

RADIO BROADCAST

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Making Wireless History With De Forest

Thrilling Days of Trial and Error in the True Pioneer Wireless Times—
A Ten-Kilowatt Set that Sent Four Miles—Thrills for the Natives
at the St. Louis World's Fair—Twenty Years of Wireless in Retrospect

By FRANK E. BUTLER

Former Chief Assistant to Dr. Lee De Forest

TO BE able to look back twenty-odd years, practically to the very inception of radio, and view the development of this wonder art through personal experiences gained from gruelling years of hopes, disappointments, and successes, is a privilege that only a few of us can share with Dr. Lee De Forest, the famous radio inventor.

Surely, the most enthusiastic radio fan cannot realize the exceptional thrill which is now mine as I listen-in on my radio receiver and compare its wondrous achievements to those of the struggling, experimental days when I assisted Dr. De Forest in his elementary pioneer work; in the building of his first few "audion bulbs", and shared with him the marvel of listening-in for the first time to a wireless telephone.

For radio is not, as many believe, a new thing. Its development has passed through the crucible of a thousand failures with their resulting disappointments. Its progress was constantly blocked by unknown scientific laws against which we pitted our puny knowledge. Every secret extracted from Nature was gained by relentless tests carried on frequently without funds and often without adequate laboratory equipment or tools, and with comparatively little encouragement from humans or from Nature. But always there was the inspiring guidance of "Determined De Forest."

It was in the early spring of 1904 when, with no more electrical knowledge than that possessed by the average telegraph operator, I gave up a promising position as train dispatcher on the New



MR. BUTLER IN 1904

A photograph of the author, taken by the official photographer of the St. Louis World's Fair, where he and Dr. De Forest were exhibiting the marvels of wireless

York Central to take up the then new work of wireless telegraphy. A short time before this, Marconi had startled the world by successfully sending and receiving telegraphic signals over a short distance without wires. De Forest, who was then a young student at Yale, took up research work in this unknown field of "wireless," and thereby became one

of the first American experimenters to turn his entire attention to this work. When I joined him, practically all of my friends and relatives with the exception of my father, chided me and advised against the move. My father thought best to let me choose my own career, and while he never lived to listen to modern radio, he was familiar with and proud of the achievement I had made up to the time he passed away. The railroad position carried a large salary with abundant opportunity for advancement, while my new "job" paid only a meagre amount and offered

no apparent assurance of a future. The idea of communicating through space without wires was at that time considered fantastic, an idle dream, an impossibility, a game for fools. Many thought it was a fake.

WIRELESS STARTLES THE WORLD'S FAIR IN 1904

SO, AFTER "burning my bridges behind me," I went to St. Louis and joined De Forest at the World's Fair where he was planning the first public wireless exhibit. Immediately, my troubles began.

Due to some slip in the arrangement, I found, upon my arrival, that our "financier" had decided upon another man for the job, and the company could not afford to pay two employees. After some scheming on ways and means, the two of us decided to double up on the salary question, and in that way we both stayed. Within a week or two I was chosen as special assistant to De Forest because I could telegraph while he could not.

From that time on, and for many years, I was perhaps closer to him in his interesting work than any other of his employees. Subsequent events and severe trials in which I stood by him through thick and thin convinced me that he appreciated my efforts. Others of his employees likewise never deserted him through even his most crucial

periods. He called us his "Old Guard" and we were as faithful as Napoleon's followers. Our working mottoes were, "Never say die," and "You can't stop a Yank." We never accepted failure as a finality, but tried to find out why we met it, and then attempted to overcome it.

At that time there was, of course, no radio public, and the range of wireless was only a few miles. The sending and receiving instruments were unbelievably crude, resembling in no way the marvels of today. Messages were sent at the snail-like pace of a few words

per minute, in the dots, spaces, and dashes of the Morse code, instead of the International code which is now generally used. Sending music or talking by wireless was then undreamed of. There were many mountainous obstacles to meet and conquer before we even had the vision of a wireless telephone, which was the forerunner of radio.

DE FOREST'S CHANGES IN THE NEW ART

ONE of the first changes to be accomplished by De Forest was to use a headphone for receiving instead of the telegraph sounder used by Marconi in early experiments. The first receiving device was called a "coherer" and was made of a glass tube filled with metal filings. These filings "cohered" when the ether impulse passed through them, thus making an electrical circuit which caused the sounder to click. This method was extremely crude and inaccurate, and the device had the unpleasant habit of occasion-

"The Man Is Crazy"

At least that is what almost everyone thought of Dr. Lee De Forest back in those early pioneer days, more than twenty years ago. Then, you could easily count all the men in the country who even pretended to know anything about wireless. No one of the few who were working with wireless then, knew whether a set carefully put together would work at all, and how far the signal could be heard was nothing but a guess. Transmissions of a hundred miles or more were hailed as remarkable. Present-day radio listeners are quite prone to think of radio as nothing more than telephonic broadcasting. But before the wireless telephone, came tremendous amounts of hard, sometimes discouraging, but always fascinating and essentially romantic work. Dr De Forest is one of those pioneers. Mr. Butler's memories of the early days are mightily worth reading, since he not only saw the early wireless drama, but himself acted in it.—THE EDITOR.

ally failing to "de-cohere." In other words it would not go back to normal after the signal had passed through. It was sometimes necessary to tap the tube with a pencil in the left hand while writing with the right.



Short words we guessed at, while long words were so badly disjointed that we figured those out as a child does a rebus puzzle.

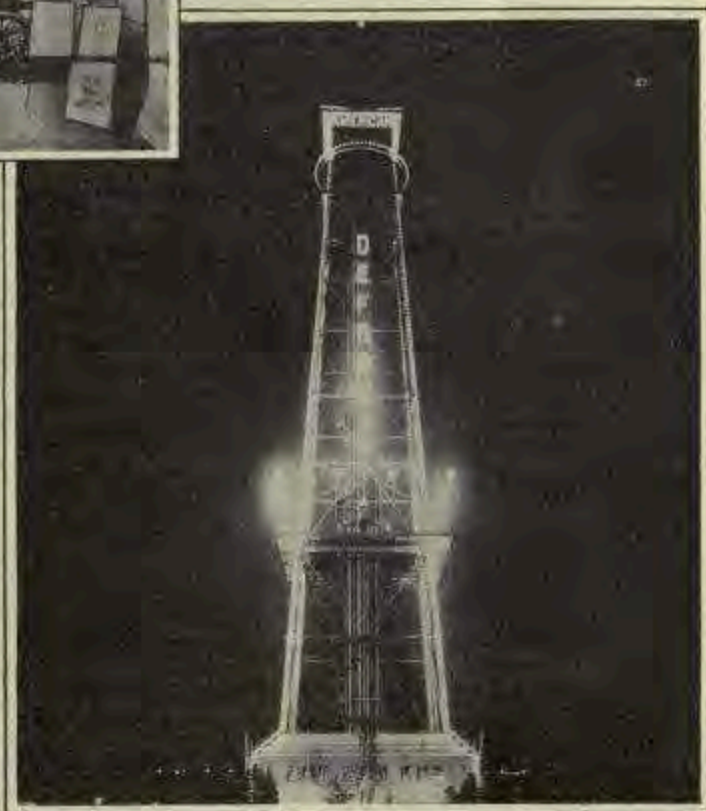
The apparatus for sending was a Ruhmkorff induction coil with a vibrator on one end. Direct current was used in the coil and the vibrator converted it into alternating current of slow oscillations as compared with those used to-day. The power used then to send six miles would to-day send almost six thousand.

One of Dr. De Forest's earliest achievements was to produce a transmitter operated by alternating current of high frequency. This gave a strong firm spark and signal far superior in carrying quality, and far easier to read than the thin weak notes from an induction coil. The transformer coils were specially wound, and near at hand were placed a "spark gap" and "helix" or tuning coil, and thus "tuning the signals" was brought into reality. Then

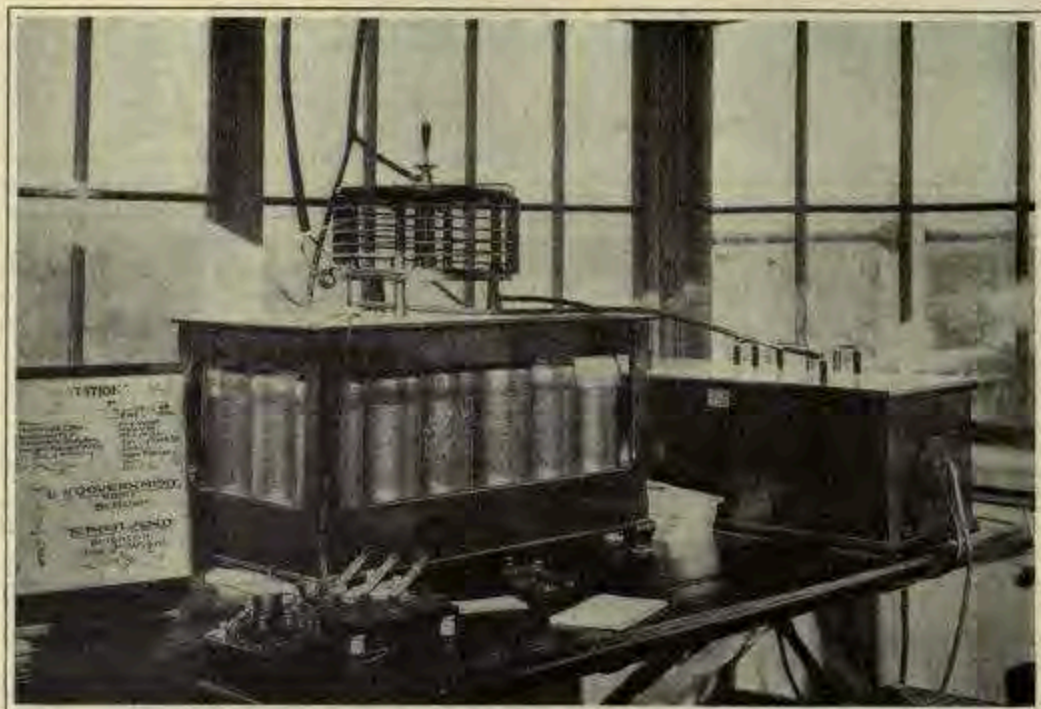
we started to talk about certain waves of different lengths, etc., and we used the tuning fork as an illustration. Mathematics had no place in the embryo radio of those days and it was many years before we learned how to measure the wavelengths and use such complicated and fearful sounding terms as of meters, kilocycles, etc. Leyden-jar condensers of various kinds of hookups were placed across the "spark-gap," and we noted the phenomenon of changing the pitch or note of the spark as we changed the capacity of the

