Chronology of Radio

Highlights of Progress in U.S. Bureau Report

An epitomized history of radio is contained in the report, "Radio Activities of the Department of Commerce," rendered by W. D. Terrell, director of the Radio Division of the Department. This chronology is reprinted herewith in full, with permission of the Department:

1827. Savary found that a steel needle could be magnetized by the discharge from a Leyden jar.

1831. Faraday discovered electromagnetic induction between two entirely separate circuits.

1837. The first patent for an electric telegraph was taken out by Cooke and Wheatstone (London) and by Morse (United States).

1838. Steinheil discovered the use of the earth return.

1840. Henry first produced high-frequency electric oscillations and pointed out that the discharge of a condenser is oscillatory.

1842. Morse made wireless experiments by electric conduction through water.

1843. Lindsay suggested that if it were possible to provide stations not more than 20 miles apart all the way across the Atlantic there would be no need of laying a cable.

1845. Lindsay made experiments in transmitting messages across the River Tay by means of electricity or magnetism without submerging wires, using the water as a conductor.

1849. Wilkins revived the same suggestions for wireless telegraphy.

Doctor O'Shaughnessy succeeded in passing intelligible signals without metallic conduction across a river 4,200 feet wide.

1862. Heyworth patented a method of conveying electric signals without the intervention of any continuous artificial conductor.

1867. Maxwell read a paper before the Royal Society in which he laid down the theory of electromagnetism, which he developed more fully in 1873 in his great treatise on electricity and magnetism. He predicted the existence of the electric waves that are now used in wireless telegraphy.

1870. Von Bezold discovered that oscillations set up by a condenser discharge in a conductor give rise to interference phenomena.

1872. Highton made various experiments across the River Thames with Morse's method.

1879. Hughes discovered the phenomena on which depends the action of coherer. The coherer was later used practically by Marconi.

1880. Trowbridge found that signaling might be carried on over considerable distances by electric conduction through the earth or water between places not metallically connected.

1882. Bell's experiments with Trowbridge method on the Potomac River resulted in the detection of signals at a distance of 1½ miles.

Professor Dolbear was awarded a United States patent in March, 1882, for wireless apparatus in connection with which he made the statement that "electrical communication, using this apparatus, might be established between points certainly more than one-half mile apart, but how much farther I can not say." It appeared that Professor Dolbear made an approach to the method that was, subsequently in the hands of Marconi, to be crowned with success.

1883. Fitzgerald suggested a method of producing electromagnetic waves in space by the discharge of a conductor.

1885. Edison, assisted by Gilliland, Phelps, and Smith, worked out a system of communication between railway stations and moving trains by means of induction and without the use of conducting wires. Edison took out only one patent on long-distance telegraphy without wires. The application was filed May 23, 1885, at the time he was working on induction telegraphy, but the patent (No. 465971) was not issued until December 29, 1891. In 1903 it was purchased from him by the Marconi Wireless Telegraph Co.

Preece made experiments at Newcastle-on-Tyne which showed that in two completely insulated circuits of square form, each side being 440 yards, placed a quarter of a mile apart, telephonic speech was conveyed from one to the other by induction.

1886. Dolbear patented a plan for establishing wireless communication by means of two insulated elevated plates, but there is no evidence that the method proposed by him did, or could, effect the transmission of signals between stations separated by any distance.

1887. Hertz showed that electromagnetic waves are in complete accordance with the waves of light and heat, and founded the theory upon which all modern radio signaling devices are based.

Teaviside established communication by telephonic speech between the surface of the earth and the subterranean galleries of the Broomhill Collieries, 350 feet deep, by laying above and below ground two complete metallic circuits, each about 2¼ miles in length, and parallel to each other.

1892. Preece adopted a method which united both conduction and induction as the means of affecting one circuit by the current in another. In this way he established communication between two points on the Bristol Channel and at Lochness in Scotland.

Branly devised an appliance for detecting electromagnetic waves, which was known as a coherer.

1894. Rathenau experimented with a conductive system of wireless telegraphy and signaled through 3 miles of water.

1895. Marconi's investigations led him to the conclusion that Hertzian waves could be used for telegraphing without wires.

1896. Marconi lodged his application for the first British patent for wireless telegraphy. He conducted experiments in communicating over a distance of 1¾ miles successfully.

The first demonstration of directional wireless using reflectors was given in England. Experiments were conducted to determine the relative speed of propagation of light waves and the electric vibrations which actuated a receiver at a distance of 1½ miles between reflectors.

1897. March: Marconi demonstrated communication being established over a distance of 4 miles.

March 17: Balloons were first used for the suspension of wireless aerials.

July 10-18: Marconi maintained communication between the shore and a ship at sea distances up to 10 miles.

September and October: Apparatus was erected at Bath, England, and signals received from Salisbury, 34 miles distant.

November 1: First Marconi station erected at the Needles, Alum Bay, Isle of Wight. Experiments were conducted covering a range of 14½ miles.

December 7: First floating wireless station was completed.

1898. June 3: The first paid radiogram was transmitted from the Needles (Isle of Wight) station.

July 20-22: Events of the Kingstown regatta in Dublin reported by wireless for a Dublin newspaper from steamer *Flying Huntress.*

1899. The American battleships *New York* and *Porter* were equipped with radio apparatus.

July: During the naval maneuvers three British warships equipped with Marconi apparatus interchanged messages at distances up to 74 nautical miles (about 85 land miles).

The international yacht races (yachts *Shamrock* and *Columbia*), which took place in September and October, were reported by wireless telegraphy for the "New York Herald." At the conclusion of the races series of trials were made between the United States cruiser *New York* and the battleship *Massachusetts,* signals being exchanged between the vessels at distances up to 36 miles. On the return journey from America Marconi fitted the steamship *St. Paul* with his apparatus, and on November 15 established communication with the Needles station when 36 miles away. Reports of the progress of the war in South Africa were telegraphed to the vessel and published in a leaflet entitled "The Transatlantic Times," printed on board.

