58 Chestnut Road
Verona, New Jersey
March 6, 1970

Mrs. Robert A Morgan,
402 Oak Grove Ave.,
Menlo Park, Calif. 94025

Dear Mrs. Morgan:

Yesterday I received from Mr. George T. Royden a copy of your letter to him dated Feb. 23, 1970. I was very much surprised to find that he had sent my letter to him on to you. What I said was between two old friends and since I never expected the subject would come up again I didn't even make a carbon copy for my own files.

Since you have expressed a hope to round out your book in future editions, I will be glad to do what I can to help you. You should understand, however, that what I have is quite limited and furthermore is not documented as well as a historian would like. (My hobby is family history and some years ago I wrote a limited history of radio in the Bell Laboratories). I started as a amateur wireless operator in 1910 in Southern California and aside from a visit to the World's Fair in 1915, when I took a radio operator's examination, I was not in the San Francisco area until I entered the University of California in 1917. So I am somewhat junior to Haraden Pratt but senior to many who came after him. I propose to put down here what comes into my head in the hope that it will serve to inform you what I do know and inform me what I should brush up on.

During college years, I was President of the U. C. Radio Club. We operated a 500 cycle spark transmitter (6XM) on the campus and in 1919, 1920 and 1921 broadcast the Stanford-California football games. The first broadcast was by telegraph from a portable transmitter outside the old wooden bleachers at Stanford; the second from the spark transmitter on the Berkeley campus; and in 1921 from inside the Stanford stadium using a radiotelephone transmitter. Our contact at Stanford was Fred Terman. I remember that in 1921 the voltage at the stadium was so low that the motor-generator speed would not get up high enough to throw out of the starting condition. We finally wound a cord around the shaft and gave a hard pull as you now might do in starting a lawn mower. Once it was up to speed we did not dare turn it off from early morning until after the game was over. The significance of these broadcasts is that they predated the time when the broadcasting companies were handling such events and connecting over wire lines to their transmitters near the big cities. The University of California owned a small surplus CW-936 Radio Set designed for use in World War I on destroyers. This the Radio Club used upon occasion for broadcasting from the Greek Theater, notably a speech by Gov. Stevens about 1921-2.

Having gone to college in the hope of learning how to design any piece of radio equipment, I was somewhat dismayed to find as I was about to graduate in 1922 that there was little demand for such a person. I interviewed Mr. Porter of RCA in San Francisco who

offered me a job as an operator in either the Pt. Reyes transmitting station or the corresponding station in Hawaii. When I enquired as to where this would lead, I was cooly informed that in some years I might become chief operator at $225 per month; so I turned the job down in spite of not having any other radio offer. The Bell Telephone people were trying hard to get me to go with them and along with a few others I was invited to have a front row seat at the first transcontinental broadcast which was held in the Municipal Auditorium in San Francisco about March or April 1922.

During our interview Mr. Porter told me a good story that ought to get in print somewhere. It seems that a society woman in San Francisco who owned some RCA stock had volunteered to give her Womens' Club a lecture on radio communication. In preparation, she went to Mr. Porter, explained her situation, and asked for a guided tour of the San Francisco terminal and an explanation of how it worked. First she was shown a typewriter-like device which punched a paper tape with the message in Morse code. This tape was then put in an automatic transmitter which sent the dots and dashes over a line to the transmitting station to Pt. Reyes. Received messages came in at the receiving station at Marshall, came down on a wire to the S. F. terminal, and were recorded as marks on a tape. This tape ran in front of an operator who transscribed the message on a typewriter. After an extensive tour, the lady prepared to leave and thanked Mr. Porter profusely for his kindness. She said that as a result of her tour she thought she understood pretty well how the system operated. There was only one point upon which she would like a little further clarification: "How does the paper tape get to Hawaii without getting wet?"