WIRELESS AT ITS FIRST WORLD'S FAIR

The De Forest tower—300 feet high—was a remarkable feature of the fair and was illuminated at night with great numbers of incandescent lights. The insert shows a wireless automobile which was equally in style for the period as far as radio and automotive construction was concerned.



jars. We found that this new form of transmitter easily outranked the old induction coil, so a decided step in advance was made. Little did we then think that this was the beginning of the rocky, curved road over which radio was to pass before reaching its goal of to-day.



PIONEER EQUIPMENT

A close-up of the De Forest transmitting equipment on top of the wireless tower at the World's Fair. Note the anchor gap at the left of the direct connected helix, which, by the way, contains the open zinc spark gap

THE "GOD" DETECTOR

MANY experiments were carried on to find a more sensitive receiver than the coherer. We knew nothing about "rectifica-

tion" then. There were no text books on the subject, nor any radio editors to write to for advice. We were merely electrical eccentrics playing with a dream, so one guess in the way of an experiment was usually as good as

EAGER CROWDS SEE MESSAGES FLASH FROM WIRELESS TOWER

Post-Dispatch Sending Station for World's Fair News Fairly
Sings as Words Leaps Across the Copy—Visitors
Attracted Manifest Keen Interest.

WORLD'S FAIR GROUNDS,
Via De Forest Wireless.

Flashing messages through space from the Fair to the office of the Post-Dispatch continues to be the wonder of Fair visitors and crowds watch the process from morning until night.

The flash of 20,000 volts every time the operator presses his key is to them a thing of fascination. Then they turn from it to look from the great De Forest tower out eastward across the large city, but they see no sign of the message which the clicking instrument is sending out there through space.

Sometimes they stop the operator at his work to ask him if it is really so. They shake their heads in amazement when he answers "yes," and explains that in the Post-Dispatch office another instrument is ticking in response to his, and thus carrying Fair news to the newspaper and the world. The loud

buzzing of the powerful instrument surrounding the operator 200 feet above the ground in the De Forest tower does not prevent the visitors from crowding about him.

It is so loud that the operator must keep his ears full of cotton. It fairly deafens visitors and sending them away with a headache if they stay too long, but nevertheless they stay for the power of the mystery is very great.

This buzzing is caused by the powerful electric spark which the operator's key releases and corresponds to the click of the ordinary wire telegraph instrument. The dots and dashes are so audible that operators for telegraph companies and the police and fire departments anywhere within two blocks of the wireless tower amuse themselves with reading the wireless messages as they are buzzed off by the sending operator.

—Published in the St. Louis Post-Dispatch during 3rd Week of June, 1904.

another. One day, while working on receivers, it was discovered that a salvy mixture of various ingredients reproduced the signals in the headphone. The "discovery" was thoroughly tried out but found lacking in any definite merit, although it did get as far as to receive a name. It was called the "goo" receiver, and I believe that somewhere in the archives of the Patent Office may be found a formal application for a patent made for it by Dr. De Forest. Finally the electrolytic receiver was introduced. This was such an advance over anything previously introduced that it seemed to be the height of perfection. It consisted of a small glass cell containing a dilute solution of caustic potash and water which formed one anode of the circuit. Into this solution was immersed a cathode point, and the incoming wave was rectified by electrolytic action. Fessenden employed a fine wire coated with silver which was dipped into nitric acid to burn off the coating and make a fine whisker point. De Forest used a different type terminal called the "spade electrode" because of the shape of the terminal. This was found to be both practical and sensitive and not subject to "burning off points" in the middle of a message as was that involved in the Fessenden principle. In this circuit was introduced the potentiometer, a name coined for radio work. This set also contained the first "variable

condenser." Instead of the movable plates so common to-day, we used a small brass tube split in halves lengthwise and rotated one half within the other without moving them backward or forward. We knew nothing about "measuring" capacity. Either our experiment worked or it didn't. If it failed, then we would "change things" until it did work.

WHAT TO NAME THE CHILD?

IT WAS always characteristic of De Forest to call every new item discovered by a simple homely name which was significant of the act it did or the thing it resembled. Most of the names coined by him many years



THE EXHIBIT

Of the "American De Forest Wireless Telegraph Company" at the St. Louis World's Fair in 1904. A sample transmitting and receiving set is installed in the booth. Its noisy crackle could be heard for great distances

ago, are still used in radio to-day. Some of these are the "fan" antenna, the "helix," the "spade" electrode, the "pancake" tuner, the "spider-web" tuner, the "wing" (now called plate), the "grid" of the audion bulb; the A and B battery; and audio and radio frequency.

The first transmitters made were of 4-k.w. power. They were soon supplanted by a 10-k.w. set. It was this latter size that was used on the large 300-foot steel tower erected on the World's Fair Grounds at St. Louis. Two spacious elevators carried visitors to the top of this observation tower where the wireless instruments were installed. Many amusing incidents happened. One day, a lady desiring her full share of information, listened intently to our explanation of wireless and then bluntly told me in front of the crowd that the whole thing was a fake. She agreed that we "sent without wires," but she insisted we did this by using a silk thread instead of a wire between the two stations, thus making it "wireless." Many persons would go outside and look up to see if anything was visible from the top of the mast when the signals left.

From this tower we transmitted daily news to the St. Louis *Star* and the *Post-Dispatch*, a distance of five miles. Thus was established the first newspaper radio service, and the reprint on page 214 from the *Post-Dispatch* during the third week of June, 1904, is the first radio news message to be flashed through the air and published in a newspaper upon a predetermined and established schedule.

WIRELESS A MIRACLE—OVER FOUR MILES

AT NIGHT the tower was illuminated by thousands of electric lights which could be seen for many miles. In addition to this station, another exhibit was maintained in the Electricity Building and from both places we demonstrated "wireless" to endless streams of

curious people. In an adjoining booth was displayed "Wireless Auto No. 1," which was the very first wireless automobile. Its range of reception was only a few blocks but it always created much interest whenever it was driven about the streets or viewed at its exhibitor's stand. Its design of chassis in comparison with present-day automobiles shows its antiquity.

Not content with the honors the 10-k.w. station had won for him, De Forest started a special experimental station on the western limits of the Fair Grounds near the Boer War Exhibit. The object of this was to increase distance of transmission. Obviously there were but two

methods by which this could be done. We had either to increase the power of the transmitter or develop the sensitivity of the receiver. The former plan was adopted and a twenty-kilowatt station was planned—of exactly twice the power used in any previous experiment. It seemed as though when we doubled our power we increased our troubles at a compound ratio. As there were no stations operating at that time it was not necessary to concern ourselves about selectivity of tuning. The immense void of ether above us was free to use without the least fear of interference.



DR. LEE DE FOREST

In a corner of his laboratory. This picture was taken years after the others which appear with this article. Dr. De Forest is standing before one of his vacuum tube telephone transmitters which he designed to operate from the ordinary 60 cycle lighting current

I was placed in charge of this station, where, in company with Dr. De Forest, we experimented for many weeks in privacy and free from the madding crowds around the other wireless exhibits.

The new experimental station was called the "Jerusalem station" because of its proximity to the Jerusalem Exhibit. It was the first high-powered station in the world. It was soon found that many of the principles employed in the ten-kilowatt station did not apply to the new station with its 60,000 volts of oscillating current. Heretofore we had been handling just a big lot of current, while now, comparatively, we were playing with miniature lightning of static electricity and did not know very well how to handle it.

CONDENSERS SEVEN FEET LONG

THE spark-gap condensers, instead of being Leyden jars, were made in heavy two-inch plank boxes, seven feet long, two and one half feet high and equally wide, and liquid-tight to hold kerosene. Immersed therein

were two large sections of plate glass upon which heavy sheets of tinfoil were pasted on both sides. Each complete tray weighed about a ton, and from four to six of these tanks were used. Huge transformers six or seven feet high "stepped up" the tremendous voltage. The spark gaps had terminals one and one half inches in diameter upon which a cold blast of air from an electric blower was constantly blown. Telegraph keys, even of extra large design, were impossible to use, so we devised a long handle arrangement which operated like a pump. The contact points were encased in a tank of oil to prevent arcing and fusing. Imagine pumping water at the old town pump for half an hour,—that's how we sent signals before we discovered a better way. Our test signal was always the Morse letter "D" consisting of "dash, dot, dot." This would be sent out for hours at a time. We occasionally changed the helix adjustment or the condensers.