1900. Between 1900 and 1905 Doctor De Forest was granted numerous patents in the United States and other countries for inventions connected with wireless telegraphy.

1901. January 1: The bark *Medora* was reported by wireless as water-logged on Ratel Bank. Assistance was immediately sent.

January 19: The *Princesse Clementine* ran ashore, and news of the accident was telegraphed to Ostend by wireless.

February 11: Communication was established between Niton Station, Isle of Wight, and the Lizard station, a distance of 196 miles.

March 1: A public wireless telegraph service was inaugurated between the five principal islands of the Hawaiian group, viz, Oahu, Kauai, Molaki, Maui, and Hawaii.

August 16: According to reliable sources the first regularly operated commercial communication stations in the United States were placed in commission. They were located at Siasconset (Nantucket), Mass., and on Nantucket Shoals Lightship *No. 66.* The first exchange of messages was with the ocean liner *Lucania,* when she was 72 miles east of Nantucket. The "New York Herald" owned and operated the stations and the greater part of the work during the earlier days consisted of reporting passing vessels which data the "Herald" published in its daily marine news.

October 15: The first fan aerials were erected for experiments between Poldhu and Newfoundland.

December 12: The letter "S" was received by Marconi from Poldhu, England, at St. Johns, Newfoundland, a distance of 1,800 miles.

Prof. R. A. Fessenden applied for United States patent on September 28 for "Improvements in apparatus for the wireless transmission of electromagnetic wave, said improvements relating more especially to the transmission and reproduction of words or other audible signals." It appears that in connection with this apparatus there was contemplated the use of an alternating-current generator having a frequency of 50,000 cycles per second. Professor Fessenden was granted a number of United States patents between 1890 and 1905 covering devices used in connection with radiotelegraphy.

1901-1904. During this period Dr. John Stone was granted more than 70 United States patents covering radiotelegraphy.

1901-1905. More than 40 United States patents were granted to Harry Shoemaker covering certain apparatus used for radio communication.

1902. February: Steamship *Philadelphia,* American Line, received messages a distance of 1,551½ statute miles and received Morse signals up to a distance of 2,099 statute miles from Poldhu station, Cornwall, England.

June 25: The first moving wire magnetic detector actuated by clockwork was installed on the Italian cruiser *Carlo Alberto.*

December: On the seventeenth the first wireless message was transmitted across the Atlantic. On the eighteenth wireless messages were dispatched from Cape Breton station to King Edward VII.

1903. March 30: First transoceanic radiogram was published in the London Times.

August 4: First International Radiotelegraphic Conference was held at Berlin.

Poulson patented the improved arc oscillation generator, using a hydrocarbon atmosphere and a magnetic field.

1904. January 20: The first press message was transmitted across the Atlantic.

August 15: The wireless telegraph act of Great Britain was passed.

November 16: Dr. J. Ambrose Fleming took out his original patent No. 24850 for thermionic valves.

1905. In October of this year erection of Clifden, Ireland, high-power radio station was commenced.

1906. Doctor De Forest was granted a patent on January 18 for a vacuum rectifier, commercially known as the audion.

Second International Radiotelegraphic Convention was held at Berlin, and a convention was signed by a majority of the principal countries of the world.

Dunwoody discovered the rectifying properties of carborundum crystals and Pickard discovered the similar properties of silicon crystals. These discoveries formed the basis of the widely used crystal detectors.

1907. Tests of radio apparatus, including radiotelephone, were carried out through the use of facilities of the United States Navy, the first shipboard radiotelephony tests being conducted in 1907 and 1908 during a world cruise.

1908. February 3: Transatlantic radio stations were opened to the general public for the transmission of messages between the United Kingdom and the principal towns in Canada.

In carrying out his invention Professor Fessenden constructed a high-frequency alternator with an output of 2.5 kilowatts at 225 volts and with a frequency of 70,000 cycles per second. Later Professor Fessenden reported successful wireless telephonic communication between his station located at Brant Rock, Mass., and Washington, D. C., a distance of about 600 miles.

October 15: A 10-kilowatt station was placed in operation at Kahuku Point, Oahu, Hawaii, at which time it was probably the most powerful station on the Pacific Ocean. Night communication was established with the station of the United Wireless Co., located on Telegraph Hill, San Francisco, Calif. This was the first direct radio communication between Hawaii and the United States, a distance of 2,100 miles.

During 1908 to 1911 the United States Navy built the first substantial highpower radio traffic station at Arlington, Va.

1910. The steamship *Principessa Mafalda* received messages from Clifden at a distance of 4,000 miles by day and 6,735 miles by night. On April 23 the Marconi trans-Atlantic (Europe-America) service was opened.

June 24: Act approved by the United States Government requiring radio equipment and operators on certain passenger-carrying vessels.

1911. July 1: Radio service organized in Department of Commerce and Labor to enforce the act of June 24, 1910.

1912. F. A. Kolster, of the Bureau of Standards, invented and developed the Kolster decremeter, which is used to make direct measurements of wave length and logarithmic decrement. This instrument has been used by the radio service of the Department of Commerce since it was invented.

In February the Marconi Co. procured the patents of Bellini and Tosi, including those for the wireless direction finder.

On February 9 the Australian Commonwealth station was opened.

On April 15 the steamship *Titanic,* on her maiden voyage, struck an iceberg and sank, but owing to the prompt wireless call for assistance the lives of more than 700 of her passengers were saved.

The International Radiotelegraphic Conference opened in London on June 4 and approved important regulations to have uniformity of practice in wireless telegraph services. On July 5 the International Radiotelegraphic Convention was signed at London.

July 23: Act approved by the United States Government extending act of June 24, 1910, to cover cargo vessels and requiring auxiliary source of power, efficient communication between the radio room and the bridge, and two or more skilled radio operators in charge of the apparatus on certain passenger-carrying vessels.

August 13: Act approved by the United States Government licensing radio operators and transmitting stations.

1913. F. A. Kolster submitted to the Government a paper pointing out the advantages of certain applications of radio signaling for use at lighthouses, lightships, and life-saving stations, especially in time of fog.

