company, or that he had power or authority to execute said assignment." It is argued that it was incumbent upon the complainant in the first instance to prove that Hamilton was the treasurer of the company and that his act in signing the name of the corporation was duly authorized by its board of directors. It is unnecessary to refer to the evidence tending to show that the act of the treasurer was duly authorized and that it was made pursuant to the insolvency laws of the commonwealth of Massachusetts, for the reason that it is thought that the assignment itself was prima facie sufficient. A contrary ruling would put the owners of patents to a vast amount of needless annoyance and expense. When a certified copy of an assignment which has been duly recorded in the patent office and which is sufficient on its face to pass the title, is introduced in evidence, enough has been done to put the defendant to his proof. The authority must be presumed till the contrary appears. Bank v. Dandridge, 12 Wheat. 64; Academy v. McKechnie, 90 N. Y. 618, 629; Jackson v. Campbell, 5 Wend. 572, 575; Dederick v. Agricultural Co., 26 Fed. Rep. 763; Parker v. Haworth, 4 McLean, 370; Ang. & A. Corp. § 224.

The complainant is entitled to a decree for an accounting.

EDISON ELECTRIC LIGHT CO. v. WESTINGHOUSE et al.

(Circuit Court, D. New Jersey. April 10, 1893.)

1. PATENTS—ELECTRIC LIGHT—EDISON FEEDER PATENT.
   Letters patent No. 264,642, issued to Thomas A. Edison, September 19, 1882, for an "electric distribution and translation system," consist of a combination of two circuits,—the one, a consumption circuit, in the main conductors of which the "drop in tension" is not sufficient to vary, practically, the candle power of the lamps connected therewith; and the other, a feeder circuit, having upon it no translating devices, so that all the harmful "drop in tension" due to distance may be located upon it without affecting the relative candle power of the lamps in the consumption circuit. *Held* that, in view of the prior state of the art, the patent involves a union of distinctive elements, forming a patentable combination, and not merely a collocation or aggregation of elements, which is not patentable.
2. SAME—ANTICIPATION—WERDERMANN BRITISH PATENT.
   The invention described in the Edison patent was not anticipated by the invention described in the British letters patent granted June 21, 1878, to Richard Werdermann, for an improvement in apparatus for electric lighting, in which the patentee endeavored to overcome the "drop in tension" by compelling the electrical current to pass over or through an equal length and sectional area of a conductor in going to and returning from each lamp, by so arranging the parallel circuits in which the lights are included that the light which is the first one or the nearest to the source of electricity on a positive conductor is also the first or nearest to the source of electricity on the negative conductor, or by so arranging them that the lamp or light which is first with regard to its position on the positive conductor is last with regard to its connection with the negative conductor.
3. SAME—ANTICIPATION—KHOTINSKY FRENCH PATENT.
   The Edison invention was not anticipated by the invention described in the French letters patent issued March 19, 1875, to M. D. Khotinsky, for improvements in electric lighting, consisting—First, of a peculiar arrangement of the conductors of the electrical current, which permits the current to pass into each lamp or light independent of the others, so that the

variation or failure of light in one lamp has no effect upon the others; and, second, the arrangement of the burners of the lamps in such a manner that after the consumption in service of one carbon, or other luminous conductor, the current passes automatically into another luminous conductor, and from that into a third, and, after the consumption of all the luminous conductors provided, the current travels automatically to a spiral or conductor of any form, whose resistance is equal to that of the lamp in connection as described; such letters patent containing an indication that the inventor intended to obviate the "drop in tension" incidental to an extended system of lighting, and not disclosing the law for the proportions of the circuit in regard to the number of lamps connected therewith, nor giving any data by which it might be concluded that the lamps would vary from each other in candle power, which variance would be cured by the invention.

4. SAME—ANTICIPATION—LANE-FOX LETTERS PATENT.
The invention described in the Edison letters patent was not anticipated by the inventions for which two British letters patent were granted to Lane-Fox in 1878, although these inventions were intended to obviate the difficulties due to "drop in tension;" the form adopted being to enlarge the system of conductors as they approach nearer to the central station, forming what is generally known as the "Tree System,"—a system of distribution in which the electrical energy starts from the central station on the largest of the conductors in the system, and divides itself into so many branches as are required to operate the lamps; the branches diminishing in sectional area as the distance from the central station increases; the system being aided by attaching Plante batteries for storing up electricity, and distributing it.

