CASES ADJUDGED

IN THE

SUPREME COURT OF THE UNITED STATES

AT

OCTOBER TERM, 1942.

MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA *v.* UNITED STATES.*

CERTIORARI TO THE COURT OF CLAIMS.

No. 369. Argued April 9, 12, 1943.—Decided June 21, 1943.

1. The broad claims of the Marconi Patent No. 763,772, for improvements in apparatus for wireless telegraphy—briefly, for a structure and arrangement of four high-frequency circuits with means of independently adjusting each so that all four may be brought into electrical resonance with one another—*held* invalid because anticipated. P. 38.

   Marconi showed no invention over Stone (Patent No. 714,756) by making the tuning of his antenna circuit adjustable, or by using Lodge's (Patent No. 609,154) variable inductance for that purpose. Whether Stone's patent involved invention is not here determined.
2. Merely making a known element of a known combination adjustable by a means of adjustment known to the art, when no new or unexpected result is obtained, is not invention. P. 32.
3. As between two inventors, priority of invention will be awarded to the one who by satisfying proof can show that he first conceived of the invention. P. 34.
4. Commercial success achieved by the later inventor and patentee cannot save his patent from the defense of anticipation by a prior inventor. P. 35.

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*Together with No. 373, *United States* v. *Marconi Wireless Telegraph Company of America*, also on writ of certiorari, 317 U. S. 620, to the Court of Claims.

5. In the exercise of its appellate power, this Court may consider any evidence of record which, whether or not called to the attention of the court below, is relevant to and may affect the correctness of its decision sustaining or denying any contention which a party has made before it. P. 44.
6. Although the interlocutory decision of the Court of Claims in this case that Claim 16 of Marconi Patent No. 763,772 was valid and infringed was appealable, the decision was not final until the conclusion of the accounting; hence, the court did not lack power at any time prior to entry of its final judgment at the close of the accounting to reconsider any portion of its decision and reopen any part of the case, and it was free in its discretion to grant a reargument based either on all the evidence then of record or only the evidence before the court when it rendered its interlocutory decision, or to reopen the case for further evidence. P. 47.
7. The judgment of the Court of Claims holding valid and infringed Claim 16 of Marconi Patent No. 763,772 is vacated and remanded in order that that court may determine whether to reconsider its decision in the light of the Government's present contention that Claim 16, as construed by the Court of Claims, was anticipated by the patents to Pupin, No. 640,516, and Fessenden, No. 706,735. P. 48.
8. A defendant in a patent infringement suit who has added non-infringing and valuable improvements which contributed to the making of the profits is not liable for benefits resulting from such improvements. P. 50.
9. Disclosure by publication more than two years before application for a patent bars any claim for a patent for an invention embodying the published disclosure. P. 57.
10. Invalidity in part of a patent defeats the entire patent unless the invalid portion was claimed through inadvertence, accident, or mistake, and without any fraudulent or deceptive intention, and is disclaimed without unreasonable neglect or delay. P. 57.
11. Fleming Patent No. 803,864 *held* invalid by reason of an improper disclaimer. P. 58.

    The specifications plainly contemplated the use of the claimed device with low as well as high frequency currents, and the patent was invalid for want of invention so far as applicable to use with low frequency currents; the claim was not inadvertent, and the delay of ten years in making the disclaimer was unreasonable.
12. That the patentee's claim for more than he had invented was not inadvertant, and that his delay in making disclaimer was unreasonable, were questions of fact; but, since the Court of Claims in

its opinion in this case plainly states its conclusions as to them, and those conclusions are supported by substantial evidence, its omission to make formal findings of fact is immaterial. P. 58.

13. The disclaimer statutes are applicable to one who acquires a patent under an assignment of the application. P. 59.

99 Ct. Cls. 1, affirmed in part.

WRITS of certiorari, 317 U. S. 620, on cross-petitions to review a judgment in a suit against the United States to recover damages for infringement of patents. See 81 Ct. Cls. 741.

Mr. Stephen H. Philbin, with whom *Messrs. Abel E. Blackmar, Jr.* and *Richard A. Ford* were on the brief, for the Marconi Company.

Assistant Attorney General Shea, with whom *Solicitor General Fahy and Messrs. Clifton V. Edwards, J. F. Mothershead, Joseph Y. Houghton* and *Richard S. Salant* were on the brief, for the United States.

MR. CHIEF JUSTICE STONE delivered the opinion of the Court.

The Marconi Company brought this suit in the Court of Claims pursuant to 35 U. S. C. § 68, to recover damages for infringement of four United States patents. Two, No. 763,772, and reissue No. 11,913, were issued to Marconi, a third, No. 609,154, to Lodge, and a fourth, No. 803,684, to Fleming. The court held that the Marconi reissue patent was not infringed. It held also that the claims in suit, other than Claim 16, of the Marconi patent No. 763,772, are invalid; and that Claim 16 of the patent is valid and was infringed. It gave judgment for petitioner on this claim in the sum of $42,984.93 with interest. It held that the Lodge patent was valid and infringed, and that the Fleming patent was not infringed and was rendered void by an improper disclaimer. The case comes here on certiorari, 317 U. S. 620, 28 U. S. C. § 288

(b), on petition of the Marconi Company in No. 369, to review the judgment of the Court of Claims holding invalid the claims in suit, other than Claim 16, of the Marconi patent, and holding the Fleming patent invalid and not infringed, and on petition of the Government in No. 373, to review the decision allowing recovery for infringement of Claim 16 of the Marconi patent. No review was sought by either party of so much of the court's judgment as sustained the Lodge patent and held the first Marconi reissue patent not infringed.

Marconi Patent No. 763,772.

This patent, granted June 28, 1904, on an application filed November 10, 1900, and assigned to the Marconi Company on March 6, 1905,[1] is for improvements in apparatus for wireless telegraphy by means of Hertzian oscillations or electrical waves. In wireless telegraphy, signals given by means of controlled electrical pulsations are transmitted through the ether by means of the so-called Hertzian or radio waves. Hertzian waves are electrical oscillations which travel with the speed of light and have varying wave lengths and consequent frequencies intermediate between the frequency ranges of light and sound waves. The transmitting apparatus used for sending the signals is capable, when actuated by a telegraph key or other signalling device, of producing, for short periods of variable lengths, electrical oscillations of radio frequency (over 10,000 cycles per second) in an antenna or open circuit from which the oscillations are radiated to a distant receiving apparatus. The receiver has an open antenna circuit which is electrically responsive

[1] On November 20, 1919, the Marconi Company assigned to the Radio Corporation of America all of its assets, including the patents here in suit, but reserved, and agreed to prosecute, the present claims against the United States, on which it had instituted suit on July 29, 1916.

to the transmitted waves and is capable of using those responses to actuate by means of a relay or amplifier any convenient form of signalling apparatus for making audible an electrically transmitted signal, such as a telegraph sounder or a loud speaker. In brief, signals at the transmitter are utilized to control high frequency electrical oscillations which are radiated by an antenna through the ether to the distant receiver and there produce an audible or visible signal.

All of these were familiar devices at the time of Marconi's application for the patent now in suit. By that time radio had passed from the theoretical to the practical and commercially successful. Four years before, Marconi had applied for his original and basic patent, which was granted as No. 586,193, July 13, 1897 and reissued June 4, 1901 as reissue No. 11,913. He applied for his corresponding British patent, No. 12039 of 1896, on June 2, 1896. Marconi's original patent showed a two-circuit system, in which the high frequency oscillations originated in the transmitter antenna circuit and the detecting device was connected directly in the receiver antenna circuit. Between 1896 and 1900 he demonstrated on numerous occasions the practical success of his apparatus, attaining successful transmission at distances of 70 and 80 miles. During those years he applied for a large number of patents in this and other countries for improvements on his system of radio communication.[2]

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[2] See *Marconi Wireless Tel. Co.* v. *National Electric Signalling Co.*, 213 F. 815, 825, 829–31; Encyclopedia Britannica (14th Ed.) vol. 14, p. 869; Dunlap, Marconi, The Man and His Wireless; Jacot and Collier, Marconi—Master of Space; Vyvyan, Wireless Over Thirty Years; Fleming, Electric Wave Telegraphy, 426–443.

Marconi was granted eight other United States patents for wireless apparatus on applications filed between the filing dates of Nos. 586,193 and 763,772. They are Nos. 624,516, 627,650, 647,007, 647,008, 647,009, 650,109, 650,110, 668,315.

The particular advance said to have been achieved by the Marconi patent with which we are here concerned was the use of two high frequency circuits in the transmitter and two in the receiver, all four so adjusted as to be resonant to the same frequency or multiples of it. The circuits are so constructed that the electrical impulses in the antenna circuit of the transmitter vibrate longer with the application to the transmitter of a given amount of electrical energy than had been the case in the previous structures known to the art, and the selectivity and sensitivity of the receiver is likewise enhanced. Thus increased efficiency in the transmission and reception of signals is obtained. The specifications of the Marconi patent state that its object is "to increase the efficiency of the system and to provide new and simple means whereby oscillations of electrical waves from a transmitting station may be localized when desired at any one selected receiving station or stations out of a group of several receiving-stations."

The specifications describe an arrangement of four high frequency circuits tuned to one another—two at the sending station associated with a source of low frequency oscillations, and two at the receiving station associated with a relay or amplifier operating a signalling device. At the sending station there is an open antenna circuit which is "a good radiator," connected with the secondary coil of a transformer, and through it inductively coupled with a closed circuit, which is connected with the primary coil of the transformer, this closed circuit being a "persistent oscillator." At the receiving station there is an open antenna circuit constituting a "good absorber" inductively coupled with a closed circuit capable of accumulating the received oscillations.

The patent, in describing the arrangement of the apparatus so as to secure the desired resonance or tuning, specifies: "The capacity and self-induction of the four

circuits—i. e., the primary and secondary circuits at the transmitting-station and the primary and secondary circuits at any one of the receiving-stations in a communicating system are each and all to be so independently adjusted as to make the product of the self-induction multiplied by the capacity the same in each case or multiples of each other—that is to say, the electrical time periods of the four circuits are to be the same or octaves of each other."[3] And again, "In employing this invention to localize the transmission of intelligence at one of several receiving-stations the time period of the circuits at each of the receiving-stations is so arranged as to be different from those of the other stations. If the time periods of the circuits of the transmitting-station are varied until they are in resonance with those of one of the receiving-stations, that one alone of all the receiving-stations will respond, provided that the distance between the transmitting and receiving stations is not too small."

The drawings and specifications show a closed circuit at the transmitting station connected with the primary

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[3] Capacity is the property of an electrical circuit which enables it to receive and store an electrical charge when a voltage is applied to it, and to release that charge as the applied voltage is withdrawn, thereby causing a current to flow in the circuit. Although any conductor of electricity has capacity to some degree, that property is substantially enhanced in a circuit by the use of a condenser, consisting of two or more metal plates separated by a non-conductor, such that when a voltage is applied to the circuit one plate will become positively and the other negatively charged.

Self-inductance is the property of a circuit by which, when the amount or direction of the current passing through it is changed, the magnetic stresses created induce a voltage opposed to the change. Although any conductor has self-inductance to some degree, that property is most marked in a coil.

See generally Albert, Electrical Fundamentals of Communication, Chs. V, VI, VII, and IX; Terman, Radio Engineering, Chs. II and III; Morecroft, Principles of Radio Communication, Chs. I, II, III; Lauer and Brown, Radio Engineering Principles, Chs. I and II.

of an induction coil, and embracing a source of electrical current and a circuit-closing key or other signalling device. The secondary of the induction coil is connected in a circuit which includes a spark gap or other producer of high frequency oscillations and, in a shunt around the spark gap, the primary coil of an oscillation transformer and a condenser, preferably so arranged that its capacity can readily be varied. This shunt circuit constitutes one of the two tuned circuits of the transmitter, and is often referred to as the closed or charging circuit. The secondary coil of the transformer is connected in the open or antenna circuit, one end of which is connected with the earth, the other to a vertical wire antenna or an elevated plate. This antenna circuit also includes an induction coil, preferably one whose inductance is readily variable, located between the antenna or plate and the transformer.

The receiver consists of a similar antenna circuit connected with the primary coil of a transformer, and having a variable induction coil located between the antenna or plate and the transformer. A shunt circuit bridging the transformer and containing a condenser which is preferably adjustable may also be added. The secondary coil of the transformer is connected through one or more interposed inductance coils, "preferably of variable inductance," with the terminals of a coherer [4] or other suitable detector of electrical oscillations. The closed receiver circuit also contained one or more condensers.

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[4] A coherer was a device disclosed by Branly as early as 1891. It was used by Lodge in experiments described in the London Electrician for June 15, 1894, p. 189, and was in common use thereafter as a detector of radio waves until replaced by the crystal and the cathode-anode tube. The most common form consisted of a tube containing metal filings which, in their normal state, were a non-conductor. When placed in a circuit through which high frequency oscillations passed, the filings aligned themselves in a continuous stream through which the low frequency electrical current operating a key or other

The devices and arrangements specified are suitable for effecting the electrical transmission of signals in the manner already indicated. By the maintenance of the same high frequency throughout the four-circuit system the cumulative resonance is attained which gives the desired increased efficiency in transmission and increased selectivity at the receiving station.

The patent describes the operation of the four circuits as follows, beginning with the transmitter:

"In operation the signalling-key *b* is pressed, and this closes the primary of the induction-coil. Current then rushes through the transformer-circuit and the condenser *e* is charged and subsequently discharges through the spark-gap. If the capacity, the inductance, and the resistance of the circuit are of suitable values, the discharge is oscillatory, with the result that alternating currents of high frequency pass through the primary of the transformer and induce similar oscillations in the secondary, these oscillations being rapidly radiated in the form of electric waves by the elevated conductor [antenna].

"For the best results and in order to effect the selection of the station or stations whereat the transmitted oscillations are to be localized I include in the open secondary circuit of the transformer, and preferably between the radiator *f* and the secondary coil *d'*, an inductance-coil *g*, Fig. 1, having numerous coils, and the connection is such that a greater or less number of turns of the coil can be put in use, the proper number being ascertained by experiment."

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signalling device could pass. By means of a device which tapped the sides of the tube, the stream of filings was broken when the high-frequency oscillations ceased. Thus the coherer was a sensitive device by which weak, high-frequency signals could be made to actuate a low-frequency current of sufficient power to operate a telegraphic key or other device producing a visible or audible signal.

The invention thus described may summarily be stated to be a structure and arrangement of four high frequency circuits, with means of independently adjusting each so that all four may be brought into electrical resonance with one another. This is the broad invention covered by Claim 20. Combinations covering so much of the invention as is embodied in the transmitter and the receiver respectively are separately claimed.[5]

Long before Marconi's application for this patent the scientific principles of which he made use were well understood and the particular appliances constituting elements in the apparatus combination which he claimed were well known. About seventy years ago Clerk Maxwell described the scientific theory of wireless communication through the transmission of electrical energy by ether waves.[6] Between 1878 and 1890 Hertz devised apparatus for achieving that result which was described by de Tunzelmann in a series of articles published in the London

[5] Of the claims in suit in No. 369, Claims 10 and 20 cover the four-circuit system, while Claims 1, 3, 6, 8, 11 and 12 cover the two transmitter circuits and Claims 2, 13, 14, 17, 18 and 19 cover the two receiver circuits. Claim 10 merely provides that the four circuits be in resonance with each other and hence does not prescribe means of adjusting the tuning. Claim 11 likewise prescribes no means of adjustment. The other claims provide means of adjustment, either a "variable inductance" (Claims 1, 2, 3, 8, 12, 13, 18, and 19) or more generally "means" for adjusting the period of the circuits (Claims 3, 6, 14 and 17). Some of the claims merely provide means of adjusting the tuning of the antenna circuit (Claims 1, 2, 8, 12, and 13) and hence do not require that the closed circuits be tuned. Others either specifically prescribe the adjustable tuning of both circuits at transmitter (Claims 3, 6) or receiver (Claims 18 and 19) or both (Claim 20) or else prescribe "means for adjusting the two transformer-circuits in electrical resonance with each other, substantially as described" (Claims 14 and 17).