During this year the Governments of France and the United States experimented between the Eiffel Tower station and Washington by wireless to procure data for comparing the velocity of electromagnetic waves with that of light.

On October 11 the *Volturno* was burned in mid-Atlantic, and in response to the wireless appeal 10 vessels came to the rescue, 521 lives being saved.

November 12: Safety at Sea Conference held in London. At this conference the use of radio received appropriate consideration.

On November 24 the first practical trials with wireless apparatus on trains were made on a train belonging to the Delaware, Lackawanna & Western Railroad.

The station at Macquerie Island was the means of keeping Doctor Mauson, the Australian explorer, in touch with the outer world. Radio dispatches were published in a small journal which was established, called the Adelle Blizzard.

1914. Experiments in wireless telephony were carried out between several vessels lying at anchor five-eighths of a mile apart, ordinary receivers being used with success. The wireless-telephone experiments were continued between two warships on the high seas, and the reception was consistently good over a distance of 18½ miles. Successful wireless-telephone communications were effected later, using only very limited energy, between vessels on the high seas 44 miles apart. These experiments were repeated where land intervened between the communicating vessels, and in this case again excellent results were obtained. On this day radiotelephonic communication was constantly maintained for 12 hours.

On April 15, at Godalming, England, a memorial was unveiled to the memory of Jack Phillips, chief radio operator of the ill-fated *Titanic,* who died at his post when the vessel foundered in mid-Atlantic on the 15th of April, 1912.

A new departure in the application of radiotelegraphy to the safety of life at sea was the equipment of the motor lifeboats of the steamship *Aquitania with radio apparatus.*

High-powered transoceanic stations were completed at Carnarvon, Wales, Belman, Honolulu, and San Francisco during the autumn of 1914. The Honolulu-San Francisco stations were opened to public service September 24. The Tuckerton-Eilvese and Sayville-Nauen stations were in operation about this time.

Most of these stations made use of the latest developments in the art, using undamped and long waves as produced by the Poulsen arc and the radio-frequency alternator.

On October 6 E. H. Armstrong was issued a patent covering the regenerative circuit also known as the feed-back and the self-heterodyne circuit.

During 1914 and 1915 the United States Navy duplexed its principal shore stations in order that these stations could communicate with ships and with each other simultaneously.

1915. During this year F. A. Kolster, of the Bureau of Standards, developed a radio compass said to be more effective than that which was being used.

April 1: Service was established between the station at Wahiawa, Oahu, Hawaii, and the United States naval station at Tutuila, Samoa Islands, a distance of 2,400 miles.

On May 12, in Battery Park, New York City, the mayor unveiled the monument in memory of wireless operators who had lost their lives at the post of duty.

On July 27 wireless communication between the United States and Japan was effected. Two terminal stations were located at San Francisco and Funabashi, near Tokyo, and the messages were relayed through Honolulu.

On July 28 the American Telephone & Telegraph Co., working in conjunction with the Western Electric Co., succeeded in telephoning the wireless across the American Continent from Arlington to Hawaii, a distance of nearly 5,000 miles.

On October 26 the wireless telephone experiments were continued, communication being effected across the Atlantic from Arlington to the Eiffel Tower, Paris.

During this year ship service was greatly improved through the installation of new equipment, embodying features of great practical value, by various operating companies. Efficient emergency radio transmitters came into wider use, owing considerably to the efforts of the radio service of the Department of Commerce and its refusal to pass inefficient equipment.

1916. During the course of a severe blizzard in the United States during February wireless telegraphy was extensively used for train dispatching, as the telegraph wires were down.

The determination of the difference in longitude between Paris and Washington with the aid of radio which had been in progress since October, 1913, was completed during May, the result, expressed in terms of time, being 5 hours 17 minutes 35.67 seconds, and has a probable accuracy of the order of 0.01 second.

The initiation of the newly established trans-Pacific wireless service between the United States and Japan was celebrated on November 5 by an interchange of messages between the Mikado and President Wilson.

1917. June 2 marked the "coming of age" of wireless telegraphy in England; that is ,that 21 years had elapsed since the registration of patent 12039 in 1896.

1918. The trend of progress toward continuous-wave communication as distinct from that by damped waves was very marked during this year, a particular impetus being given by the continued development of the electron tube as an efficient receiver and generator of undamped oscillations. Steady improvement was also evident in the arc form of generator which was installed in many new high-power stations.

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Wireless telephony also progressed to a marked extent, particularly in the direction of reliability and increase of range, due mainly to the development of valve generators and receivers.

In the equipment of aircraft with wireless great progress was made, both in radiotelegraphy and radiotelephony.

In April a high-power station was opened at Stavanger, Norway, for the use of the Norwegian Government. The station communicates with the United States.

In the Argentine the erection of a station destined for direct communication with the North American Continent was commenced in the vicinity of Buenos Aires.

On July 31 the United States Government took over all wireless land stations in the United States, with the exception of certain high-power stations, which remained under the control of commercial companies.

On September 22 messages transmitted from Carnarvon were received in Sydney, 12,000 miles away. Cable confirmations of these messages were sent forward at the same time, but were received some hours later than the corresponding radiotelegrams.

At the end of the year a high-power station, erected by the United States Government, was opened at Croix d'Hins, near Bordeaux.

1919. The successful trans-Atlantic flights of Alcock and Brown, of the American *NC4* and of the British dirigible *R34* during the summer of the year focused attention upon the application of radio for aviation purposes and its great value for aerial navigation.

In February a Spanish decree was issued to the effect that all sailing vessels of 500 tons or over and carrying 50 or more passengers must be equipped with wireless apparatus.

On June 30, 1919, there were 2,312 ship stations of the United States, having increased from 1,478 on June 30, 1918. At this time new ship stations were increasing at the rate of 100 a month. This increase was due to the great number of vessels built during the war period.

During the year the Radio Corporation took over the radio interests of the American Marconi Co.

The war-time ban on private and experimental wireless stations was removed.

