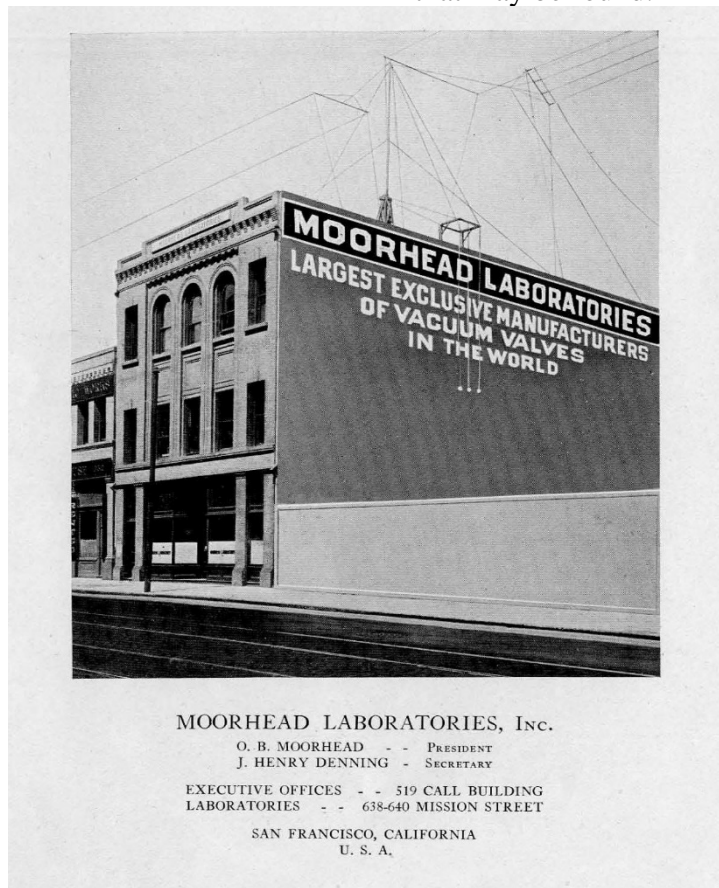


FIG. 31

Another version and shipping box of the A-P Two In One tube is shown in Fig. 31. A-P Radio Laboratories made several other tubes similar to the 199 and specific detector and amplifier tubes as well. A-P Radio Laboratories ceased to exist after May, 1925. QRS Music, the company that purchased the remaining assets of A-P, made the QRS Redtop, a quite similar tube with 2 internal structures probably with A-P designs.

FIG. 33

Moorhead Laboratories, Inc factory is shown in Fig. 33. The address was 638-640 Mission St. San Francisco, Ca. The Executive offices were a few blocks away at 519 Call Building.



UNBASED TUBES				
Type	E_f	I_f	E_p	Dimensions
ER (1916)	4.0	1.1	20-45	0.75" D x 3.95" L
External Grid	4.0	1.0	15-35	0.85" to 0.88" D, 3.05" to 3.70" L
ER (1917)	4.0	0.94	20-45	0.85 to 0.95" D, 3.60 to 3.70" L
ER (1920) / (Type D?)*	4.0	0.65	20-45	3.25" D x 0.90" L

* Serial number range seen was 173-254.

BASED TUBES						
Type	E_f	I_f	E_p	E_g	G_m	S/N Range Observed
Type R (British)	4.0	0.7	40	-1.3	180	1842-19756
Type B (British)**	6.0	0.85	400	-4.5	405	17994
VT 32 (British)**	6.0	0.85	400	-4.5	405	None
SE 1444	4.0	0.7	40	-1.3	180	34-26209
Type A (Marconi VT Class II)	4.0	0.7	40	-1.3	180	168-5941 200065-207184
Type B (Marconi VT Class I)	4.0	0.65	20-40	-	-	223-10241 100141-109846
Type C**	6.0	0.85	400	-4.5	260	264
Moorhead VT	4.0	0.7	40	-1.3	180	207547-247180
ER (Tall Plate)	4.0	0.7	20-40	-	-	500252-502935 504649-510775 (mica)
ER	4.0	0.6-1.0	20-40	-	5	11058-551279
Type TT**	6.0	.85	400	-4.5	260	400251-400333
Rectifier	9.0	3.15	(75 mA output)		-	28-531

** The test conditions used for the transmitting tubes were arbitrarily selected to provide a plate dissipation of 3 to 5 watts. Tests were run on a total of four samples, two British and two US. Averaged results are shown for the British tubes and the US tubes.

FIG. 32

The information in Fig. 32 gives the observed serial numbers of Moorhead tubes compiled by collectors with what they had in their possession. Looking at the number on the tube is a quite good method to ID the type of tube that may be found.

All tubes and paper are in the writer's possession unless otherwise noted.
Paper in Fig,'s 12 and 17 courtesy of Eric Wenaas

References: **“Saga of the Vacuum Tube” Gerald Tyne**
 AWA Review vol. 27 “Otis B. Moorhead and the Vacuum –Tube Tangle” Eric Wenaas
 Tube Collectors Association vol. 5 #2 “Moorhead and His Tubes” Bill Condon
 George Clark Radioana Collection Smithsonian Institution
 “History of Communication-Electronics in the US Navy” Captain L.S. Howeth, USN
 Moorhead Laboratories Inc. factory picture, fig 29 “Moorhead and His Valve” brochure, 1919
 “The United States Navy in the World War” James Russell, William Moore
 “Radio Equipment on the NC Seaplanes” Lt. Commander Robert Lavender, USN