[6] A Dynamical Theory of the Electromagnetic Field (1864), 155 Philosophical Transactions of the Royal Society 459; 1 Scientific Papers of James Clerk Maxwell 526.

Electrician in 1888. One, of September 21, 1888, showed a transmitter comprising a closed circuit inductively coupled with an open circuit. The closed circuit included a switch or circuit breaker capable of use for sending signals, and an automatic circuit breaker capable, when the switch was closed, of setting up an intermittent current in the closed circuit which in turn induced through a transformer an intermittent current of higher voltage in the open circuit. The open circuit included a spark gap across which a succession of sparks were caused to leap whenever the signal switch was closed, each spark producing a series of high frequency oscillations in the open circuit.

By connecting the spark gap to large area plates in the open circuit Hertz increased the capacity and thus not only increased the force of the sparks but also changed one of the two factors determining the frequency of the oscillations in the circuit, and hence the wave length of the oscillations transmitted. Hertz's receiver was shown as a rectangle of wire connected to the knobs of a spark gap, both the wire and the spark gap being of specified lengths of such relationship as to render the circuit resonant to the wave lengths in the transmitter. At times Hertz attached to the rectangle additional vertical wires which provided additional capacity, and whose length could readily be varied so as to vary the wave lengths to which the receiver was responsive, thus providing a "method of adjusting the capacity" of the receiver.[7] Thus Hertz at the outset of radio communication recognized the importance of resonance and provided means for securing it by tuning both his transmitting and re-

[7] See the London Electrician for September 21, 1888, p. 628.

Ebert, in the London Electrician for July 6, 1894, p. 333, likewise pointed out that Hertz's receivers are "so arranged that they show the maximum resonant effect with a given exciter; they are 'electrically tuned.'"

ceiving circuits to the same frequency, by adjusting the capacity of each.[8]

Lodge, writing in the London Electrician in 1894, elaborated further on the discoveries of Hertz and on his own experiments along the same lines. In one article, of June 8, 1894, he discussed phenomena of resonance and made an observation which underlies several of the disclosures in Marconi's patent. Lodge pointed out that some circuits were by their nature persistent vibrators, i. e., were able to sustain for a long period oscillations set up in them, while others were so constructed that their oscillations were rapidly damped. He said that a receiver so constructed as to be rapidly damped would respond to waves of almost any frequency, while one that was a persistent vibrator would respond only to waves of its own natural periodicity. Lodge pointed out further that Hertz's transmitter "radiates very powerfully" but that "In consequence of its radiation of energy, its vibrations are rapidly damped, and it only gives some three or four good strong swings. Hence it follows that it has a wide range of excitation, *i. e.*, it can excite sparks in conductors barely at all in tune with it." On the other hand Hertz's receiver was "not a good absorber but a persistent vibrator, well adapted for picking up disturbances of precise

[8] De Tunzelmann shows that Hertz clearly understood the principles of electrical resonance. Some of his early experiments were designed to determine whether principles of resonance were applicable to high frequency electrical circuits. From them Hertz concluded that "an oscillatory current of definite period would, other conditions being the same, exert a much greater inductive effect upon one of equal period than upon one differing even slightly from it." *Id.* p. 626. Hertz knew that the frequency to which a circuit was resonant was a function of the square root of the product of the self-inductance and capacity in the circuit and by a formula similar to that now used he calculated the approximate frequency of the oscillations produced by his transmitter. *Id.*, September 28, 1888, 664–5.

and measurable wave-length." Lodge concluded that "The two conditions, conspicuous energy of radiation and persistent vibration electrically produced, are at present incompatible." (pp. 154–5.)

In 1892, Crookes published an article in the Fortnightly Review in which he definitely suggested the use of Hertzian waves for wireless telegraphy and pointed out that the method of achieving that result was to be found in the use and improvement of then known means of generating electrical waves of any desired wave length, to be transmitted through the ether to a receiver, both sending and receiving instruments being attuned to a definite wave length.[9] A year later Tesla, who was then preoccupied with the wireless transmission of power for use in lighting or for the operation of dynamos, proposed, in a lecture before the Franklin Institute in Philadelphia, the use of adjustable high frequency oscillations for wireless transmission of signals.[10]

Marconi's original patent No. 586,193, which was granted July 13, 1897, and became reissue No. 11,913, disclosed a two-circuit system for the transmission and reception of Hertzian waves. The transmitter comprised an antenna circuit connected at one end to an aerial plate and at the other to the ground, and containing a spark gap. To the knobs of the spark gap was connected a transformer whose secondary was connected with a source of current and a signalling key. The low frequency current thereby induced in the antenna circuit was caused to discharge through the spark gap, producing the high frequency oscillations which were radiated by the antenna. The receiver similiarly contained an antenna circuit between an elevated plate and the ground, in which

[9] Fortnightly Review, No. 101, February, 1892, 173, 174–5.

[10] Martin, Inventions, Researches and Writings of Nikola Tesla, pp. 346–8.

a coherer was directly connected. Marconi claimed the construction of transmitter and receiver so as to be resonant to the same frequency, and described means of doing so by careful determination of the size of the aerial plates.

The Tesla patent No. 645,576, applied for September 2, 1897 and allowed March 20, 1900, disclosed a four-circuit system, having two circuits each at transmitter and receiver, and recommended that all four circuits be tuned to the same frequency. Tesla's apparatus was devised primarily for the transmission of energy to any form of energy-consuming device by using the rarified atmosphere at high elevations as a conductor when subjected to the electrical pressure of a very high voltage. But he also recognized that his apparatus could, without change, be used for wireless communication, which is dependent upon the transmission of electrical energy. His specifications declare: "The apparatus which I have shown will obviously have many other valuable uses— as, for instance, when it is desired to transmit intelligible messages to great distances . . ." [11]

Tesla's specifications disclosed an arrangement of four circuits, an open antenna circuit coupled, through a transformer, to a closed charging circuit at the transmitter, and an open antenna circuit at the receiver similarly coupled to a closed detector circuit. His patent also in-

[11] Tesla's specifications state that the current should preferably be "of very considerable frequency." In describing apparatus used experimentally by him, the specifications state that the oscillations are generated in the charging circuit by the periodic discharge of a condenser by means of "a mechanically operated break," a means whose effects are similar to those of the spark gap generally used at this period in the radio art. He further states that the inductance of the charging circuit is so calculated that the "primary circuit vibrates generally according to adjustment, from two hundred and thirty thousand to two hundred and fifty thousand times per second." The

structed those skilled in the art that the open and closed circuits in the transmitting system and in the receiving system should be in electrical resonance with each other. His specifications state that the "primary and secondary circuits in the transmitting apparatus" are "carefully synchronized." They describe the method of achieving this by adjusting the length of wire in the secondary winding of the oscillation transformer in the transmitter, and similarly in the receiver, so that "the points of highest potential are made to coincide with the elevated terminals" of the antenna, i. e., so that the antenna circuit will be resonant to the frequency developed in the charging circuit of the transmitter. The specifications further state that "the results were particularly satisfactory when the primary coil or system A′ with its secondary C′ [of the receiver] was carefully adjusted, so as to vibrate in synchronism with the transmitting coil or system AC."

Tesla thus anticipated the following features of the Marconi patent: A charging circuit in the transmitter for causing oscillations of the desired frequency, coupled, through a transformer, with the open antenna circuit, and the synchronization of the two circuits by the proper disposition of the inductance in either the closed or the antenna circuit or both. By this and the added disclosure of the two-circuit arrangement in the receiver with similar adjustment, he anticipated the four-circuit tuned

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range of radio frequencies in use in 1917 was said by a witness for the plaintiff to extend from 30,000 to 1,500,000 cycles per second. The range of frequencies allocated for radio use by the International Telecommunication Convention, proclaimed June 27, 1934, 49 Stat. 2391, 2459, is from 10 to 60,000 kilocycles (10,000 to 60,000,000 cycles) per second, and the spectrum of waves over which the Federal Communications Commission currently exercises jurisdiction extends from 10 to 500,000 kilocycles. Code of Federal Regulations, Title 47, Ch. I, § 2.71. Thus Tesla's apparatus was intended to operate at radio frequencies.

combination of Marconi. A feature of the Marconi combination not shown by Tesla was the use of a variable inductance as a means of adjusting the tuning of the antenna circuit of transmitter and receiver. This was developed by Lodge after Tesla's patent but before the Marconi patent in suit.

In patent No. 609,154, applied for February 1, 1898 and allowed August 16, 1898, before Marconi's application, Lodge disclosed an adjustable induction coil in the open or antenna circuit in a wireless transmitter or receiver or both to enable transmitter and receiver to be tuned together. His patent provided for the use, in the open circuits of a transmitter and a receiver of Hertzian waves, of a self-induction coil between a pair of capacity areas which he stated might be antenna and earth. His specifications state that a coil located as described could be made adjustable at will so as to vary the value of its self-inductance; that the adjustment, to secure the "desired frequency of vibration or syntony with a particular distant station," may be attained either "by replacing one coil by another" or by the use of a coil constructed with a movable switch so related to the coil as to short circuit, when closed, any desired number of turns of the wire, "so that the whole or any smaller portion of the inductance available may be used in accordance with the correspondingly-attuned receiver at the particular station to which it is desired to signal." Thus Lodge adjusted his tuning by varying the self-inductance of the antenna circuits, for, as he explained, the adjustment of wave lengths, and hence of frequency in the circuits, could be made by varying either or both the inductance and capacity, which are the factors controlling wave length and hence frequency in the antenna circuits.

Lodge thus broadly claimed the tuning, by means of a variable inductance, of the antenna circuits in a system of radio communication. His specifications disclose what is substantially a two-circuit system, with one high fre-

quency circuit at the transmitter and one at the receiver. He also showed a two-circuit receiver with a tuned antenna circuit, his detector circuit at the receiver being connected with the terminals of a secondary coil wound around the variable inductance coil in the antenna circuit and thus inductively coupled through a transformer with the antenna circuit.[12] Lodge thus supplied the means of varying inductance and hence tuning which was lacking in the Tesla patent. He also showed a receiver which completely anticipated those of the Marconi receiver claims which prescribe adjustable means of tuning only in the antenna circuit (Claims 2, 13 and 18) and partially anticipated the other receiver claims.

The Stone patent No. 714,756, applied for February 8, 1900, nine months before Marconi's application, and allowed December 2, 1902, a year and a half before the grant of Marconi's patent, showed a four-circuit wireless telegraph apparatus substantially like that later specified and patented by Marconi. It described adjustable tuning, by means of a variable inductance, of the closed circuits of both transmitter and receiver. It also recommended that the two antenna circuits be so constructed as to be resonant to the same frequencies as the closed circuits. This recommendation was added by amendment to the specifications made after Marconi had filed his application, and the principal question is whether the amendments were in point of substance a departure from Stone's invention as disclosed by his application.

Stone's application shows an intimate understanding of the mathematical and physical principles underlying radio communication and electrical circuits in general.

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[12] Marconi's patent No. 627,650, of June 27, 1899, similarly showed a two-circuit receiving system, in which the coherer was placed in a closed circuit which was inductively coupled with a tuned antenna circuit. The Court of Claims found, however, that this patent did not clearly disclose the desirability of tuning both circuits.

It contains a critical analysis of the state of the art of radio transmission and reception. He said that as yet it had not been found possible so to tune stations using a vertical antenna as to make possible selective reception by a particular station to the exclusion of others. His effort, accordingly, was to transmit a "simple harmonic wave" of well defined periodicity to a receiver which would be selectively responsive to the particular frequency transmitted, and thereby to achieve greater precision of tuning and a higher degree of selectivity.

Stone discusses in some detail the difference between "natural" and "forced" oscillations. He says "If the electrical equilibrium of a conductor be abruptly disturbed and the conductor thereafter be left to itself, electric currents will flow in the conductor, which tend to ultimately restore the condition of electrical equilibrium." He points out that a closed circuit containing a condenser and a coil is "capable of oscillatory restoration of equilibrium upon the sudden discharge of the condenser" and that "the electrical oscillations which it supports when its equilibrium is abruptly disturbed and it is then left to itself are known as the *natural vibrations* or oscillations of the system."

In addition to its ability to originate "natural vibrations" when its electrical equilibrium is disturbed, Stone says that an electrical circuit is also "capable of supporting what are termed *forced vibrations*" when electrical oscillations elsewhere created are impressed upon it. In contrast to the "natural" vibrations of a circuit, whose frequency depends upon "the relation between the electromagnetic constants [capacity and self-inductance] of the circuit," the frequency of the "forced" vibrations is "independent of the constants of the circuit" on which they are impressed and "depends only upon the period [frequency] of the impressed force." In other words, Stone found that it was possible not only to originate high-

frequency oscillations in a circuit, and to determine their frequency by proper distribution of capacity and self-inductance in the circuit, but also to transfer those oscillations to another circuit and retain their original frequency.

Stone points out that in the existing systems of radio transmission the electric oscillations are "naturally" developed in the antenna circuit by the sudden discharge of accumulated electrical force through a spark gap in that circuit. Such oscillations are "necessarily of a complex character and consist of a great variety of superimposed simple harmonic vibrations of different frequencies." "Similarly the vertical conductor at the receiving station is capable of receiving and responding to vibrations of a great variety of frequencies so that the electro-magnetic waves which emanate from one vertical conductor used as a transmitter are capable of exciting vibrations in any other vertical wire as a receiver . . . and the messages from the transmitting station will not be selectively received by the particular receiving station with which it is desirous to communicate, and will interfere with the operation of other receiving stations within its sphere of influence."

In contrast to the two-circuit system whose inadequacies he had thus described, Stone's drawings and specifications disclose a four-circuit system for transmitting and receiving radio waves which was very similar to that later disclosed by Marconi. The transmitter included a source of low frequency oscillating current and a telegraph or signalling key connected in a circuit which was inductively coupled with another closed circuit. This included an induction coil, a condenser, and a spark gap capable of generating high frequency oscillations. It in turn was inductively coupled through a transformer with an open antenna circuit connected to an aerial capacity at one end and the earth at the other. The receiver included a sim-

ilar antenna circuit, inductively coupled with a closed oscillating circuit containing an induction coil, a condenser, and a coherer or other detector of radio waves.