1920. The steady development of continuous-wave wireless work was continued during the year and some further progress made in the commercial application of tube apparatus.

1921. Experiments were carried out in France with successful results in the application of Baudot and similar high-speed telegraph apparatus to radio work.

The progress made in amateur and experimental wireless is exemplified by the attempts made in February and December of this year to effect communication on short-wave lengths between the wireless amateurs of the United States and Great Britain. The first attempt was unsuccessful, but during the second test signals from many American amateur stations were heard both by British radio amateurs and by the representative of the American Radio Relay League who was sent over for the tests. The signals were also heard in Holland.

The American Radio Relay League held its first annual convention in Chicago, August 30-September 3, at which many thousands of amateurs of the United States were present.

The first licenses for broadcasting stations in the United States were issued in September of this year.

New York radio central station opened on Long Island.

1922. During this year broadcasting stations increased rapidly in keeping with the great interest taken in the art.

First Annual Radio Conference held in Washington, D. C., February 27.

On June 7 E. H. Armstrong read a paper before the Institute of Radio Engineers on some recent developments by him of regenerative circuits. Professor Armstrong was granted a patent for the superregenerative circuit.

Experiments in radiotelephony from ship to shore were conducted during this year. In tests from the steamship *America* it was proved possible to communicate with land telephone stations more than 400 miles distant from the ship.

1923. On March 2 L. A. Hazeltine, of Stevens Institute of Technology, presented a paper before the Radio Club of America on tuned radiofrequency amplification with neutralization of capacity coupling. Professor Hazeltine was granted a patent for the nonradiating neutrodyne receiver.

On March 4 the Cleveland. Ohio (KDPM), station of the Westinghouse Electric & Manufacturing Co. successfully repeated short waves from the East Pittsburgh, Pa. (KDKA), station for the first time in history.

Second Annual Radio Conference held in Washington, D. C., March 20.

The Marconi Co. made a tender, which was accepted, for the erection of a transmitting station in Australia of a power of 1,000 kilowatts with 20 steel masts, 800 feet high. Corresponding stations were to be provided in England and Canada. The receiving arrangements would permit simultaneous reception from five stations.

The construction of a large radio station in a valley between the Herzogstand and the Stein, two of the foothills in the Bavarian Alps, was undertaken. The aerial was suspended by wire cables stretched between the tops of the two hills, the aerial wires being suspended from these cables.

The increase in traffic on some of the large liners of the Atlantic route led to the installation of apparatus for high-speed automatic transmission and reception on several lines.

Successful tests on wireless-controlled airplanes were carried out at the Etampes Aerodrome in France. Flights were made without a pilot. Flights were also made with a pilot using a gyroscopic stabilizer and special steering motors which could be controlled from the ground.

The International Commission for Aerial Navigation agreed, as a general principle, that all aircraft engaged in public transport must carry radio apparatus.

The General Electric Co. developed a tube capable of delivering 20 kilowatts of high-frequency energy to an aerial. Using six of these tubes in parallel with 15,000 volts on the anode, a current of 310 amperes in an Alexanderson multiple-tuned aerial was obtained. A tube of the magnetron type was developed by the same company capable of giving 1,000 kilowatts at 20,000 cycles with an efficiency of 70 per cent.

Short waves were used to greater advantage than heretofore. The McMillan expedition to the polar regions had radio as their only means of direct communication. Using low power and short waves, their vessel, *Bowdoin*, communicated with several stations in the United States while they were frozen in thousands of miles away. Broadcasting concerts from United States stations were heard during the long dark nights of the Arctic Zone.

During the year foreign countries became interested in radiotelephone broadcasting.

Broadcasting in the United States heard in England. British programs were also heard in the United States.

November 26: 2-way amateur communication was conducted for the first time between a station in the United States and a station in a foreign country. Station 1MO, West Hartford, Conn., operated by Fred Schnell, and station 8AB, Nice, France, operated by Leon Deloy, were the participants. The transmissions were made on a wave length of 100 meters. Stations IXAM and 1QP, operated by John Rineartz, South Manchester, Conn., also was successful in communicating with 8AB.

On December 31, East Pittsburgh, Pa. (KDKA), transmitted a program to Great Britain on a short wave.

1924. The high-power station at Monte-Grande, Argentina, was opened in January for direct communication with New York, Paris, and Berlin. The service to be extended to Great Britain when a corresponding transmitting station was available. The power of the station was 800 kilowatts, the aerial being carried on 10 masts, each 690 feet high. The receiving station was at Villa Eliza, 30 kilometers from Buenos Aires, the actual control being effected from a central office in Buenos Aires.

On February 5 a radio program broadcasted in the United States from the East Pittsburgh, Pa. (KDKA), station of the Westinghouse Electric & Manufacturing Co. was received and rebroadcast in England for the benefit of English stations.

On February 23 a concert broadcast by the same station and relayed from London, England, was heard clearly in Calcutta, India.

In July an agreement was concluded between the British Government and the Marconi Wireless Telegraph Co. (Ltd.) for the construction of a wireless station on the beam system, capable of communicating with Canada and of being extended to India, South Africa, and Australia, the transmitting station to have an input of at least 20 kilowatts and the receiving station to have an aerial designed to focus the received waves within an angle of 30°.

The short-wave direction system of radiotelegraphy and the results obtained in tests made on it were described in a lecture before the Royal Society of Arts, in July by Senatore Marconi.

During the period from August 5 to September 24 the East Pittsburgh, Pa. (KDKA), station maintained communication with the ship *Arctic* while on its expedition to the Arctic regions. Upon the ship's return it was reported that messages sent on short waves by the East Pittsburgh station were received at Cape Sabine within 11° of the North Pole. This is the farthest north radio messages have been received.

Third National Radio Conference held in Washington, D. C., October 6.

On October 11 signals from the East Pittsburgh station were successfully repeated from a station in Cape Town, Africa.

An expedition from the United States, under the leadership of Hamilton Rice, to explore the Amazon and Orinoco Rivers in Brazil and Venezuela, in the interest of geographical sciences in general, had radio as their only means of communication.

