called a "condenser," is radically different from the old "condensers," for in the Dolbear receiver one of the plates is held firmly so that it cannot vibrate, and the other is held so as to be free to vibrate (according to the variations of electrical charge) and beat the air and give audible sound; the two plates being separated by a body of air so that no current can pass.

Here is a change of construction designed to produce a new operation, for a new purpose, without which change that operation could not be performed nor that purpose answered. No operation of vibrating either plate by variations of electrical charge was contemplated or performed in the old condensers. The arrangement of the parts or elements of the old condensers did not admit of its being performed.

To hold one element of a condenser still, so that it shall not vibrate, and suspend the other so that it shall vibrate, and then make use of its vibration according to variations of electric charge, was wholly and absolutely new. No such instrument existed. No such use of any instrument had ever been proposed or supposed to be possible. It cannot be said with any show of reason that any equivalent for it was found in any of the old condensers.

Mr. Grosvenor P. Lowrey for the Molecular Telephone Company. *Mr. Wheeler H. Peckham* and *Mr. H. D. Donnelly* were with him on the brief.

The judgment appealed from decides that the appellant's transmitter infringes the fifth claim of Bell's patent of 1876, which is for "5. The method of, and apparatus for, transmitting vocal or other sounds telegraphically, *as herein described*, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds, *substantially as set forth:*" and also that the receiver infringes the sixth, seventh, and eighth claims of Bell's patent of 1877.

Certain Errors to be corrected in Limine.

Two popular errors which have a tendency to mislead the judgment, should be corrected at the outset, viz.:

(1) That "vocal sounds" and "articulate speech" are convertible terms in acoustics or telegraphy.

"Vocal sound" is an utterance common to all animals possessing the organ of voice. "Articulate speech" is a series of sounds uttered in accordance with the laws of language in arbitrary sequence, to express ideas. At the date of Bell's patent "vocal sounds" was a term used in connection with multiple telegraphy, in which the signals were certain sustained or broken musical notes of a given pitch. The use of that term in the fifth claim does not, therefore, imply that articulate speech was contemplated.

(2) That this controversy relates to a telephonic device — the invention of Mr. Bell.

No part of the transmitting instrument so familiar to our eyes, in the commercial business of telephony, was invented or is claimed by him. When, therefore, the appellees speak of a Bell telephone, they refer not to any device which they claim was invented by Mr. Bell, but to any and every telephone which transmits speech "by causing electrical undulations similar in form to the vibrations of the air accompanying" the transmitted sound.

No telephone *can* transmit speech except by producing in the line wire *some* electrical action equivalent to the exciting cause.

What that action is cannot be known; but Mr. Bell and others have inferred — perhaps not unreasonably — that it consists in a series of changes in current strength; and one of them, Mr. Varley, in 1870, gave to these changes the name "undulations."

Bell having adopted the inference and the name, has — according to his present interpretation of the Patent Office language — patented the inference.

Points of Difference arising upon the Record.

The differences between the litigants in the Molecular case arise chiefly on the interpretation of the fifth claim. Certain particular facts and ideas affecting, modifying or arising out of these differences need to be indicated at the outset in order to relieve the later discussion from repetition.

Appellants' Construction of the 5th Claim.

The appellants concede the fifth claim to be a good claim when restricted to *a specific apparatus* (Fig. 7 of the patent), which includes a closed circuit *incapable of being opened*, and a continuous current *incapable of being intermittent;* and *the method* by which alone that apparatus can be operated.

Any broader interpretation they regard as an unauthorized enlargement of the words of the patent, resulting in a monopoly to (1) some things invented before Bell's time; (2) some other things invented afterwards, and in no sense derived from him; and to (3) scientific facts or laws of nature, the monopolizing of which no statute justifies.

Appellees' Construction.

The appellees regard this claim — and upon their persuasion the courts below have so interpreted it — as a "broad claim" to all electrical transmission of speech, which results from "causing electrical undulations similar in form to the vibrations of the air accompanying" the sound; on the ground that Bell first discovered that this is the way in which speech is transmitted electrically. In fact, the words of the claim are a mere formula to express that thing, whatever it may be, which occurs in the line wire when speech is transmitted.

A claim is thus virtually made to speech transmission *by the transmitting of* it; or, in other words, for all *such doing* of a thing as is *provable* by its *being done.*

The significance and far-reaching effect of such a claim (thus interpreted) needs only to be realized, to be rejected by an application of the *argumentum ab inconvenienti.* To test this an analogous claim covering speech transmission by the *air*, as a medium, may be formulated and compared with Bell's actual claim, as follows:

Claim for AIR *Transmission of Speech.*

1. A says: "I will *speak* to C."

2. B says: "I will *cause* by the action of my vocal organs, &c., an *undulation of air* particles between C and me, in a form similar to the originating movements in my vocal chords, mouth cavities, &c."

These two propositions are equivalents.

Claim for ELECTRICAL *Transmission of Speech.*

3. Reis, Bourseul and Bell each say: "We will by means of membranes, conductors and magnets *transmit* and *reproduce sounds electrically* (Bourseul and Reis add "speech," which Bell omits).

4. Reis and Bourseul say: "We will do this by speaking to a membrane connected with a wire and battery, and thus *cause the air vibrations* accompanying any sound to be *taken up* by an electrical current, and by *means of that current* to be *reproduced, so as* to give to the hearer the same sensation as the original vibrations would have done. To do this, however, the mechanical arrangement must be such as *will enable the syllables to reproduce* their *vibrations* — so that *none shall be lost* — throughout *all* the intervening *media*" (including of course the wire).

5. Bell says: "I will do this by 'method of and apparatus for *causing electrical undulations similar in form* to the *vibrations of the air* accompanying' such sounds."

These three propositions are equivalents.

If we now attempt to frame a patent claim for, say, proposition 2, it will be apparent that such a claim will cover proposition 1 — and that would be intolerable to common sense. If we attempt to patent proposition 5, which is Bell's precise claim (with its present interpretation understood), we shall

find that we have covered proposition 3 — which is again intolerable as being too broad; and besides was anticipated by proposition 4, which was announced to the world at a much earlier date.

This broad construction has nevertheless been sustained upon an elaborate exposition, by counsel and experts, of the physical laws involved in the operation of telephony; and an assumption that (1) some of these essential laws and conditions were unknown before Bell, and were discovered by him; (2) that Reis failed in 1861 to transmit speech because he was ignorant of them; (3) that his system demands a mode of operation inconsistent with those laws; and that therefore it could never succeed.

Certain General Principles to be read into the Specific Work of Reis and others before 1861 — as due to a right understanding of them.

During all the period to which it is necessary to refer, a general principle of philosophy has fully possessed the scientific minds of the world, viz., that all forces of nature act and exist under certain laws of correlation which assume that energy is indestructible, and that its forms are capable of mutual conversion. It was not only believed but demonstrated that mechanical action (which is a motion of masses) may be transformed into heat and electricity (which was held to be a motion of the atoms of matter), and *vice versa*. These mutations were found to be rigidly subject to the laws of quantity, *i.e.* a given amount of one force was known to produce a definite quantity of another. This implies that where the originating force is variable, the resulting force will be correspondingly variable. These relations of the modes of energy commonly known by the phrase, "correlation of forces," or "persistence of forces," has formed a living element in scientific literature, and occupied the thoughts and guided the investigations of philosophical inquirers since about 1835.

It was also known that sound is a vibratory to and fro motion in ordinary matter; and that different sounds produce

different vibrations both as to the number of to and fro motions which an air particle will make in a given time, and also in the extent or amplitude of these vibrations. The rate of the vibration was imputed as the cause of pitch in sounds; and the amplitude of the vibration was imputed as the cause of its loudness. As these varied, the pitch and loudness varied.

But besides pitch and loudness, a characteristic which in acoustics is called "quality" enters into sounds, and enables us to distinguish one voice, instrument or other sound-producing cause from another, while both are giving forth the same pitch and loudness; and this was also known prior to 1861. The physicists inferred that this effect must arise from something in the movement of the air particle besides its rate and amplitude. They concluded that the air-particle journey performed under the impulse of one voice, differed from that which, at the same pitch and loudness, it performed under the impulse of another voice.

Thus in one case the movement might rise to a maximum of speed quickly; and in the other, slowly. In one it might maintain a nearly uniform rate of increase and decrease throughout, while in the other, there would be apparent irregularities.

These variations they called the "form" of the motion; as its results had before been called the "quality" of the resulting sound. Probably the term "form" was adopted from the use of graphical curves, by which the order and succession of motions or events are exhibited in the shape of a curved line.

Particular Application of these Principles to Electric Telephony.

All these things being known prior to 1861, the date to which attention must be called, it results that any physicist engaged at that time upon an effort to transmit and reproduce sounds by electricity must be considered to have known that as the motion of the air particle accompanying the sound may vary in form, violence or amplitude, the electrical changes —

or "undulations" — into which that motion is to be transformed, must correspondingly vary.

Under the general philosophical principles above stated, and which were universally accepted at the dates of Reis's inventions and publications, it was also clear that nature's way of transforming mechanical energy (such as the to and fro movement of an air particle) with all its variations of force, into electrical energy of similar mutations, was, and necessarily must always be, by successively reducing or increasing in a corresponding manner the strength of an electrical current. The phrase "electrical undulations similar in form," etc., is, therefore, a mere restatement of that universally recognized law, for the purpose of applying it to the specific subject of electrical sound transmission. These things being understood, it remained for the inventor and man of science to devise mechanical means and processes by which to bring about these needed electrical mutations in an order and degree suitable to maintain and reproduce the air vibrations accompanying the particular sound whose reproduction at a distance was desired. The mechanical devices sought for might vary, and the processes which within themselves they were to develop might vary, but it was known that the process of nature — to wit, the creation of something, in the electrical field (called by Bell, "undulations") equivalent in sequence, power and form to the motion of the air particle accompanying a sound — was the only process by which those motions could be counterfeited at a distance. This last process being a recognized law of nature, which experimenters and investigators were endeavoring to find means to bring into action, has been in previous adjudications confounded by the courts with those other invented processes or methods which are provided to control the operation of the mechanical devices of man. It will be easy to see, in reading the decisions below, that in using the terms "means," "method," and "process," the courts sometimes intend the means, method, or process of Bell's apparatus for taking up the sound-wave and bringing its energy to bear upon the electrical current; and in other cases they intend the means, method, or process by which the elec-

trical current, acting under a universal law, receives that energy and sustains and finally retransforms it; and these two meanings they confound to the prejudice of a correct intellectual judgment.