I finally went to work in the Radio Laboratory at the Mare Island Navy Yard which at that time was headed by Mr. Royden. The work done at Mare Island was a mixture of installation and maintenance of ship and shore radio stations with research and development. My first job was to determine the cause of noise in the Moorehead receiving tubes which had been purchased during WW I. I also worked on the development of coil antennas for submarines, a comparison of the merits of steel and bronze clearing lines for submarine antennas and various other things. Much of the work was related to the design of the Navy shore stations. At that time Mare Island had the general supervision of all the shore stations in the Pacific running all the way from Alaska to Panama and including Hawaii, the Philippines, Guam, Tutuilla, and the U. S. Embassy in Peking.

During the time I was there we initiated a frequency measuring program on the Navy stations above mentioned to try to reduce the interference which had been getting more intolerable. Once a month I stayed up all night listening to these stations and measuring their frequencies. The program ended at 8 AM when I held down the key on the 100 kw Mare Island transmitter for a sufficient time so that I could measure its frequency locally and others at the various receiving stations over the Pacific could also measure it. Not being able to set the frequency accurately at its assigned value, I then transmitted my frequency reading over the transmitter, thus informing the distant receiving stations. At that time there were no accurate standards of radio frequencies that could be purchased and the Laboratory had one man who spent a couple of years

calibrating a standard wavemeter by the use of a tuning fork and multivibrators as well as Lecher wire systems. Mr. Royden published an article in the Proceedings of the Institute of Radio Engineers in the early 1920s about this work.

About the time I went to Mare Island in June 1922 the Federal Telegraph Company was finishing the installation of circuits which were designed to reduce the interference caused by the arc transmitter. Previous to this modification, the arcs had been keyed by shifting the frequency a large amount (also unknown amount) and receiving only the desired frequency, leaving the "compensating" wave to interfere with other transmissions. The new circuits were also effective in reducing the "mush" that was one of the undesirable features of arc transmitters. From the viewpoint of radio history, which was the electronics history of its day, the Mare Island laboratory was one of the earliest places where scientific radio technology was studied and applied. It had been going a number of years when I went there. A surprisingly large number of the men who worked there at one time or other made their marks in radio and electronics history.

Among those who worked there were Haraden Pratt, Harold Buttner, Archibald S. Brown, Lewis M. Clement, Archie Stevens and George Royden. Many of these are still around and should be interviewed if they have not already been. Harold Buttner lived in New York but I believe is on the Board of Hewlett-Packard and comesto San Francisco periodically. Archie Brown was at Stanford Research and lives nearby I believe. Lewis Clement is living on Saw Mill Road in Doylestown, Pa. Archie Stevens was living near New York but I am not sure is still living. There are undoubtedly others that should be mentioned. Albert Hodges was at Mare Island and more recently at the Navy Yard in South San Francisco but retired a few years ago. The addresses of any of the members of the IEEE can easily be obtained in Stanford Library from the IEEE annual directory

I did not want to work permanently for the Civil Serivce and consequently when I got an offer from the A-P Radio Laboratories on Mission St., San Francisco to be their chief engineer in 1924 I accepted. In interviewing the president I had disclaimed knowing anything about vacuum tube manufacture but he said I had appeared much better informed than anyone else he had interviewed and I could have the job if I wanted it. When I left him I went directly to McGraw-Hill up the street and bought Van Der Bijl's book on the design of vacuum tubes, the only book on the subject then available.

The A-P Radio Laboratories was the outgrowth of the former Moorehead Laboratories which had manufactured vacuum tubes for the Navy during WW I. I do not know just when it started but I understood that it had been licensed to manufacture tubes during the war on account of the need for tubes but had later been closed for patent infringement when the dire need no longer existed. I believe that the man behind the company was one Shaw who perhaps lived in the Boston area.

The tubes which were manufactured by Moorehead had the original standard 4-prong base, a straight-sided bulb, and a pure tungsten filament. They were simple three-element tubes with rather course grid and short cylindrical plate structure. The characteristic

which differentiated it from other tubes was the use of phosphorus for a getter, giving the tube a yellowish-brown appearance rather than the silvery sheen characteristic of later tubes. These tubes were still on sale in the early 1930s on Courtland Street, New York, and the Bell Laboratories bought up a few at that time to use for UHF experiments for which they were well suited.