A wireless lighthouse was set upon an island in the Firth of Forth, Scotland. Wireless waves were concentrated by reflectors into a beam which could be sent 100 miles, giving ships their position in a fog.

1925. Considerable progress was made during 1925 in working with short waves. Several transoceanic stations are working foreign stations at great distances on wave lengths varying from 22 to 103 meters.

In an experiment between the Hastings (Nebr.) station and the East Pittsburgh (Pa.) station the Westinghouse Electric & Manufacturing Co. demonstrated that a 64-meter wave could be picked up, and by placing it on a short transmission line to the transmitting station, increasing the strength of the signals to their original power or greater, if necessary, the amplified wave could be transmitted onward. This experiment showed that repeater stations could be constructed in different parts of the world and be fairly certain of transmitting a strong signal.

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A number of short-wave transmissions were made by East Pittsburgh (KDKA) transmitting to South Africa and Australia.

During July programs were broadcast to the American naval fleet in Australian waters.

The practical use of the telephone and radio for the transmission of photographs was more clearly demonstrated during the year.

Broadcasting programs from airplanes was done in a few instances.

The General Electric Co., the Radio Corporation of America, and the Westinghouse Electric & Manufacturing Co. conducted experiments in broadcasting, using as high as 50 kilowatts.

The Department of Commerce placed in commission a "radio test car" which is equipped with an assortment of radio instruments used in conducting tests and investigations.

The Fourth National Radio Conference was held in Washington, D. C., November 9, 1925.

The Radio Corporation of America began the operation of a high-powered broadcasting station at Bound Brook, N. J., for transmision of programs to Europe. This station is equipped so as to use as high as 50 kilowatts.

One of the large electrical companies conducted experiments to determine the characteristics and peculiarities inherent in the piezo crystals. Several stations are now using this quartz crystal to maintain a constant frequency which eliminates to a great extent the "beat notes" resulting from two stations heterodyning at an audio-frequency. The radio-inspection service of this department has been supplied with these crystals to insure accuracy in frequency or wavelength measurements.

1926. During this year directional or beam transmission developed to a point where it may now be considered as practical for commercial usage.

The use of quartz plates for maintaining constant frequency or radio transmitters advanced considerably during the year.

Successful radiotelephone experiments were conducted between New York and London. This service will be used commercially in the near future.

With the development of transmitting pictures by radio it is now practical to transmit weather maps to vessels at sea.

The single-dial receiver came into greater use for reception of programs from broadcasting stations.

Commercial pictoradiogram services are now in operation between New York and London and between San Francisco and Hawaii.

On July 8 the Attorney General of the United States rendered a decision to the effect that the Secretary of Commerce has no jurisdiction as to the wave length, with the exception of the band betwen 600 and 1,600 meters reserved for Government stations, or the power used by commercial stations, including broadcasting stations.

Radiotelephone was used for the first time in directing the filming of a naval scene, off the coast of California, for a photoplay.

During the year successful development of a wireless system for controlling fog signals from unattended lighthouses and beacons marked a great advance on the automatic or semiautomatic systems for starting and stopping acetylene fog-signal gun by wireless impulses.

Successful experiments of synchronizing two or more stations in order that simultaneous operation on the same wave length without interference may be accomplished were conducted by the Westinghouse Electric & Manufacturing Co. during the year.

1927. Transatlantic radiophone service opened to the public on January 7.

Radio act of 1927 passed February 23, creating the Federal Radio Commission.

On April 7 the experimental radio station of the Bell Telephone laboratory at Whippany, N. J. (3XN), was successfully used in a public demonstration of television; the facial expression and voice of Secretary of Commerce Hoover could be seen and heard in New York distinctly and at the same time.

Radio was used by the airplane *America* on June 29 for the first time by an airplane in crossing the Atlantic Ocean from the United States to France.

International Radio Telegraph Conference held at Washington, D. C., October 4 to November 25.

As a result of experiments conducted during the past two years on methods of synchronization broadcasting stations WBZ at Springfield, Mass., and WBZA at Boston, Mass., owned by the Westinghouse Electric & Manufacturing Co., are now being regularly operated simultaneously in absolute sychronism, the wave length of the transmitter at the Boston station being automatically controlled by the Springfield transmitter so that any variation at Springfield will create a similar variation at Boston, assuring absolute synchronism at all times during the operation of these stations.

Experiments are now being conducted for the synchronization of two or more transmitters by radio control instead of by wire as in the case of the two stations referred to.

The U. S. S. *Kittery,* experimenting with a radio compass during hurricane weather, found that the intensity of static may be useful in detecting and locating storms at a considerable distance.

The experimental station of the General Electric Co. at Schenectady, N. Y., call signal 2XAG, in experiments used a vacuum tube of 100,000 watts power.

The Department of Commerce began the installation of directional radio-beacons for use in aviation. Two-way communication experiments between plane and ground carried on with considerable success.

1928. January: Commander A. Hoyt Taylor, United States Navy, was awarded the Morris Liebman memorial medal by the Institute of Radio Engineers for research in short-wave phenomena during the previous year.

February 8: A successful television demonstration was carried on during the night between station 2KZ in London, England, and amateur station 2CVJ in Hartsdale, N. Y.

March 7: A successful ship-to-shore television test was conducted from a London (England) station with the steamer *Berengaria.*

March 28: Amendment to the radio act of 1927 approved.

June 27: A 2-way short-wave radio circuit was first used commercially for telephony between America and Europe. The short-wave circuit supplements the long-wave circuit which was opened for commercial service during 1927.

September 11: Station WGY, Schenectady, N. Y., was the first station to broadcast a play by television. The play, a 1-act drama, entitled "The Queen's Messenger," was broadcast during the afternoon and again in the evening.

November 1: 2-way telephone communication established between Sydney, Australia, and Schenectady, N. Y., a distance of 10,000 miles.