The appellants object to nothing in the judgments sustaining the fifth claim except that which grants to Mr. Bell a monopoly of the right to appeal to nature and to solicit her—acting according to her own laws—to receive, sustain, and retransform mechanical energy of sound-waves, when brought to the electrical current by an invented method and apparatus different from those of Mr. Bell.

Two different methods and apparatus by which sound-wave energy may be successfully transformed into electrical energy.

There are two mechanical methods by which man's invention is able to invoke and avail of this law of nature.

One was invented by Mr. Bell, and is called the "magneto-electric method." It involves a closed circuit and continuous current, without possibility of change.

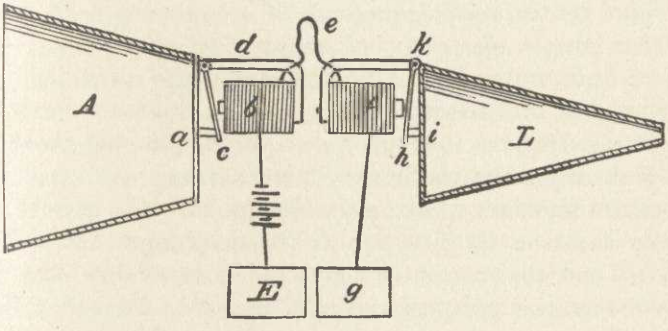
The other was not invented by Mr. Bell, and is called the "variable resistance method." It involves a circuit which may be opened and a current which may be made intermittent, automatically and irregularly.

As is apparent from the construction of the Reis instruments, the latter was employed by Reis and he was under the impression that his instruments *regularly* continued their variation of the degree of resistance to a point at which it became infinite; that is to say, to the point of breaking the current altogether. That his opinions upon this point have no relevancy in this contest will be shown hereafter; as also that his opinion as to the operation of his instrument is probably a mistaken one. The method used by him of placing in his transmitting instrument two electrodes in normal contact which could be separated so that no current could pass, (but which under the impulse of air-waves were really intended to vary their degree of pressure and the consequent

degree of resistance only so far as was necessary to accomplish the intended work), is now in universal use in telephony. There are numerous devices for operating by this principle. The Molecular Company's transmitter is one; and the Blake transmitter, used by the appellees, is another. Neither of these instruments could be used in the "closed circuit" method described by Bell in his patent, and by which method alone can the apparatus described in his patent (the magneto-electric telephone) be used.

1. Bell's Magneto-Telephone and its Methods.

"The method of, and apparatus for, transmitting vocal or other sounds telegraphically, *as herein described*," and "*substantially as set forth*," etc. 5th claim of Bell's patent of 1876.



The above drawing is copied from the patent, and together with the text of the patent, it clearly shows what "method" is applicable to what "apparatus."

The method may now be defined as follows: A method of transforming the mechanical energy of air-waves into electrical energy, by moving a piece of inductive material (diaphragm) in front of the poles of an electro-magnet, by which movement new electrical currents are set up in the coils of the electro-magnet; which, passing over a connected line in degrees of strength constantly varied by the movement of the inductive material, vary the magnetic power of a second electro-magnet; causing it to exercise a variable attraction on

another diaphragm in its neighborhood; which second diaphragm is thus made to copy the movements of the first diaphragm and reproduce in the adjacent air-particles, vibrations similar to those which accompanied the original sound.

The novelty in all this consisted not in the idea of transmitting sounds; not in the use of a movable membrane, disc, or diaphragm, for that purpose; not in the use of the energy of air-waves to act upon the membrane, etc., and thus to reproduce sounds; not in the employment of electro-magnets, conductors, or other electrical means — for all these were old; but — simply — in using the energy of air-waves to actuate mechanically a little *dynamo machine* and to cause it — not to *mould* an existing current — but to *create* new currents.

The essential characteristic of operation which distinguishes this method, more abstractly stated, is: A magnetic field, disturbed by the shifting presence of an inducing body, which thereby creates electricity of varying direction and electromotive force, in the wire. The efficient is the magnetic force; its source is the magnetic field; and the battery current — where a battery is used (as shown in the drawing above), — is not in any sense the cause of work, being used merely to magnetize the cores of the electro-magnets. The current constantly varies in its direction as the diaphragm advances or recedes, and the circuit *is never and can never be broken* — there being one complete metallic or earth connection from the transmitter to the receiver and back again.

2. The Variable Resistance Method used by Appellees.

In the variable resistance method the operative current has its source in a battery without which it would have no life. The current flows from the battery with a constant energy and direction, and the needed changes in it are caused by a variation of the resistance to its flow.

This is known in the arts as the "loose contact," "variable contact" or "variable resistance" method. In every apparatus devised to work by this method — beginning with that of Reis, in 1861 — the necessity to keep the contact loose and variable

introduces the possibility that the variation may be carried to the extent of breaking it altogether, by exceeding a certain degree of loudness in the tones which it is called on to take up and transmit. With this mechanical element in its construction, by which the apparatus, working automatically, constantly varies the connection of its parts — sometimes separating them entirely — the circuit cannot properly be spoken of as a "closed circuit" within the sense of this patent, because it may be broken.

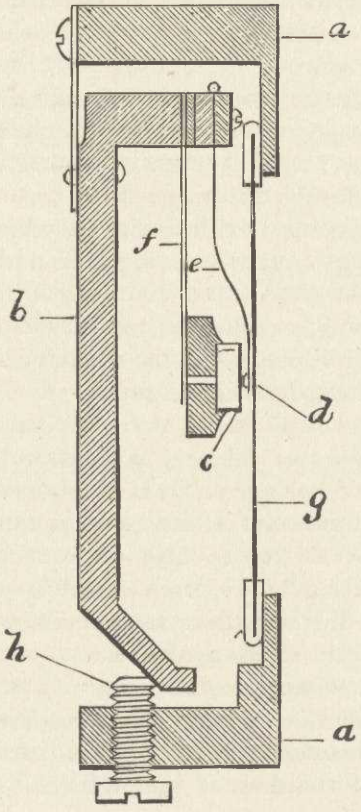
In the variable resistance method the energy of sound-waves is taken up by a movable diaphragm, which being acted upon by the impact of the air particles, moves to and fro in such a way as to produce a constant variation of pressure between the electrodes, from one to the other of which a current must pass (in conventional phrase) from its source in the battery to the receiver. By a well-known law this variation of pressure results in a constantly changing degree of resistance to the passage of the current, which has the effect to weaken or strengthen the current momentarily throughout the entire line, whereby the magnetic attraction of the electro-magnet in the receiver is varied and its related diaphragm is moved accordingly. All this being done under the influence of the movements of the first diaphragm, the result is that the second diaphragm copies the movements of the first and thereby causes air vibrations at the receiving station similar to those accompanying the original sound.

These two ways of producing current changes by the energy of sound-waves are two different methods in the arts and the law; and would be proper subjects of separate patents. The magneto method, invented by Bell, as appellants insist, *is what is referred to by him* in the fifth claim as "The method of . . . transmitting," etc. Such a reading satisfies the facts, the context of the specification and every other demand except the cupidity of his assignees.

The essential characteristics — more abstractly stated — which distinguish the variable resistance method are: That the current originates in a battery; that the cause of work is a disturbance of the flow of that current by a variation of

resistance in the conductor, thus creating undulations or vicissitudes of strength in the current; and that the working of the method depends on the circuit being capable of being open *or* closed — with a capacity for all degrees of pressure between the surfaces of the electrodes, from utmost contact to no contact.

In order that the apparatus capable of use in this may be contrasted with that capable of use in the other method, we exhibit an outline drawing of the Blake transmitter, a variable resistance instrument now in universal use by the Bell Company, and which is as incapable of being used by Bell's method, as Bell's apparatus is of being used by the Blake, or variable resistance, method.



Mr. Lowrey's Argument for Molecular Telephone Co.

[At this point *Mr. Lowrey* explained the principles and modes of operation of different telephonic apparatus, illustrating by large models of Bell's Fig. 7, as a pure example of the magneto telephone; and of the Blake and molecular transmitters, as examples of the variable resistance telephones, of which, as he stated, there are numerous forms. He contrasted the Blake transmitter with the Reis-Legat, deducing from the fact that both were provided with springs and adjusting screws by which to control the degree of pressure between the electrodes, that they are alike variable resistance instruments; and that the sole and entire effect of appellees' argument was to allow the Reis-Legat screw to be turned (say) twice — at which adjustment perhaps the transmitter would not transmit — and to prevent it being turned three times, at which adjustment speech could certainly be heard.]

The early judgments sustaining Bell's claim were founded on "concessions" which were not true — and were not conceded.

The claim of Bell to every transmission of sound "by causing electrical undulations similar in form to the vibrations of the air" (that being only another way of claiming the transmission of sound by transmitting it), needed a broad base to support it. This was supplied by the astounding concession made to him (by the court) in the Spencer case, that he is "admitted . . . to be the original first inventor of *any* mode of transmitting speech," and by the further statement, "but Bell *discovered a new art*, — that of transmitting speech by electricity, — and has a right to hold the broadest claim for it which can be permitted in any case; not to the abstract right of sending sounds by telegraph without any regard to means, but to all means and processes which he has both invented and claimed;" and that "the invention is nothing less than the *transfer to a wire* of electrical vibrations *like those which a sound has produced in the air.*" 8 Fed. Rep. 511.

If these concessions had been true, the consequences inferred would be fairly disputable; but they are not true.

This Court must consider:

(1) Of what does this "art" consist?

(2) Had it not, as a generic art, been discovered and announced to the world prior to the date of Mr. Bell's investigations?

(3) Does not the state of the art at the date of Bell's invention necessarily limit his fifth claim to that natural interpretation which covers whatever is accomplished by uttering a sound before the transmitter of a *magneto telephone* connected in an hermetically closed circuit — that being his only invention.