Some time prior to the Spring of 1924 a man by the name of Huppert, a German who was an X-ray technician in partnership with a doctor in San Francisco, opened up a little shop and started making a few vacuum tubes. The machinery of the old Moorehead plant had been left in place awaiting the expiration of the fundamental De Forest patents in 1924. Shortly before they expired, Mr. Huppert got together with the Moorehead people (Moorehead himself had died some time before) and combined forces, opening up the old Moorehead plant.

They started to manufacture a tube having a similar electrical characteristic to the 201A which was quite popular in radio sets at that time. The mechanical structure consisted of two parallel filaments surrounded by grids and plates to form a double-barreled system much like two of the original Moorehead tubes but having a longer plate and grid structure and a higher mu. The filament was of thoriated tungsten drawing a quarter ampere at six volts. At this time thoriated tungsten was difficult to get. Some could be purchased on Courtland Street, New York City, which was probably stolen from General Electric, some made by the Pinsch (sp?) patent could be obtained from Germany, as could also some coated filament. On account of very limited resources, the company could not stock more than a very small amount which meant that each new shipment gave trouble, resulting in frequent shut-downs of the plant and a highly variable product. In addition to doing considerable supervision, I endeavored to set up standards for treating filaments, including proper flashing and operating temperatures, and manufacturing tests. The company was in financial trouble from the start and after a year it folded up temporarily and I went out and got a job with the Pacific Tel. & Tel. Company. The company opened up again and soon after the QRS Music Company of Chicago took over the operation of the plant and sent my successor, Mr. R. O. Ford, back to Chicago for training in their Chicago plant. I believe the plant continued in operation for a year or two but I do not know its subsequent history. I am now trying to contact Mr. Ford.

It was in 1924 while working for the A-P that Charles Litton came around and asked for part-time work. He was then a graduate student at Stanford. We gave him work, most of which he did at home, reporting to us every week or two. A year or two later he went to work for the Bell Telephone Laboratories at Deal, N. J. where I also went to work in the Spring of 1927. His mother came back by train in the Summer and Charley quit and they drove home to California in Charley's Model A Ford.

Between the closing of the Moorehead plant and the opening of the A-P Radio Laboratories in 1924, there was another company called the Atlantic and Pacific Radio Company or something of the sort which which ran a radio parts and equipment sales organization at or near the same location on Mission Street. I think Ellery W. Stone was the leading light. He subsequently headed Federal in Palo Alto and has been an IT&TCo executive ever since aside from

being a naval officer during WW II and a military governor in Italy after the war. He is presently living around New York.

At around 1920-5 there was a firm called Haller-Cunningham that sold electronic equipment on lower Market Street, San Francisco, and did some little manufacturing. Royden could probably tell you more about them.

There was also a Cunningham, perhaps the same man, who started making and selling cylindrical vacuum tubes having leads out both ends. This was in 1917 or earlier. I still have a couple of these tubes along with an early De Forest audion. The tubes were gassy but made suitable detectors for receivers if the operating temperature of the filaments was carefully adjusted. These tubes were in great demand for receiving Poulsen arcs and other CW stations since they could be made to oscillate and give a beat note. The early CW reception was by means of a ticker which was just a bad contact that broke up and rectified the CW signal so that it could be heard. I think this Cunningham was the same man who got in on the ground floor in merchandising vacuum tubes. He later made arrangements for G. E. to manufacture tubes with his name on them and Cunningham tubes were considered among the best obtainable. A Roger Wise worked for him but died many years ago. Cunningham also sold Remler products in San Francisco.

About 1913 there was an amateur in Englewood, Calif., who had a Poulsen arc which he modulated by voice. I remember hearing him testing when I was tuning for time signals from NPL at San Diego. At that time I was the only one in town who had ever heard a voice over the wireless.