Our experiments continued to result in nothing but one failure after another. Some-



AT THE NEW YORK RADIO SHOW

Last October. Mr. Butler is talking into a microphone connected to a De Forest "singing arc," built in 1907. The "singing arc" was one of the earliest methods of producing continuous waves for wireless telephony and the three-element vacuum tube of DeForest successfully superseded it.

times, after days and nights of hard, painstaking work building up the series of condensers we would "blow up" the entire set in an instant, smashing the heavy glass plates to small pieces, blowing kerosene all over us and over the premises, only to gather up the fragments, rebuild with new glass and tinfoil, change the experiment, and try another hook-up. Static electricity was so free and unharnessed in this station, that it was not at all uncommon to get a "poke" in the head or elbow if one came within a foot of the apparatus while it was sending. The roar from the spark gap could be heard a block away and it held its own in noise intensity with the ballyhoo bagpipe of the Jerusalem Exhibit on the one side and the cannonading in the Boer War Exhibit on the other. The odor of ozone, mixed with kerosene, was always present.

"And hour after hour, one of us was listening-in with the headphones with ears strained to the utmost. Nothing in that long period of experimenting was more tiresome than this.

DOING THINGS NEVER BEFORE DONE

THUS, blazing the radio trail, we encountered the immensity of space. We listened-in on this infinite space and heard nothing. The silence was at times unbearable; the waiting, nerve racking; but always there were hope and expectancy. It was a royal game of angling. We changed things, fussed and fussed and experimented, still hearing nothing except an occasional rift of static which at that time was a blessing, because it meant that we were at least "getting something." Oftentimes we were awed at the thing we were trying to do. There was something uncanny in trying to snatch the tangible out of the intangible nothingness

of the free air. No wonder folks doubted our sanity. However, our longest waits were always rewarded, and finally, we accomplished what we had aimed to do. The thrill then was indescribable because the very thing we had just accomplished had never before been done by man. We never thought then that

in our little way we were piecing together some of the foundation stones of the huge radio structure which exists to-day. In his memoirs of those days, Dr. De Forest writes:

"Night and day there is no respite from care, from toil, from interest. But it is a life well worth the living, the full accomplishment such, perchance, as is not given to many. Those who once enter this work, on whom the enticing spell of the wireless once falls, never quit it, no matter what the demands on patience, nor how great the sacrifices—always hopeful, always in effort, fascinating forever."

Control of the apparatus having been achieved, we immediately began to smash records for distance. The first event was on September 5th, when communication was established between St. Louis and Springfield, Ill., a distance of 105 miles. On this occasion, President Francis of the World's Fair sent the following wireless message to Governor Yates of Illinois:

I salute you as the distinguished executive of a great commonwealth by the modern means of communication, the wireless telegraph, a great achievement of science, of the marvelous advancement of which this universal exposition furnished many interesting evidences. I hope to see you within these grounds often during the remaining three months of the St. Louis World's Fair.

Shortly afterwards, communication was established with the Railway Exchange Building in Chicago, a distance of 300 miles.



1907-1924

Mr. Butler is holding a De Forest audion tube made in 1907 and contrasting it with a tube made by the same company in 1924. He hazards that the 1907 one is perhaps the oldest tube in existence. The old tube was made with a fragile double filament so that when one burned out, the remaining one could be used. Their life was very short. The grid and "wing" were on opposite sides of the tube. The "wing"—now called the plate—was a flat piece of metal and not a tube as is used to-day.

In writing of this event of September 18th, 1904, Dr. De Forest says:

"This was indeed a stride in progress, fulfilling careful promises, crowning long and discouraging efforts. Especially significant was it that the formal opening of the St. Louis-Chicago service should occur on Electricity Day at the Fair with the Jury of Awards and the Delegates of the Electrical Congress present."

It is amusing to recall the elaborate precautions this austere body of officials took to make certain that this new service was actually by wireless. Some of the party was stationed at Chicago and the remainder at St. Louis. Complete communication was maintained all afternoon to their entire satisfaction, and as a result we were awarded the

Grand Prize which was one of the highest honors bestowed upon any exhibitor.

Upon the strength of these singular accomplishments the United States Government became so interested that a contract was signed to erect five similar high-powered stations in the West Indies, each station guaranteed to work successfully one thousand miles. This was a distance *three times* greater than that we had just bridged, but with light heart and high hopes we packed up our tools and started south for new worlds to conquer.

Little did we dream of the tremendous difficulties awaiting us and the months of tedious, sweltering days ahead before our task was accomplished.

The next article of this series will describe and illustrate the events of this tropical venture.—THE EDITOR.

WEATHER BUREAU

U. S. DEPARTMENT OF AGRICULTURE

Program for Broadcasting Weather Forecasts and Reports by Radio—Illinois Section

NAJ, Great Lakes: (151 Kc.) 9.45 A. M.—Morning lake forecasts; 4.00 P. M.—storm warnings; 10.00 P. M.—evening lake forecasts. (In code).

WLS, Chicago: (870 Kc.) 1.00 P. M. to 2.00 P. M., except Sundays (probably about 12 M. after Sept. 14)—morning state forecasts, general forecast, special forecasts, weather—crop summary on Wednesday, special warnings issued after sending hour, broadcast immediately.

KYW, Chicago: (560 Kc.) 12.00 noon, (11.00 A. M. during local "Daylight Saving")—morning local forecast, state forecasts, lake forecast; special warnings at 2.15 and 4.15 P. M.; 9.25 to 9.30 P. M.—evening local forecast, state forecasts, lake forecast, aviation forecasts. Monday, "silent night."

WAAF, Chicago: (1050 Kc.) 10.30 A. M.—morning local forecast, state forecasts, general forecast, general weather conditions, aviation forecasts, shippers' advices during winter season; weather-crop summaries on Wednesday during crop season; 12.30 P. M.—repeats the 10.30 A. M. information and on Saturday gives weekly outlook. Silent Sundays and important holidays.

WGN, Chicago: (810 Kc.) 10.00 A. M.—morning local forecast, state forecasts; 9.35 P. M. or later, at end of regular program—evening local forecast, state forecasts, lake fore-

casts, aviation forecasts, general forecast, general weather conditions. Monday, "silent night." Sundays and holidays irregular.

WOC, Davenport: (620 Kc.) 11.00 A. M.—morning local forecast, state forecasts, river forecast, general weather conditions, weather—crop summaries on Wednesday; 12.15 P. M.—forecasts repeated; special cold wave warnings sent as flashes. Tuesday, "silent night."

WJAN, Peoria: (1070 Kc.) 9.15 A. M.—morning local forecast, state forecast, shippers' forecasts, general weather conditions, special warnings; repeated at 10.30 A. M. and 12.30 P. M.

WEW, St. Louis: (1072 Kc.) 10.00 A. M.—morning local forecast, state forecasts, general weather conditions, river forecasts; special warnings at 5.00 P. M.

KSD, St. Louis: (550 Kc.) 10.40 A. M.—morning local forecast, state forecasts, general weather conditions, river forecasts and stages; special warnings at 12.40 P. M., 1.40 P. M., and 3.00 P. M., 10.00 P. M.—evening state forecasts.

Amateurs receiving weather forecasts are requested to advise (by mail) Weather Bureau Office, Springfield, Ill., of the quality of service received and how distinctly the stations are heard.

W. F. FELDWISH
Meteorologist in Charge.

RADIO BROADCAST

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January, 1925

Sound: First and Last in Radio

The Romance of Radio—Radio the Superlative Degree of Communication—Sound and Radio—Importance of Scientific Knowledge of Sound in Broadcasting—A Discussion for Layman and Technician Alike

By B. F. MIESSNER

Consulting Engineer, Wired Radio, Inc.

GENII," said Aladdin to the phantom who appeared as he rubbed his wonderful magic lamp, "build me a palace fit to receive my betrothed, the Princess Buddir al Buddoor. Let it be built of porphyry, jasper, agate, lapis lazuli, and the finest marble of various colors and surmounted by a dome of gold and silver. Let there be a spacious garden, a treasure house filled with jewels and precious metals, kitchens and store houses, stables and horses, and a royal staff of servants."

It was about the hour of sunset when Aladdin gave these orders and the next morning before the break of day, the Genii pre-

sented himself saying, "Sir, your palace is finished."

Who among us does not remember with delight this story from the Arabian Nights of the boy Aladdin and his wonderful lamp? He had only to rub his lamp and give his commands to the Genii who immediately ap-

peared to obtain whatsoever his boyish heart desired.

If Aladdin were to come to life to-day he would rub his eyes and not his lamp, for millions of real magic lamps are in actual use in hundreds of thousands of homes. He would find the users of these lamps are not in a fairyland of myths and fables, but in a land just as entrancing and even more won-



THE PYRAMIDS OF CHEOPS

The secret of their building died with the dynasties that built them. Had modern arts of communication then been developed, the constructional marvels in building them would now be known

Pioneering With De Forest in Florida

High Adventure with Temperamental Wireless When Forty Feet of Sand Brought Failure Close—Despair, Expense, Trouble, and Final Success—How the Pensacola and Key West Navy Wireless Stations Were Built

By FRANK E. BUTLER

Former Chief Assistant to Dr. Lee De Forest

THE erection of five high-powered wireless stations in the South guaranteed to give perfect communication over a distance of one thousand miles was the flattering contract offered Dr. Lee De Forest by the United States Government after he had made his sensational success at the St. Louis World's Fair. Naturally, he was elated at such unqualified endorsement of this success coming from so high a source. And I, having worked with him during every hour of that long and desperate struggle, and having shared with him the final triumph, was equally elated.

The stations were to be built at Pensacola and Key West, Florida; at Guantanamo, Cuba; San Juan, Porto Rico; and Colon, Panama.

They were to be the first wireless stations ever erected in the tropics. They were to work over a distance two thirds greater than wireless communication had before carried. But what of it? Had we not smashed the world's record at St. Louis? As a preliminary to this stupendous achievement had we not conquered all installation troubles? This Southern job was going to be an easy matter now that we had the St. Louis experience back of us! There was nothing to worry about, even though this time we were working for the Government.