The operating of such an apparatus, by the energy of air waves, is *a* method of setting on foot the transmission of sounds.

It is *the* method, and the *only* method described in the specification of the patent in connection with *the transmitting of sounds;* and it is the only method capable of use by the apparatus delineated and described in the same connection.

A claim for "the method of and apparatus for" doing any particular thing must mean a method by which *the* designated apparatus can work; and an apparatus by which *the* described method can be employed.

It is an axiom of patent law that an inventor may claim a NEW ART *by pointing out an old apparatus; but can he claim an* OLD *art by pointing out a* NEW APPARATUS?

Reis's "Telephone."

In 1861, Philipp Reis, of Germany, made an instrument intended for the electrical transmission of "*all sounds capable of being perceived by the human ear*," and publicly described it in an article entitled, "On Telephony by Means of the Galvanic Current." This instrument was called a telephone. The means of using it, and the details of its action (both those which were observed and known, and those which were beyond the inventor's means for observation, and could therefore be spoken of speculatively only), were set forth. The acoustical and electrical principles which were then and are now supposed to underlie the operation of every telephone were ex-

plained in this paper. The sworn evidence of numerous witnesses is that the apparatus succeeded well in transmitting the tones of various instruments, and the tones of the human voice in the singing of words, and that it did also, on numerous occasions, transmit and reproduce the tones of the human voice in speaking. To this there is the testimony of Professor Quincke, at present vice-rector and actual head of the Heidelberg University;[1] Dr. Rudolph Messel, a well-known chemist of London; Johann Philipp Schmidt, paymaster in the Imperial German Navy; Heinrich Hold, of Friedrichsdorf; Johann Hausser, music teacher, in Wasselheim; and others.

From time to time other instruments similar in mechanical

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[1] At page 217 of appellees' brief it is said: "Last year at the great anniversary of the University of Heidelberg Mr. Bell received an honorary degree which *declared* him to be THE INVENTOR OF THE TELEPHONE."

This is certainly important, if true. Let us see.

The exact language of the diploma is: "Nos decanvs senior ceteresqve professores ordinis medicorvm in litterarvm vniversitate Rvperto Carola qvibvs conditæ ante haec qvinqve saecula vniversitatis nostræ sollemnia concelebramvs in virvm egregivm Alexandrvm Gr. Bell, Scotvm, qvi vt apparatv telephonico ingeniose invento societati hvmanæ magna negotiorvm peragendorvm emolvmenta largitvs est atqve dies increscentia ita chronographo perfectissime excogitato tam physicen non mediocriter adivvit qvam physiologiæ ipsiqve arti medicæ instrvmentvm rervm sat gravivm definiendarvm svppeditavit ivra et privilegia Doctoris Medicinæ honoris cavsa rite contvlimvs et hoc diplomate sigillo ordinis nostri monito testati svmvs."

It is believed that the following will be approved by any careful scholar as a true translation:

"We, senior Dean and other Professors of the order of Physicians in the Ruperta Carola University of Letters, during the days in which we join in celebrating the solemnities of the founding of our university five centuries ago, upon the distinguished man, Alexander Gr. Bell, a Scotchman, who, *as he has by telephonic apparatus ingeniously invented*, furnished great and daily increasing aids in transacting the business of human society, and also by a chronograph very perfectly devised has in no small degree rendered service to Physics, and also furnished to Physiology and to the Medical Art in particular, an instrument for defining things of grave import, have, in due form, and for the sake of doing honor, conferred the rights and privileges of Doctor of Medicine, and have attested it by this Diploma, guarded by the seal of our body."

As "the inventor of THE telephone" is to "the inventor of *a telephonic apparatus* ingeniously invented," etc., so is the *false* interpretation of the fifth claim to the *true* interpretation thereof.

action were constructed by Reis for the same purpose. One of them was publicly explained by V. Legat, Royal Prussian Telegraph Inspector, in 1862. Concerning these different instruments, the evidence is now that without material change of any of their parts, they will, with care and proper adjustment, all transmit speech, though imperfectly. This adjustment is, in the case of the Reis-Legat instrument, by means of a set screw and spring by which the contact of the electrodes is controlled; in the case of the cubical box instrument, by proper weighting of the parts with the same object; and by similar means in the case of the bored block instrument. The witnesses to this are Professors Brackett and Young, of Princeton College; Prof. A. E. Dolbear, of Tufts College, Boston; Prof. Charles R. Cross (appellees' expert); Messrs. Channing, Waite, Green, Paddock, and others. There is proof by several witnesses that in 1869, in the City of New York, at a public exhibition, they heard such instruments — made by Prof. Van der Weyde — transmit and reproduce the tones of the human voice in singing, and were able to distinguish words, which they now repeat.

With what has been said it will now be convenient to consider various facts and arguments as to their bearing on the subject stated, and which may for convenience be restated as follows:

(1) The general history of the art of sound transmission, — which is to be examined with a view to determine whether the principles of that art were not known before Bell's investigations.

(2) The general language and true scope and meaning of the patent of 1876, — which is to be examined with a view to determine whether it has been unwarrantably expanded by construction; and

(3) Whether under any circumstances so broad an interpretation as that adopted in the courts below can be sustained.

Mr. Lowrey's Argument for Molecular Telephone Co.

The Principles of Sound Transmission.

Electric telephony rests upon the sciences of acoustics and electricity, or magnetism.

Acoustics is that branch of natural philosophy which treats of the physical nature of sound, and the laws of its origin, propagation and effects.

Sound may be considered as a physical, or as a physiological phenomenon.

Physically, it is a particular vibratory motion in ordinary matter. Its existence implies that the sound-producing body has been thrown by some means into a state of agitation or tremor, which motion has been communicated to the neighboring air particles.

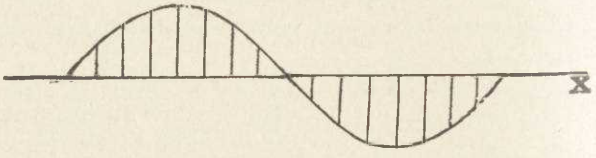
Considered in the physiological sense, sound is a sensation of the organ of hearing and of the brain. In order that the ear may be affected and the sensation of tone evoked, it is necessary that there should be interposed between the sounding body and the ear, one or more intermediate bodies (*media*) capable of molecular vibration. The air forms the most important medium for this purpose, but all matter may serve to transmit motion; that is to say, one particle or one mass of matter being by motion brought in contact with another, causes the other to move similarly, and in that way motion is said to be transmitted. The approximate cause of the sensation of sound is the condensation and rarefaction of the air lying against the ear drum. Thus sound begins in the motion of matter and results in the production of a physiological effect. In that effect the ear recognizes the character of the motion. It recognizes (1) pitch — that is, that the sounds are high or low; (2) intensity — that is, that the sounds are loud or soft; (3) quality — that is, they are distinguishable as emanating from one or another instrument, from the human voice, or from one or many of countless causes.

These effects arise from differences in (1) the extent, (2) the number and (3) the character of the vibrations made by an air particle in obedience to some motion of the sound-producing cause.

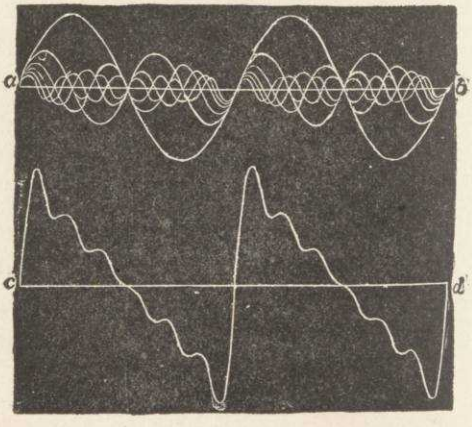
Simple and Compound Sounds.

All sounds capable of being appreciated by the ear are simple or compound; and among compound sounds, the most complex are the sounds of articulate speech.

A simple sound is one which causes the air particles to move in a straight line to and fro with a velocity of uniform increase and decrease; and is called pendular, because in this respect it is like the motion of a pendulum. That motion is represented by a curve called "sinusoidal," as follows:



A compound sound is one which is composed of several tones each of which, if sounded alone, would give to the air particle a pendular motion, but which, when sounded together, give it an irregular motion, compounded of all the forces of the different sounds. Compound sounds are variously represented, and are for illustration represented by the following plate, which shows by different lines from *a* to *b* all the mo-



tions of six different tones; while the line from *c* to *d* represents the actual motion which the air particle takes on in obedience to the simultaneous sounding of all these different tones. In this case it appears that the air particle sprang at once to a maximum of speed, which it reached — speaking roughly — before it had traversed one-sixth of its appointed journey — and then fell off rapidly at three intervals until it stopped, and returned by a motion almost exactly reversed.

In acoustics the principle of sound conduction is the same, therefore, whether the sound be complex or simple; that is to say, the principle is that the air particle will act in obedience to the particular sound, whatever it may be, by moving to and fro in a manner peculiarly deduced from the influence of the particular sound-producing cause or causes. As soon as a sound-producing body causes the air particles (1) not only to move to and fro a requisite number of times in a given time, but also (2) a definite distance backward and forward, and (3) also to do something else at the same time, so as to produce such difference in the sounds as will enable the listener to distinguish the sound-producing cause — then the sound is perceivable in all its elements of pitch, loudness and quality.

"Quality" is a term arbitrarily used by physicists for a long time, to indicate something done by the air particle outside of rate and amplitude of motion. What this something is, is entirely a matter of hypothesis.

Helmholtz, in his "Sensations of Tone," says:

"On inquiring to what external physical difference in the waves of sound the different qualities of tone correspond, we must remember that the amplitude of the vibration determines the force or loudness, and the period of vibration the pitch. Quality of tone can, therefore, depend upon neither of these. The only possible hypothesis, therefore, is that the quality of tone should depend upon the manner in which the motion is performed within the period of each single vibration."