A wireless telegraph station was installed on Catalina at a very early date. About 1921 the Bell System decided to establish a radio telephone circuit to the island. The amateurs up and down the coast were intrigued by what they heard and listening in on this circuit was a favorite sport at a time when there was very little to listen to. Many of the amateurs appeared to have difficulty in reception and got out their soldering irons to go over the set for loose joints. The matter was cleared up when some of them went to an Institute of Radio Engineers meeting in Los Angeles at which one of the engineers described the system. He stuttered.

The Secretary of the A-P Radio Laboratories, whose name I think was Gunn and I would guess that he was born about 1885-1895, lived in Burlingame or some place nearby. He appeared to be independent financially and perhaps had money invested in the company. I understood that he had all of the old records of the Moorehead Company as well as a clipping book on the operation of the California Theater radio station, which I think was operated by the same interests. If these records could be found, they would throw considerable light on both the organization and early broadcasting in San Francisco. I am now trying to contact Mr. Ford to see what he can tell me about Mr. Gunn.

The California Theater station broadcast organ music on Sunday mornings in the 1920 period before other stations were in operation or broadcasting anything worth while. It is my impression that this station closed down before 1922 and Mr. Shaw built a station on the hill east of Oakland as a substitute.

After leaving the A-P Radio Laboratories in 1925 I spent a couple of years with the Pacific Tel. & Tel. Co. in San Francisco and in the course of my work came in contact with some Bell Laboratories people through whom I maneuvered a transfer to New York in 1927. So after that, although I continued in electronics for the remainder of my career, I know relatively little first-hand of electronics in California. It should be said, however, that the opportunities in this field in California were extremely limited at the time I went to New York, otherwise I would not have left. It was another decade or so before the electronics boom hit California.

During the period I was at Mare Island, Arthur Rice, was the civilian head of the radio organization. He died some years ago. George O'Hara I believe was a graduate of the University of California and was in charge of the electrical shop at Mare Island for a long period of years. Although he was involved in administrative work and shop work more than the technical work, he was around longer than anyone else and was intimately acquainted with what was going on. The last I knew he was still living in Vallejo and would be an excellent man to interview regarding the history of radio at Mare Island.

I presume that you have most of the references to published articles on the subjects I have mentioned. There is an excellent definitive history of the Federal Telegraph Company in their house technical magazine, Electrical Communication I think it is called. I would guess that it was about 20 years ago. I think the Proceedings of the Institute of Radio Engineers in the early 1920s had an article on the RCA radio stations at Pt. Reyes and Marshall. George Royden had an article on the calibration of wavemeters at about the same time. He wrote a thesis on the design of litzendrah wire for his E. E. degree at Stanford.

Mrs. Moorehead was alive in 1924 and worked at the A-P Radio plant as an assembler. While she was not an educated person, if she is still alive she might add something to the history of the company. If alive, she should be under 80.

The Navy receiving station was at Goat (Yerba Buena or Treasure) Island in 1922 but was moved to South San Francisco about 1924. Al Hodges, previously mentioned, was chiefly responsible for this. He took the receiving equipment out of the boxes which had usually been placed on tables and mounted it on racks in the manner which has since been standard. This was against Navy regulations but met with general approval. In recent times I believe the receiving station was moved to a place in the marshes north of Mare Island.

I have not said anything about the AT&TCo radio telephone stations. Following the opening of short-wave (HF) radio circuits to Europe in 1927, there was an urge to install some trans-Pacific circuits and stations were installed about 1929 at Pt. Reyes (receiving) and at Dixon (transmitting). I think the rhombic antennas used were the first on the Coast. I was intimately concerned with the design of the Pt. Reyes station and can supply more data if desired.

There was a radio magazine that was published in San Francisco for some years which should be an excellent source of information on local happenings. I cannot remember the name at this time. Jerry Best may have had something to do with it. About 1921 I attended a regional convention of the American Radio Relay League in San Francisco (and had 6 votes as the representative of the U. C. Radio Club) at which the owners of this magazine made a strong try to become the official west coast magazine in place of the national magazine QST. They were unsuccessful. Was the magazine Radio News?