Stone thus recognized, although he used different terminology, the fact, previously observed by Lodge, that an open antenna circuit, so constructed as to be an efficient radiator, was not an oscillator capable of producing natural waves of a single well-defined periodicity, and consequently had a wide range of excitation. He adopted the same remedy for this defect as Marconi later did, namely to produce the oscillations in a closed circuit capable of generating persistent vibrations of well-defined periodicity, and then induce those oscillations in an open antenna circuit capable of radiating them efficiently to a distant resonant receiver. He states that the vibrations in his closed circuit "begin with a maximum of amplitude and gradually die away," a good description of the results obtainable by a "persistent oscillator." [13] Similarly in his receiver Stone recognized that an open antenna circuit (Lodge's "good absorber") was not a highly sensitive responder to waves of a particular frequency, and accordingly he sought to augment the selectivity of tuning at the receiver by interposing between the antenna circuit and the responding device a closed circuit which would be a more persistent vibrator and hence render the receiv-

[13] That the closed circuit was intended to be a "persistent oscillator" is also brought out by Stone's emphasis on "loose coupling." Stone's application explained in detail the fact that when two circuits are inductively coupled together there normally result "two degrees of freedom," that is to say, the superposition of two frequencies in the same circuit because of the effect on each of the magnetic lines of force set up by the other. He discussed in detail methods of eliminating this superposition, which interfered with accurate selectivity of tuning, by so constructing his circuits as to be "loosely coupled." This he achieved by including in the closed circuits a large inductance coil, which had the effect of "swamping" the undesirable effect of

ing apparatus more selectively responsive to waves of a particular frequency. In so doing, however, as will presently appear, he did not disregard the favorable effect on selectivity of tuning afforded by making the antenna circuits resonant to the transmitted frequency.

Stone's application recommends that the inductance coils in the closed circuits at transmitter and receiver "be made adjustable and serve as a means whereby the operators may adjust the apparatus to the particular frequency which it is intended to employ." He thus disclosed a means of adjusting the tuning of the closed circuits by variable inductance. His original application nowhere states in so many words that the antenna circuits should be tuned, nor do its specifications or drawings explicitly disclose any means for adjusting the tuning of those circuits. But there is nothing in them to suggest that Stone did not intend to have the antenna circuits tuned, and we think that the principles which he recognized in his application, the purpose which he sought to achieve, and certain passages in his specifications, show that he recognized, as they plainly suggest to those skilled in the art, the desirability of tuning the antenna circuits as well. The disclosures of his application were thus an adequate basis for the specific recommendation, later added by amendment, as to the desirability of constructing the

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the lines of force set up in the primary of the transformer by the current induced in the secondary. Since the turns of wire in the primary of the transformer constituted a relatively small part of the total inductance in the closed circuit the effect of those turns on the frequency of the circuit was minimized.

But the testimony at the trial was in substantial agreement that the looser the coupling the slower is the transfer of energy from the closed charging circuit to the open antenna circuit. Hence the use of loose coupling presupposes a charging circuit that will store its energy for a considerable period, i. e., that will maintain persistent oscillations.

antenna circuits so as to be resonant to the frequency produced in the charging circuit of the transmitter.

The major purpose of Stone's system was the achievement of greater selectivity of tuning. His objective was to transmit waves "of but a single frequency" and to receive them at a station which "shall be operated only by electric waves of a single frequency and no others." He states:

"By my invention the vertical conductor of the transmitting station is made the source of electro-magnetic waves of but a single periodicity, and the translating apparatus at the receiving station is caused to be selectively responsive to waves of but a single periodicity so that the transmitting apparatus corresponds to a tuning fork sending but a single simple musical tone, and the receiving apparatus corresponds to an acoustic resonator capable of absorbing the energy of that single, simple musical tone only."

He says that "when the apparatus at a particular [receiving] station" is properly tuned to a particular transmitting station the receiver will selectively receive messages from it. He adds:

"Moreover, by my invention the operator at the transmitting or receiving station may at will adjust the apparatus at his command in such a way as to place himself in communication with any one of a number of stations . . . by bringing his apparatus into resonance with the periodicity employed."

And with respect to the transmitter he says, "It is to be understood that any suitable device may be employed to develop the simple harmonic force impressed upon the vertical wire [antenna]. It is sufficient to develop in the vertical wire practically simple harmonic vibrations of a fixed and high frequency."

These statements sufficiently indicate Stone's broad purpose of providing a high degree of tuning at sending and receiving stations. In seeking to achieve that end he not unnaturally placed emphasis on the tuning of the closed circuits, the association of which with the antenna circuits was an important improvement which he was the first to make. But he also made it plain that it was the sending and receiving "apparatus" which he wished to tune, so that the sending "apparatus" "would correspond to a tuning fork" and the receiving "apparatus" to "an acoustic resonator" capable of absorbing the energy of the "single, simple musical tone" transmitted. And this he sought to achieve by "any suitable device."

Stone thus emphasized the desirability of making the entire transmitting and receiving "apparatus" resonant to a particular frequency. As none of the circuits are resonant to a desired frequency unless they are tuned to that frequency, this reference to the transmitting and receiving apparatus as being brought into resonance with each other cannot fairly be said to mean that only some of the circuits at the transmitter and receiver were to be tuned. To say that by this reference to the tuning of sending and receiving apparatus he meant to confine his invention to the tuning of some only of the circuits in that apparatus is to read into his specifications a restriction which is plainly not there and which contradicts everything they say about the desirability of resonance of the apparatus. It is to read the specifications, which taken in their entirety are merely descriptive or illustrative of his invention, compare *Continental Paper Bag Co.* v. *Eastern Paper Bag Co.*, 210 U. S. 405, 418, 419–20, as though they were claims whose function is to exclude from the patent all that is not specifically claimed. *Mahn* v. *Harwood*, 112 U. S. 354, 361; *McClain* v. *Ortmayer*, 141 U. S. 419, 423–5; *Milcor Steel Co.* v. *Fuller Co.*, 316 U. S. 143, 146.

Stone had pointed out that the tuning of the antenna circuits shown in the prior art did not of itself afford sufficient selectivity. It was for that reason that he used the tuned closed circuit in association with the antenna circuit. But in the face of his emphasis on the desirability of tuning the transmitting and receiving apparatus, we cannot impute to him an intention to exclude from his apparatus the well known use of tuning in the antenna circuits as an aid to the selectivity which it was his purpose to achieve. The inference to be drawn is rather that he intended the tuned closed circuits which he proposed to add to the then known systems of radio communication, to be used in association with any existing type of vertical wire antenna circuit, including one so constructed as to be either resonant to a particular frequency, or adjustably resonant to any desired frequency, both of which involved tuning.

Stone's full appreciation of the value of making all of his circuits resonant to the same frequency is shown by his suggestion to insert, between the closed and antenna circuits at the transmitter and receiver, one or more additional closed circuits, so constructed as to be highly resonant to the particular frequency employed. He says that the purpose of such an intermediate circuit is "to weed out and thereby screen" the antenna circuit at the transmitter and the detecting device at the receiver from any harmonics or other impurities in the wave structure.

He states: "This screening action of an interposed resonant circuit is due to the well known property of such circuits by which a resonant circuit favors the development in it of simple harmonic currents of the period to which it is attuned and strongly opposes the development in it of simple harmonic currents of other periodicities." His original application thus disclosed the advantage, where vibrations created in one circuit are to be impressed on another, of making the latter circuit resonant to the same frequency as the former, in view of the "well

known property" of a resonant circuit to favor the "development" in it of forced vibrations of the same frequency as its natural periodicity.

Stone's application shows that these principles of resonant circuits were no less applicable to the antenna circuit, and suggests the use of "any suitable device" to "develop" in the antenna circuit the "simple harmonic force impressed" upon it. It was then well known in the art that every electrical circuit is to some degree resonant to a particular frequency to which it responds more readily and powerfully than to others. Although the degree of resonance attained by a vertical wire is small, its natural resonance is no different in kind from that of a closed circuit such as Stone's screening circuit. Stone recognized this in his application. In describing the complex natural vibrations set up by a sudden discharge in an antenna circuit, such as that commonly used at the time of his application, Stone said that "the vibrations consist of a simple harmonic vibration of lower period than all the others, known as the fundamental with a great variety of superimposed simple harmonics of higher periodicity superimposed thereon." And he says that the oscillations developed in the charging circuit of his system "induce corresponding oscillations in the vertical wire," which are "virtually" forced vibrations, and "practically independent, as regards their frequency, of the constants of the second circuit in which they are induced"—a plain recognition that the antenna circuit has electro-magnetic constants which affect its natural periodicity, and that that natural periodicity does have some effect on the frequency of the vibrations impressed upon the antenna circuit.[14]

[14] Stone's recognition of the similarity between his antenna circuit and his screening circuit is further shown by his direction that the coupling between the screening circuit and the charging circuit, like that between the antenna and charging circuits where no screening circuit is used, be loose. See note 12, *supra*.

Thus Stone did not, as the Marconi Company suggests, say that the antenna circuit had no natural periodicity. He recognized that its natural periodicity was less strongly marked than that of his closed circuit, and hence that the wave structure could be greatly improved by creating the oscillations in a closed circuit such as he described. But he also plainly recognized that the antenna circuit, like his screening circuit, was a circuit having a natural period of vibration which would therefore be more responsive to impressed oscillations of that same periodicity. Since he had previously said that "any suitable device may be employed to develop the simple harmonic force impressed upon the vertical wire," we think that Stone's specifications plainly suggested to those skilled in the art that they avail themselves of this means of developing in the antenna this simple harmonic force, and that they tune the antenna circuit in order to improve the strength and quality of the "forced" vibrations impressed upon it.

The Marconi Company argues that Stone's theory of "forced" oscillations presupposes that the open transmitter circuit be untuned. It is true that Stone said that such "forced" oscillations have a period of vibration which is "independent of the electrical constants of the circuit" on which they are impressed. But the fact that the "forced" vibration will retain its natural period whatever the frequency of the antenna circuit may be, does not preclude, as Stone showed, the tuning of that circuit so as to achieve maximum responsiveness to the vibrations impressed upon it. Stone's specifications indicate that he used the term "forced" merely as meaning that the vibrations are developed in another circuit and then transferred to the antenna circuit by inductive coupling, as distinguished from "natural" vibrations which originate in the antenna or radiating circuit—in short that "forced" is merely used as a synonym for "in-

duced." Thus he states in describing the operation of his transmitter, "The high frequency current . . . passing through the primary I_1 [of the antenna transformer] induces a corresponding high-frequency electromotive force and current in the secondary I_2 and forced electric vibrations result in the vertical conductor *v* . . ." [15]

Hence there is ample support for the finding of the court below that

"By free oscillations is meant that their frequency was determined by the constants of the circuit in which they were generated. The Stone application as filed impressed these oscillations upon the open circuit, and therefore used 'forced' oscillations in the open circuit of the transmitter, that is, the frequency of the oscillations in the open circuit was determined by the frequency of the oscillations in the closed circuit.

"The effect of forcing vibrations upon a tuned and untuned circuit may be likened unto the effect of a tuning fork upon a stretched cord in a viscous medium. When the cord is vibrated by the tuning fork it has the same period as does the fork regardless of whether such period be that of the natural period of the cord, but when the fork vibrations are in tune with the natural period or

[15] Stone's language here makes it plain that throughout his allusions to a frequency developed in one circuit as being "impressed" or "forced" on another circuit when the two circuits are coupled through a transformer, are used figuratively or metaphorically only as synonymous with "induced." Scientifically the oscillations in the charging circuit are not impressed or forced on the other. The stress in the magnetic field of the first circuit sets up or induces corresponding stresses in the magnetic field of the other circuit. The resulting frequency in the second circuit is affected both by the frequency of the oscillations in the charging circuit and the inductance and capacity in the second circuit. The result may be the superposition of two frequencies in the second circuit. This may be avoided and a single frequency developed, as Stone showed, by tuning the second circuit so as to be resonant to the frequencies created in the first.

fundamental of the cord, then the amplitude of vibrations in the cord is a maximum."

Thus Stone's application, prior to Marconi, showed a four-circuit system, in which the oscillations were produced in a closed charging circuit and impressed on an open antenna circuit in the transmitter, and were similarly received in an open antenna circuit and by it induced in a closed circuit containing a detector. He showed the effect of resonance on the circuits resulting from their tuning to a desired frequency, and emphasized the importance of making the transmitting and receiving apparatus resonant to that frequency.

Stone's patent,[16] granted a year and a half before Marconi—although after Marconi's application was filed—makes explicit, as the patent law permits, what was implicit in Stone's application. By amendments to his specifications made April 8, 1902, he recommended that the frequency impressed upon the vertical conductor at the transmitter "may or may not be the same as the natural period or fundamental of such conductor" and that the antenna circuit at the transmitter "may with advantage be so constructed as to be highly resonant to a particular frequency and the harmonic vibrations impressed thereon may with advantage be of that frequency." Since Stone used a variable inductance to alter at will the frequency of the charging circuit, this direction plainly indicated that the frequency of the antenna circuit might also be variable, and suggested the inclusion of the well-known Lodge variable inductance in the construction of the antenna circuit to achieve that result. And since Stone had specified that "by my invention" the operator at the receiving station is able to "adjust" the receiving

[16] At the insistence of the Patent Office Stone divided his original application, and was granted two patents, No. 714,756 for a method and No. 714,831 for apparatus. The former is the one particularly relied on here.

apparatus so as to place it in resonance with any particular transmitting station, his patent equally plainly suggested the use of the Lodge variable inductance as a means of adjusting the tuning of the receiving antenna.

Stone's 1902 amendments also suggested that an "elevated conductor that is aperiodic may be employed"—i. e., one having very weak natural periodicity and consequently "adapted to receive or transmit all frequencies." But this suggestion was accompanied by the alternative recommendation in the 1902 amendments that the antenna circuits at transmitter and receiver "may with advantage be made resonant to a particular frequency," i. e., be periodic. No inference can be drawn from this that only an aperiodic antenna was contemplated either by the application or the amendments. The application was sufficiently broad to cover both types, since both were suitable means of achieving under different conditions the results which the application described and sought to attain. The amendments thus merely clarified and explained in fuller detail two alternative means which could be employed in the invention described in the original application, one of those means being the construction of the antenna so as to be highly resonant, i. e., tuned, to a particular frequency.[17]

The only respects in which it is seriously contended that Marconi disclosed invention over Stone are that Marconi explicitly claimed four-circuit tuning before

[17] This is borne out by the subsequent letter from Stone to the Commissioner of Patents dated June 7, 1902. Stone there refers to a letter by the Patent Office saying that the statement that a simple harmonic wave developed in the closed circuit "can be transferred to the elevated conductor and from the latter to the ether without change of form" is "an argument the soundness of which the Office has no means of testing." Stone replied with arguments to show that the vibrations radiated by the antenna circuit would be sufficiently pure for practical purposes either if the antenna circuit were

Stone had made it explicit by his 1902 amendment, and that Marconi disclosed means of adjusting the tuning of each of his four circuits whereas Stone had explicitly shown adjustable tuning only in the two closed circuits. But we think that neither Marconi's tuning of the two antenna circuits nor his use of the Lodge variable inductance to that end involved any invention over Stone. Two questions are involved, first, whether there was any invention over Stone in tuning the antenna circuits, and, second, whether there was any invention in the use of the Lodge variable inductance or any other known means of adjustment in order to make the tuning of the antenna circuits adjustable.

For reasons already indicated we think it clear that Stone showed tuning of the antenna circuits before Marconi, and if this involved invention Stone was the first inventor. Stone's application emphasized the desirability of tuning, and disclosed means of adjusting the tuning of the closed circuits. His very explicit recognition of the increased selectivity attained by inductive coupling of several resonant circuits plainly suggested to those skilled in the art that the antenna circuit could with advantage be a resonant circuit, that is to say a tuned circuit, and hence that it was one of the circuits to be tuned. He stressed the importance of tuning "by any suitable device" the "apparatus" at transmitter and receiver, which included at both an antenna circuit.

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aperiodic, or if it had a fundamental which was of the same frequency as that of the forced vibrations impressed upon it, although they would not be pure if the antenna circuit had a marked natural periodicity and was untuned. This letter, while somewhat later in date than the amendments, reinforces the conclusion that the purpose of those amendments was to explain more fully the details of theory and practice necessary to the success of the idea underlying Stone's original invention.