Upon this hypothesis rests, therefore, the assumption at present universally made and accepted for purposes of scientific reasoning, that quality depends upon certain assumed or postulated eccentricities of conduct of the air particle while

engaged in performing the certain number of journeys of a certain length in a certain time. Upon this Mr. Bell forms a similar hypothesis for electricity, and has drawn the conclusion that the electrical current similarly undulates, or undergoes changes of force, — and, in the case of his magneto system, also of direction.

This conclusion — built up, hypothesis upon hypothesis — may or may not be true. Upon ultimate analysis, therefore, the fifth claim (as interpreted) appears to be clearly, for an intellectual conclusion from hypothetical premises, only; and is therefore, merely, a patented hypothesis.

It has been necessary for appellees' counsel to treat "quality" as a new idea in physics, not known in 1861 when Philipp Reis produced the first instrument ever made for transmitting sounds electrically. It was necessary that they should do this in order to sustain a forced interpretation of the language of Reis in describing his instrument and its principles of operation. They say that Reis did not know of quality or its cause. This is not true, as may be seen in Young's Lectures on Natural Philosophy, published in 1807, Vol. I, p. 388, as well as in the other numerous citations in our brief of dates prior to 1861.

Philipp Reis, on introducing his telephone in 1861, wrote an article in which he said that the "ear can no longer satisfactorily discern the relation of the proportionally *great vibrations* which determine the pitch, to the *small vibrations* on which *vocal quality* depends."

In these early expressions, made before any pecuniary interest had arisen to stimulate men to great scrutiny and exactness, and before a scientific terminology had been evolved and adopted, it is natural that Reis should choose his own terms, and he did it well. The cut showing the curve of a compound sound, shows what Reis meant by "great vibrations" in distinction to "small vibrations on which vocal quality depends." The full length of one vibration forward and back is shown by the entire length of the curved line above the straight or zero line, and then across it and below it until it crosses the second time; and that is a "great vibration." The "zig-zag"

shown both above and below the zero line represents those changes in velocity (and sometimes, for an infinitely short space, of direction) which are the "small vibrations" (included in the great vibration) "on which vocal" (or all) "quality depends."

Afterwards, in the same year, Reis read to the Physical Society of Frankfort a "Statement of a new theory about the perception of chords and the *quality* of sounds as a continuation of and supplement to the lecture on the telephone."

It should be considered as beyond dispute, that Reis understood that the air particle in doing its work represented quality by irregularity of movement; and that when he spoke of reproducing these movements electrically he knew that *none* of these "small vibrations" must be *lost* on their journey through the electrical field; or, in Bell's words, that the electrical undulations to be caused must be *similar in form* to the air vibration, &c.

The claim made for Mr. Bell, as already stated, that he first found out that quality needed something special for its transmission, is elucidated in a manner gratifying to appellants by Mr. Bell in an affidavit in the Drawbaugh case, that "Before this time, I had perfectly satisfied myself that the true and only method for the telegraphic transmission of vocal sounds involved as its fundamental element *an apparatus* which should transmit amplitude or intensity, as well as pitch — for quality, or timbre, or articulation, are ultimately resolvable into those two characteristics of vibration, &c., to be transmitted." Molecular Record, p. 2158.

Thus we find Mr. Bell stating that quality is resolvable into the two things, namely, amplitude (loudness) and rate (pitch), which are contemplated by Reis in his use of the term "great vibrations" as distinguished from "smaller vibrations" (quality). What was needed was "an apparatus."

We also find Prof. Cross testifying on this subject satisfactorily:

"The quality of a sound depends upon the number, loudness and relative pitch of the different partial tones. If the pitch and loudness of each partial tone can be accurately repro-

duced, the quality of the original sound can be reproduced." N. J. McDonough, R., p. 240.

"x–Int. 214. What do you understand him (Reis) to mean by the statement, 'Our ear can under no circumstances appreciate more than can be represented by these curves'?"

"Ans. *Reis knew that all the characteristics of sound* are due to *differences in the condensations and rarefactions* of the air conveying the sound-waves, and since these differences can all be represented graphically, he saw and stated, as in your quotation, that it was possible thus to represent all of the variation which affected the ear." *Ib.*, 186.

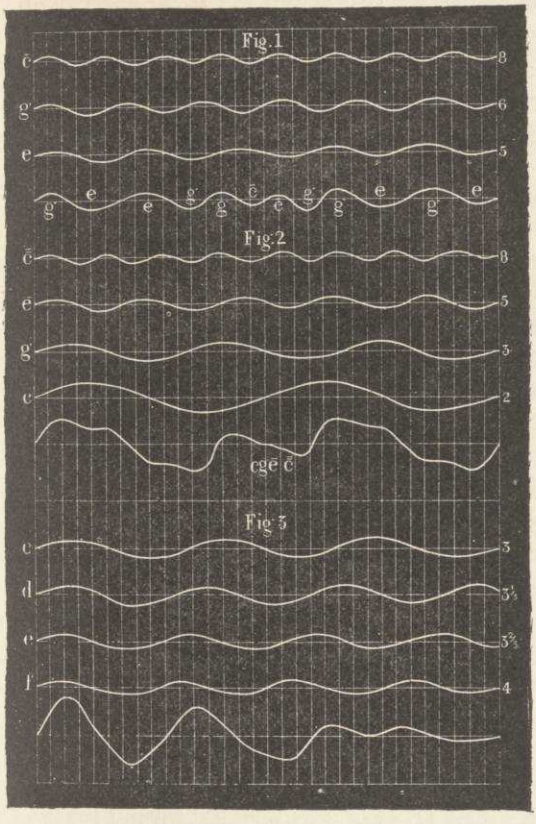
In the same examination, Prof. Cross says:

"x–Int. 218. In fact, the curve in the first diagram of Reis's lecture represents *only* the two characteristics of sound, —pitch and loudness?"

"Ans. On the contrary, it *represents quality* as well, though Reis makes no allusion to this." *Ib.*, 188.

The diagrams referred to are as follows:

Mr. Lowrey's Argument for Molecular Telephone Co.



Reis curves of three or four tones sounded simultaneously — and the combination or resultant curve in each case.

These diagrammatic curves prove that Reis understood the nature of "quality" and "form." The lines *c g e* are the curves of three separate simple sounds which being sounded together, produce a different curve, to wit, that from *g* to *e* in Fig. 1. In Fig. 2 the same comparative result is shown, as also in Fig. 3. These curves exhibit truly not only the motion of an air particle, but the rise and fall in strength of an electrical current which is being acted upon through suitable mechanism by the motion of the air particle. These curves

Reis made use of in connection with an instrument intended to transmit all sounds through the agency of electrical currents.

Resumé of Material Facts known to Physicists in 1861.

The material facts in acoustics, magnetism and electricity which were known prior to 1861, and knowledge of which must therefore be imputed to Philipp Reis, may be recapitulated as follows:

1. That sounds are propagated vibrations of matter.

2. That the loudness of any sound is determined by the amplitude of the vibration, or the distance through which the air particle moves to and fro.

3. That the pitch of a sound is determined by the number of times in which an air particle will traverse this amplitude in a given time.

4. That simple sounds give simple periodic and regular vibrations.

5. That all sounds are compound whose vibrations are the result of simultaneous action of several simple tones, whether resulting from one or from a number of sounding bodies.

6. That the term "quality" pertains to, and is predicable of, all compound sounds — of which articulate speech is only one class; and that the air particle, in obeying the impulses of the compound sound-producing causes, no longer makes the motion due to any one of them, but another motion, which is a compromise upon, and the algebraic sum of, all their varying and perhaps conflicting impulses.

7. That quality is expressed and represented by something in the manner in which the vibration is made — different from the amplitude and rate, but included within the amplitude.

8. That air vibrations can be taken up and reproduced by a plate or diaphragm.

9. That plate or membrane vibrations, derived from air vibrations, can be made to produce in a conductor, electrical changes corresponding to the air vibrations.

10. That by the use of an electro-magnet and a second plate,

the electrical vibration *will* produce another air vibration, in another place, corresponding to that which accompanied the original sound; or, in other words, that vocal and other sounds can be transmitted "telegraphically, by causing electrical undulations similar in form to the vibrations of the air accompanying the . . . sounds" (Bell's fifth claim).

With these observations upon the state of the art before 1861, we may next give attention to —

The First Conception of the Art of Transmitting Speech by Electricity.

Charles Bourseul, in 1854, published in a Paris journal his belief that a spoken word could be transmitted by electricity, and said:

"The thing is practicable in this way. We know that sounds are made by vibrations, and are made sensible to the ear by the same vibrations which are reproduced by the intervening medium. . . . Suppose a man speaks near a moving disk, sufficiently flexible to *lose none* of the vibrations of the voice; that this disk alternately makes and breaks the connection with a battery; you may have at a distance another disk which will simultaneously execute the same vibrations. . . .

"However this may be, observe that the syllables can only reproduce upon the *sense of hearing* the vibrations of the *intervening medium.* Reproduce *precisely* those vibrations, and you will reproduce precisely those *syllables.* . . . I have made some experiments in this direction. . . . The approximations obtained promise a favorable result."

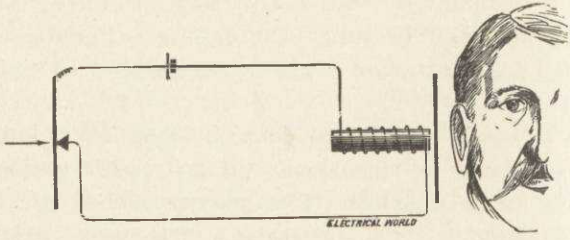
Except that it is now doubtful whether in case of successful speech transmission "this disk alternately makes and breaks the connection," etc., the language of Bourseul is a precise and complete statement of the law of operation expressed in and patented by Bell's fifth claim. One absolute condition is suggested by Bourseul, which is, with absolute fidelity, restated in Bell's claim, as will be seen by placing them side by side in the identical words of each author.

1854, Bourseul.

Bourseul is writing specifically of the transmission of "speech," by electricity over a wire, and its reproduction by suitable apparatus; and says:

"I have asked myself, for example, if the spoken word itself could not be transmitted by electricity; in a word, if what is spoken in Vienna may not be heard in Paris? . . . The thing is practicable in this way: . . ."