November 6: In broadcasting the returns of the presidential election the National Broadcasting Co. had 59 stations throughout the United States connected into a single network, and the Columbia Broadcasting System had 26 stations connected in another network.

November 26: The transatlantic radiophone service between North America and Europe was extended to another continent —Africa—by the establishment of service to Ceuta, Spanish Morocco.

December: Commander Richard Byrd, on a scientific expedition in the Antarctic, operated a radio station, located farther south than any station heretofore, to keep in touch with civilization. Programs of the short-wave relay broadcasting station of the East Pittsburgh (Pa.) station of the Westinghouse Electric & Manufacturing Co. were received by the station.

At one time during the political campaign 106 broadcasting stations in the United States were connected into a single network by means of approximately 25,000 miles of telephone circuits together with about 48,000 miles of telegraph circuits for program coordination and auxiliary communication.

During the year radio apparatus was used to detect mineral deposits in the United States.

Amateur and commercial stations were used to great advantage through lack of other means of communication during the Florida and Porto Rico storms.

The use of receiving sets operated by house current and dynamic loud speakers came into greater use during the year.

The General Electric Co. developed a vacuum tube, 5 inches in diameter and about 2 feet long. It was operated as a self-excited oscillator on a wave length of 6 meters and was capable of radiating from 10 to 15 kilowatts of high-frequency power—probably fifty times as much as any short-wave tube had previously been able to radiate.

1929. January 21: Conference held at Ottawa, Canada, for the purpose of allocating certain high-frequency channels for the use of Canada, Cuba, Mexico, Newfoundland, Central American countries, and the United States.

March 4: The inauguration of President Hoover and Vice President Curtis, in Washington, was carried to 118 radio broadcasting stations in all parts of the United States, making the occasion the largest chain broadcast which has ever occurred. More than 30,000 miles of wire telephone program circuit were employed. Several high-frequency stations also transmitted the ceremonies primarily for the benefit of listeners in foreign countries.

April 16: International Safety of Life at Sea Conference held at London, England (April 16 to May 31).

May 1: There was a demonstration of 2-way telephone communication between an airplane in flight and telephones connected to the ordinary land telephone lines. Reporters of the New York metropolitan press flying in an airplane of the Bell telephone laboratories over northern New Jersey conversed with men at the city desks of their respective newspapers in New York.

May 6-7: A number of outstanding achievements in radio communication were made during the year in keeping the Byrd Antarctic Expedition in touch with civilization. On May 6 at 5 p.m., or 2 a.m. the next day at Greenland, the short-wave telephone station of the Byrd Expedition at Little America, Antarctic, communicated with the meteorological station of the University of Michigan at Mount Evans, Greenland, a distance of about 12,000 miles, on 34 meters. The signals were sufficiently strong at Little America that a loud speaker was used in receiving.

Programs during the year were regularly transmitted by a short-wave experimental station of the Westinghouse Electric & Manufacturing Co. at East Pitsburgh, Pa., on 25 meters to the Byrd Antarctic Expedition, a distance of approximately 11,000 miles.

Steamship *City of New York* (WFBT) of the Byrd Expedition relayed communications from a portable station regularly

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to the station of the New York Times located in New York City.

The plane *Stars and Stripes*, flying at about 3,000 feet above Commander Byrd's base, Little America, transmitted messages on 34 meters, using 50 watts power, to the New York Times station.

Station KDKA, East Pittsburgh, Pa., during the past three years has been broadcasting on schedule to the Royal Canadian Mounted Police post at Bache Peninsula, Ellesmereland, northwest of Etah, Greenland, located in approximately 75 degrees west, 78 degrees 30 minutes north (10½ degrees from the North Pole). This, according to reports, is the farthest north that regular broadcast programs have been received.

June 1: On June 1 and December 1 the third and fourth transatlantic radio radio-telephone circuits were put into operation between New York and London. This results in there being now in service one long-wave and three short-wave circuits. On the American side the short-wave transmitting station is located at Lawrenceville, N. J., and the receiving station at Netcong, N. J.

During the year further extensions of the transatlantic telephone service were made by wire to other points and countries in Europe, including extensions to the cities of Milan, Turin and Genoa in Italy, and to the entire telephone system of Czechoslovakia.

June 27: A demonstration of television in color was given by the Bell Telephone laboratories. Much of the apparatus employed was essentially the same as that used in the 1-color demonstration of April, 1927. Three channels were used for the transmission of the signals, one for each of the fundamental colors—red, green and blue. While transmission with this system may be by either wire or radio, transmission on the occasion of the demonstration of June 27 was by three pairs of wires.

Three interesting demonstrations took place during the year of the possibility of connecting together two radiotelephone links for the purpose of forming a through circuit. One of these was a connection made in London between the transatlantic radiotelephone circuit and a new short-wave radiotelephone channel which was being experimented with by the British General Post Office between Great Britain and Australia. This connection enabled speakers in America, using the regular telephone system, to talk, via London, to Australia over two short-wave links totaling some 15,000 miles in length. Conversations took place on September 25 at 4 o'clock in the afternoon, New York time, corresponding to 9 o'clock in the evening in London and to 6 a.m. on September 26 in Sydney. A second interesting trial was that of connecting in America the transatlantic telephone circuit with an airplane in flight near New York, enabling newspaper representatives in the plane to talk to people in London, via the radio link to the ground and thence the transatlantic radio link to London. This was on June 25, 1929. The third case on December 22, 1929, involved a radiotelephone circuit to an airplane flying over New Jersey and a separate radiotelephone circuit to the S. S. *Leviathan*, connections between the two being made through the long-distance terminal of the Bell system in New York.

August: The *Graf Zeppelin*, first dirigible to make a trip around the world, was equipped with radio transmitting apparatus which proved to be of inestimable value in its epochal flight.

September 19: The first meeting of technical consultative committee of the International Radiotelegraph Convention, Washington, 1927, was held at The Hague.

October: Work began on Department of Commerce (radio division) Grand Island, Neb., Central Monitoring Station, secondary stations being placed in each radio district and on six radio-test cars.