Tuning of the antenna circuit was nothing new; Lodge had not only taught that the antenna circuits at transmitter and receiver should be tuned to each other but had shown a means of adjusting the tuning which was the precise means adopted by Marconi, and which Stone had, prior to Marconi, used to tune his closed circuit—the variable inductance. Tesla, too, had shown the tuning of the antenna circuit at the transmitter to the frequency developed by the charging circuit, and the tuning of both circuits at the receiver to the frequency thus transmitted. Thus Marconi's improvement in tuning the antenna circuits is one the principles of which were well understood and stated by Stone himself before Marconi, and the mechanism for achieving which had previously been disclosed by Lodge and Stone.[18]

Since no invention over Stone was involved in tuning the antenna circuits, neither Marconi nor Stone made an invention by providing adjustable tuning of any of the circuits or by employing Lodge's variable inductance as a means of adjusting the tuning of the resonant four-circuit arrangement earlier disclosed by Stone's application and patented by him. No invention was involved in employing the Lodge variable inductance for tuning

[18] It is not without significance that Marconi's application was at one time rejected by the Patent Office because anticipated by Stone, and was ultimately allowed, on renewal of his application, on the sole ground that Marconi showed the use of a variable inductance as a means of tuning the antenna circuits, whereas Stone, in the opinion of the Examiner, tuned his antenna circuits by adjusting the length of the aerial conductor. All of Marconi's claims which included that element were allowed, and the Examiner stated that the remaining claims would be allowed if amended to include a variable inductance. Apparently through oversight, Claims 10 and 11, which failed to include that element, were included in the patent as granted. In allowing these claims the Examiner made no reference to Lodge's prior disclosure of a variable inductance in the antenna circuit.

either the closed or the open circuits in lieu of other structural modes of adjustment for that purpose. The variable inductance imparted no new function to the circuit; and merely making a known element of a known combination adjustable by a means of adjustment known to the art, when no new or unexpected result is obtained, is not invention. *Peters* v. *Hanson*, 129 U. S. 541, 550–51, 553; *Electric Cable Co.* v. *Edison Co.*, 292 U. S. 69, 79, 80, and cases cited; *Smyth Mfg. Co.* v. *Sheridan*, 149 F. 208, 211; cf. *Bassick Mfg. Co.* v. *Hollingshead Co.*, 298 U. S. 415, 424–5 and cases cited.

Stone's conception of his invention as disclosed by his patent antedated his application. It is carried back to June 30, 1899, seven months before his application, when, in a letter to Baker, he described in text and drawings his four-circuit system for wireless telegraphy in substantially the same form as that disclosed by the application. His letter is explicit in recommending the tuning of the antenna circuits. In part he wrote as follows:

"Instead of utilizing the vertical wire [antenna] itself at the transmitting station as the oscillator, I propose to impress upon this vertical wire, oscillations from an oscillator, which oscillations shall be of a frequency corresponding to the fundamental of the wire. Similarly at the receiving station, I shall draw from the vertical wire, only that component of the complex wave which is of lowest frequency.

"If now the fundamental of the wire at the receiving station be the same as that of the wire at the transmitting station, then the receiving station may receive signals from the transmitting station, but if it be different from that of the transmitting station, it may not receive those signals.

. . . . .

"The tuning of these circuits one to another and all to the same frequency will probably be best accomplished

empirically, though the best general proportions may be determined mathematically."

On July 18, 1899, Stone again wrote to Baker, mathematically demonstrating how to achieve the single frequency by means of forced vibrations. He expressed as a trigonometric function the form taken by the forced wave "if the period of the impressed force be the same as that of the fundamental of the vertical wire." He also pointed out that the transmitting circuit which he had disclosed in his earlier letter to Baker, "is practically the same as that employed by Tesla," except that Stone added an inductance coil in the closed circuit "to give additional means of tuning" and to "swamp" the reactions from the coil of the oscillation transformer and thus loosen the coupling between the open and closed circuit of the transmitter.[19] His recognition of the effect upon the current in the antenna if it is of the same period as the charging circuit; his statement that his transmitting system was the same as that employed by Tesla; his recognition that the fundamental of the receiver should be the same as that of the transmitter antenna when used for the transmission of a single frequency, and finally his statement that all four circuits are to be tuned, "one to another and all to the same frequency," all indicate his understanding of the principles of resonance and of the significance of tuning the antenna circuits.

Stone disclosed his invention to others, and in January, 1900, described it to his class at the Massachusetts Institute of Technology. Before 1900 he was diligent in obtaining capital to promote his invention. Early in 1901 a syndicate was organized to finance laboratory experiments. The Stone Telegraph & Telephone Co. was organized in December, 1901. It constructed several experimental stations in 1902 and 1903; beginning in 1904

[19] See footnote 13, *supra*.

or 1905 it built wireless stations and sold apparatus, equipped a Navy collier and some battleships, and it applied for a large number of patents. The apparatus used in the stations is described by Stone's testimony in this suit as having resonant open and closed circuits loosely coupled inductively to each other, at both the transmitter and receiver, and all tuned to the same wave length, as described in his letters to Baker and his patent.

We think that Stone's original application sufficiently disclosed the desirability that the antenna circuits in transmitter and receiver be resonant to the same frequency as the closed circuits, as he expressly recommended in his patent. But in any event it is plain that no departure from or improper addition to the specifications was involved in the 1902 amendments, which merely made explicit what was already implicit. *Hobbs* v. *Beach*, 180 U. S. 383, 395–7. We would ordinarily be slow to recognize amendments made after the filing of Marconi's application and disclosing features shown in that application. Cf. *Schriber-Schroth Co.* v. *Cleveland Trust Co.*, 305 U. S. 47, 57; *Powers-Kennedy Corporation* v. *Concrete Co.*, 282 U. S. 175, 185–6; *Mackay Radio Co.* v. *Radio Corporation*, 306 U. S. 86. But here Stone's letters to Baker, whose authenticity has not been questioned in this case, afford convincing proof that Stone had conceived of the idea of tuning all four circuits prior to the date of Marconi's invention. Cf. *Bickell* v. *Smith-Hambury-Scott Welding Co.*, 53 F. 2d 356, 358.

It is well established that as between two inventors priority of invention will be awarded to the one who by satisfying proof can show that he first conceived of the invention. *Philadelphia & Trenton R. Co.* v. *Stimpson*, 14 Pet. 448, 462; *Loom Co.* v. *Higgins*, 105 U. S. 580, 593; *Radio Corporation* v. *Radio Laboratories*, 293 U. S. 1, 11–13; *Christie* v. *Seybold*, 55 F. 69, 76; *Automatic Weighing Mach. Co.* v. *Pneumatic Scale Corp.*, 158 F. 415, 417–

22; *Harper* v. *Zimmermann*, 41 F. 2d 261, 265; *Sachs* v. *Hartford Electric Supply Co.*, 47 F. 2d 743, 748.

Commercial success achieved by the later inventor and patentee cannot save his patent from the defense of anticipation by a prior inventor.[20] Compare *Smith* v. *Hall*, 301 U. S. 216 with *Smith* v. *Snow*, 294 U. S. 1. To obtain the benefit of his prior conception, the inventor must not abandon his invention, *Gayler* v. *Wilder*, 10 How. 477, 481, but must proceed with diligence to reduce it to practice. We think Stone has shown the necessary diligence. Compare *Radio Corporation* v. *Radio Laboratories*, *supra*, 13, 14. The delay until 1902 in including in his patent specifications the sentences already referred to, which explicitly provide for tuning of the antenna circuits, does not in the circumstances of this case show any abandonment of that

[20] Even if the lack of invention in Marconi's improvement over Stone—making adjustable the tuning of the antenna circuits which Stone had said should be tuned—could be said to be in sufficient doubt so that commercial success could aid in resolving the doubt, *Thropp's Sons Co.* v. *Seiberling*, 264 U. S. 320, 330; *DeForest Radio Co.* v. *General Electric Co.*, 283 U. S. 664, 685; *Altoona Theatres* v. *Tri-Ergon Corp.*, 294 U. S. 477, 488, it has not been established that the alleged improvement contributed in any material degree to that success. Compare *Altoona Theatres* v. *Tri-Ergon Corp.*, *supra*. Marconi's specifications disclose a large number of details of construction, none of which is claimed as invention in this patent, in which his apparatus differed from, and may have been greatly superior to, Stone's. Many of these formed the subject of prior patents. After his application for his patent, as well as before, Marconi made or adopted a great number of improvements in his system of wireless telegraphy. Two of his engineers have written that a major factor in his successful transmission across the Atlantic in December, 1901, was the use of much greater power and higher antennae than had previously been attempted, an improvement in no way suggested by the patent here in suit. Fleming, Electric Wave Telegraphy, 449–53; Vyvyan, Wireless Over Thirty Years, 22–33. Indeed both are agreed that in the actual transmission across the Atlantic tuning played no part; the receiver antenna consisted of a wire suspended by a kite which rose

feature of Stone's invention since, as we have seen, the idea of such tuning was at least implicit in his original application, and the 1902 amendments merely clarified that application's effect and purport.

Marconi's patent No. 763,772 was sustained by a United States District Court in *Marconi Wireless Telegraph Co.* v. *National Signalling Co.*, 213 F. 815, and his invention as specified in his corresponding British patent No. 7777 of 1900, was upheld in *Marconi* v. *British Radio & Telegraph Co.*, 27 T. L. R. 274, 28 R. P. C. 18. The French court likewise sustained his French patent, Civil Tribunal of the Seine, Dec. 24, 1912. None of these courts considered the Stone patent or his letters. All rest their findings of invention on Marconi's disclosure of a four-circuit system and on his tuning of the four circuits, in the

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and fell with the wind, varying the capacity so much as to make tuning impossible. *Ibid.*

By 1913, when he testified in the National Electric Signalling Co. case, that "due to the utilization of the invention" of this patent he had successfully transmitted messages 6,600 miles, he had, after almost continuous experimentation, further increased the power used, developed new apparatus capable of use with heavy power, enlarged his antennae and adopted the use of horizontal, "directional" antennae, and made use of improved types of spark gaps and detecting apparatus, including the Fleming cathode-anode tube, the crystal detector, and sound recording of the signals—to mention but a few of the improvements made. He had also discovered that much greater distances could be attained at night. See Vyvyan, *supra*, 34–47, 55–60. The success attained by the apparatus developed by Marconi and his fellow engineers by continuous experimentation over a period of years—however relevant it might be in resolving doubts whether the basic four-circuit, tuned system disclosed by Marconi, and before him by Stone, involved invention—cannot, without further proof, be attributed in significant degree to any particular one of the many improvements made by Marconi over Stone during a period of years. The fact that Marconi's apparatus as a whole was successful does not entitle him to receive a patent for every feature of its structure.

sense of rendering them resonant to the same frequency, in both of which respects Stone anticipated Marconi, as we have seen. None of these opinions suggests that if the courts had known of Stone's anticipation, they would have held that Marconi showed invention over Stone by making the tuning of his antenna circuit adjustable, or by using Lodge's variable inductance for that purpose. In *Marconi Wireless Telegraph Co.* v. *Kilbourne & Clark Mfg. Co.*, 239 F. 328, affirmed 265 F. 644, the district court held that the accused device did not infringe. While it entered formal findings of validity which the Circuit Court of Appeals approved, neither court's opinion discussed the question of validity and that question was not argued in the Circuit Court of Appeals.[21]

Marconi's reputation as the man who first achieved successful radio transmission rests on his original patent, which became reissue No. 11,913, and which is not here

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[21] A preliminary injunction restraining infringement was entered in *Marconi Wireless Tel. Co.* v. *DeForest Co.*, 225 F. 65, affirmed, 225 F. 373, both courts, without independent discussion of the validity of the patent, determining that the decision in the *National Signalling Co.* case justified the grant of preliminary relief. A preliminary injunction was also granted in *Marconi Wireless Tel. Co.* v. *Atlantic Communications Co.*, an action brought in the Eastern District of New York.

Stone's letters were introduced in evidence in the *Atlantic Communications Company* case and the *Kilbourne & Clark* case. His deposition in the latter case, taken February 28 and 29, 1916, was incorporated in the record in this case. He there testified that he had refrained from producing proofs of the priority of his invention when called upon to testify in prior litigation in 1911 and 1914 because he wished the priority of his invention to be established by the owners of the patent—the Stone Telegraph Co. and its bondholders—in order to be sure that a bona fide defense would be made. He said that by May 1915, when he testified in the *Atlantic Communications Co.* case, he had concluded that the owners of the patent were not in a financial position to litigate, and that the Atlantic Co. "would make a bona fide Stone defense."

in question. That reputation, however well-deserved, does not entitle him to a patent for every later improvement which he claims in the radio field. Patent cases, like others, must be decided not by weighing the reputations of the litigants, but by careful study of the merits of their respective contentions and proofs. As the result of such a study we are forced to conclude, without undertaking to determine whether Stone's patent involved invention, that the Court of Claims was right in deciding that Stone anticipated Marconi, and that Marconi's patent did not disclose invention over Stone. Hence the judgment below holding invalid the broad claims of the Marconi patent must be affirmed. In view of our interpretation of the Stone application and patent we need not consider the correctness of the court's conclusion that even if Stone's disclosures should be read as failing to direct that the antenna circuits be made resonant to a particular frequency, Marconi's patent involved no invention over Lodge, Tesla, and Stone.

Claim 16 of Marconi patent No. 763,772.

The Government asks us to review so much of the decision of the Court of Claims as held valid and infringed Claim 16 of Marconi's patent No. 763,772. That claim is for an antenna circuit at the receiver connected at one end to "an oscillation-receiving conductor" and at the other to a capacity (which could be the earth), containing the primary winding of a transformer, "means for adjusting the two transformer-circuits in electrical resonance with each other," and "an adjustable condenser in a shunt connected with the open circuit, and around said transformer-coil." Marconi thus discloses and claims the addition to the receiver antenna of an adjustable condenser connected in a shunt around the primary of the transformer. The specifications describe the condenser as "preferably one provided with two telescoping metallic tubes separated by a dielectric and arranged to readily

vary the capacity by being slid upon each other." Marconi, however, makes no claim for the particular construction of the condenser.

Although the claim broadly provides for "means of adjusting the two transformer-circuits in electrical resonance," Marconi's drawings disclose the use of a variable inductance connected between the aerial conductor and the transformer-coil in such a manner that the variable inductance is not included in that part of the antenna circuit which is bridged by the condenser. The condenser is thus arranged in parallel with the transformer coil and in series with the variable inductance. In his specifications Marconi enumerates a number of preferred adjustments for tuning the transmitting and receiving stations, showing the precise equipment to be used to achieve tuning to the desired wave-length. The two tunings which show the use of the adjustable condenser in the receiver antenna also make use of the variable inductance. And his specifications state: "In a shunt around said primary j^1 [the primary of the transformer] I usually place a condenser h . . . An inductance coil g^1 of variable inductance is interposed in the primary circuit of the transformer, being preferably located between the cylinder f^1 [the aerial capacity] and the coil j^1."

In this respect the devices which the court below found to infringe Claim 16 exhibit somewhat different arrangements. Apparatus manufactured by the Kilbourne and Clark Company, and used by the Government, had a receiver antenna circuit containing a variable inductance in addition to the transformer coil, and having an adjustable condenser so constructed that it could be connected either in series with the two inductances, or in a shunt bridging both of them. Apparatus manufactured by the Telefunken Company showed a similar antenna circuit having no variable inductance, but having an adjustable condenser so arranged that it could be connected either in

series with the transformer coil, or in parallel with it by placing the condenser in a shunt circuit which would thus bridge all the inductance in the antenna circuit.