Then follows the suggestion of an apparatus which may be sufficiently shown by the following electrical diagram·



"We know that sounds are made by vibrations . . . observe that the syllables can only reproduce upon the sense of hearing" (*i.e.* at the distant receiving station of Vienna and Paris) "the *vibrations of the intervening* medium (the line wire) . . . reproduce precisely these vibrations" (*i.e.* the original syllable vibrations) "and you will reproduce precisely these syllables."

Reis and Bourseul Publications, page 3.

1876, Bell.

Bell is writing of the "electrical transmission" of "vocal and other sounds," which terms, as we have seen, do not necessarily include articulate speech; and says:

"I desire here to remark that there are many other uses to which these instruments may be put, such as the simultaneous transmission of musical notes, differing in loudness as well as pitch, and the telegraphic transmission of noises or sounds of any kind" (Specification, Patent No. 174,465).

* * * * * * *

"A cone is used to converge sound vibrations upon a membrane. When a sound is uttered in the cone, the membrane *a* is set in vibration . . . and thus electrical undulations are created upon the circuit. . . . These undulations are similar in form . . ." (*Ibid*).

"I claim:

"5. The method of, and apparatus for" (*i.e.* the *invented* process, etc., for producing desired undulations) "transmitting vocal or other sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the . . . sound," etc. (*i.e. nature's* process of immediately transforming, and ultimately reproducing, sounds telegraphically).

Let us place ourselves now at the date of Bell's Patent; and contrasting these respective declarations inquire, whether on that day Bell had achieved anything new in discovery — except his magneto method of *creating* currents and their needed undulations, which is what is referred to in those words of the claim, "*as herein described*" and "*substantially as set forth*"?

Since down to that date neither Bourseul nor Bell had actually transmitted speech; and since one or the other is now to be awarded the fame of first discovering and expressing that *law* which must be conformed to, by proper mechanical apparatus and operation, whenever and by whomsoever speech is to be transmitted; and since the mere intellectual conception of this law, accompanied by the pointing out of suitable apparatus to work it, has heretofore been held to be the discovery of "a new art," etc., it becomes most interesting to repeat in more specific form our questions:

(1) WHAT CONSTITUTES AN ART — in the sense of the patent law?

(2) WHEN IS AN ART "DISCOVERED" — in that sense?

(3) WHEN WAS THE ART OF TRANSMITTING SPEECH and other sounds (*by preserving all the sound vibrations* through an electrical metamorphosis, and reproducing them identically as air vibrations), DISCOVERED — and by whom?

These questions can be fully answered only when the con-

tributions of Philipp Reis to the operative part of this art are added to the theoretical announcements of Bourseul.

We have no evidence that Bourseul ever constructed any specific apparatus. His part in the evolution of this art consisted in recognizing and stating the *process of nature*, and thus opening to invention the task of providing *mechanical arrangements* by which to avail of that process.

To bring the process thus *discovered* and stated, within the control of man, was the work of *invention*. To reduce it to practice was a mechanical problem. The success at present attained is the joint achievement of Reis, Bell, Edison, Hughes, Blake, and numerous others; most of whom have asked and received patents for their specific devices. Bell alone has asked a patent for the *discovered* process of nature which all these invented devices serve; or in other words for achieving the natural result at which the mechanical efforts are aimed.

First realization of the transmission of speech and other sounds.

In 1861 Philipp Reis, at Frankfort, in Germany, published to the world a paper, entitled "On Telephony by means of the Galvanic Current," and exhibited an apparatus contrived, as he expressly states, for the purpose of transmitting speech and *all* other sounds. The acoustic principles involved are carefully explained, and the subject with all its difficulties is fully spread before the scientific world by the question:

"How, indeed, could a single instrument reproduce the combined effect of all the organs occupied in human speech? This was always the cardinal question; finally I got the notion of putting the question in another way —

"How is our ear affected by the *totality of vibrations* produced by the organs of speech all simultaneously active? Or more generally —

"How are we affected by the vibrations of *several simultaneously sounding bodies?*"

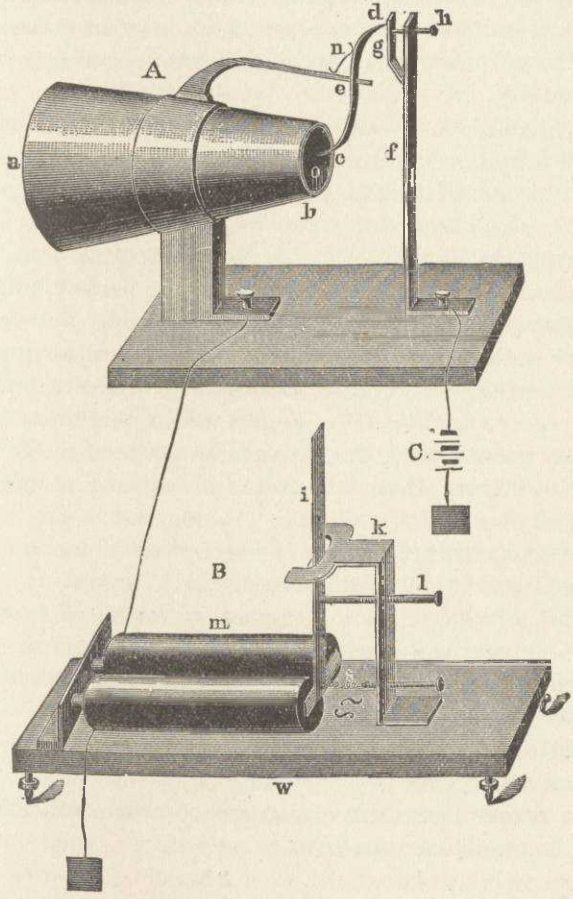
The instrument exhibited transmitted (according to the reports of the society to which the paper was read) melodies and the sounds of various musical instruments audibly.

In the paper describing it Reis says:

"With the above principles as a foundation, I have succeeded in constructing an apparatus with which I am enabled to reproduce the tones of various instruments and even to a certain extent the human voice."

"Hitherto it has not been possible to reproduce the tones of human speech with a distinctness sufficient for every one. The consonants are for the most part reproduced pretty distinctly, but the vowels as yet not in an equal degree."

The Reis-Legat Telephone of 1863.



So much, however, proves as completely as the most perfect performance could do that the transmitter was intended — and in a degree was able — to mould the current into the forms of different sound vibrations. The instrument spoken of was succeeded by modifications and improvements, so that several forms of the Reis telephone were in existence as early as 1864; and notably one which is described in a public journal by V. Legat, Royal Prussian Telegraph Inspector, in 1863.

Concerning this instrument much testimony has been given, all to the effect that it will transmit speech without adding to or taking away any of its parts, merely by adjusting the pressure of the electrodes through means of a set screw and springs with which it is provided, and the functions and uses of which are explained.

The capacity of the Reis instruments to transmit speech is supported by the sworn testimony of many of the most eminent physicists of this and other countries; and by various witnesses of highest respectability in Germany who heard it talk during the lifetime of Reis. None of the Reis instruments are good telephones, as compared with the perfect instruments of this day, *but they are as good as the original Bell telephone.* They are capable of being made good through the application of the inventions of Hughes, Edison and others; upon which, and *not upon the inventions of Mr. Bell*, the efficiency of the telephone system used by the appellees depends. Their principle of operation when transmitting speech is a matter still in dispute.

To overcome the effect of these historical facts, appellees have been driven to take positions as follows:

1. That although Reis designed and wished to transmit speech — he never succeeded in doing so.

2. That he failed because his apparatus was "intended" to make and break the circuit — and did so.

3. That Bell adopted the plan of a closed circuit, and by that means succeeded.

These propositions are a mixture of truth and error, and require examination and sifting.

Mr. Lowrey's Argument for Molecular Telephone Co.

1. *That although Reis designed and wished to transmit speech, he never succeeded in doing so.*

To admit, as Prof. Cross does, that the Reis instrument will speak now, and at the same time to deny that with all his efforts to that end, the inventor made it speak in his time, in view of unimpeached and highly responsible testimony — old and new — to the contrary, has only boldness to commend it.

2. *That he failed because his apparatus was "intended" to, and did, make and break the circuit.*

The supposed make and break element in the Reis instrument has been the crucial test upon which the courts below have been able to disregard proven facts, and satisfy themselves by a shred of theory. Adopting the arguments of counsel in the place of proof, Judge Lowell declares that:

"A century of Reis would never have produced a speaking telephone by mere improvement in construction."

This was said in connection with a statement that:

"The deficiency was inherent in the principle of the machine. It can transmit electric waves along a wire, under very favorable circumstances, not in the mode *intended* by the inventor, but one suggested by Bell's discovery; but it cannot transmute them into articulate sounds at the other end, because it is constructed on a false theory. . . ."

There is a mischievous fallacy here which consists in imputing to Reis an "intention" that his instrument should make and break the circuit anyhow, whether it succeeded in transmitting speech or not; and to the instrument itself a construction incompatible with any other mode of operation than such make and break.

The evidence of an "intention" on the part of Reis is derived from one or two expressions in his writings, which are given, first, an interpretation contradictory to the real sense of the whole; and second, an importance disproportionate to their true significance. Honest construction of the few pages which Reis has given us requires us to bear in mind, *first*, his professed object, which was *to transmit speech* and all other sounds; *second*, the construction of his transmitters (for rea-

sons of space the Reis-Legat only is referred to), which exhibit adjusting screws and springs so placed as to enable the operator to bring the electrodes together, and either render a separation impossible, or hold them in every degree of contact down to an actual separation of their surfaces; *third*, that at the time Reis wrote, many instruments of precision now in existence for making electrical tests were wanting; *fourth*, that the terminology of electrical science had not developed into general use any words by which to express *degrees* of make and break; *fifth*, that whether the instruments did or did not make and break was quite immaterial; and does not affect the sufficiency of his instructions to enable a skilled person to use his apparatus, *or the legal effect of his writings as published anticipations of Bell's fifth claim* (as interpreted).