This was the way we felt the day we started for the South. But, alas!

That Southern trip, begun in 1905, lasted close to two years. In the exercise of patience and the development of skill it made those gruelling days at St. Louis seem as no more than a preliminary bout before the battle royal.

It was a battle from the very start. All nature seemed in revolt at our intrusion.

She fought us with static overhead. It was fierce, relentless static such as was never heard before with the crude tuning devices at hand. She baffled us by "ground conditions" underneath that taxed to the utmost our perseverance and ingenuity in the effort to conquer them. She pestered us day and night with insects so vicious we grew to think of the mosquito as a friend. But we stuck. And we stuck until we conquered.



TOWER BASE AT THE PENSACOLA STATION

The masts were two hundred feet high.

Each timber in the base is eight by eight

SCENE OF OUR FLORIDA STRUGGLES

MY FIRST stop was at the Warrington Navy Yard, Pensacola, where I was to have charge of the erection of a two-masted station with a fan antenna. This station was to be of 10 kw capacity, and although very similar to the St. Louis Fair installation, excelled it in refinements of apparatus and wiring. I had a special letter from Mr. Breckenridge Long, then Secretary of the Navy (under

President Roosevelt), requesting all navy officers to assist us as much as possible in our work, but it was not necessary for me to use it because the navy officers at this yard were always exceedingly courteous and helpful to us in every way.

For a time I lived at the hotel in Pensacola. But only for a time. As our troubles multiplied I found it necessary to be right on the spot day and night. So I moved down to the wireless station where I slept on a bunk and ate my meals with the "Jack Tars" in their mess hall. It was here among these happy fellows that I learned many things which have proved most helpful to me ever since. They patiently taught me the knack of tying knots and of rope splicing, accomplishments I afterward found most useful in making proper antenna construction. I was allowed access at all times to their machine shop and electrical department, and I had the advantage of their experience with heavy construction work, wind stresses, mathematical formulas, etc. And so, for weeks, all concerned in the erection of the station worked happily, undaunted by nature's enmity, worked with the persistent energy that comes from a surety of ultimate success.

When the installation was finally completed it had all the aspects of a beautiful job.

As the day arrived for the initial test, the stage was all set to begin the test signals at 8



P.M. Dr. De Forest was located at Key West, about 400 miles distant. He was notified to listen-in at the appointed time when we were to send out the accustomed "D" test signals. All of the reading instruments on the operating table registered perfectly, the



"WE SHOULD WORRY"

They seem to be saying, even though they are away down in Pensacola. Mr. Butler, third from the left, of this group of "Jolly Tars" is helping the boys form the lucky combination of "four eleven, forty four"

spark across the spark gap was fast and powerful, and there was every indication of a perfect inauguration of service without delay.

IT WOULDN'T WORK

THE battleship *Brooklyn* was anchored in the harbor about two miles distant. The wireless operator aboard had been a daily visitor at the station and was interested in the test, so he planned to listen-in that evening. It seemed ridiculous to us that he should listen in on a 10 KW station located only two miles away, but he did.

As I started the test I was positive of its success. I sent "D's" for hours, waiting

MUNICIPAL PROGRESS AT KEY WEST IN 1905

The lower cut shows the transportation system of the city. One car, one mule, one street. To board car, proceed to center of street. The mule then stops, turns head around, and will not start until passenger is aboard. The conductor at rear of car

gives the mule "motorman" the bell twice and on you go until the "motorman" stops of his own accord at the other side of the next street. At the left, the diamond stack wood-burning locomotive that was still in use on the Florida railroads when Mr. Butler went from Pensacola to meet De Forest at Key West in 1905



anxiously for a telegram from De Forest at Key West. Nothing came.

However, at eleven o'clock, the *Brooklyn* operator came ashore in a launch and reported at the station. He inquired as to why we had not been sending, and added that he "had not heard a peep" from us.

The following morning a message was received from Dr. De Forest stating that he had not heard our signals.

Every item of the installation was carefully checked over and not a flaw found. A slight change in adjustment was made and the test resumed that evening with the same result. This testing continued week after week with relentless patience and continual changes. Even the large spread fan antenna was taken down, closely inspected and replaced.

What Dr. De Forest Said of the Author

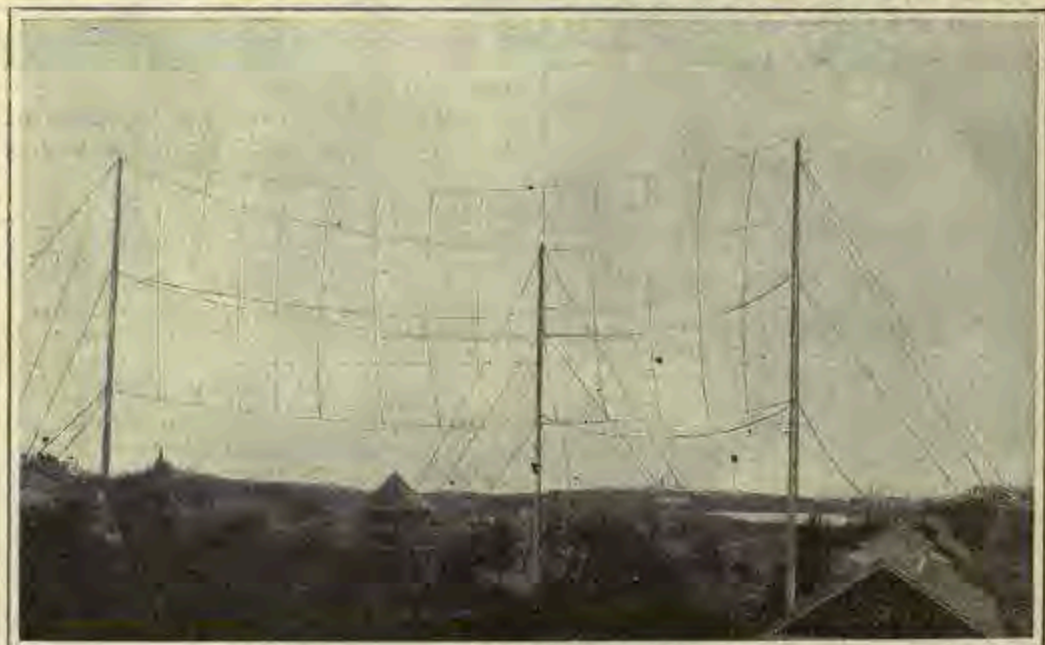
"Mr. Butler, is in fact the only surviving member of the "old guard" who is still interested in wireless and who is in a position to lay before the public, in a graphic and interesting manner, a gripping story of those old days and the subsequent development of radio under the De Forest banner. He has just read me the first three installments of a most graphic story of his early days in wireless, recalling a thousand interesting facts which I had forgotten, and in which every radio fan must be intensely interested."

The "ground" was an item of suspicion.

This "ground" had been considered a good one for the reason that it was made of heavy sheet copper one hundred feet square and buried five feet underground two feet under water, and connected to the spark gap by a four-inch copper bus bar.

To make sure the ground was all right, we dug up the plate and prepared to sink it deeper into the sea water. To do this it was necessary to construct a cofferdam, and while a

force of men shoveled out the sand another crew on each corner operated force pumps to keep out the water so the digging gang could work. It was slow, stubborn work. When a depth of eleven feet had been reached, we were compelled to stop further excavation on account of the increased rush of the incoming



"KW"

The De Forest station at Key West, erected in 1905 for the United States Navy. This spark set had a capacity of twenty kilowatts. The radio scenery at Key West now looks vastly different, what with the tall steel masts of the present modern Navy station now there.

water. Then we dropped a new one hundred square feet of copper and buried it, feeling certain it would solve our ground difficulties. That evening we sent "D's" energetically and with renewed confidence in our success.

It was a staggering blow to receive the following morning the old accustomed telegram from Dr. De Forest, "Heard nothing." This was followed by some suggestions of another change and an admonition to keep up courage.

That day, when the clouds of despair were at their darkest, an incident occurred which, trivial in itself, was the turning point in our apparently hopeless battle with an unknown trouble.

It was a drink of water that brought about the idea that solved the Pensacola problem.

A DRINK OF WATER SOLVED THE PROBLEM

WITHIN a few rods of the wireless station was a well from which we obtained our clear, cool drinking water. As I strolled over to the pump to get a drink on this day I met a Navy officer who reached the spot at the same time I did. After the usual greeting, I said:

"This is fine drinking water. Wonder if it's a drilled well."

To which he replied:

"It is. I know because I drilled it."

"How deep?" I asked, and little realized the tremendous importance of the question.

"Fifty feet," came the answer. "But," went on the officer, "if I had stopped at forty feet or gone down to sixty feet, I would have had nothing but salt water."

"How's that?"

"Well, you see it's this way. This white sand around these parts is about forty feet deep, and below that is a stratum of clay and stone twenty feet thick, and beyond that is an indefinite reach of sand."

"Ah, I see," was my rather inane comment. But I was too stunned by the idea that had flashed into my mind to carry on the conversation further.

The idea was that perhaps that white silica sand, the body of which was greater than the thin film

of seawater that seeped around it, offered too much resistance or formed a dielectric which prevented a good ground.

I spent the rest of the day absorbed with this idea. It still had full possession of me when, in the evening, I went to the Western Union office to send a telegram. Before I left I asked the operator what kind of a ground he had. He replied that the ground they used consisted of an iron pipe driven down forty feet, and that using any less than that produced no electrical results whatever.

That settled it. I was sure the solution of our baffling problem was at hand.