The Marconi patent does not disclose the function which is served by the adjustable condenser disclosed by Claim 16, except in so far as Marconi in his specifications, in describing the means of tuning the receiver circuits to a particular desired frequency, prescribes specific values for both the variable inductance and the adjustable condenser in the receiver antenna circuit. The Court of Claims found that this indicated "that the purpose of the condenser connected in shunt with the primary winding of the transformer of the receiver, is to enable the electrical periodicity or tuning of the open circuit of the receiver to be altered."

The court thus based its holding that Claim 16 disclosed patentable invention on its finding that Marconi, by the use of an adjustable condenser in the antenna circuit, disclosed a new and useful method of tuning that circuit. The Government contends that the arrangement of the antenna circuit disclosed by Marconi's specifications—with the condenser shunted around the transformer coil but not around the variable inductance—is such that the condenser cannot increase the wave-length over what it would be without such a condenser, and that it can decrease that wave-length only when adjusted to have a very small capacity. The Government contends therefore that its principal function is not that of tuning but of providing "loose coupling." [22] The Government does not deny that this precise arrangement is novel and useful, but it contends that its devices do not infringe that

[22] See note 13, *supra*. Most of the current in the antenna circuit is said to pass through the condenser shunt and not through the transformer coil, thus minimizing the effect upon the frequency of vibrations in the antenna circuit of the magnetic stresses set up in the primary of the transformer by the current induced in the secondary.

precise arrangement, and that Claim 16, if more broadly construed so as to cover its apparatus, is invalid because anticipated by the prior art, particularly the patents of Pupin and Fessenden.

As we have seen from our discussion of the other claims of the Marconi patent, the idea of tuning the antenna circuits involved no patentable invention. It was well known that tuning was achieved by the proper adjustment of either the inductance or the capacity in a circuit, or both. Lodge and Stone had achieved tuning by the use of an adjustable induction coil, so arranged that its effective inductance could readily be varied.

But capacity was no less important in tuning. De Tunzelmann's descriptions of Hertz's experiments show that Hertz, in order to make his receiving apparatus resonant to the particular frequency radiated by the transmitter, carefully determined the capacity of both, and indeed disclosed a means of adjusting the capacity of the receiver by attaching to it wires whose length could readily be varied. Marconi in his prior patent No. 586,193, granted July 13, 1897, which became reissue No. 11,913, had disclosed a two-circuit system for the transmission of radio waves in which both transmitter and receiver had large metal plates serving as capacity areas. His specifications describe the construction of transmitting and receiving stations so as to be resonant to the same frequency by calculation of the length of these metal plates, thereby determining the capacity of the antenna circuits of transmitter and receiver respectively. He states that the plates are "preferably of such a length as to be electrically tuned with the electric oscillations transmitted," and describes means of achieving this result so as to determine "the length most appropriate to the length of wave emitted by the oscillator." Claim 24 of his patent claims "the combination of a transmitter capable of producing electrical oscillations or rays of definite character at the

will of the operator, and a receiver located at a distance and having a conductor tuned to respond to such oscillations . . ." The only means of achieving this tuning disclosed by the specifications is the determination of the capacity of the antenna of transmitter and receiver in the manner described.

Moreover the use of an adjustable condenser as a means of tuning was known to the prior art. Pupin in patent No. 640,516, applied for May 28, 1895, and granted January 2, 1900, before Marconi, disclosed the use of an adjustable condenser as a means of tuning a receiving circuit in a system of wired telegraphy. Pupin's patent was designed to permit the simultaneous transmission over a wire of several messages at different frequencies, and the selective reception at a given receiving station of the particular message desired, by tuning the receiving circuit to the frequency at which that message was transmitted. His specifications and drawings disclose at the receiver a telegraph key or other suitable detecting instrument located in a shunt from the wire along which the messages were passed. The shunt circuit included a condenser "of adjustable capacity," an adjustable induction coil, and a detecting instrument. His specifications state that "the capacity of the condenser H and the self-induction of the [induction] coil I being such that the natural period or frequency of the shunt or resonance circuit HI is the same as the period of one of the electromotive forces which produce the current coming over the line . . . this circuit HI will be in resonance with the current and therefore will act selectively with respect to it." He disclosed an alternative system in which a similar shunt circuit containing a condenser, already described as of adjustable capacity, and the primary of a transformer, was inductively coupled with another circuit containing the secondary of the transformer, an induction coil, an adjustable condenser, and a receiving device. He thus in effect dis-

closed an open receiving circuit with earth connection including the primary of an oscillation transformer—the secondary of which is connected in a circuit with a telegraph key or other suitable detecting instrument—and an adjustable condenser in a shunt bridging the primary of the transformer and thus connected in parallel with it.

Thus Pupin showed the use of an adjustable condenser as a means of tuning an electrical circuit so as to be selectively receptive to impulses of a particular frequency. It is true that his patent related not to the radio art but to the art of wired telegraphy, an art which employed much lower frequencies. But so far as we are informed the principles of resonance, and the methods of achieving it, applicable to the low frequencies used by Pupin are the same as those applicable to high frequency radio transmission and reception.

Fessenden, in patent No. 706,735, applied for Dec. 15, 1899, before Marconi, and granted Aug. 12, 1902, disclosed, in the antenna circuit of a radio receiver, a condenser in a shunt around a coil. The coil was used in effect as a transformer; by the magnetic lines of force set up when a current passed through it an indicator was caused to move, thereby either closing an electrical connection or giving a visible signal. Fessenden's specifications do not clearly disclose the purpose of his condenser, but they specify that it must be "of the proper size." He also discloses a condenser in a shunt circuit around the terminals of a spark gap in the antenna circuit of the transmitter, and his specifications prescribe that "This shunt-circuit must be tuned to the receiving-conductor; otherwise the oscillations produced by it will have no action upon the wave-responsive device at the receiving-station."

We have referred to the Pupin and Fessenden patents, not for the purpose of determining whether they anticipate Claim 16 of Marconi, as the Government insists, but to indicate the importance of considering them in that

aspect, together with the relevant testimony, which the court below did not do. In the present state of the record we do not undertake to determine whether and to what extent these disclosures either anticipate Claim 16 of the Marconi patent or require that claim to be so narrowly construed that defendants' accused devices or some of them do not infringe Marconi.

Although the Pupin and Fessenden patents were in the record before the Court of Claims when it entered its decision finding Claim 16 valid and infringed, they were not referred to in connection with Claim 16 either in the court's opinion or in its findings, evidently because not urged upon that court by the Government as anticipating Claim 16. But this Court, in the exercise of its appellate power, is not precluded from looking at any evidence of record which, whether or not called to the attention of the court below, is relevant to and may affect the correctness of its decision sustaining or denying any contention which a party has made before it. *Muncie Gear Co.* v. *Outboard Motor Co.*, 315 U. S. 759, 766–8; Act of May 22, 1939, 28 U. S. C. § 288; cf. *Hormel* v. *Helvering*, 312 U. S. 552, 556.

In order to determine whether this Court should consider the evidence which the Government now presses upon it, and should on the basis of that evidence either decide for itself whether Claim 16 is valid and infringed or remand that question to the Court of Claims for further consideration, it is necessary to set out in some detail the relevant proceedings below. The case was referred to a special commissioner for the taking of testimony under a stipulation that the issue of reasonable compensation for damages and profits be postponed until the determination of the issues of validity and infringement. On June 26, 1933, the Commissioner filed a report in which he made the following findings with regard to Claim 16, which the Court of Claims later adopted in substance:

"LXII. Claim 16 of Marconi #763772 is directed to subject matter which is new and useful . . .

"LXV. The receiving apparatus of the Kilbourne & Clark Company, shown in exhibit 95, and the receiver made by the Telefunken company, illustrated in exhibit 79, each has apparatus coming within the terminology of claim 16."

Both parties filed exceptions to the Commissioner's report. The Marconi Company excepted to part of finding LXII, and took several exceptions which were formally addressed to finding LXV. The Government, in a memorandum, opposed the suggested amendments to these findings. But the Government filed no exceptions to these two findings, nor did it, in its extensive brief before the Court of Claims, make any contention that Claim 16 either is invalid or was not infringed.

After the court had rendered its interlocutory decision holding Claim 16 valid and infringed, the case was sent back to the Commissioner to take evidence on the accounting. Much evidence was taken bearing on the function served by the condenser in the arrangement described in Claim 16 and in the Government's receivers, and in that connection the Pupin and Fessenden patents were again introduced in evidence by the Government. When the Pupin patent was offered the Commissioner stated: "Obviously, as I understand the offer of this patent of Pupin, it does not in any way attack the validity of Claim 16 of the Marconi patent in suit. As you state Mr. Blackmar, that has been decided by the Court, and I do not recall just now what procedure was followed after the decision and prior to this accounting proceeding; but the defendant had at that time opportunity for a motion for a new trial and presentation of newly-discovered evidence and all those matters." Accordingly, the Commissioner stated that he received the patent in evidence "for the sole purpose of aiding the witness and the Commissioner and the

Court in an understanding of how the condenser in the Marconi patent operates." And in offering the Fessenden patent counsel for the Government similarly stated that it was offered "not to show invalidity but as showing justification for the defendant's use."

In its exceptions to the Commissioner's report on the accounting the Government asked the Court of Claims to make certain specific findings as to the mode of operation of the arrangements disclosed in the Pupin and Fessenden patents, and also to find that

"The mode of connecting the primary condenser in parallel with the antenna-to-earth capacity used by the defendant followed the disclosure of Pupin 640,516 and the Fessenden patent 706,735 . . . and hence does not infringe the Marconi claim 16 which is based upon a different arrangement, operating in a different manner to obtain a different result."

The Government contended that there was no finding of fact that Claim 16 had been infringed, and that the court, in the course of the accounting proceeding had by an order of October 22, 1937, reopened the entire subject of infringement. We agree with the court that the Commissioner's finding LXV, which the court adopted as finding LXIII, was a finding of infringement, and we see no reason to question the court's conclusion that its order had not reopened the subject of infringement.

In view, however, of the Government's apparent misunderstanding of the scope of the issues left open on the accounting we think that its request for a finding of noninfringement specifically addressed to the Pupin and Fessenden patents was a sufficient request to the court to reconsider its previous decision of infringement. And while most of the argument on the Government's exceptions to the Commissioner's report was based on evidence taken upon the accounting, the Government's briefs suf-

ficiently disclosed to the court that the Pupin and Fessenden patents, at least, had been in the record prior to the interlocutory decision.

The court, in rejecting the Government's request for a finding of non-infringement, stated: "The question of infringement of Marconi Claim 16 . . . is not before us in the present accounting." "The sole purpose and function of an accounting in a patent infringement case is to ascertain the amount of compensation due, and no other issue can be brought into the accounting to change or alter the court's prior decision." We cannot say with certainty whether in rejecting the Government's request the court thought that it lacked power to reconsider its prior decision, or whether it held merely that in the exercise of its discretion it should not do so. Nor does it appear that, assuming it considered the question to be one of discretion, it recognized that in part at least the Government's request was based on evidence, having an important bearing on the validity and construction of Claim 16, which had been before the court but had not been considered by it when it held Claim 16 valid and infringed.

Although the interlocutory decision of the Court of Claims on the question of validity and infringement was appealable, *United States* v. *Esnault-Pelterie*, 299 U. S. 201, 303 U. S. 26; 28 U. S. C. § 288 (b), as are interlocutory orders of district courts in suits to enjoin infringment, 28 U. S. C. § 227 (a); *Simmons Co.* v. *Grier Bros. Co.*, 258 U. S. 82, 89, the decision was not final until the conclusion of the accounting. *Barnard* v. *Gibson*, 7 How. 649; *Humiston* v. *Stainthorp*, 2 Wall. 106; *Simmons Co.* v. *Grier Bros. Co.*, *supra*, 89. Hence the court did not lack power at any time prior to entry of its final judgment at the close of the accounting to reconsider any portion of its decision and reopen any part of the case. *Perkins* v. *Fourniquet*, 6 How. 206, 208; *McGourkey* v. *Toledo & Ohio Central Ry. Co.*, 146 U. S. 536, 544; *Simmons Co.*

v. *Grier Bros. Co., supra,* 90–91. It was free in its discretion to grant a reargument based either on all the evidence then of record or only the evidence before the court when it rendered its interlocutory decision, or to reopen the case for further evidence.

Whether it should have taken any of these courses was a matter primarily for its discretion, to be exercised in the light of various considerations which this Court cannot properly appraise without more intimate knowledge than it has of the proceedings in a long and complex trial. Among those considerations are the questions whether, as appears to be the case from such portions of the record as have been filed in this Court or cited to us by counsel, the Government failed to make any contention as to the validity or construction of Claim 16 in the proceedings leading to the interlocutory decision; whether the showing of non-infringement which it now makes is sufficiently strong, and the public interest that an invalid patent be not sustained is sufficiently great, to justify reconsidering the decision as to Claim 16 despite the failure of Government counsel to press its contention at the proper time; whether adequate consideration of the question of non-infringement can be had on the existing record, or whether additional testimony should be received; and whether, balancing the strength or weakness of the Government's present showing of non-infringement against the undesirability of further prolonging this already extended litigation, the case is one which justifies reconsideration.

These are all matters requiring careful consideration by the trial court. In order that the case may receive that consideration, we vacate the judgment as to Claim 16 and remand the cause to the Court of Claims for further proceedings in conformity to this opinion.

If on the remand the court should either decline to reconsider its decision of infringement, or should upon reconsideration adhere to that decision, it should pass upon

the contention of the Government, urged here and below, as to the measure of damages, with respect to which the court made no findings. The Government's contention is that the variable capacity shunt of the accused devices bridged all the inductance in the receiving antenna circuit, and that even though those devices infringed they nevertheless embody an improvement over Marconi's Claim 16, in which only the transformer coil was bridged. In computing the damages the court measured them by 65% of the cost to the Government of the induction coils which would be required to replace in the accused devices the adjustable condensers as a means of tuning, taking into account the greater convenience and efficiency of condenser tuning. The allowance of only 65% was on the theory that if the parties had negotiated for the use of the invention the price would have been less than the cost to the Government of the available alternative means of tuning.

In computing the damages the court apparently did not take into account or attempt to appraise any contribution which may have been made by the improvement over Marconi which the Government asserts was included in the accused devices. The court found that where the condenser is connected in series with the inductance coils in the antenna it "can be used to shorten the natural resonant wave length of the antenna circuit but cannot lengthen it beyond what would be the resonant wave length if the condenser were not present." On the other hand, it found that when the condenser is connected in parallel it enables the periodicity of the antenna to be lowered, permitting the reception of longer wave-lengths.

The computation of damages was based on the premise that the advantage to the Government resulting from the infringement was derived from the ability which the accused devices had thus acquired to receive longer wave-lengths. But there was substantial testimony that the ar-

rangement disclosed by Marconi's specifications was in effect a connection in series which did not make possible reception of longer wave-lengths, as did the arrangement in the accused devices. And the court nowhere found that the arrangement covered by Marconi's Claim 16 did make possible such reception. The appropriate effect to be given to this testimony is important in the light of the recognized doctrine that if a defendant has added "non-infringing and valuable improvements which had contributed to the making of the profits," it is not liable for benefits resulting from such improvements. *Westinghouse Electric Co.* v. *Wagner Mfg. Co.*, 225 U. S. 604, 614–15, 616–17; *Sheldon* v. *Metro-Goldwyn Corp.*, 309 U. S. 390, 402–406, and cases cited. Finding LXIII that the Government was using "apparatus coming within the terminology of Claim 16," and Finding 23 on the accounting that the accused devices "infringe Claim 16 of the Marconi patent," give no aid in solving this problem for they are not addressed to the question whether, assuming infringement, the Government has made improvements which of themselves are non-infringing. That can only be afforded by findings which appraise the evidence, establish the scope of Marconi's claim and the nature and extent of the difference in function, if any, between the device claimed by Marconi and those used by the Government, and determine whether any differences shown to exist constitute a "non-infringing improvement" for which Marconi deserves no credit.