The quotation chiefly in use to establish the assertion that he had built upon a wrong principle (Judge Lowell), or that he made *strenuous endeavors* to *prevent* a continuity of circuit (Prof. Cross), is found in his description of what he *supposed* to be the operation of his instrument. To know what value to give this description as evidence of the real fact, it should be considered that the separation of surfaces for $\frac{1}{50000}$ of a second of time, and a space of $\frac{1}{70000}$ of an inch would be sufficient to break a telephonic electrical current, as it is now used.

In the Frankfort lecture (Reis and Bourseul Publications, 16), Reis, after stating the principles of acoustics in such a way as to include the general law above stated, viz.: *that the intervening media between a sound-producing cause and a sound-perceiving organ must preserve all the original vibrations*, said:

"With the above principles as a foundation, I have succeeded in constructing an apparatus with which I am enabled to reproduce the tones of various instruments, and even to a certain extent the human voice."

Then follows the clause in question:

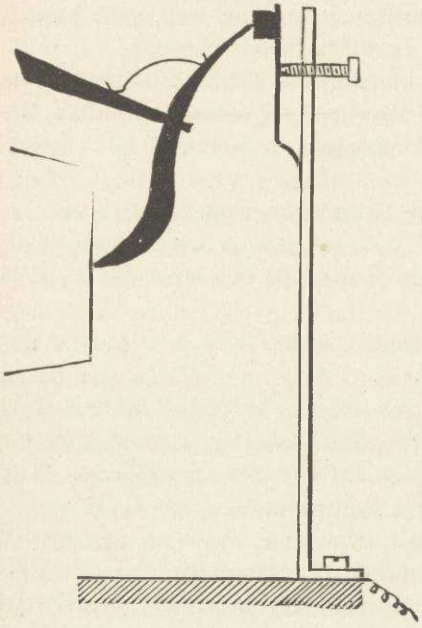
"At the first condensation, the hammer-like wire *d* is pushed back; at the rarefaction it *cannot* follow the retreating membrane and the current traversing the strip remains broken until the membrane, forced by a new condensation

again presses the strip against *d*. In this way each sound-wave causes a breaking and closing of the current."

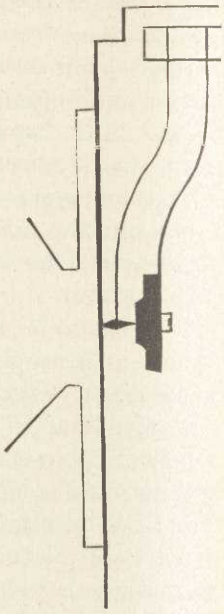
Upon this is rested the bold assertion that Reis adopted as the *principle* of his machine that it *must* make and break the current; and that he made "*endeavors to prevent*" the current from being *continuous*.

The language is before the court; the apparatus of the inventor and the principles of its construction are the subject of observation; the witnesses in respect to its performance have been heard.

It is seen to be an instrument of the class now universally known as microphone; and its action is what is known as microphonic action. Any two electrodes placed normally in contact with a slight pressure, and forming part of a circuit supplied with a current from a battery is a microphone. The principle of the microphone is the principle of the loose joint. The Blake transmitter is, up to this time, the most perfect and sensitive of all the microphones, but its relation to the Reis transmitter is genetic. Whatever may be done by a Blake transmitter may be done by a Reis transmitter; although more care will be needed with the Reis and less certainty will result; because the Blake is mechanically more perfect. The principle of the two is the same. Their objects are the same. Outline drawings of the workings of both are here shown. In each of these as will be seen there is a loose contact between the electrodes.



Reis-Legat Transmitter.



Blake Transmitter.

It is in the transmitter that the principle upon which Bell's broad claim is based does its work; it is here that the current is "moulded" into a "form similar," etc. The Blake transmitter has had the good fortune always to be mated with a good receiver; and when it "moulds" well the receiver is its witness. The Reis transmitter was in its origin mated with an insensitive and imperfect receiver. That receiver is doubtless chargeable with most of the failures to hear the words of the transmitter. The moulded undulations, similar in form, were there; but the receiver was inadequate to retransform them properly. When united to a good receiver the Reis instrument, as is admitted by the appellees, will talk; *thus proving that a Reis transmitter is "an apparatus"—and works by "a method"—capable of* "transmitting vocal and other sounds telegraphically, by causing electrical undulations similar in form to the air vibrations," etc. Professor Cross testifies:

Mr. Lowrey's Argument for Molecular Telephone Co.

"I have been able to transmit speech intelligibly by speaking *gently* into a Reis transmitter in circuit with a Bell magneto receiver."

But "gentle" speaking, since 1876, is forbidden, because, notwithstanding Reis, in 1861, had hinted this condition by saying:

"I was enabled to render audible to a large assembly (The Physical Society of Frankfort a.M.) melodies, which were sung (*not very loud*) into the apparatus in another house three hundred feet away" (Reis & Bourseul Publications, 17): still, Judge Lowell says, in effect, that singing "not very loud" is a "mode suggested by Bell's discovery." In short, in the view of that judge, it is lawful to sing loud enough to fail, but not gently enough to succeed.

Legat (Reis & Bourseul Publications, 33) is more explicit than Reis in the way of giving directions about adjustment, &c. After describing the transmitter shown, he says:

"The *proper lengths* of the respective arms *c e* and *e d* of this lever are regulated by the laws of the lever. It is advisable to make the arm *c e* longer than the arm *e d* in order that the *least motion* at *c* may operate with greatest effect at *d*. It is also desirable that the lever itself be made *as light as possible* that it MAY FOLLOW the movements of the membrane. *Any inaccuracy in the operation of the lever c d* in this respect will produce false tones at the receiving station. When in a state of rest, the contact at *d g* is closed and a delicate spring *n* maintains the lever in this position. . . . Upon the standard *f* is arranged a spring with a contact point corresponding to the contact point *d* of the lever *c d*. The position of *g* is regulated by the screw *h*."

From this it is made clear that Legat knew the electrodes must be kept together, mostly, if all sounds were to be effectively transmitted; and after this it was and is quite unimportant to know whether the current is sometimes, in fact, or only in the imagination, made and broken. Indeed, it is unimportant to know whether by that term Reis and Legat understood what we now understand by "make and break."

Describing the supposed operation he says:

"The lever *c d* follows the movement of the membrane and opens and closes the galvanic current at *d g* so that at each condensation of the air in the tube, the circuit is opened, and at each rarefaction the circuit is closed."

"In consequence of this operation, the electro-magnet of the apparatus in accordance with the condensations and rarefactions of the column of air in the tube *a b* . . . *is correspondingly* demagnetized and magnetized, and the armature of the magnet is set into vibrations *like* those of the membrane in the transmitting apparatus." . . .

He adds:

"In consequence of the imperfection of the apparatus at this time, the minor differences of the original vibrations are distinguishable with more difficulty; that is, the vowel sounds appear more or less indistinct, — inasmuch as each tone depends not merely upon the number of vibrations of the medium, but also upon its condensation and rarefaction."

"This also explains why chords and melodies were transmitted with marvellous accuracy, in the practical experiments hitherto made, while single words in reading, speaking, etc., were less distinctly recognizable, although even in these the inflections of the voice, as in interrogation, exclamation, surprise, calling, etc., were clearly reproduced."

"There is no doubt that the subject which we have been considering, before it becomes practically valuable, for use, will require considerable improvement; it will especially *be necessary to perfect the mechanism* of the apparatus to be employed; . . . "

From all the foregoing it must be clear

(1) that *all* sounds are transmitted by means of electrical undulations similar to their original vibrations; (2) that Legat and Reis understood that in order to succeed in the transmission of sounds, *none of the vibrations* belonging to the original sound must be lost; (3) that they were under the impression that the electrodes of the transmitter were separated with each rarefaction of the air and that during that separation the current ceased to flow; (4) that what they said was an ex-

pression of opinion, and not of intention; nor a declaration of the principle of the machine.

If continuity of circuit is requisite to transmit speech, then the means for preserving that continuity were provided by Reis and applied; and the proof that all sounds, including the tones of the human voice, and articulate speech, were transmitted, is proof that the needed continuity was preserved.

3. *That Bell adopted the plan of a closed circuit and by that means succeeded.*

It is true that Bell adopted the idea of a closed circuit which cannot be opened. That is shown in the drawing annexed to his patent, and the term "closed circuit" when used in the patent, or when used in supporting its claims, must in fairness be construed to cover, not a circuit like the microphone circuit of Reis or Blake (which may be closed or may be opened, according to the degree of power brought to bear upon it), but a circuit like that of Fig. 7, which cannot by any force whatever be opened.

That speech may be transmitted by such a closed circuit is now known, though it was not experimentally known when Bell took out his patent, nor until a considerable time after.

That speech cannot be transmitted when the circuit is sometimes automatically opened and closed, cannot be proven. The opinions of physicists differ. The truth about that matter is not so material as it would be if Reis had, as appellees sophistically aver, based his claims to performance upon make and break *as a condition.* The terrible force of logic upon the necessities of the appellants' theory concerning the Reis instruments will be found in the evidence of Professor Cross.

"47 x-Int. Do you understand that an apparatus which is capable of transmitting sounds *other* than vocal sounds, not articulate words, by causing electrical undulations similar in form to such sounds, would embody the invention described in said fifth claim?

"Ans. I do." The Amer. Bell Tel. Co. *v.* Spencer, p. 129, O., p. 3954.

From this answer it is evident that they are driven to claim

even the things which they must *admit Reis did*, viz.: the transmission of sounds *other than vocal sounds*, not articulate speech — *e.g.* the tones of the piano, accordion, clarionet, horn, organ pipe, etc., which were — of course — distinguishable only by their QUALITY (Reis & Bourseul Publications, 17).

Burdened with this necessity to stretch the 5th claim to the point of breaking, the witness elsewhere says:

"45 x-Int. At that time (1876) was the art of transmitting musical tones, including vocal musical tones, by electricity known?

"Ans. The art of transmitting the characteristic pitch of musical sounds, including the pitch of a sound produced by the voice, was known. The transmission of all the characteristics of *any* sound — its intensity, its pitch and its quality — was not known.

"46 x-Int. Don't you, in your last answer as to what was not known, describe an art which, if known, would have been the art of transmitting articulate speech?