The following day I bought about six hundred feet of four-inch pipe and engaged men to drive twelve iron pipes each forty-five feet long into the loose, moist sand. These were grouped in a small circle about two feet apart. The twelve tops were joined together with heavy copper cable and a large bus bar run into the spark-gap.

The evening after this was finished we started sending "D's" promptly at 8 o'clock, and scarcely before I could realize it, the joyful news was received from Dr. De Forest that he had heard the first signals we sent out. To have success so suddenly thrust upon us after weeks of discouraging failures, was indeed a



PALMS AND WIRELESS AT KEY WEST

The palms hid the masts, but the station and its buildings took up an entire block. The insert at the right shows Dr. De Forest as he looked when he was doing the installation at Key West

keen pleasure and relief. You radio fans who enjoy making your own sets and revel in the thrill of "hearing results" for the first time, can perhaps appreciate to a degree the sensation that was ours that evening.

From this time on "en" worked perfectly, and it was not long before we were heard by distant Northern stations.

KEY WEST GETS A STATION

COURAGE soared. It was time for another "forward march!"

Leaving the Pensacola station in charge of the Navy wireless operators, I departed for Key West, overland, by way of Tampa, and thence by steamer. Even if I had not taken a snapshot of it, I should still be able to visualize the primitive engine that went ambling leisurely from Pensacola to Tampa, an engine of the "diamond stack" wood burning type. About every twenty-five miles cords of three foot stove wood were loaded on the tender, to be consumed during the next twenty-five miles with much belching of smoke that, compared to coal smoke, was a grateful odor.

Arriving at the Tampa docks just before noon, I had lunch, after which I found my finances reduced to exactly five cents. My boat ticket included meals, but the boat was not to leave until evening. There was nothing but a railroad yard at the Tampa docks, and the city itself was ten miles distant. So, with insufficient carfare to "go to town" there was nothing to do during the long afternoon but to watch the fish from the dock. It did not occur to me to mourn over being broke, for, during those early days of wireless, being broke was the usual condition with all of us, and being flush meant knowing where next month's rent

was coming from. And it was worth it, the fight, the privation, the anxiety. And even if any of us had had it in us to weaken, it would have been impossible with De Forest always at the helm, an inspiring leader.

I found him at Key West in his wireless station set in the midst of a picturesque tropical grove. Coconut, banana, and palm trees completely surrounded the station and the living quarters of the wireless crew. So far as climate and scenery were concerned, this island was an ideal place in which to live. But the restaurants were exceedingly poor. The only appetizing food was rice and hard rolls. Although fish was abundant, no one seemed to know how to cook it. When our work was going fairly well (comparatively speaking) we felt rather disturbed about this inadequate food supply. But when trying to solve seemingly unsolvable problems, we scarcely knew whether we ate or not.

Spread majestically over the trees of the grove that sur-

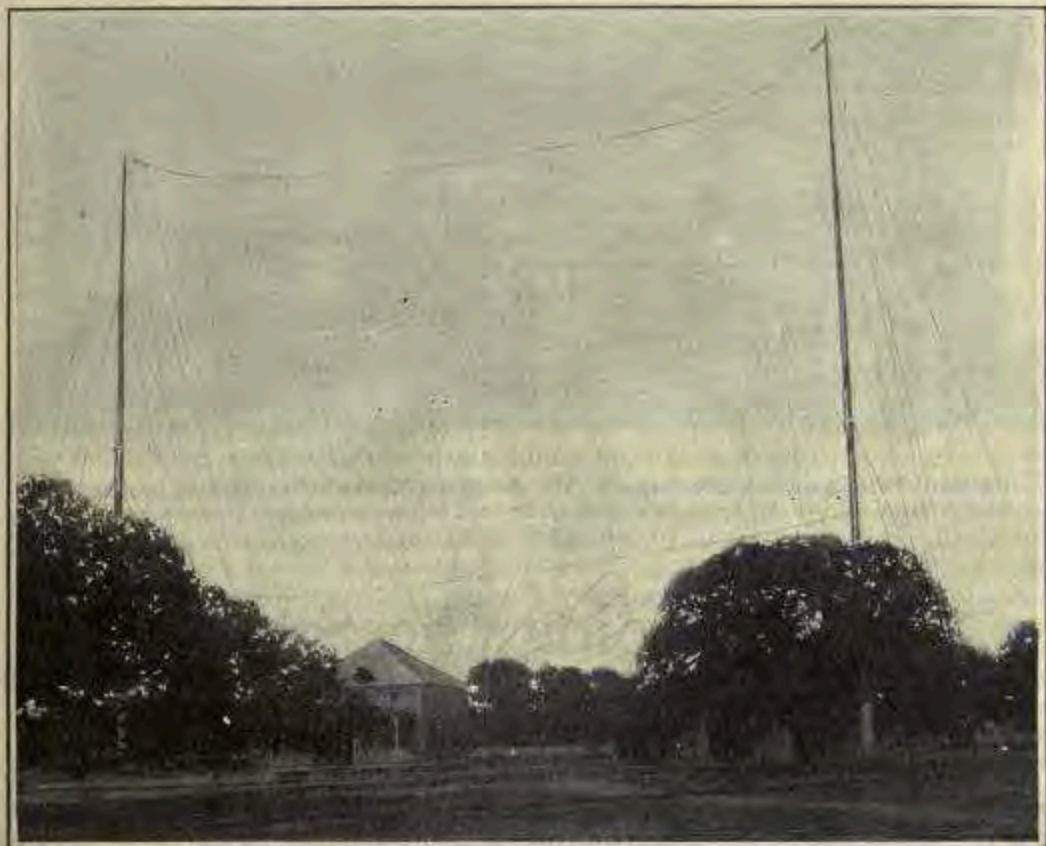
rounded the station was the huge triangular cage antenna consisting of 45,000 feet of wire, suspended from three equi-distant masts, two hundred feet high. The radio fan who has used seven stranded phosphor bronze wire for antenna purposes knows how stubborn and kinky it is and how difficult to handle. Think, then, of the difficulty of this antenna installation owing to the density of the tree foliage and the prevalence of high winds.

Many improvements in the wireless apparatus were noted at this station, and the quality of the spark at "kw" (as it was then called) was better than hitherto heard. Most notable of these changes were new ideas in receiving tuning devices. We made a definite endeavor to overcome the incessant static.



ALL IN THE DAY'S WORK

Here are the laborers pumping out water from the "ground excavation" at Pensacola to enable the diggers to get at their job of making a place for the large copper ground plate and below, the gang of diggers shovelling sand for the "ground" excavation at Pensacola. Some of them had to work waist deep in the cofferdam. The peculiar character of the ground connection here led to some unusual and very discouraging difficulties



STATION PN

The De Forest Station at the Warrington Navy Yard, Pensacola, Florida

In my diary, under date of April 16, 1905, I find a notation of an experiment we carried on at this Key West station with an *incandescent lamp for the purpose of eliminating static*. In these tests we used bulbs of various voltages and watts in conjunction with coils and condensers. The results were unique but not definite.

This was two years *before* the famous "audion" bulb was invented by Dr. De Forest. Little did we know how closely we were stumbling at the door of the "wonder lamp" that was destined to revolutionize wireless and make radio broadcasting possible. Had we gone a degree or two farther we might have a different story to tell here.

Evidently the doctor had become tired of "pump handling" "D" signals as was done

at St. Louis, day after day, because here he had devised a mechanical contrivance operated by clockwork, which sent out the "dash-dot-dot" "D" signals incessantly, without manual effort.

My stay at Key West was short, as it was now time to begin operation at Guantanamo Cuba, where the third station of the group was to be erected. Again, I started forth with high hopes, believing that the worst of my experiences with wireless were behind me. As it turned out I was going straight into a work that called for wholly unforeseen and difficult engineering feats and the most crucial physical endurance test of the entire contract.

How success was finally accomplished after eleven months of hardships and disappointments is a story in itself which will follow.

(The next article in this series will deal with the experience of these radio pioneers in Cuba)

Radio Broadcast

ARTHUR H. LYNCH, EDITOR

MARCH, 1925

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ON CUBAN SANDS

The party which installed the station had to live in tents for some time before other buildings could be put up to house them.

How Wireless Came to Cuba

The Drama and Struggle of Strenuous Radio Times in the Jungle—
Hitherto Unpublished Memoirs of High Technical and Human Interest
—What Really Happened in the Early Days of Wireless Telegraphy

By FRANK E. BUTLER

Former Chief Assistant to Dr. Lee De Forest

THE way we went about building a wireless telegraph station in 1905 was an entirely different procedure from that followed to-day when the modern radio engineer starts out to construct a broadcasting or any other type of radio station.

Instead of blue prints to guide us in those pioneer days we used only past "experience," and our stock of that was mighty limited. If past "experience" failed as a means of attaining further satisfactory results, then we relied upon patience and determination. These unscientific assets were all we had to help us in the working out of each new problem.

Up to this time, three high powered stations had been erected by Dr. Lee De Forest, one at the St. Louis World's Fair, one at Pensacola, and the third at Key West, Florida. These stations, while practically of the same

design and construction, had presented in their building individual problems which had to be worked out. These experiences had somewhat tempered our conceit as to what we thought we knew about installation. We began to realize the uncertainty of any set radio laws, and to expect anything to happen, or fail to happen.

This was the situation when I went to Guantanamo, Cuba, to erect the next in the series of five powerful stations to be built by Dr. De Forest for the United States Navy Department.

I sailed from Key West early in the spring of 1905 for Havana from whence I was to take a train overland to Santiago and from there embark once more by boat to within a few miles of my destination.