The Mr. Huppert who was at the A-P Radio Laboratories, is said to have opened a radio treatment parlor in or near Santa Cruz at which patients could put a coil around their middles and absorb radio frequencies. Ralph Heintz knew him and perhaps knows what happened to him. Huppert might add a little to just when and how A-P got started but his version might not tally with mine. A-P also made a 3 volt, .06 ampere tube which was similar to a popular tube used in portable battery radios at that time.

There was a man by the name of Solle or something of the sort who was an operator at Mr. Shaw's radio station in Oakland and used to often visit the U. C. Radio Club. He later went to work for Federal or perhaps Makay Radio in the San Francisco area. He may be the Sigurd A. Sollie who in 1967 was listed as a Staff Assistant Honeywell Inc., Aero Florida Dept., U. S. Highway 19, St. Petersburg, Fla. 33733. I think he was a protege of Mr. Shaw and might know more about Shaw and certainly about the Oakland radio station. He may have at one time worked for Royden when Royden was in charge of Makay in San Francisco and Royden probably knows more about him than I.

The story of the radiotelephone circuit to Catalina I believe has been published but I do not have a reference to it now. I could undoubtedly find something about it if you needed it.

I seem to have run out of steam. Looking back at what I have written, it does not seem very important but it may serve to broaden your viewpoint and possibly help in making your book more cohesive. If, after reading this letter, you see any way in which I can help you further, please feel free to call upon me.

Yours sincerely,

Frank A. Polkinghorn

Frank A. Polkinghorn

P. S.

About 1923 the Federal company negotiated a contract with the Chinese government for a huge radio station to be installed in Peking. A new subsidiary was formed and a number of people recruited to do the engineering. Al Hodges was one of these; he left Mare Island at that time. Was later on active duty with the Navy and engineer for one of the San Francisco radio stations before moving to New York where he became one of the installation managers for ERPI in the early days of talking pictures. After the Chinese station engineering was well started, the Chinese government fell and the work stopped. It was the frame of the Poulsen arc that was to have been used on this project that was used by Lawrence for the cyclotron. I write this from recollection and it should be checked for detail with someone who had direct contact with the job.

In the interim period between the Moorehead Laboratories and the A-P Radio Laboratories the Atlantic & Pacific (Radio Sales Co.?) sold a 10 or 25 watt vacuum tube called a "singer" tube. I suppose it was made in the Moorehead factory but I do not know. There was some sheet tungsten around when I was working there which may have been used for the plates of these tubes.

There is a retired Bell Laboratories man who has been collecting vacuum tubes for many years and working on a book on the history of vacuum tubes. Recently it was announced that he had been in Europe interviewing people there and the intimation was that the book would soon be published but I have not seen any announcement. At the moment I cannot recall his name. Many years ago I gave him some A-P tubes and a Moorehead booklet. I think I have a copy of the Moorehead booklet but at the moment cannct put my hands on it. My files are in bad shape as I have so many family history papers about that I hope to throw away before another year is out.

I seem to have omitted any mention of the fact that in the Fall of 1920 Mr. N. C. Youngstrom and I undertook to write a senior thesis on some experiments on modulating a vacuum tube radio transmitter and in simultaneous transmission and reception. The University had a G. E. Type P 1kw tube which we used. We used a phonograph for the testing. There may still be people about who never want to hear "Sweet Alice Ben Bolt" again. We ran the same record over and over some times for hours on 210 meters, the experimental frequency of the times.

58 Chestnut Road
Verona, New Jersey
April 21, 1970

Mrs. Robert A. Morgan,
402 Oak Grove Ave.,
Menlo Park, Calif. 94025

Dear Mrs. Morgan:

On March 6th I wrote you a letter in which I stated that I was trying to get more data on the origin of the Morehead Laboratories in San Francisco. I have just received a letter from Mr. Robert O. Ford who followed me as Chief Engineer of the A-P Radio Laboratories or its successors. While it does not give much information of value I will quote from it for what it is worth.