5. SAME — ANTICIPATION — METHODS IN USE FOR DISTRIBUTION OF GAS AND WATER.
The invention described in the Edison letters patent was not anticipated by the prior methods and systems of gas and water distribution for public use; these methods and systems not being such as to form a basis upon which the Edison electric system could have been constructed.

6. SAME — ANTICIPATION — METHODS EMPLOYED IN ELECTROTYPING AND ELECTROPLATING.
The Edison invention was not anticipated by the methods in which electricity had previously been utilized in electrotyping and electroplating.

In Equity. Bill by the Edison Electric Light Company against Westinghouse, Church, Kerr & Co., to restrain an alleged infringement of letters patent. Decree for complainant.

Betts, Atterbury, Hyde & Betts, Frederic H. Betts, Eaton & Lewis, and S. B. Eaton, for complainant.

Kerr & Curtis and Leonard E. Curtis, for defendants.

GREEN, District Judge. The bill of complaint in this cause charges the infringement by the defendants of letters patent No. 264,642, granted Thomas A. Edison, September 19, 1882, for an "electric distribution and translation system." The alleged infringement is charged to be the construction and operation of an "electric light plant" in the city of Trenton, in this state.

Previously to the issuing of the letters patent, and on or about the 21st day of June, 1881, Mr. Edison duly assigned to the complainant all his right, title, and interest in and to the said invention, and any letters patent of the United States which might thereafter be granted to him therefor. The invention which was intended to be secured by the letters patent is declared by Mr. Edison, in the specification, to relate to a method of equalizing the tension

or "pressure" of the current through an entire system of electric lighting, or other translation of electric force, preventing what is ordinarily known as a "drop" in those portions of the system the more remote from the central station.

Six claims were made in the letters patent, but, of these, only the 1st, 2d, and 3d are relied upon by the complainant in this action. They are as follows:

(1) A consumption circuit, in the main conductors of which the drop in tension is not sufficient to vary, practically, the candle power of the lamps connected therewith, in combination with feeding conductors connecting the consumption circuit with the source of electrical energy, and having no translating devices connected therewith,—the drop in tension upon such feeding conductors not affecting the relative candle power of the lamps of the consumption circuit,—substantially as set forth.

(2) A consumption circuit, in the main conductors of which there is a definite, small drop in tension, not sufficient to vary, practically, the candle power of the lamps connected therewith, in combination with feeding conductors connecting the consumption circuit with the source of electrical energy, and having no translating devices connected therewith; the loss upon such feeding conductors being greater than upon the main conductors of the consumption circuit,—substantially as set forth.

(3) The combination of a consumption circuit, in the main conductors of which the drop in tension is not sufficient to vary, practically, the candle power of the lamps connected therewith, with a feeding circuit having no translating devices, and extending from the source of electrical energy to the center of the consumption circuit, substantially as set forth.

The defendants, by their answer filed in this suit, deny infringement, and insist that there is no patentable novelty in the alleged invention; contending that the invention claimed by Mr. Edison had been anticipated by various preceding patents, and had been described in numerous scientific and technical publications, and that the method and system of gas and water supply now customarily in use in large cities were entirely analogous and similar to the scheme devised by Mr. Edison for electrical distribution.

It goes without saying that no problem ever so severely vexed the marvelous ingenuity of invention as that which concerned itself with the safe, economical, and successful distribution of electric light over a large area of territory by subdivision of the current. The problem involved, as apparently unresolvable factors, not only the bringing to perfectibility the devices by which the translating of electrical vibrating force, electrical current, or electrical energy into the illuminating light could be readily and surely accomplished, but, as well, the successful evolution of a method or a process whereby the same current could be thoroughly divided in supply to numerous translating devices, and be rendered so subject to regulation that its operation under all imaginable circumstances should be uniform. In other words, the problem was to devise a system of distribution by which the current of electricity necessary to operate