A brief stay in the delightful city of Havana

enabled me to form an idea of the difficulties I would have in a country whose language I didn't know and where buying facilities were very inadequate. My stay there was during the celebration of the first Cuban Independence Day, which resembled our own Fourth of July. The city was full of natives from all over the island, and when the train left Havana that evening I was mixed in with the most motley lot of passengers I ever met. I was the only white man.

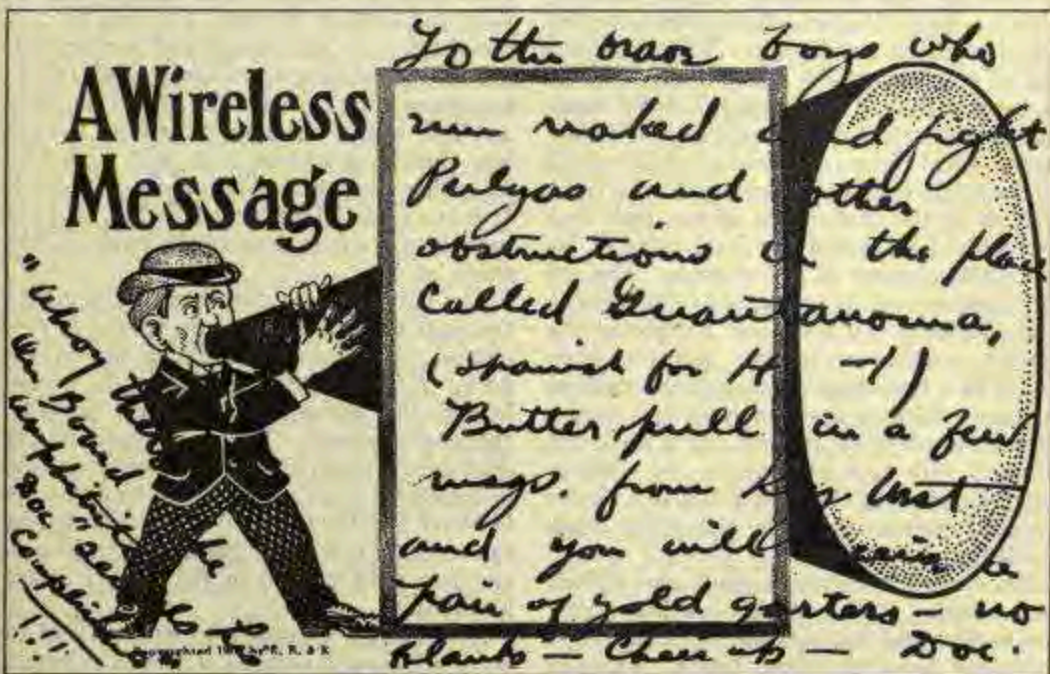
A great quantity of wire, instruments, etc. had been shipped to me at Havana from New York. Having been forewarned of the advisability of not checking this material as baggage or shipping it via express on account of the unreliability and slowness of these methods, I decided to take it all in the car with me. As a result, my seat in the so-called, "sleeper," resembled a baggage car.

EN ROUTE TO GUANTANAMO

THE train dragged along slowly all night and seemed to stop at every sugar plantation. In the morning we stopped thirty

minutes at a town for breakfast which was served in a large room adjoining the depot. The passengers swarmed in there like a lot of cattle. There were no chairs, just long benches to sit on. Everybody grabbed, and so did I. They all talked Spanish, and they all talked at once. I was the only American in the crowd. The only Spanish I knew was "agua" but as they did not have any water, this one-word proficiency in the language was useless. Everybody was drinking wine, so I drank it, too, the while I sat in amaze as I watched the others empty glass after glass until they were stopped only by the call that the train was ready to move on.

At each station I hoped that some one would come aboard who could speak English. But all that I heard from the new passengers as well as the old, was Spanish. During the stop for lunch I was sitting rather disconsolate by myself when I noticed a dapper young Cuban army officer, who had, apparently, been to Havana for the recent celebration. He appeared very popular with the entire crowd. Just before leaving the station to board the



"DOC" DE FOREST TO MR. BUTLER—

The postal card was mailed in St. Louis on June 14, 1905. He writes: "To the brave boys who run naked and fight pulgas and other obstructions in the place called Guantanamo (Spanish for h-1) Better pull in a few msgs. [messages] from Key West and you will receive a pair of gold garters—no blanks—cheer up—Doc." And along the side: "Ahoj there on board the *Amplitrite*—Doc sends his compliments." The pulgas are small insects, almost invisible. They swarmed about the station in clouds, and their bite, while not poisonous, was very annoying. Since these insects chose to hover under clothing, the radio pioneers at Guantanamo often took the easiest way and removed most of theirs, hence Dr. De Forest's remark about the "boys who run naked"

train he came over to me and said, in perfect English, "Hello, John. Are you going to Santiago?" Every stranger in Cuba in those days was called, "John."

When I replied in the affirmative, the dashing young officer told me that he, also, was going there. From that moment the aspect of the trip was changed. I had found a companion, and a delightful one he proved to be!

About three o'clock the train stopped at what appeared to be a railway terminal. I stepped out to the platform for a little exercise while engines were being changed. After about ten minutes everything was in readiness, yet the train did not move. Fifteen, twenty, thirty minutes passed, and still we stood there. I noticed a little crowd by the baggage car so I strolled up to investigate the trouble. Imagine my surprise to find the entire crew circled around a large coil of wire which had been taken from my seat while I was away. All were talking excitedly and casting suspicious glances at me. I couldn't understand the situation. I hurried back to the "sleeper" to seek the assistance of my English-speaking Cuban friend. He came forward with me and asked what the trouble was. They explained that it was against the rules of the company to carry such kind of "baggage" in the sleeping car unless the express charges on it were paid. I had visions of a hold-up which would either mean most of my money for carrying charges or the confiscation of my tools and material. So I asked my interpreter to inquire the amount of the charges. The excited gestures and the combined talking of the crew increased my fears and I expected the worst. Imagine my surprise, however, when I was told I would have to pay the railroad company thirteen cents in American money to release the wire so that the train could proceed with my baggage in the sleeper. Upon payment of this sum I had to wait for several receipts and then the train again started on its journey.

We arrived at Santiago about nine o'clock that evening after a twenty six hour drag. It was dark and the town was lighted with old fashioned kerosene street lamps. Through the officer I engaged several Cuban boys to assist me to the dock with my luggage as there were no conveyances about. From here I boarded a small steamer enroute to Boqueron, located on the interior shores of the Bay of Guantanamo.

The boat steamed out of the bay and past old Morro Castle over the spot where, a few

years before, Hobson had sunk the *Merri-mac*. We skirted the southern shore of the island and could see, as we passed by, the dim outlines of some of the hulls of the Spanish fleet which Admiral Sampson beached during the Spanish war.

THE SCENE OF ACTION

EARLY the next morning we arrived at the little group of huts which was called Boqueron. This hamlet port was the nearest point to the site of the contemplated government wireless station, which in Spanish was called telegrafo sin hilo.

It will be remembered that it was only a few years previous to this time that the Spanish-American war occurred which resulted in the freedom of the Cuban people. The United States Government had only very recently completed the arrangements of the formal turning over of the island to its natives, and it was the jollification at Havana which I saw only a few days before which had been held in honor of the event. In this transaction it was agreed that the United States should retain a small spot in Cuba as a naval base and coaling station. The site selected was the Bay of Guantanamo and its surrounding land consisting approximately of thirty-six square miles. About half of this was land and half water. The entrance from the sea was through a narrow inlet with high hills on either side extending along the coast. It was an ideal land-locked harbor, and big enough to accommodate all the navies of the world at once.

The sight of the harbor was inspiring, and the sight of Boqueron was depressing in proportion. The principal building was at the dock. A few native huts, a store and a saloon, housed the entire population of, perhaps, twenty-five people. The loungers around the dock were a tough looking lot, mostly negroes or half-breed Spaniards, just the kind you see in blood and thunder plays. I learned later that a few of them were fugitives from justice, and two were wanted in the United States for murder.

As I needed assistance to get overland to my destination I engaged a Jamaican negro, George Morehead, who spoke English, to go as my guide. We strapped the luggage across the backs of two horses and started afoot on the hike through the jungle to the government "lines" beyond which was the continuance of the jungle to the point where the wireless station was to be built. Government surveyors were the only white men who had pre-

ceded me through this wilderness, and the marks of their hatchets as they hewed the trail through the underbrush, were the only signs that any one had ever been there before. The land on this entire reservation, and for miles beyond, was in its virgin state. All was a dense undergrowth and jungle, interspersed with low, arid, sand flats: a paradise for mosquitoes, snakes, horned toads, scorpions, tarantulas, wild cats, and all other kinds of tropical creatures, flying and crawling.

I found George an intelligent fellow, entertaining and thoroughly trustworthy. This in itself was a godsend, as one would hardly expect to find anything like honor in surroundings such as these. As we journeyed he asked me if I had a pistol and I told him I had. He advised me to carry it always in my belt whether or not I ever had occasion to use it, as the many bad Negroes down there behaved only when they knew that the white man had a gun. I later found this advice valuable.

ONE THRILL OF MANY

ONE of my first thrills happened on this pathfinder trip. As we emerged from the jungle trail onto a wide level stretch of sand flats, I noticed that far ahead of us the earth looked bluish white, while beneath us it was hard packed salty sand. Nearing the blue patch I noticed this "land" moving. Slowly the bluish white part was separating in the middle with a wide swath and making a path showing the earth underneath. The negro, noticing my amazement, smiled and told me that this was a large army of land crabs scampering away to avoid us. They were there by the millions—ugly, worthless, destructive creatures with glaring, protruding eyes and wicked claws, some of them as big as human hands. In their cowardly nature they scurried and scampered away from us. But had we fallen helpless by the wayside they would immediately have returned to devour us.