"Ans. The *theoretical knowledge* of the manner in which the *one* could be done would, I think, *necessarily involve* the theoretical knowledge of the way in which the *other* could be done. The *practical realization* of an instrument which could transmit the three characteristics of pitch, intensity and *quality* of a musical sound would not necessarily involve the practical realization of the transmission of articulate speech." Molecular Record, 129.

"57 x-Int. Suppose a Reis transmitter of the form shown on page 10 or page 13 of said Prescott's work (being the form known as the Reis-Legat transmitter) is spoken into so softly as not to cause any actual separation of the electrodes, will not such transmitter act so as to vary the electric current so as to produce in such current an undulation corresponding in form to the sound spoken into such transmitter?

"Ans. When operated in the manner described, the transmitter figured on page 10 will do this.

"58 x-Int. In your opinion, will the efficiency of the Reis transmitter vary with the kind of material which is used in the electrodes?

"Ans. For use as a Reis transmitter, the efficiency is doubtless much influenced by the nature of the electrodes, which is well known to be the case in all circuit breakers.

"59 x-Int. Suppose a Reis transmitter of the form shown on page 10 of said Prescott's work is spoken to so softly as not to cause any actual separation of the electrodes, will not the transmitter produce in the electric currents in the line wire a series of undulations corresponding to the quality of the sounds spoken into such transmitter? I use the term quality in the sense in which you have used it in speaking of the characteristics of sound vibrations.

"Ans. IT WILL." The Amer. Bell Tel. Co. *v.* Spencer, p. 131, O., pp. 3956–7.

This testimony alone contains all which is required to defeat Bell's claim to the discovery of a new art in such a sense as to entitle him to a broad claim.

The favorite definition by counsel of Mr. Bell's invention is that he found out how to "mould" the electrical current into the form of the air-waves. Manifestly this "moulding" occurs in the transmitter: and the evidence that moulding has taken place is that speech is heard. If, then, the Reis transmitter united with any receiver whatever, gives that evidence that the transmitter has "moulded" the current, this is proof that Mr. Bell is not the originator of this art of "moulding." Upon this point the testimony of Prof. Cross recently taken and read into this case by stipulation is instructive.

In former cases Prof. Cross had said:

"It is possible, with the Reis transmitter, to produce electrical undulations similar in form to the sound-waves producing them," and

"I do not deny the possibility that *in spite of the endeavors of Reis to prevent it*, the circuit may have remained unbroken, and some sounds have been transmitted by the production of electrical undulations" (Dolbear Record, 508 and 515).

In the McDonough case he said:

"x-Int. 74. Is there no practical method of determining whether, in any particular apparatus, the deformation and loss of portions of the electrical undulations have reached such a

point as to place the apparatus outside the scope of Bell's fifth claim, or, in other words, so that the apparatus will cease to operate upon the method referred to in that claim?

"Ans. If an actual piece of apparatus, which could be experimented with were produced, it would be possible to determine whether it did or did not operate according to the method described in the fifth claim.

"x-Int. 75. What would be the practical test?

"Ans. One would observe the construction of the apparatus, the mode in which it was intended to operate if this were stated, *and the results actually obtained as apparent to the ear.*

"x-Int. 76. Could you determine the question by the last test alone?

"Ans. I have not found any difficulty in determining it in any apparatus that I have ever seen.

"x-Int. 130. Do you know of any method of adjusting a Blake transmitter so that it will operate efficiently otherwise than by listening to a receiver joined in the same circuit?

"Ans. *Not of any method which would be a practical one and satisfactory.* I know of no other which has been used.

* * * * *

"x-Int. 135. You know it to be a fact, do you not, that the electrodes of a Reis transmitter can be so adjusted relatively to each other by the mode in which the instrument is talked to that it will transmit speech?

"Ans. I have been able to transmit speech intelligibly by speaking gently to a Reis transmitter in circuit with a battery and Bell magneto receiver.

"x-Int. 136. At such times, as you understand it, the Reis instrument is producing undulations similar in form to the air waves?

"Ans. It is.

"x-Int. 137. And embodies the invention of Bell's fifth claim of the patent of 1876?

"Ans. I understand that it does when so operated.

"x-Int. 139. Did you find that you were also able with that same Reis transmitter to so adjust the electrodes in their relation to each other simply by your mode of talking to it that it would not transmit speech?

"Ans. When I talked to it loudly so that the circuit was broken frequently I was unable to transmit speech by it.

"x-Int. 140. Did it at such times embody the invention of Bell's fifth claim?

"Ans. I should say that it did not.

"x-Int. 141. Then, according to your belief, the determination of the question whether or not a Reis transmitter embodies the invention of the fifth claim of Bell's patent of 1876 does not depend upon the construction of the instrument or the relation of the parts to each other when at rest, but upon the mode in which the instrument is used; is that correct?

"Ans. It is." The N. J. McDonough Record, pages 152, 153, *et seq.*

From which it clearly appears that a Reis transmitter runs great risk of never being a Blake transmitter — in the hands of complainant's experts!!

The proofs as they affect the Reis instruments may be summed up as follows:

1. Reis devised an apparatus which he called a telephone for use in the transmission of language or words [1] (Tonsprache); the sounds of musical instruments; chords composed of simultaneously sounded notes, etc.

2. It is admitted that they were and are capable to trans-

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[1] The minute care which has been devoted to adjusting all facts and literature so as to be harmonious with the appellee's case concerning Reis is shown with respect to the translation of the word "Tonsprache" in the Reis article of 1861.

That article made its appearance first in the Spencer case in 1881, where "Tonsprache" was translated as "speech." In the next — the Dolbear — case, the article was (by stipulation between counsel) printed so as to substitute "musical tones" for "speech" as the true translation of "Tonsprache." From the latter case the exhibit has been adopted in subsequent cases by stipulation, apparently without any revision of the translation, so that the paper reads now "The extraordinary results . . . have . . . raised the question if it might not be possible to transmit *musical tones* themselves ('speech itself' — 'Tonsprache') to a distance."

The first translation is correct. See testimony of Bjerregaard, Molecular Record, p. 673, O., p. 1070, and the standard authority Lucas' German Dictionary, Bremen, 1868, as follows:

Tonsprache — f., *language, words* (oppos. to Geberdensprache, *pantomime*).

mit musical tones having quality, in such a way that the instruments can be distinguished.

3. It is proved that they did in the time of Reis, and will now — transmit words and sentences.

4. It is admitted that the Reis transmitter will transmit clearly and well when united to a good receiver.

5. It is proved that the Reis apparatus entire will "talk" when carefully handled — and that it will talk well without the addition of any element not already there, if slight changes in the mechanical construction (by a varying of the stiffness of springs, etc.) be made, and if the instruments be properly adjusted.

6. It is proved by Prof. Cross that any instrument capable to transmit any tone having quality is theoretically capable to transmit articulate speech; from which it results that to make it practically capable is a mechanical achievement, simply.

7. Whenever any transmitting telephone does actually transmit speech or any other sound possessing quality, it must necessarily have availed itself of some natural process in the line wire; which is probably the same process whether the impulse be received from a magneto transmitter or from a variable resistance transmitter; and which process Mr. Bell, under a name and description — the fitness of which appears as yet incapable of verification — has set forth in his fifth claim.

Upon this state of facts concerning the history of the art; and in view of the judgment below upholding the fifth claim because Mr. Bell is supposed to have discovered and announced in it a new art, to wit, "the new art of speech transmission," it now becomes material to consider certain legal questions.

1. *What is an art, in the sense of the patent law?*

2. *When may an art be regarded as discovered in contemplation of law?*

3. Who discovered the "art" portion of the practical business of speech and other sound transmission?

To conceive that a new thing can be done; to indicate in a correct though general way the laws of nature which must be availed of; to create suitable apparatus — although suitable only in a limited degree; to use the apparatus and succeed in

the avowed purpose — though only in a limited degree; to publish the result with sufficient specification to reveal the whole purpose, and put the world fairly upon further inquiry, appears to result in the production of a new art, and to take the doing of that special thing out of the category of undiscovered arts.

From that stage, in the development of that art, it would seem that invention and discovery must be deemed limited to the improvement and perfecting of old or the invention of new, modes of mechanism.

This difference between the discovery of an art and the perfected price thereof is what the court is called on in this case to clearly distinguish.

The error below has in part consisted in the apparently unconscious assumption of a false premise, viz., that the art of transmitting speech was undiscovered in 1876, because no good way of practising it had yet been worked out.

As to the Specific Art of Electric Telephony or Speech Transmission.

It appears clearly that the art of sound transmission is one art, the principles of which are in no wise changed or varied on account of the special sound to be transmitted.

It would then appear that there was not a special art of speech transmission left to be discovered after the general art of tone transmission was known.

Examining the works and considering the language of Reis, it appears that he set to himself and to the world a problem in this form:

How shall we mechanically take up and control the air vibrations accompanying any sound or sounds, and by their own energy create electrical actions corresponding to them; and afterwards by the energy of these electrical actions create other air vibrations which shall be so like the first as to produce in the organ of hearing the sensation of tone which would have been produced in it by the original sound or sounds?

The problem was *mechanical.*

He essayed an answer to this mechanical problem by a variety of devices.

There is not a *scintilla* of proof that Reis *ever tried to break or not to break the current.* He tried to *speak* so as to be *heard.* The consequence of such speech to the current, he left to nature and the automatic action of the instrument.

The words, the "little hammer, . . . *cannot* follow," etc., *had reference only to the Bored Block transmitter of 1861, and was never repeated in respect to the subsequent "cubical box" or Legat forms.*

Make and Break and Continuous Current.

Mr. Lowrey urged that it is a moot question whether absolute continuity of current is requisite to speech transmission; saying that it is not proved that speech cannot be transmitted when the current is intermittent; and therefore that the fact of transmission by a current *capable* of being broken does not prove that it has at all times remained continuous.

It is undoubtedly proved that something occurs in the electrical field which has an agency in the reproduction of sounds. Whether it is some variation of the intermolecular relations of the conducting medium brought about by attaching the conductor to a source of electricity; or some change in the tension of whatever is the product of the battery or magnet, and therefore called electrical; or whether it is some other occult process as yet not recognized, which results in allowing motion to be transferred and reproduced is not known.