The judgment as to Claim 16 will be vacated and the cause remanded for further proceedings.

The Fleming Patent No. 803,684.

The Fleming patent, entitled: "Instrument for Converting Alternating Electric Currents into Continuous Currents" was applied for April 19, 1905, and granted on November 7, 1905 to the Marconi Company, as assignee

of Fleming. Its specifications state that "this invention relates to certain new and useful devices for converting alternating electric currents, and especially high-frequency alternating electric currents or electric oscillations, into continuous electric currents for the purpose of making them detectable by and measurable with ordinary direct-current instruments, such as a 'mirror-galvanometer' of the usual type or any ordinary direct-current ammeter." Fleming's drawings and specifications show a combination apparatus by which alternating current impulses received through an antenna circuit containing the primary of a transformer are induced in the secondary of the transformer. To one end of the secondary coil is connected a carbon filament like that of an incandescent electric lamp, which is heated by a battery. Surrounding, but not touching the filament, is a cylinder of aluminum open at the top and bottom, which is connected with the other end of the secondary. The cylinder and filament are enclosed in an evacuated vessel such as an ordinary electric lamp bulb. An indicating instrument or galvanometer is so located in this circuit as to respond to the flow of current in it. The specifications explain the operation of this device:

"This arrangement described above operates as an electric valve and permits negative electricity to flow from the hot carbon *b* to the metal cylinder *c*, but not in the reverse direction, so that the alternations induced in the coil *k* by the Hertzian waves received by the aerial wire *n* are rectified or transformed into a more or less continuous current capable of actuating the galvanometer *l* by which the signals can be read."

The specifications further state:

". . . the aerial wire *n* may be replaced by any circuit in which there is an alternating electromotive force, whether of low frequency or of high frequency . . ."

"Hence the device may be used for rectifying either high-frequency or low-frequency alternating currents of electrical oscillations . . ."

Only Claims 1 and 37 of the patent are in suit. They read as follows:

"1. The combination of a vacuous vessel, two conductors adjacent to but not touching each other in the vessel, means for heating one of the conductors, and a circuit outside the vessel connecting the two conductors.

"37. At a receiving-station in a system of wireless telegraphy employing electrical oscillations of high frequency a detector comprising a vacuous vessel, two conductors adjacent to but not touching each other in the vessel, means for heating one of the conductors, a circuit outside of the vessel connecting the two conductors, means for detecting a continuous current in the circuit, and means for impressing upon the circuit the received oscillations."

The current applied to the filament or cathode by the battery sets up a flow of electrons (negative electric charges) from the heated cathode, which are attracted to the cold plate or anode when the latter is positively charged. When an alternating current is set up in the circuit containing the cathode, anode, and secondary of the transformer, the electronic discharge from the cathode closes the circuit and permits a continuous flow of electricity through it when the phase of the current is such that the anode is positively charged, while preventing any flow of current through the tube when the anode is negatively charged. The alternating current is thus rectified so as to produce a current flowing only in one direction. See *DeForest Radio Co.* v. *General Electric Co.*, 283 U. S. 664; *Radio Corporation* v. *Radio Laboratories*, 293 U. S. 1; *Detrola Radio Corp.* v. *Hazeltine Corporation*, 313 U. S. 259.

Claims 1 and 37 of the Fleming patent are identical in their structural elements. Both claim the vacuum tube,

and the two electrodes connected by a circuit outside the tube, one element being heated. The claims differ only in that Claim 37 includes "means for detecting" the continuous or direct current in the anode-cathode circuit, and "means for impressing upon the circuit the received oscillations" from the transformer coil of the antenna circuit.

In the patent as originally issued there had been another difference between the two claims. Claim 37 describes the tube as being used "in a system of wireless telegraphy employing electrical oscillations of high frequency." No such limitation was placed on Claim 1 as originally claimed, and the specifications already quoted plainly contemplated the use of the claimed device with low as well as high frequency currents. This distinction was eliminated by a disclaimer filed by the Marconi Company November 17, 1915, restricting the combination of the elements of Claim 1 to a use "in connection with high frequency alternating electric currents or electric oscillations of the order employed in Hertzian wave transmission," and deleting certain references to low frequencies in the specifications. The result of the disclaimer was to limit both claims to the use of the patented device for rectifying high frequency alternating waves or currents such as were employed in wireless telegraphy.

The earliest date asserted for Fleming's invention, as limited by the disclaimer, is November 16, 1904. Twenty years before, on October 21, 1884, Edison had secured United States Patent No. 307,031. In his specifications he stated:

"I have discovered that if a conducting substance is interposed anywhere in the vacuous space within the globe of an incandescent electric lamp, and said conducting substance is connected outside of the lamp with one terminal, preferably the positive one, of the incandescent conductor, a portion of the current will, when the lamp is in opera-

tion, pass through the shunt-circuit thus formed, which shunt includes a portion of the vacuous space within the lamp. This current I have found to be proportional to the degree of incandescence of the conductor or candle-power of the lamp."

Edison proposed to use this discovery as a means of "indicating, variations in the electro-motive force in an electric circuit," by connecting a lamp thus equipped at a point where the current was to be measured. The drawings of his patent show an electric circuit, including a filament (cathode) and a plate (anode) both "in the vacuous space within the globe"—an electric light bulb. The shunt-circuit extends from the plate through a galvanometer to the filament. His specifications disclose that the vacuous space within the globe is a conductor of current between the plate anode and the filament; that the strength of the current in the filament-to-plate circuit through the vacuum depends upon the degree of incandescence at the filament; and that the plate anode is preferably connected to the positive side of the current supply. The claims of the patent are for the combination of the filament, plate and interconnecting circuit, including the galvanometer. Claim 5, a typical claim, reads as follows:

"The combination, with an incandescent electric lamp, of a circuit having one terminal in the vacuous space within the globe of said lamp, and the other connected with one side of the lamp-circuit, and electrically controlled or operated apparatus in said circuit, substantially as set forth."

The structure disclosed in Fleming's Claims 1 and 37 thus differed in no material respect from that disclosed by Edison. Since Fleming's original Claim 1 is merely for the structure, it reads directly on Edison's Claim 5 and could not be taken as invention over it.

Fleming used this structure for a different purpose than Edison. Edison disclosed that his device operated to pass a current across the vacuous space within the tube between filament and plate. He used this current as a means of measuring the current passing through the filament circuit. Fleming, in his specifications, disclosed the use of his tube as a rectifier of alternating currents, and in Claim 37 he claimed the use of that apparatus as a means of rectifying alternating currents of radio frequency. But in this use of the tube to convert alternating into direct currents there was no novelty for it had been disclosed by others and by Fleming himself long before Fleming's invention date.

On January 9, 1890, ten years before Fleming filed his application, he stated in a paper read before the Royal Society of London:

"It has been known for some time that if a platinum plate or wire is sealed through the glass bulb of an ordinary carbon filament incandescent lamp, this metallic plate being quite out of contact with the carbon conductor, a sensitive galvanometer connected between this insulated metal plate enclosed in the vacuum and the external *positive* electrode of the lamp indicates a current of some milliampères passing through it when the lamp is set in action, but the same instrument when connected between the *negative* electrode of the lamp and the insulated metal plate indicates no sensible current. This phenomenon in carbon incandescence lamps was first observed by Mr. Edison, in 1884, and further examined by Mr. W. H. Preece, in 1885." Proceedings of the Royal Society of London, vol. 47, pp. 118–9.

Fleming's 1890 paper further pointed out that the vacuous space "possesses a curious unilateral conductivity"; that is, it permits current to "flow across the vacuous space from the hot carbon [cathode]to the cooler metal plate [anode], but not in the reverse direction." *Id.* 122.

He noted the ability of the tube to act as a rectifier of alternating current, saying:

"When the lamp is actuated by an *alternating* current a *continuous* current is found flowing through a galvanometer, connected between the insulated plate and *either* terminal of the lamp. The direction of the current through the galvanometer is such as to show that negative electricity is flowing from the plate through the galvanometer to the lamp terminal." *Id.* 120.

Fleming's paper thus noted, contrary to the then popular conception, that it is negative electricity which flows from cathode to anode, but he emphasized that even this had been a part of general scientific knowledge, as follows:

"The effect of heating the negative electrode in facilitating discharge through vacuous spaces has previously been described by W. Hittorf ('Annalen der Physik und Chemie,' vol. 21, 1884, p. 90–139), and it is abundantly confirmed by the above experiments. We may say that a vacuous space bounded by two electrodes—one incandescent, and the other cold—possesses a unilateral conductivity for electric discharge when these electrodes are within a distance of the mean free path of projection of the molecules which the impressed electromotive force can detach and send off from the hot negative electrode.

"This unilateral conductivity of vacuous spaces having unequally heated electrodes has been examined by MM. Elster and Geitel (see 'Wiedemann's Annalen,' vol. 38, 1889, p. 40), and also by Goldstein ('Wied. Ann.,' vol. 24, 1885, p. 83), who in experiments of various kinds have demonstrated that when an electric discharge across a vacuous space takes place from a carbon conductor to another electrode, the discharge takes place at lower electromotive force when the carbon conductor is the negative electrode and is rendered incandescent." *Id.* 125–6.

Fleming's reference in this publication to the unilateral conductivity of the vacuous space between cathode and anode, and the consequent ability of the two to derive a continuous unidirectional current from an alternating current was a recognition that the Edison tube embodying the structure described could be used as a rectifier of alternating current. This knowledge, disclosed by publication more than two years before Fleming's application, was a bar to any claim for a patent for an invention embodying the published disclosure. R. S. §§ 4886, 4920; 35 U. S. C. §§ 31, 69. *Wagner* v. *Meccano Ltd.*, 246 F. 603, 607; cf. *Muncie Gear Co.* v. *Outboard Co., supra*, 766.

It is unnecessary to decide whether Fleming's use of the Edison device for the purpose of rectifying high frequency Hertzian waves, as distinguished from low frequency waves, involved invention over the prior art, or whether the court below rightly held that the devices used by the Government did not infringe the claims sued upon, for we are of the opinion that the court was right in holding that Fleming's patent was rendered invalid by an improper disclaimer. It is plain that Fleming's original Claim 1, so far as applicable to use with low frequency alternating currents, involved nothing new, as Fleming himself must have known in view of his 1890 paper, and as he recognized by his disclaimer in 1915, made twenty-five years after his paper was published and ten years after his patent had been allowed. Its invalidity would defeat the entire patent unless the invalid portion had been claimed "through inadvertence, accident, or mistake, and without any fraudulent or deceptive intention," and was also disclaimed without "unreasonable" neglect or delay. R. S. §§ 4917, 4922; 35 U. S. C. §§ 65, 71; *Ensten* v. *Simon Ascher & Co.*, 282 U. S. 445, 452; *Altoona Theatres* v. *Tri-Ergon Corp.*, 294 U. S. 477, 493; *Maytag Co.* v. *Hurley Co.*, 307 U. S. 243.

We need not stop to inquire whether, as the Government contends, the subject matter of the disclaimer was improper as in effect adding a new element to the claim. See *Milcor Steel Co.* v. *Fuller Co.*, 316 U. S. 143, 147–8. For we think that the court below was correct in holding that the Fleming patent was invalid because Fleming's claim for "more than he had invented" was not inadvertent, and his delay in making the disclaimer was "unreasonable." Both of these are questions of fact, but since the court in its opinion plainly states its conclusions as to them, and those conclusions are supported by substantial evidence, its omission to make formal findings of fact is immaterial. Act of May 22, 1939, 53 Stat. 752, 28 U. S. C. § 288 (b); cf. *American Propeller Co.* v. *United States*, 300 U. S. 475, 479–80; *Great Lakes Dredge & Dock Co.* v. *Huffman*, 319 U. S. 293.

The purpose of the rule that a patent is invalid in its entirety if any part of it be invalid is the protection of the public from the threat of an invalid patent, and the purpose of the disclaimer statute is to enable the patentee to relieve himself from the consequences of making an invalid claim if he is able to show both that the invalid claim was inadvertent and that the disclaimer was made without unreasonable neglect or delay. *Ensten* v. *Simon Ascher & Co., supra.* Here the patentee has sustained neither burden.

Fleming's paper of 1890 showed his own recognition that his claim of use of his patent for low frequency currents was anticipated by Edison and others. It taxes credulity to suppose, in the face of this publication, that Fleming's claim for use of the Edison tube with low frequency currents was made "through inadvertence, accident or mistake," which is prerequisite to a lawful disclaimer. No explanation or excuse is forthcoming for his claim of invention of a device which he had so often dem-

onstrated to be old in the art, and which he had specifically and consistently attributed to Edison. Nor is any explanation offered for the delay of the patentee—the Marconi Company—in waiting ten years to disclaim the use of the device with low frequency currents and to restrict it to a use with high frequency Hertzian waves which Edison had plainly foreshadowed but not claimed. For ten years the Fleming patent was held out to the public as a monopoly of all its claimed features. That was too long in the absence of any explanation or excuse for the delay, and hence in this case was long enough to invalidate the patent. The conclusion of the Court of Claims not only has support in the evidence, but we can hardly see how on this record any other could have been reached.

The Marconi Company's contention that it nowhere appears that Fleming was not the first inventor of the use of the patented device to rectify high frequency alternating currents is irrelevant to the question of the sufficiency of the disclaimer. The disclaimer itself is an assertion that the claimed use of the invention with low frequencies was not the invention of the patentee, whose rights were derived wholly from Fleming. This improper claim for something not the invention of the patentee rendered the whole patent invalid unless saved by a timely disclaimer which was not made.

The Marconi Company also asserts that, as it is suing as assignee of the patentee, it is unaffected by the provisions of the disclaimer statutes, which it construes as restricting to the "patentee" the consequences of unreasonable delay in making the disclaimer and as exempting the assignee from those consequences by the sentence "But no patentee shall be entitled to the benefits of this section if he has unreasonably neglected or delayed to enter a disclaimer." 35 U. S. C. 71. As the court below found, the Marconi Company was itself the patentee to whom the patent was

issued on the assignment of Fleming's application in conformity to 35 U. S. C. § 44. The right given by § 71 to the patentee or his assignees to sue for infringement upon a proper disclaimer obviously does not relieve the patentee from the consequences of his failure to comply with the statute because he acquired his patent under an assignment of the application. *Altoona Theatres* v. *Tri-Ergon Corp., supra; Maytag Co.* v. *Hurley Co., supra; France Mfg. Co.* v. *Jefferson Electric Co.*, 106 F. 2d 605, 610. Such a contention is not supported by the words of the statute and if allowed would permit the nullification of the disclaimer statute by the expedient of an assignment of the application. We need not consider whether one who has taken an assignment of a patent after its issuance would have any greater rights than his assignor in the event of the latter's undue delay in filing a disclaimer. Compare *Apex Electrical Mfg. Co.* v. *Maytag Co.*, 122 F. 2d 182, 189.