A short time previous to my arrival the U. S. monitor, *Amphitrite*, had anchored in the harbor with officers and men to break ground for the construction of the new Naval Station. This ship was the Naval headquarters of the entire reservation and its commanding officer was the acting Commandant of the Navy Yard. Three Navy electricians from the ship were assigned ashore with me. They were: John Watts, Chief Electrician, of New York, Roscoe Kent of St. Paul, and V. Ford Greaves of Minneapolis.

First we lived in a tent and got our food



A TYPICAL NATIVE HUT

supplies from the ship. The initial general work to be done was the clearing of the dense growth of mango bushes which grew profusely along the shores around the station site. This made sport for the mosquitoes. Next a small dock was made so as to land supplies for the engine house and other necessary material. Finally, the engine house was completed to the extent that we could move in there until our regular living quarters were finished. Mosquitoes by the millions abounded and they made life miserable for us both day and night until we were able to obtain the necessary fine mesh netting to protect our tent and house.

It was not uncommon to be awakened in the night by the sound of a wildcat outside, for the animal was attracted there by the smell of food. Once we failed to close the flap of our tent and were awakened in the middle of the night by a suspicious but familiar sound inside. We switched a flashlight in the direction of the sound. Instantly a huge cat sprang completely across three of our cots to the tent opening and escaped with our next day's quota of meat.

Any one who has ever witnessed a southern sky can understand our enjoyment in watching the southern constellations which are so different from those at home. Huge fireflies as big as bumblebees emitting a bright green light filled the air at night. Small deer were plentiful and once we shot a fine specimen from our door. In the nearby inlets were the beautiful pink plumed flamingo birds so free from the haunts of man as not to fear our approach. In the waters all about us were gold fish, star fish, sea urchins, cow fish, and scores of other tropical wonder fish, besides many of the edible variety.

But enjoyment of the scenery had to take

second place to work. Heavy concrete abutments were constructed for the huge towers. These were in triangle formation three hundred feet apart. The towers were made of eight inch timbers, about three feet square at the base and tapering to one foot square at the top. They were two hundred and eight feet high. Suspended from the cross cables at the top was a big fan antenna from each of the three sides of the triangle. Heavy, seven-strand phosphor bronze wire was used and each triangle consisted of about 15,000 feet of wire or a total of 45,000 feet for the entire cage. This immense amount of wire weighed over a third of a ton, or the equivalent to the amount used to-day by radio fans in building five hundred sets of antennas. The huge cage resembled a giant gold fish globe two hundred feet high, and months afterwards, when the station was in operation, the mesh of wires would emit a bluish brush discharge at night which was beautiful beyond description and always proved of unending awe to the natives who would stand off from afar and gaze in open mouthed wonder.

QUARTERS

THE main building consisted of six rooms, which included living quarters. About 100 feet distant was the engine house which contained a 50-horsepower gasoline driven dynamo that furnished the electrical power. The station was rated at 20 kilowatts. One room contained the operating instruments, another the huge condenser trays, the spark gap and helix. So many wires from the antenna came into the one point of the bottom apex that it was necessary to build a gibbet to hold them on account of their weight before running them into the station.

It so happened that the site of the station was selected by Navy officials who instead of first considering its location from the point of its adaptability for perfect wireless work, selected it because that particular space was down on the blue print as the place, just as every other building planned for the reservation. As a result, a worse location could not have been chosen. The little peninsula upon which the station stood was wholly of coral formation, entirely dead as far as moisture or good ground facilities were concerned. This condition gave us no end of trouble in getting the station to function properly.

The days were hot and dry and the insects bothered us so much that work progressed slowly in the erection of the buildings and the installation of the apparatus. Many times

it was necessary to tie a towel around one's face, neck, and head, leaving only opening enough to see and breathe, wearing overalls and shirts saturated in kerosene was another method used to ward off the pestering insects.

Hard luck seemed to follow every move. High winds often blew down our antenna, and the station was struck by lightning three times. Once we experienced a slight earthquake shock, but aside from frightening us it did no damage.

An outcast Frenchman by name of Émile was our cook. He spoke broken English, poor Spanish, and never ceased telling us of his acquaintance with Sarah Bernhardt. He was a chef by courtesy only, but was the best we could procure in that godforsaken land. Another interesting member of our family was Marianna Binaga, a Cuban Negro, black as the ace of spades, but loyal to the last degree. He was a general roustabout; but did everything in his power for us. He watched over our health and comfort always, once saying me from the bite of a scorpion by quickly cautioning me not to put my arm in the sleeve of a coat which had been hanging for some time in the closet without being worn. Excitedly he told me in Spanish (which by this time I had begun to grasp) to shake the garment. Sure enough, out from the sleeve dropped the wicked insect which Marianna quickly surrounded with an oiled wick, then lighted it so that the scorpion would commit suicide—which it did—thus giving me, as Marianna had designed—another souvenir, which I still possess. To Marianna, I was, "Mistah Fraang." Kent was "Mistah Kee." Watts was "Mistah Gwaa" and Greaves was "Mistah Greavo." He was as faithful as Friday to us.

GOVERNMENT INSPECTION

FOR some reason, unknown to me, a so-called government inspector was sent there for the purpose of watching me and my work. I will not mention his name here, but Marianna called him "Mistah Sinka-Walla" and that name stuck with him till he left after I did. He stayed on the job religiously for eleven long months, every day, Sunday included, from 8 A. M. till 5 P. M. He watched me constantly and said nothing. Never a word of encouragement or suggestion, but whenever anything went wrong he was always there with his familiar, "I thought so."

As we had no fresh water supply on account of the dead ground formation, we made a cement cistern to hold our drinking water.

To obtain this water it was necessary for the Government tug to steam up the Guantanamo River to where the supply was fresh, there fill its tanks, and then run down to our dock

and fill the cistern. Usually it required half a day to do this and of course was of some expense to the Government, so naturally we tried to be as saving with the water as possible.

One day after this filling was done, we forgot to place the cover over the cistern hole and that night a big wildcat, smelling the fresh water, went to the opening, fell overboard, and was drowned. The next morning Mr. Watts notified the officer on the ship of what had occurred, and requested that the water



IN AND AROUND THE WIRELESS STATION

Which was installed by Mr. Butler, working for Dr. De Forest's American Wireless Telegraph Company at Guantanamo, Cuba, for the United States Navy. The lower photograph shows the station house and the masts. The oval next above it shows the view of the Cuban landscape, on which the operators could feast their eyes. The top oval is taken outside the operating shack and shows a part of the staff then attached to the station.

be pumped out and the cistern refilled with fresh water. A prompt, curt refusal was the result. Such an order coming from their superior officer had to be obeyed, of course. I then sent a similar request and received the answer that the matter had been taken care of through Mr. Watts. Here, then, was the first time it was necessary for me to use the special letter I had from the Secretary of the Navy which requested all officials where I operated to assist me in every possible way. Without further argument I cabled Washington. Within a few hours an answer came and we got what we asked for. A short time afterwards a case of yellow fever broke out in the laboring camps nearby and my three Navy companions were ordered to vacate the station and come aboard ship until the disease subsided. This inhuman action left me helpless and alone at the station with an imminent danger near. I again sought recourse from the Navy department with instant and satisfactory results.

In reviewing my old diary I find under date of Tuesday, November 14th, 1905, that I employed a Negro by name of Joe Francis to repair a parted main antenna cable which spanned the space of 300 feet between two masts. To repair this was not only a difficult task but an extremely dangerous one because most of the splicing work had to be done 200 feet above the ground. No one but Francis could be found who was daredevil enough to risk it. He was a notorious bad man and had a price on his head for a murder alleged to have been committed in the United States. I dickered with him to do the job for \$40.00 and he accepted.

However, after he had nearly finished the work, and while sitting up there swaying between heaven and earth, he called

down and declined to proceed unless I doubled the amount of pay. This I flatly refused to do and he still maintained his strike until I drew my pistol and threatened to shoot him down from his perch unless he completed the job as he had contracted to do. To this threat he promptly replied: "I guess you'd do that all right, Mistah Frank. I'll finish the job." I kept him covered while he continued the work because he continually looked down at me to see if I still meant business. He afterwards told others he was going to get me for that trick.

One night about nine o'clock, a few days later, one of the station boys and myself were returning with fruit from "the halfway house," a tent shack, not far away where native fruits and vegetables could be bought.

The night was starlit and the journey was three miles over a zig-zag path through the jungle. We had to walk single file. Some of the spots on the way were so dense with overhanging moss and tropical foliage as to entirely cut out the view of

the sky. There were comparatively few snakes here, but there were plenty of horned toads, tarantulas, land crabs, mosquitoes, and wildcats, so we always carried a pistol. At a spot, such as this, one third of the way home we met Joe Francis, the Negro. He spoke coolly and slunk by us like a panther, looking over his shoulder as he passed. Fortunately I was ahead of my partner and I think this was what saved me. We were suspicious of his designs, so the instant he left our view we turned off the trail and penetrated the jungle, deciding to attempt to feel our way home through the uncharted underbrush. This, in itself was dangerous, but we thought it the lesser of the two evils. Scarcely had we left the path and fallen to the ground than we heard Francis retracing his steps stealthily. Not having



THE OPERATING ROOM AT GUANTANAMO

The huge contrivance on the right is the antenna switch; next is the power-control panel. An electrolytic detector and slide tuning coil receiver completed the installation

a compass with us we selected, before moving, a group of stars which we figured was above the wireless station. Then, instead of starting directly for the station we doubled back further toward the way we had come and planned on a wide circle around so as to enter the station from the other side, thus avoiding that trail entirely. We encountered bogs, marshes and everything imaginable, but after several hours of maneuvering we reached home safely and without further adventure.