Mr. Bell has taken a step forward and given the name of "electrical undulations similar in form" to that something which occurs. Having thus embodied and personified the theory in an expression, he has taken a patent for the expression and is now in position to restrain all transmission of speech upon the ground that when it is transmitted, "undulations similar in form," &c., are caused, and his idea thereby infringed.

That Mr. Bell and his experts are wrong, and that the proximate cause of speech transmission may hereafter be found to be, *not* the *similarity in form* of the undulations, etc.,

is not only not impossible, but in view of the many instances in which scientific theories as reasonable and as strongly upheld as the present undulatory theory of electricity have proved untrue, is not highly improbable.

One thing, however, is certain, that the words "*as herein described*," etc., hold the appellees to an apparatus which like that described, *owns absolute continuity* as its invariable law.

Bell's Present Broad Interpretation of the 5th Claim results in a Monopoly of a Scientific Fact or Law of Nature.

There remains still the important question — granting all which is claimed in the patent to be novel, *How much is patentable invention* or discovery, and how *much is unpatentable discovery* of scientific facts or laws of nature.

This brings us to the consideration of *Tilghman* v. *Proctor*, and other process cases; and *O'Reilly* v. *Morse*.

In one of the cases on appeal (the Dolbear case) the court says:

"There can be no patent for a mere principle. The discoverer of a *natural force* or a *scientific fact* cannot have a patent for that."

But it proceeds to make this exception nugatory by confounding the natural process (or scientific fact) with the invented process for working the apparatus; sustaining the patent for the last upon a construction which blindly sweeps in the first:

"The evidence in this case clearly shows that Bell discovered that articulate sounds *could* be transmitted by undulatory vibrations of electricity, and *invented* THE way or *process* of transmitting such sounds by means of such vibrations. If THAT *art* or *process* . . . is . . . the only way by which speech can be transmitted by electricity, that fact does not lessen the merit of his invention or the protection which the law will give *it*. . . ."

" . . . The essence of his invention consists not merely in the form of apparatus which he uses, but in the *general process* or method of which that apparatus is the embodiment." . . .

"Whatever name may be given to a property or manifestation of electricity in the defendant's receiver, the facts remain that they availed themselves of Bell's *discovery* that undulatory vibrations of electricity *can* intelligibly and accurately transmit articulate speech as well as of *the process* which Bell invented, and by which he reduced his discovery to practical use."

As interpreted, therefore, by the court and the counsel who uphold it, the fifth claim is a claim for the electrical transmission of speech under the form of a pretended description of how nature does it! Having found that a result happens, and guessed at the explanation, Bell patented the guess; and evidence that the effect has been attained is permitted to prove that his conjectural method is infringed.

In fact, what Mr. Bell discovered — assuming now the novelty of his work and accepting his formula as a conventional way of expressing the conception of science, about *something* which happens — was, not that electrical undulations *can* (as if there were some choice on the part of the inventor), but that they *do*, transmit sounds by conforming themselves to the characteristics of the energy which creates the sound — and that they will do this in no other way.

This is a scientific fact.

If his theory is true, and his claim to originality genuine, he had detected a secret of nature; and had found out how from the energy of motion in ordinary matter (sound) she sets up equivalent action (undulations) in the molecular, magnetic or electrical states of a conductor, and afterwards causes the force or energy to emerge from that intermediate state or form of manifestation into its original form.

In fact, he has merely reasoned on the subject, and has not, in any true sense, "discovered" anything.

In other words, Mr. Bell thinks he has discovered that the law of the persistence or correlation of forces holds good in its application to this subject.

Having so reasoned, he proceeded promptly to patent, not only a particular method and apparatus for availing of that law, but also the *right to* avail of that law by any means whatever.

Thus considered *he has been able to monopolize a natural force, and patent a scientific fact.*

To show how clearly this case is within the reasoning used in the case of *O'Reilly* v. *Morse*, 16 How., let us drop the middle term in the fifth claim and read it as follows: "5. The method of, and apparatus for, transmitting telegraphically vocal or other sounds . . . substantially as set forth" (*i.e.* the process of speaking and listening in a circuit specially arranged). Does the middle term thus left out describe anything discovered by Mr. Bell, in the sense of the patent law? If electricity undulates, Mr. Bell did not invent that action. As the claim stands, interpreted, therefore, it is pure and simple for the action of electricity whenever and in whatever manner it transmits sounds.

Suppose Mr. Morse had learned or surmised that electricity, when employed in transmitting signals, gains heat or color, and is gray, or blue, or red, and had said "I claim not only an apparatus by which electricity can be put into a heated or colored state, but I claim electricity whenever it is hot or colored in the act of transmitting."

In what sense would this be different from his disallowed eighth claim, — if it is only in and by the predicated conditions that electricity performs its work?

In short, Mr. Bell's way of claiming this law of nature is the way of Morse in his famous, disallowed eighth claim, disguised only by the turn of a phrase. Morse claimed the use of electricity for transmitting signals, and this was disallowed. Bell claims the use of electricity *when undulating* in correspondence with air vibrations and transmitting sounds. Since electricity will not transmit, except by undulating, the claim is in effect broadly for the use of electricity *when transmitting.*

The Morse fifth claim, which was sustained, was for the system of dots and dashes, — an arbitrary and conventional arrangement by which ideas were conveyed. Morse, and the world knowing already that the flow of a current could be interrupted and renewed, invented a certain order of interruption and renewals which would produce certain signals, the meaning of which could be fixed by agreement. This was an

artificial thing, and as such signals could be indefinitely varied, and the doing this was wholly the conception of his mind, he was given a patent for breaking up a current into any recognized succession of interruptions and renewals.

But the undulations of a current in the act of transferring mechanical movements of air particles is a natural system. Nobody wants it to undulate. It *will* undulate automatically when spoken to in certain right ways — of which Bell has one and the defendant another. The discovery of this fact belonged to the same class which the biologist makes, when, looking more and more closely into nature, he learns the process of ovation and germination.

To allow a patent claim for such a discovery might be likened to a claim for raising wheat by the germination of the seed: *leaving mankind free to produce wheat by all other methods!*

The Fifth as a Process Claim.

The arguments for sustaining the fifth as a claim to the process of transmitting sounds by causing electrical undulations, without reference to the means, has no support in the doctrine of Tilghman *v.* Proctor, *or any of the process cases.*

Mr. Lowrey argued, that in all the cases upholding a claim for a process, the process was one capable of being sensually perceived, verified and proved by oath — not as a matter of opinion, but as a matter of fact. That the process of transmission by undulations is plausible, and probably true; but is not proven; that we have merely adopted a term to signify something which happens, but the true nature of which remains as yet undiscovered; that the plausibility of the theory implied in the name, cannot justify a court of law in treating the theory as a proven fact, and sufficient basis for legal judgment affecting rights; that the theory of Sir Isaac Newton concerning the emission of light was no less plausible and remained for generations the accepted theory of the scientific world; yet now it is without a single believer. In the Tilghman case, for instance, the specifications say: "My invention consists of (1) a process for (2) producing free fat acids," &c.

Suppose the inventor had surmised some hidden chemical action as being a step in the operation; and, having obtained a patent for producing, etc., by causing that chemical operation, had insisted upon preventing all persons "from producing free fat acids," etc., by any means whatever, on the ground that the fact of production proves that his unseen and patented chemical process has occurred. We should then have a case analogous to this.

But that is not the case of *Tilghman* v. *Proctor*, 102 U. S. 707.

In Tilghman's specification the process is set out as follows: "I subject these fatty oily matters to the action of water at a high temperature and pressure," etc.

The court in interpreting the patent, says (p. 708): that it "is for a process of separating their component parts so as to render them better adapted to the use of the arts."

The claim was the manufacturing of fat, acids and glycerine from fatty bodies, *by the action of water at a high temperature and pressure.*

There was a process, all of which lay within ordinary means of observation and verification; being thus wholly unlike in material respects to the supposed process of creating undulations *in a continuous current*, which is Bell's claim.

It is believed, therefore, that so much of the fifth claim as by any construction is capable to be extended to the transmission of speech, should be expressly limited to what is accomplished by uttering — "as herein described" — the sound *before the transmitter of a magneto telephone.*

As this is not the appellant's way, he does not infringe the patent.

Varley and others.

The anticipations of Varley and others are treated fully in the Molecular Company's brief.

[Mr. Lowrey referred to the inventions of Varley and others as being fully set out in the brief of the Molecular Company as anticipations; and especially considered the claim that Bell's

patent has by proper references included the variable resistance method among those pointed out by him for use in transmitting sounds "by causing," etc., together with the evidence offered to show that he did make some experiments at one time with a stretched wire to ascertain whether a varying resistance to a current could be made to produce undulations in its force.

He asserted that no serious evidence existed in the case that Mr. Bell had ever before the date of his patent contemplated the production of undulations for the transmission of sounds by any other than the magneto-telephone method; and left the further consideration of the history of Mr. Bell's investigations and experiments to other counsel.]

Mr. Lysander Hill for the People's Telephone Company [Drawbaugh], and for the Overland Telephone Company. The briefs in these cases were signed by *Mr. Hill*, *Mr. George F. Edmunds*, *Mr. Don M. Dickinson*, *Mr. Charles P. Crosby*, *Mr. T. S. E. Dixon*, *Mr. Henry C. Andrews*, and *Mr. Melville Church.*

There are four or five different interests here; and each one wants to be heard by its own counsel. But, if your Honors please, some of us are substantially agreed in our general mode of presenting the case, and we shall not overlap each other. I shall take up the subject, for example, as nearly as I can, where Mr. Lowrey left it; and I shall endeavor not to walk over the ground which he has traversed, but rather to advance from the point where he stopped.

The order in which I shall take up the subjects which I shall discuss will be, as near as I can follow it, substantially this: I shall first discuss briefly the history of what Mr. Bell did, and what he did not do, endeavoring to give the court some idea of exactly what Mr. Bell did and what he did not do, what he sought to do, what his plans, his thoughts, his theories were, as obtained from his own testimony. And, I must say to the court that in all I shall say I shall be discussing the complainants', the appellees' testimony. I shall not have occasion to refer to the testimony of the appellants at