November 18: An earthquake in the bed of the North Atlantic Ocean snapped 12 cables and from that time until the end of the year a greatly increased proportion of the transatlantic communications were handled by radio.

December 8: Telephone service was inaugurated between land telephone lines and the S. S. *Leviathan*. The shore transmitting and receiving stations are located on the New Jersey coast and each is connected by wire to the long-distance telephone operating building in New York. The radio link between the ship and shore utilizes high frequencies (short waves). Here connections between the telephone subscribers on land and those with whom they converse on the S. S. *Leviathan* are handled as in the cases of telephone calls to various foreign points, such as Cuba, Mexico and Europe.

During the year there was continued growth in chain broadcasting. On September 1 about 34,000 miles of telephone circuit were in use for program transmission. One hundred and fifty-two broadcasting stations were provided with regular connections.

December 18: Radio act placing Federal Radio Commission on permanent basis approved.

Screen-grid tubes for radio receivers came into use during the year.

During the year the Riverhead, Long Island, receiving station of the Radio Corporation of America Communications (Inc.) picked up short-wave programs on foreign stations for rebroadcasting by regular broadcasting chains.

1930. April 3: Radiotelephone service between North America and South America was opened to the public. This service now interconnects 20,000,000 telephones in the United States as well as all telephones in Cuba and all the principal points in Mexico and Canada with the subscribers reached by the telephone networks in Argentina, Chile and Uruguay. The connection is made by means of a short-wave radio circuit covering a distance of 5,300 miles. The transmitting station in North America is located near Lawrenceville, N. J., and the corresponding station in South America is located near Buenos Aires.

April 27: A radiotelephone conversation lasting 15 minutes was carried on between a train running at 84 miles an hour between Toronto and Montreal, Canada, and London, England. The system broadcasts the voice from train to carrier-current telegraph wires which parallel the track, and vice versa. From these wires it is carried to pick-up stations and then transferred to the telephone office at Kingston, Canada, where it is placed on regular long distance telephone circuits. Connections from the train are made by an operator stationed on the train. Connections outside are made by placing calls with the long-distance telephone operator.

October 27: Regular commercial radiotelephone service between North America and Australia was inaugurated on this date. The service is provided through the linking together in England of the radiotelephone circuits from New York to London and from London to Sydney. A call over this system from Los Angeles by way of New York and London to Sydney covers a total distance estimated at about 21,000 miles.

December 7: Announcers on two submarines speeding along 10 miles off the coast of New London, Conn., depicted for listeners what they saw as one submarine (O-8) went below and the other (O-4) stayed on the surface. It was the first broadcast program from a submersible as it sank below the surface.

Direct radiotelegraph circuits were inaugurated during 1930 from New York, N. Y., to Santiago, Chile; Panama, Moscow; Prague, Czechoslovakia; and Santo Domingo on January 13, May 1, November 13, December 1 and December 24, respectively. Circuits were opened between San Francisco, Calif., and Panama on May 10, and between San Francisco, Calif., and Shanghai, China, on December 6.

During the year transatlantic radiotelephone service was extended through the provision of connections to a number of additional points in Europe. These extensions include practically the whole of northern Italy, the city of Rome, Vatican City, the cities of Warsaw, Poland, and Helsingfors, Finland, and the cities of Memel and Koxno, Lithuania. Service is now given to practically the entire telephone network of western Europe.

During the year ship-to-shore radiotelephone service in addition to being available to the steamship *Leviathan* was extended to the *Majestic, Olympic, Homeric* and *Belgenland*. This service is given through shore transmitting and receiving stations located at Ocean Gate and Forked River, N. J., respectively. Through connections with the land telephone system, this service is available not only to all points in this country but to most of the cities of Cuba, Canada and Mexico. Similar telephone service to the continent of Europe is available to passengers on these vessels through stations at Rugby and Baldock, England.

Television was employed for the first time as part of a regular performance in a theater, the television images being transmitted by radio from a studio about 1 mile from the theater.

The active images of the performers were reproduced upon a screen 6 by 7½ feet and were readily visible to those seated in the back rows of the balcony. The light impulses were transmitted on a wave length of 140 meters, and were accompanied by voice and sound effects. This increase in area of the projected image from the previous size of about 14 inches square to an area equivalent to about one-fourth that of the standard motion-picture screen was rendered possible by the introduction in the projection optical train of a light valve operating on the principle of altering the direction of polarization of a beam of polarized light by passing the beam from an electrostatic field. This light valve thus renders possible the use of more powerful rays of light than have heretofore been practicable in television projection.

A television picture which had traveled approximately 20,000 miles through space was received with a fair degree of accuracy, thereby establishing a distance record for television reception. The picture, a rectangular design in black on a white card, was transmitted by the short-wave station, W2XAF (31.48 meters) at Schenectady, N. Y., received in Sydney, Australia, by station VK2ME, rebroadcast by that section on 28.8 meters, and received back in Schenectady in about an eighth of a second.

The United States now leads the world in radio communication with circuits spanning every ocean and touching every continent on the globe.

During the year diversity in reception was improved upon. The method, as now used to a great extent and which is growing, is accomplished by the erection of three antenna spaced approximately 1,000 feet apart. Observations over a long period have shown that the strength of the received signal varies considerably within a radius of 2,000 feet and while the radio impulse at one of three antennae may be faint, the other two will be clear and strong. By connecting the three antennae with a central receiver a signal of uniform strength representing the composite level of the three antennae is obtained.