The judgment in No. 373 is vacated and the cause remanded to the Court of Claims for further proceedings not inconsistent with this opinion.

The judgment in No. 369 is affirmed.

So ordered.

MR. JUSTICE MURPHY took no part in the consideration or decision of this case.

MR. JUSTICE FRANKFURTER, dissenting in part:

I regret to find myself unable to agree to the Court's conclusion regarding the invalidity of the broad claims of Marconi's patent. Since broad considerations control the significance and assessment of the details on which judgment in the circumstances of a case like this is based, I shall indicate the general direction of my views.

It is an old observation that the training of Anglo-American judges ill fits them to discharge the duties cast

upon them by patent legislation.[1] The scientific attainments of a Lord Moulton are perhaps unique in the annals of the English-speaking judiciary. However, so long as the Congress, for the purposes of patentability, makes the determination of originality a judicial function, judges must overcome their scientific incompetence as best they can. But consciousness of their limitations should make

[1] "Considering the exclusive right to invention as given not of natural right, but for the benefit of society, I know well the difficulty of drawing a line between the things which are worth to the public the embarrassment of an exclusive patent, and those which are not. As a member of the patent board for several years, while the law authorized a board to grant or refuse patents, I saw with what slow progress a system of general rules could be matured. . . . Instead of refusing a patent in the first instance, as the board was authorized to do, the patent now issues of course, subject to be declared void on such principles as should be established by the courts of law. This business, however, is but little analogous to their course of reading, since we might in vain turn over all the lubberly volumes of the law to find a single ray which would lighten the path of the mechanic or the mathematician. It is more within the information of a board of academical professors, and a previous refusal of patent would better guard our citizens against harassment by law-suits. But England had given it to her judges, and the usual predominancy of her examples carried it to ours." Thomas Jefferson to Mr. Isaac M'Pherson, August 13, 1813, Works of Thomas Jefferson, Wash. Ed., vol. VI, pp. 181–82.

"I cannot stop without calling attention to the extraordinary condition of the law which makes it possible for a man without any knowledge of even the rudiments of chemistry to pass upon such questions as these. The inordinate expense of time is the least of the resulting evils, for only a trained chemist is really capable of passing upon such facts, e. g., in this case the chemical character of Von Furth's so-called 'zinc compound,' or the presence of inactive organic substances. . . . How long we shall continue to blunder along without the aid of unpartisan and authoritative scientific assistance in the administration of justice, no one knows; but all fair persons not conventionalized by provincial legal habits of mind ought, I should think, unite to effect some such advance." Judge Learned Hand in *Parke-Davis & Co.* v. *Mulford Co.*, 189 F. 95, 115 (1911).

them vigilant against importing their own notions of the nature of the creative process into Congressional legislation, whereby Congress "to promote the Progress of Science and useful Arts" has secured "for limited Times to . . . Inventors the exclusive Right to their . . . Discoveries." Above all, judges must avoid the subtle temptation of taking scientific phenomena out of their contemporaneous setting and reading them with a retrospective eye.

The discoveries of science are the discoveries of the laws of nature, and like nature do not go by leaps. Even Newton and Einstein, Harvey and Darwin, built on the past and on their predecessors. Seldom indeed has a great discoverer or inventor wandered lonely as a cloud. Great inventions have always been parts of an evolution, the culmination at a particular moment of an antecedent process. So true is this that the history of thought records striking coincidental discoveries—showing that the new insight first declared to the world by a particular individual was "in the air" and ripe for discovery and disclosure.

The real question is how significant a jump is the new disclosure from the old knowledge. Reconstruction by hindsight, making obvious something that was not at all obvious to superior minds until someone pointed it out,—this is too often a tempting exercise for astute minds. The result is to remove the opportunity of obtaining what Congress has seen fit to make available.

The inescapable fact is that Marconi in his basic patent hit upon something that had eluded the best brains of the time working on the problem of wireless communication—Clerk Maxwell and Sir Oliver Lodge and Nikola Tesla. Genius is a word that ought to be reserved for the rarest of gifts. I am not qualified to say whether Marconi was a genius. Certainly the great eminence of Clerk Maxwell and Sir Oliver Lodge and Nikola Tesla

in the field in which Marconi was working is not questioned. They were, I suppose, men of genius. The fact is that they did not have the "flash" (a current term in patent opinions happily not used in this decision) that begot the idea in Marconi which he gave to the world through the invention embodying the idea. But it is now held that in the important advance upon his basic patent Marconi did nothing that had not already been seen and disclosed.

To find in 1943 that what Marconi did really did not promote the progress of science because it had been anticipated is more than a mirage of hindsight. Wireless is so unconscious a part of us, like the automobile to the modern child, that it is almost impossible to imagine ourselves back into the time when Marconi gave to the world what for us is part of the order of our universe. And yet, because a judge of unusual capacity for understanding scientific matters is able to demonstrate by a process of intricate ratiocination that anyone could have drawn precisely the inferences that Marconi drew and that Stone hinted at on paper, the Court finds that Marconi's patent was invalid although nobody except Marconi did in fact draw the right inferences that were embodied into a workable boon for mankind. For me it speaks volumes that it should have taken forty years to reveal the fatal bearing of Stone's relation to Marconi's achievement by a retrospective reading of his application to mean this rather than that. This is for me, and I say it with much diffidence, too easy a transition from what was not to what became.

I have little doubt, in so far as I am entitled to express an opinion, that the vast transforming forces of technology have rendered obsolete much in our patent law. For all I know the basic assumption of our patent law may be false, and inventors and their financial backers do not need the incentive of a limited monopoly to stimulate

invention. But whatever revamping our patent laws may need, it is the business of Congress to do the revamping. We have neither constitutional authority nor scientific competence for the task.

MR. JUSTICE ROBERTS joins in this opinion.

MR. JUSTICE RUTLEDGE, dissenting in part:

Until now law[1] has united with almost universal repute[2] in acknowledging Marconi as the first to establish wireless telegraphy on a commercial basis. Before his invention, now in issue,[3] ether-borne communication traveled some eighty miles. He lengthened the arc to 6,000. Whether or not this was "inventive" legally, it was a great and beneficial achievement.[4] Today, forty years after the event, the Court's decision reduces it to an electrical mechanic's application of mere skill in the art.

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[1] *Marconi* v. *British Radio Tel. & Tel. Co.*, 27 T. L. R. 274; *Marconi* v. *Helsby Wireless Tel. Co.*, 30 T. L. R. 688; *Société Marconi* v. *Société Générale, etc.*, Civil Tribunal of the Seine, 3d Chamber, Dec. 24, 1912; *Marconi Wireless Telegraph Co.* v. *National Electric Signalling Co.*, 213 F. 815 (D. C.); *Marconi Wireless Telegraph Co.* v. *Kilbourne & Clark Mfg. Co.*, 265 F. 644 (C. C. A.), aff'g 239 F. 328 (D. C.).

[2] Cf., e. g., 14 Encyc. Britannica (14th ed.) 869.

[3] His earliest American patent, U. S. Patent No. 586,193, granted on July 13, 1897, later becoming Reissue Patent No. 11,913, is not in suit here. That patent did not embrace many of the crucial claims here involved and its product cannot compare in commercial usefulness with that of the patent in suit.

[4] Courts closer to it chronologically than we are have characterized it as a "conspicuous advance in wireless telegraphy"; "a real accomplishment" and the ideas involved in the patent were said to "have proven of great value to the world," to have brought about "an entirely new and useful result," "a new and very important industrial result" and "a wonderful conquest." "The Marconi patent stands out as an unassailable monument until new discoveries are made." Cf. the authorities cited in note 1, *supra*.

By present knowledge, it would be no more. School boys and mechanics now could perform what Marconi did in 1900. But before then wizards had tried and failed. The search was at the pinnacle of electrical knowledge. There, seeking, among others, were Tesla, Lodge and Stone, old hands and great ones. With them was Marconi, still young as the company went[5] obsessed with youth's zeal for the hunt.

At such an altitude, to work at all with success is to qualify for genius, if that is important. And a short step forward gives evidence of inventive power. For at that height a merely slight advance comes through insight only a first-rate mind can produce. This is so, whether it comes by years of hard work tracking down the sought secret or by intuition flashed from subconsciousness made fertile by long experience or shorter intensive concentration. At this level and in this company Marconi worked and won.

He won by the test of results. No one disputes this. His invention had immediate and vast success, where all that had been done before, including his own work, gave but narrowly limited utility. To make useful improvement at this plane, by such a leap, itself shows high capacity. And that is true, although it was inherent in the situation that Marconi's success should come by only a small margin of difference in conception. There was not room for any great leap of thought, beyond what he and others had done, to bring to birth the practical and useful result. The most eminent men of the time were conscious of the problem, were interested in it, had sought for years the exactly right arrangement, always approaching more nearly but never quite reaching the stage of prac-

[5] He was only twenty-six years old at the time he applied for the patent in suit, but he had already made substantial contributions to the field.

tical success. The invention was, so to speak, hovering in the general climate of science, momentarily awaiting birth. But just the right releasing touch had not been found. Marconi added it.

When to altitude of the plane of conception and results so immediate and useful is added well-nigh unanimous contemporary judgment, one who long afterward would overturn the invention assumes a double burden. He undertakes to overcome what would offer strong resistance fresh in its original setting. He seeks also to overthrow the verdict of time. Long-range retroactive diagnosis, however competent the physician, becomes hazardous by progression as the passing years add distortions of the past and destroy its perspective. No light task is accepted therefore in undertaking to overthrow a verdict settled so long and so well, and especially one so foreign to the art of judges.

In lawyers' terms this means a burden of proof, not insurmountable, but inhospitable to implications and inferences which in less settled situations would be permissible to swing the balance of judgment against the claimed invention. That Marconi received patents elsewhere which, once established, have stood the test of time as well as of contemporary judgment, and secured his American patent only after years were required to convince our office he had found what so many others sought, but emphasizes the weight and clarity of proof required to overcome his claim.

Marconi received patents here, in England, and in France.[6] The American patent was not issued perfunctorily. It came forth only after a long struggle had brought about reversal of the Patent Office's original and later rejections. The application was filed in November,

[6] U. S. Patent No. 763,772; British Patent No. 7777 of 1900; French Patent No. 305,060 of Nov. 3, 1900.

1900. In December it was rejected on Lodge,[7] and an earlier patent to Marconi.[8] It was amended and again rejected. Further amendments followed and operation of the system was explained. Again rejection took place, this time on Lodge, the earlier Marconi, Braun and other patents. After further proceedings, the claims were rejected on Tesla.[9] A year elapsed, but in March, 1904, reconsideration was granted. Some claims then were rejected on Stone,[10] others were amended, still others were cancelled, and finally on June 28, 1904, the patent issued. French and British patents had been granted in 1900.

Litigation followed at once. Among Marconi's American victories were the decisions cited above.[11] Abroad the results were similar.[12] Until 1935, when the Court of Claims held it invalid in this case, 81 Ct. Cl. 671, no court had found Marconi's patent wanting in invention. It stood without adverse judicial decision for over thirty years. In the face of the burden this history creates, we turn to the references, chiefly Tesla, Lodge and Stone. The Court relies principally on Stone, but without deciding whether this was inventive.

It is important, in considering the references, to state the parties' contentions concisely. The Government's statement is that they differ over whether Marconi was first to conceive four-circuit "tuning" for transmission of sound by Hertzian waves. It says this was taught previously by Tesla, Lodge and Stone. Petitioner however says none of them taught what Marconi did. It contends that Marconi was the first to accomplish the kind of tun-

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[7] British patent to Lodge No. 29,505.

[8] Cf. note 3 *supra*.

[9] U. S. Patent to Tesla No. 649,621, May 15, 1900, division of 645,576, March 20, 1900 (filed Sept. 2, 1897).

[10] Cf. text *infra*.

[11] Cf. note 1 *supra*.

[12] *Ibid.*

ing he achieved, and in effect urges this was patentably different from other forms found earlier.

Specifically petitioner urges that Tesla had nothing to do with either Hertzian waves or tuning, but in fact his transmitting and receiving wires could not be tuned.[13] Lodge, it claims, disclosed a tuned antenna, for either transmitter or receiver or both, but the closed circuits associated with the antenna ones were not tuned. Finally it is said Stone does not describe tuning the antenna, but does show tuning of the associated closed circuit. And Marconi tuned both.

Petitioner does not claim the general principles of tuning. It admits they had long been familiar to physicists and that Lodge and others fully understood them. But it asserts Lodge did not know what circuits should be tuned, to accomplish what Marconi achieved, and that, to secure this, "knowledge that tuning is possible is not enough—there is also required the knowledge of whether or not to tune and how much."

Likewise, petitioner does not deny that Stone knew and utilized the principles of tuning; but urges, with respect to the claim he applied them to all of the four circuits, that the only ones tuned, in his original application, were the closed circuits and therefore that the antenna circuits were not tuned; although it is not denied that the effects of tuning the closed circuits were reflected in the open ones by what Stone describes as "producing *forced* simple

[13] Tesla in fact did not use Hertzian waves. His idea was to make the ether a conductor for long distances by using extremely high voltage, 20,000,000 to 30,000,000 volts, and extremely high altitudes, 30,000 to 40,000 feet or more, to secure transmission from aerial to aerial. Balloons, with wires attached reaching to the ground, were his suggested aerials. His system was really one for transmitting power for motors, lighting, etc., to "any terrestrial distance," though he incidentally mentions "intelligible messages." As he did not use Hertzian waves, he had no such problem of selectivity as Marconi, Lodge, Stone and others were working on later.

harmonic electric vibrations of the same periodicity in an elevated conductor."

The Stone amendments of 1902, made more than a year after Marconi's filing date, admittedly disclose tuning of both the closed and the open circuits, and were made for the purpose of stating expressly the latter effect, claimed to be implicit in the original application. Petitioner denies this was implicit and argues, in effect, that what Stone originally meant by "producing *forced* . . . vibrations" was creating the desired effects in the antenna *by force*, not by tuning; and therefore that the two methods were patentably different.

It seems clear that the parties use the word "tuning" to mean different things and the ambiguity, if there is one, must be resolved before the crucial questions can be stated with meaning. It will aid, in deciding whether there is ambiguity or only confusion, to consider the term and the possible conceptions it may convey in the light of the problems Marconi and Stone, as well as other references, were seeking to solve.

Marconi had in mind first a specific difficulty, as did the principal references. It arose from what, to the time of his invention, had been a baffling problem in the art. Shortly and simply, it was that an electrical circuit which is a good conserver of energy is a bad radiator and, conversely, a good radiator is a bad conserver of energy. Effective use of Hertzian waves over long distances required both effects. To state the matter differently, Lodge had explained in 1894 the difficulties of fully utilizing the principle of sympathetic resonance in detecting ether waves. To secure this, it was necessary, on the one hand, to discharge a long series of waves of equal or approximately equal length. Such a series can be produced only by a circuit which conserves its energy well, what Marconi calls a persistent oscillator. On the other hand, for distant detection, the waves must be of substantial

amplitude, and only a circuit which loses its energy rapidly can transmit such waves with maximum efficiency. Obviously in a single circuit the two desired effects tend to cancel each other, and therefore to limit the distance of detection. Similar difficulty characterized the receiver, for a good radiator is a good absorber, and that very quality disables it to store up and hold the effect of a train of waves, until enough is accumulated to break down the coherer, as detection requires.