"I have been racking my brain trying to remember more about the old A-P laboratories. I am sure the head man was a Colonel Seagrave who was a big operator in the bay area but I can't remember any of his other connections. It seems to me that the superintendant was a german former X-ray technician named Huppert. I can't remember the secretary and the name Dunn or Gunn does not seem familiar.

"After A-P folded I went to the Pacific Gas & Electric Co. After about a year there I was offered a job with the QRS Co and took it. I never heard of a lease - it was my understanding that it was an outright purchase of equipment and patent rights. QRS planned to produce tubes in chicago and San Francisco. I was sent to Chicago for two weeks to study their plant and methods. The plant there was new and modern for that time with a capability of producing more tubes more efficiently than the San Francisco plant. The president of QRS was a human dynamo named Tom Pletcher. He was also president of the Zenith Radio Co. He hoped to use QRS tubes in all Zenith radios. I don't think this worked out. The tube engineer in Chicago was a Dr. Spaeth.

"After I returned to San Francisco we moved the equipment to a modern factory building at Seventh & Folsom Streets. We occupied one corner of a building where QRS made player piano rolls. They hoped to supplement the music business with radio tube business - radio was killing the player piano roll sales. After operating about a year with fair success, we were suddenly shut down. I was told the shut down was due to patent litigation in Chicago. That ended my connection with the radio tube business.

"When I was in France during world war one I was trained to be a radio operator. We were equipped with French receivers consisting of a crystal detector and a three stage amplifier. The tubes were American Moorehead tubes. They had no bases and were mounted by suspending the tubes by their wire leads. This was in 1918 and may give you a clue as to the time the laboratory started operation.

"It was always my understanding that Dr. DeForest had started the laboratory and that it was originally known as the De Forest laboratory - this may or may not be true. Sorry I can't be of more help."

Mr. Ford's account of what happened to the A-P Radio Laboratories after I left it is probably the most accurate you are likely to get as he was intimately connected with it. The Moorehead tubes that he used in France in 1918 may have been the long tubular variety that had been manufactured in San Francisco as early as 1916. They had no base and connections were made with binding posts. I do not believe that Dr. DeForest had anything to do with the Moorehead Labs but I could be wrong. I don't suppose that his latest wife would know anything about that as she was much younger than he.

The Bell Laboratories man who has been writing a history of vacuum tubes is Gerald F. J. Tyne. A recent address for him is 40 Kline Place, South, Berkeley Heights, New Jersey 07922. I do not know the present status of his book. If it is not yet published, I suppose he might be reluctant to give any information on Moorehead, if he has any. I gave him a booklet on Moorehead about twenty years ago; on second thought more nearly forty years ago.

I just noted that in the last paragraph of the P. S. of my last letter to you I noted that N. C. Youngstrom undertook to write a thesis in 1920 but neglected to say that I was a partner with him in the undertaking.

During the IEEE Convention recently in New York I was talking with Fred Terman. He seemed to have considerable information about Cunningham and perhaps you should ask him about it when you have occasion to talk with him again.

Was there not a man by the name of Beale who was an official in Federal in Palo Alto. I believe that he is now dead but he was also on the Board of Directors of A-P and very likely Moorehead and if he left any papers they might throw some light on these companies.

All of the early vacuum tubes used filaments directly and were generally used with direct current. When radio receiving sets using alternating current were first introduced there was some difficulty with hum when using filament type tubes and the present heater type of tube was introduced. It is my impression that Itel-McCullough or perhaps just McCullough pioneered the introduction of heater tubes.

My wife and I are planning on driving to California about the middle of May. We will be visiting relatives in Southern California most of the time but hope to go up the coast to Oregon or Washington before turning east again. If the scrap books that were once in the possession of Mr. Gunn (?) of Burlingame (?) could be located, I might be able to be of some assistance to you in interpreting their meaning. Perhaps if you looked in a 1924 directory of Burlingame and found such a name it might be possible to trace the man down to the present.

Yours truly,

Frank A. Polkinghorn

Frank A. Polkinghorn