Experimental facsimile transmissions conducted during the year indicate the possibility that eventually a complete daily

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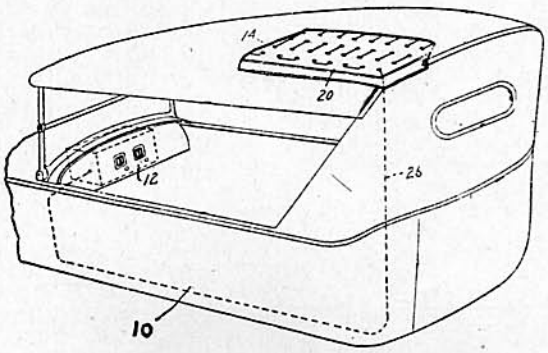
New Radio Patents

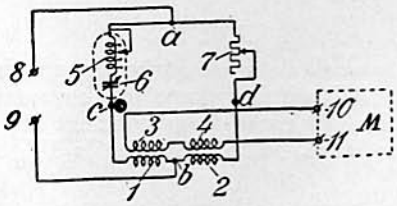
Illustrated Reports with Selected Claims

[Newly issued or reissued radio patents are recorded in this department. The number of the patent itself is given first. Usually only one claim is selected and the claim number also is cited. All inquiries regarding patents should be addressed to Ray Belmont Whitman, Patent Editor, RADIO WORLD, *145 West 45th Street, New York, N. Y.]*



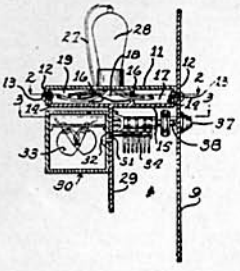
1,829,219. Portable Radio Apparatus. William M. Heina, Long Island City, N. Y., assignor, by mesne assignments, to Transitone Automobile Radio Corporation, Philadelphia, Pa., a Corporation of Delaware. Filed Jan. 15, 1929. Serial No. 332,620. 3 Claims. (Cl. 250—33.)

3. In combination with the collapsible top of a vehicle, a radio antenna comprising a wire carried by said top and arranged to form a plurality of spaced lengths extending back and forth in succession and transversely of said top.



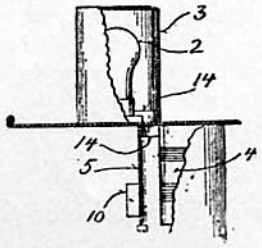
1,834,975. Radio Circuit. Wilhelm Scheppmann, Berlin-Tempelhof, Germany. Filed Jan. 27, 1927, Serial No. 164,020, and in Germany Feb. 3, 1926. 16 Claims. (Cl. 250—17.)

1. The combination in a radio circuit arrangement of the character described of an output circuit, an input circuit having two circuit paths that are in equal and opposite coupling relationship to said output circuit to produce opposite effects therein, only one of said circuits being a tuned circuit and comprising an acceptor circuit introduced into one of said circuit paths and tuned to the frequency of the current to be neutralized in the output circuit.



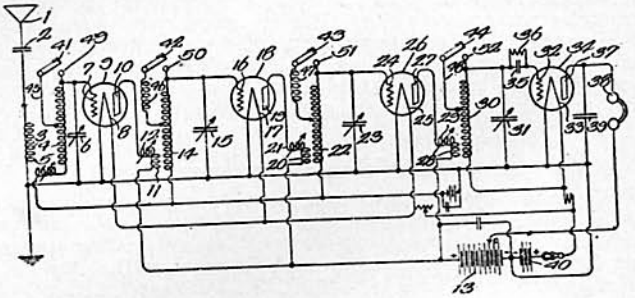
1,835,036. Radio Receiving Set. Frederick A. Gehm, Chicago, Ill. Filed Aug. 8, 1929. Serial No. 384,327. 4 Claims. (Cl. 250—14.)

1. In combination with a panel of a radio receiving set, a comparatively shallow casing removably secured to said panel, a plurality of compartments in said casing, one of said compartments separately receiving the alternating current energizing wires of said radio receiving set, another of said compartments receiving other wires leading to the electrodes of vacuum tubes removably and operatively secured in an upper section of said casing, and a downwardly projecting partition secured to another section of said casing, said partition providing a means for supporting a plurality of transformers on one side thereof, and a plurality of condensers on the other side thereof, said transformers being individually segregated and shielded by containers removably secured to said partition.



1,836,260. Radio Apparatus. William Turnor Lewis, Racine, Wis. Filed Apr. 26, 1929. Serial No. 358,230. 8 Claims. (Cl. 250—16.)

6. In a radio receiving system, the combination of a box-like metal body portion, a plurality of vacuum tubes mounted on one side of said body portion, tuning condensers mounted on the same side of said body portion, a shielding can for each of said tubes and each of said condensers, coupling devices mounted upon the opposite side of said body portion, and shielding cans for said coupling devices, the outline of said last mentioned shielding cans overlapping the outline of said first mentioned shielding cans.



1,836,461. Radio Receiving System. Henry C. Forbes, Chicago, Ill., assignor to Zenith Radio Corporation, Chicago, Ill., a Corporation of Illinois. Filed Dec. 26, 1925. Serial No. 77,834. 7 Claims. (Cl. 250—20.)

1. A radio receiving system including a primary radio frequency transformer winding; a winding in secondary relation to the aforesaid winding; a thermionic valve having an input circuit supplied from the second aforesaid winding; variable capacity means for tuning said input circuit to the signal frequency; and a local circuit exclusive of said valve, comprising a serial part of the second aforesaid winding, a resistance element, and a switch for opening and closing said local circuit.

The Chronology of Radio, An Epitomized History

(Continued from preceding page)

newspaper may be transmitted by this system of radio communication.

International broadcasting gained impetus during the year through the address of King George of England opening the London Naval Conference, the achievement of linking the World Power Conference in Berlin with the National Electric Light Association Convention in San Francisco by addresses broadcast from San Francisco, Berlin, London and Orange, N.J., and the broadcast of the ceremonies connected with the exchange of ratifications of the London Naval Treaty.

In developing synchronization of two or more stations operating on the same frequency without causing interference to each other, broadcasting station WTIC in Hartford, Conn., and WEAF in New York, N. Y., were granted authority to carry on this form of transmission. Station WBAL in Baltimore, Md., and WJZ in New York, N. Y., were also authorized to synchronize.

At the close of 1930, nearly 200 stations were embraced in the broadcasting networks of the National and Columbia chains. The length of permanent program telephone circuits used for this purpose was about 34,500 miles.