Since the difficulty was inherent in a single circuit, whether at one end or the other, Marconi used two in both transmitter and receiver, four in all. In each station he used one circuit to obtain one of the necessary advantages and the other circuit to secure the other advantage. The antenna (or open) circuits he made "good radiators" (or absorbers). The closed circuits he constructed as "good conservers." By coupling the two at each end loosely he secured from their combination the dual advantages he sought. At the transmitter, the closed circuit, by virtue of its capacity for conserving energy, gave persistent oscillation, which passed substantially undiminished through the coupling transformer to the "good radiator" open circuit and from it was discharged with little loss of energy into the ether. Thence it was picked up by the "good absorber" open circuit and passed, without serious loss of energy, through the coupling transformer, into the closed "good conserving" circuit, where it accumulated to break the coherer and give detection.

Moreover, and for present purposes this is the important thing, Marconi brought the closed and open circuits into almost complete harmony by placing variable inductance in each. Through this the periodicity of the open circuit was adjusted automatically to that of the closed one; and, since the circuits of the receiving station were similarly adjustable, the maximum resonance was secured throughout the system. Marconi thus not only solved

the dilemma of a single circuit arrangement; he attained the maximum of resonance and selectivity by providing in each circuit independent means of tuning.

In 1911 this solution was held inventive, as against Lodge, Marconi's prior patents, Braun and other references, in *Marconi* v. *British Radio Tel. & Tel. Co.*, 27 T. L. R. 274. Mr. Justice Parker carefully reviewed the prior art, stated the problem, Marconi's solution, and in disposing of Braun's specification concluded it "did not contain even the remotest suggestion of the problem . . ., much less any suggestion bearing on its solution. . . ." As to Lodge, Mr. Justice Parker observed, referring first to Marconi:

". . . It is important to notice that *in the receiver* the mere introduction of two circuits instead of one was no novelty. A figure in Lodge's 1897 patent shows the open circuit of his receiving aerial linked through a transformer with a closed circuit containing the coherer, *his idea being, as he states, to leave his receiving aerial freer to vibrate electrically without disturbance from attached wires.* This secondary circuit, as shown, *is not tuned to, nor can it be tuned to,* the circuit of the aerial. This, in my opinion, is exceedingly strong evidence that Marconi's 1900 invention was not so obvious as to deprive it of subject matter. In the literature quoted there is no trace of the idea underlying Mr. Marconi's invention, nor, so far as I can see, a single suggestion from which a competent engineer could arrive at this idea." (Emphasis added.)

It was therefore clearly Mr. Justice Parker's view, in his closer perspective to the origin of the invention and the references he considered, that in none of them, and particularly not in Lodge or Braun, was there anticipation of Marconi's solution.

He did not mean that the references did not apply "the principle of resonance as between transmitter and re-

ceiver" or utilize "the principle of sympathetic resonance for the purpose of detection of ether waves." For he expressly attributed to Lodge, in his 1894 lectures, explanation "with great exactness [of] the various difficulties attending the full utilization" of that principle. And in referring to Marconi's first patent, of 1896, the opinion states that Marconi "*for what it was worth* . . . tuned the two circuits [i. e., the sending and receiving ones] together as Hertz had done." (Emphasis added.)

From these and other statements in the opinion it is obvious that Mr. Justice Parker found Marconi's invention in something more than merely the application of the "principle of resonance," or "sympathetic resonance," or its use to "tune" together the transmitting and receiving circuits. For Marconi in his own prior inventions, Lodge and the other references, in fact all who had constructed any system using Hertzian waves capable of transmitting and detecting sound, necessarily had made use, in some manner and to some extent, of "the principle of resonance" or "sympathetic resonance." That principle is inherent in the idea of wireless communication by Hertzian waves. So that, necessarily, all the prior conceptions included the idea that common periodicity must appear in all of the circuits employed.

Nor did Mr. Justice Parker's opinion find the inventive feature in the use of two circuits instead of one, at any rate in the receiver. For he expressly notes this in Lodge. But he points out that Lodge added the separate circuit "to leave his receiving aerial freer to vibrate electrically without disturbance from attached wires." And he goes on to note that this secondary (or closed) circuit not only was not, but could not be, "tuned" to the aerial circuit. And this he finds "exceedingly strong evidence" that "Marconi's 1900 invention was not so obvious as to deprive it of subject matter." Lodge had "tuned" the antenna circuit, by placing in it a variable inductance. But

he did not do this or accomplish the same thing by any other device, such as a condenser, in the closed circuit. And the fact that so eminent a scientist, the one who in fact posed the problem and its difficulties, did not see the need for extending this "independent tuning" (to use Marconi's phrase) to the closed circuit, so as to bring it thus in tune with the open one, was enough to convince Mr. Justice Parker, and I think rightly, that what Marconi did over Lodge was not so obvious as to be without substance.

In short, Mr. Justice Parker found the gist of Marconi's invention, not in mere application of the general principle or principles of resonance to a four-circuit system, or in the use of four circuits or the substitution of two for one in each or either station; but, as petitioner now contends, in recognition of the principle that, whether in the transmitter or the receiver, attainment of the maximum resonance required that means for tuning the closed to the open circuit be inserted in both. That recognized, the method of accomplishing the adjustment was obvious, and different methods, as by using variable inductance or a condenser, were available. As petitioner's reply brief states the matter, "The Marconi invention was not the use of a variable inductance, *nor* indeed *any other specific way* of tuning an antenna—before Marconi it was known that electrical circuits could be tuned or not tuned, by inductance coils or condensers. His broad invention was *the combination of a tuned antenna circuit* and *a tuned closed circuit.*" (Emphasis added.) And it is only in this view that the action of the Patent Office in finally awarding the patent to Marconi can be explained or sustained, for it allowed claims both limited to and not specifying variable inductance. That feature was essential for both circuits in principle, but not in the particular method by which Marconi accomplished it. And it was recognition of this which eventually induced allowance of the claims, notwithstanding the previous

rejections on Lodge, Stone and other references, including all in issue here.

In the perspective of this decade, Marconi's advance, in requiring "independent tuning," that is, positive means of tuning located in both closed and open circuits, seems simple and obvious. It was simple. But, as is often true with great inventions, the simplest and therefore generally the best solution is not obvious at the time, though it becomes so immediately it is seen and stated. Looking back now at Edison's light bulb one might think it absurd that that highly useful and beneficial idea had not been worked out long before, by anyone who knew the elementary laws of resistance in the field of electric conduction. But it would be shocking, notwithstanding the presently obvious character of what Edison did, for any court now to rule he made no invention.

The same thing applies to Marconi. Though what he did was simple, it was brilliant, and it brought big results. Admittedly the margin of difference between his conception and those of the references, especially Lodge and Stone, was small. It came down to this, that Lodge saw the need for and used means for performing the function which variable inductance achieves in the antenna or open circuit, Stone did the same thing in the closed circuit, but Marconi first did it in both. Slight as each of these steps may seem now, in departure from the others, it is as true as it was in 1911, when Mr. Justice Parker wrote, that the very fact men of the eminence of Lodge and Stone saw the necessity of taking the step for one circuit but not for the other is strong, if not conclusive, evidence that taking it for both circuits was not obvious. If this was so clearly indicated that anyone skilled in the art should have seen it, the unanswered and I think unanswerable question remains, why did not Lodge and Stone, both assiduously searching for the secret and both preëminent in the field, recognize the

fact and make the application? The best evidence of the novelty of Marconi's advance lies not in any judgment, scientific or lay, which could now be formed about it. It is rather in the careful, considered and substantially contemporaneous judgments, formed and rendered by both the patent tribunals and the courts when years had not distorted either the scientific or the legal perspective of the day when the invention was made. All of the references now used to invalidate Marconi were in issue, at one time or another, before these tribunals, though not all of them were presented to each. Their unanimous conclusion, backed by the facts which have been stated, is more persuasive than the most competent contrary opinion formed now about the matter could be.

It remains to give further attention concerning Stone. Admittedly his original application did not require tuning, in Marconi's sense, of the antenna circuit, though it specified this for the closed one. He included variable inductance in the latter, but not in the former. His device therefore was, in this respect, exactly the converse of Lodge. But it is said his omission to specify the function (as distinguished from the apparatus which performed it) for the antenna circuit was not important, because the function was implicit in the specification and therefore supported his later amendment, filed more than a year following Marconi's date, expressly specifying this feature for the open circuit.

Substantially the same answer may be made to this as Mr. Justice Parker made to the claim based on Lodge. Tuning both circuits, that is, including in each independent means for variable adjustment, was the very gist of Marconi's invention. And it was what made possible the highly successful result. It seems strange that one who saw not only the problem, but the complete solution, should specify only half what was necessary to achieve it, neglecting to mention the other and equally important

half as well, particularly when, as is claimed, the two were so nearly identical except for location. The very omission of explicit statement of so important and, it is claimed, so obvious a feature is evidence it was neither obvious nor conceived. And the force of the omission is magnified by the fact that its author, when he fully recognized its effect, found it necessary to make amendment to include it, after the feature was expressly and fully disclosed by another. Amendment under such circumstances, particularly with respect to a matter which goes to the root rather than an incident or a detail of the invention, is always to be regarded critically and, when the foundation claimed for it is implicit existence in the original application, as it must be, the clearest and most convincing evidence should be required when the effect is to give priority, by backward relation, over another application intermediately filed.

Apart from the significance of omitting to express a feature so important, I am unable to find convincing evidence the idea was implicit in Stone as he originally filed. His distinction between "natural" and "forced" oscillations seems to me to prove, in the light of his original disclosure, not that "tuning" of the antenna circuit as Marconi required this was implicit, but rather that it was not present in that application at all. It is true he sought, as Marconi did, to make the antenna circuit at the transmitter the source of waves of but a single periodicity and the same circuit at the receiver an absorber only of the waves so transmitted. But the methods they used were not the same. Stone's method was to provide "what are *substantially forced* vibrations" in the transmitter's antenna circuit and, at the receiver, to impose "between the vertical conductor [the antenna] . . . and the translating devices [in the closed circuit] [other] *resonant circuits attuned* to the particular frequency of the electro-magnetic waves

which it is desired to have operate the translating devices." (Emphasis added.) In short, he provided for "tuning," as Marconi did, the transmitter's closed circuit, the receiver's closed circuit and the intermediate circuits which he interposed in the receiver between the open or antenna one and the closed one. But nowhere did he provide for or suggest "tuning," as Marconi did and in his meaning, the antenna circuit of the transmitter or the antenna circuit of the receiver. For resonance in the former he depended upon the introduction, from the closed circuit, of "substantially forced electric vibrations" and for selectivity in the latter he used the intermediate tuned circuits. Stone and Marconi used the same means for creating persistent oscillation, namely, the use of the separate closed circuit; and in this both also developed single periodicity to the extent the variable inductance included there and there only could do so. But while both created persistent oscillation in the same way, Marconi went farther than Stone with single periodicity and secured enhancement of this by placing means for tuning in the antenna circuit, which admittedly Stone nowhere expressly required in his original application. And, since this is the gist of the invention in issue and of the difference between the two, it will not do to dismiss this omission merely with the statement that there is nothing to suggest that Stone "did not desire to have those circuits tuned." Nor in my opinion do the passages in the specifications relied upon as "suggesting" the "independent" tuning of the antenna circuits bear out this inference.

When Stone states that "the vertical conductor at the transmitter station is made the source of . . . waves of but a single periodicity," I find nothing to suggest that this is accomplished by specially tuning that circuit, or, in fact, anything more than that this circuit is a good conductor sending out the single period waves forced into it from the

closed circuit. The same is true of the further statement that "the *translating apparatus* at the receiving station is caused to be selectively responsive to waves of but a single periodicity" (which tuning the intermediate and/or closed circuits there accomplishes), so that "*the transmitting apparatus* corresponds to a tuning fork sending but a single musical tone, and *the receiving apparatus* corresponds to an acoustic resonator capable of absorbing the energy of that single simple musical tone only." (Emphasis added.) This means nothing more than that the transmitter, which includes the antenna, and the receiver, which also includes the antenna, send out and receive respectively a single period wave. It does not mean that the antenna, in either station, was tuned, in Marconi's sense, nor does it suggest this.

The same is true of the other passages relied upon by the Court for suggestion. No word or hint can be found in them that Stone intended or contemplated independently tuning the antenna. They merely suggested, on the one hand, that when "the apparatus" at the receiving station is properly tuned to a particular transmitter, it will receive selectively messages from the latter and, further, that the operator may at will adjust "*the apparatus* at his command" so as to communicate with any one of several sending stations; on the other hand, that "any suitable device" may be used at the transmitter "to develop the simple harmonic force impressed upon" the antenna. "The apparatus," as used in the statements concerning the adjustments at the receiving station, clearly means "the apparatus at his command," that is, the whole of that station's equipment, which contained in the intermediate and closed circuits, but not in the open one, the means for making the adjustments described. There is nothing whatever to suggest including a tuning device also in the open circuit. The statement concerning the use of "any

suitable device" to "develop the simple harmonic force impressed upon the vertical wire" might be taken, in other context, possibly to suggest magnifying the impressed force by inserting a device for that purpose in the open circuit and therefore to come more closely than the other passages to suggesting Marconi's idea. But such a construction would be wholly strained in the absence of any other reference or suggestion in the long application to such a purpose. Standing wholly alone as it does, it would be going far to base anticipation of Marconi's idea upon this language only. The more reasonable and, in view of the total absence of suggestion elsewhere, the only tenable view is that the language was intended to say, not that Stone contemplated including any device for tuning in the open circuit, but that he left to the mechanic or builder the choice of the various devices which might be used, according to preference, to create or "develop," in the closed circuit, the force to be impressed upon the antenna.

Finally, Stone was no novice. He too was "a very expert person and one of the best men in the art." *National Electric Signalling Co.* v. *Telefunken Wireless Tel. Co.*, 209 F. 856, 864 (D. C.). He knew the difference between tuned and untuned circuits, how to describe them, and how to apply them when he wanted to do so. He used this knowledge when he specified including means for tuning in his closed circuit. He did not use it to specify similarly tuning the open one. The omission, in such circumstances, could hardly have been intentional. In my opinion he deliberately selected an aperiodic aerial, one to which the many receiving circuits his application contemplated could be adjusted and one which would carry to them, from his transmitter's tuned periodicity and by its force alone, what it sent forward. In short, Stone deliberately selected an untuned antenna, a tuned

closed circuit, and controlled the periodicity of both, not by independent means in each making them mutually and reciprocally adjustable, but by impressing upon the untuned antenna the forced periodicity of the closed circuit.

It may be that by his method he attained results comparable, or nearly so, to those Marconi achieved. The record does not show that he did so prior to his amendment. If he did, that only goes to show he accomplished in consequence what Marconi did, but by a different method. That both had the same "broad purpose" of providing a high degree of tuning at both stations, and that both may have accomplished this object substantially, does not show that they did so in the same way or that Stone, by his different method, anticipated Marconi.

In my opinion therefore Stone's amendment was not supported by anything in his original application and should not have been allowed. As petitioner says, it added the new feature of tuning the antenna and in that respect resembled the amendment of a Fessenden application "to include the tuning of the closed circuit." *National Electric Signalling Co.* v. *Telefunken Wireless Tel. Co., supra.* The amendment here should receive the same fate as befell the one there involved.

Stone's letters to Baker, quoted in the Court's opinion, show no more than his original application disclosed. There is no hint or suggestion in them of tuning the antenna circuits "independently" as Marconi did. And the correspondence gives further proof he contemplated introducing the inductance coil (or a device equivalent in function) into the closed circuit, but expressed no idea of doing the same thing in the open one.

In my opinion therefore the judgment should be reversed, in so far as it holds Marconi's broad claims invalid.