About a week later, Castro Frerrar, a Spanish surveyor with whom I was well acquainted, was stabbed and killed on this lonely trail a short distance from the wireless station. No one ever knew who did the deed or for what purpose. He was about the same size as I and might easily have been mistaken for me. The singular coincidence was that Joe Francis left a few days later and was never seen or heard of afterward.

TESTING THE STATION

FINALLY after many months the station was completed and the long series of tests began. Static was terrific. It was a continual rumble. Our principal tuning device was a two-coil slider which to-day would not be considered worth anything by a nine-year-old school boy with a crystal set. Realizing the immense importance of developing the receiving end of wireless, Dr. De Forest left Key West and went back to New York to study out this problem.

I firmly believe it was our gruelling experience with these southern stations that turned the doctor's attention so strongly toward this subject that he never gave it up until he later perfected the heart of radio—his three-element audion bulb, without which present day broadcasting and receiving would be impossible.

His immediate work, however, after going north was to perfect a tuning device which would handle static better. This led to his invention of the pancake tuner which consisted of fine insulated wire wound spirally on glass with variable adjustments. This we found more efficient than anything used previously and it became one of the principal elements in the success of these installations.

In reviewing the many letters which passed between Dr. De Forest and me during these trying days it is gratifying and interesting to note his keen appreciation of our difficult work—his determination to succeed, and his constant belief in ultimate success. Too much credit cannot be given to Dr. De Forest for what he has contributed toward the de-



A LAND CRAB

Which was caught in the act of carrying away a pair of overalls belonging to one of the workmen at the station. His claws are about the size of a man's hand. These bluish white molluscs crawling across the bare wooden floor of the porch at night sounded like people walking across the creaking spaces

velopment of wireless and radio. His dominant persistence, patience and ability were as prominent two score years ago as they are to-day. Had this development been left in the hands of a less determined or less capable man than he, it would probably not be in the advanced stage it is to-day. I firmly believe this, because during the twenty years I have watched the progress of radio I have seen many experimenters who started with great expectations but soon fell by the wayside, not strong enough at heart or in ability to stand the test of constant disappointments.

Here are a few excerpts from some of the De Forest letters:

July 28th, 1905: Your very interesting letter concerning the lightning storm received. It was a very graphic account of a frightful experience. I appreciate your devotion to the cause in taking the risk you did and am glad so little damage to our apparatus occurred.

August 9th, 1905: You certainly are the star martyr to the wireless cause at present and have our fullest sympathies—if those will do you any appreciable good. None of us are too happy or enjoying flowery beds of ease. It is a tough problem and I can't tell what "ist los," but will keep on trying new stunts until it is solved. "Never say die," and "You can't stop a Yank," are the two cardinal mottoes of the wireless bunch, you know.

October 4th, 1905: "I am enclosing plan for



THE SPARK-GAP AT GUANTANAMO

The electrodes were encased in an asbestos-lined muffler box. The spark jumped a one-inch gap, shunted by four large condensers

connecting up the six condensers. The tinfoil has been shipped from the lab. You can put this on with paraffin, as we generally do now, *building up the whole thing under oil.* (Imagine working for days with arms immersed in kerosene.)

November 8th, 1905: Glad to get your long letter of 30th, and regret it is so full of hard luck tales. Sincerely hope your big transformer (weighing a ton) won't blow up again and believe that the new ground plate will remedy your troubles. You show splendid grit as you always do in facing these difficulties.

November 20th, 1905: Your yellow feverish, earth quakish letter came to hand this morning. I am sorry your troubles are holding up so well, but do not get discouraged as we have ours here, and you have not succeeded in cornering the trouble market by any means.

December 26, 1905. I want to thank you most heartily for the very kind letter of Christmas greetings you wrote me. There is no one in our employ who has shown himself more loyal and determined in his efforts to hasten success of the system than yourself, and you may be sure that I appreciate it fully.

Then, in reviewing my diary of that year, the following few terse sentences graphically portray the unbroken schedule of daily mishaps we encountered:

June 5th, 1905: Big 50 H. P. motor generator blew up, damaging armature.

June 7th. Commenced taking off tin roof on building and substituting it with asbestos.

June 12th. Commenced repairing damaged trays in condensers.

June 14th. Lined condenser trays with portland cement.

June 26th. Killed an 8-foot Moha snake in back yard. This was the cause of so many of our chickens disappearing.

July 10th. Constructed plate glass condensers for motor and circuit breakers.

July 13th. Terrific storm 2:30 A. M. Lightning struck station bursting an entire room full of condensers—just finished after two weeks of hard work—throwing oil and plate glass all over the room and into the walls.

July 14th. Repaired damaged antenna wires.

July 26th. Changed all d. c. wiring throughout station 36 inches away from a. c. from engine house to station.

August 14th. Rained this evening during exceedingly bright moon which caused unusual phenomena of two bright rainbows at night.

August 21st. Small cyclone struck us.

August 31st. Lightning struck the station at 4:15 P. M. blowing up one set of condensers.

September 5th. No fresh water. Had to drink salt water all day.

Sept. 24th. Another entire span of 15,000 feet antenna wire blew down.

Sept. 27th. Touched off station again and blower motor blew up.

October 8th. Herd of horses from workmen's camp broke corral in night and demolished the guy wires on the entire aerial spans twisting wires badly.

October 15th. Earthquake at 4:43 P. M. while eating supper.

October 17th. Finished new ground to-day.

October 19th. Rewound blower armature.

November 7th. Secretary of Navy Taft visited us to-day.

November 17th. Heard Key West and Pensacola first time.

December 10th. Key West heard us first time. Blew up blower motor.

December 15th. Big two-ton transformer blew up.

I had almost begun to think I was waging a hopeless battle against nature as week after week a fresh burst of some new and unforeseen trouble presented itself.

MORE TROUBLE

ABOVE the door of our station we tacked a motto: "Abandon hope, all ye who enter here, for verily this is hell." It was there for months and was a grim way we had of joking with ourselves.

It was not until the following March that we finally overcame all our troubles and succeeded in establishing communication with

our distant stations to the entire satisfaction of the Navy Department.

When the end finally came, when my work was finished, I was more than overjoyed to get away from that place of trials, but I was sorrowful to leave my three faithful navy companions, Watts, Kent, and Greaves, likewise faithful Marianna, who so loyally stood by me through, perhaps, the most crucial period that any group of early wireless workers ever experienced.

In the meantime, Dr. De Forest had sailed for Europe and shortly after my arrival in New York I received the following letter from him, which I highly prize, because of the wonderful sentiment and appreciation it discloses.

London, E. C.
April 20th, 1906

Mr. Frank E. Butler,
New York City.

MY DEAR FRANK:

Upon the occasion of the final acceptance by the U. S. Navy of the five large stations, of which you have been in charge, I wish to extend to you on behalf of myself and of the American De Forest Wireless Telegraph Co., congratulations, hearty and sincere, and to felicitate you upon your safe return to God's country.

Too often it is the case that while the faults and blunders of men receive prompt and severe criticism, the merits of their work, the fidelity of their services pass unacknowledged, even if fully appreciated by their employers. I trust that this may never be the policy of our company.

All of the officials of this corporation have watched with intense pride the heroic efforts you have made, the great patience through long months of discouragement and difficulties which have necessarily preceded this success. I can deeply appreciate the nature of your labors, your trials, the hardships you have undergone, for it has been my good fortune to have been with you at your post and shared in, while directing, your work.

This work, these experiments, these long-drawn-out tests, carried on in the face of unforeseen and manifold difficulties have, I believe, not only achieved the wireless success intended, but have been the means of developing character, a determination to bear and achieve like good soldiers; have ripened a friendship and a loyalty to one another and to a worthy cause, which constitutes in life elements of even greater value than commercial success.

We do not, we cannot forget the obstacles you have had to face and which you have bravely overcome.

For tedious months away from home and friends, in climates scorching and unhealthy, deprived of all usual comforts of life, tormented night and day by insect pests, distressed but not baffled by static

unknown to any other wireless workers, delayed month after month by breakdowns of Navy apparatus, continually called upon to make repairs, often without proper tools, facing skeptical criticism, surrounded by hostility, open or concealed on the part of officials from whom we had every reason to expect cooperation and interest,—yet, you have stuck to your posts, have triumphed over one difficulty after another, have forced new secrets from Nature, and having by your tenacity, patience and skill accomplished your ends, you have won at last an acknowledgment of the success of the system from the entire Navy Department, and set a new standard in the art of Wireless Telegraphy.

In view of your services in this unexampled undertaking we wish to express, although in inadequate words, some portion of praise you so well deserve, and to express our confidence that this navy work is but the beginning of greater things we are yet to accomplish together in wireless.

Very sincerely yours,

LEE DE FOREST,
Vice Pres. and Scientific Director.

All the desperate trials of the Cuban experience seemed wiped out by this letter. For were they not worth it, those trials, when one was working for Dr. Lee De Forest?

RECEIVED			
COMPAGNIE FRANÇAISE DES CABLES TELEGRAPHIQUES			
Station de		Pensacola	
DATE		30	
N° d'ordre		20	
Lettre de service		B	
RECU		5, 40 per	
Butler naval wireless tele. station			
Guantanamo			
listen for thirty to eleven thirty am			
no night work check coming			
Lee de forest			

ONE OF DR. DE FOREST'S CABLEGRAMS

To Mr. Butler and his associates in Cuba. It was filed in Pensacola, Florida on August 3, 1905 and reads: "Butler Naval Wireless Station Guantanamo listen five thirty to eleven thirty A. M. no night work check coming Lee De Forest". Many messages of this sort had to be exchanged before the new Naval station in Cuba could be put in order