the lamps in a district or territory of large area could be propelled to all parts of the district, at all times, in such volume, and under such pressure, as to cause all the lamps operated to develop a practically uniform and useful amount of illuminating power. Not more than 10 years have gone by since the most learned and astute scientists on both sides of the Atlantic unitedly declared the utter impossibility of its solution. After the most careful consideration, the most incessant experimentation, the intensest study, electricians and physicists acknowledged their inability to conquer success. At this time, indeed, the obtaining of light from a single lamp, or from a small group of lamps, by transmission of electric current, had been successfully accomplished. Edward Austin King, as far back as 1846, had been granted by the English government letters patent for an invention which consisted in "the application of continuous metallic and carbon conductors, intensely heated by the passage of a current of electricity, to the purposes of illuminating." And ever since, down to the very present, the records of the various departments for the granting of letters patent in almost every nation teem with descriptions of the inventions of those who have devoted their time and exercised their skill in the investigation of the subject of electrical illumination, and who have published in this manner their conclusions to the world.

But the successful production of "light" as the result of the intense heating of a carbon or metallic conductor by a current of electricity accomplished little or nothing towards overcoming those difficulties which were considered insurmountable by learned men, and were regarded as standing directly in the way of successful lighting of large districts by the illuminating power of the electric current. Those difficulties were the economic distribution and the proper division of the electrical current on a scale, and under conditions of convenience, adequate to a system of illumination for domestic purposes, in villages and cities, analogous to that of gas. The chief difficulty arose out of the admitted fact that no method was known at that time by which the electric current necessary to operate the lamps of such low candle power as to be comparable in illuminating power with the light from ordinary gas burners, could be sent to all parts of the territory to be supplied, at all times, in such volume, and under such pressure or tension as to cause all the lamps to develop a useful amount of light, at the same time having the current so regulated and controlled that it would never rise in degree at any lamp so as to injure the lamp itself by excess of power; that the system, practically, should be so arranged that the consumer would be enabled to illuminate or extinguish all the lamps on his premises without sensibly affecting the current of electricity passing by him to other lamps. In other words, the question was, how could there be delivered to all lamps in use, whether few or many, at all times a uniform current of electricity, of intensity severely adequate for the work required to be done?

In the attempt to solve the problem of electric lighting, two systems of arranging the translating devices with reference to the source of the electrical current or energy, and to each other, have

been suggested and tested by practical use. The one is known as the "Series" system; the other, as the "Multiple Arc" system.

In the series system the translating devices or lamps are arranged upon a single conductor wire, along and through or by means of which the electric current is impulsed through its entire length, and to each lamp, causing each lamp to be illuminated successively. As the current in such a system must, of necessity, pass through each intervening lamp between the generator and the end of the circuit to reach the one beyond, it is obvious that to overcome the joint resistance of the conducting wire, and of each lamp, it must be the subject of very great propulsive force. In the multiple arc system, lamps are arranged upon parallel bridges connecting the outgoing with the incoming conductor, and are supplied with electrical current simultaneously. In operating such a system the current sent from the generator, upon reaching the first bridge, itself divides; one part going over the bridge to the first lamp, and the balance surging forward to the second bridge and lamp, where the same action is repeated. In this system each lamp is practically independent of any other in the system, so far as the mere translation of the current into light is concerned. The electrical current which burns illumination into the first lamp has performed entirely its destined work, and in no wise concerns itself with any other lamp in the system. Each lamp is operated by its own proportion of the current. Hence, it follows that the distinctive characteristic of this system is found in the very great quantity of current which is required for successful operation in a large system; for at each lamp the primal electric current is necessarily diminished by that portion which devotes itself to the operation of that lamp.

That these two systems marked a great advance in electrical lighting is very apparent. Yet, when put to the test of use in the lighting of large areas, defects that seemed fatal speedily manifested themselves. Thus, in the series system, there was first the difficulty that—as all the lights were placed upon the one conductor wire, and the same current necessarily passed through each lamp in succession—the initial propulsive force exerted upon it must equal the sum of the resistance of all the lamps in the system. That the electric pressure might be kept within manageable bounds would, of necessity, greatly limit the number of lamps. Another and equally serious defect was caused by the fact that the extinguishment of one lamp by the breaking of the circuit necessarily extinguished all lamps; for the breaking of the circuit at any point severed its continuity, and caused an absolute stoppage of the progress of the current. The putting out of one lamp by destruction of the circuit extinguished all lamps upon the circuit.

The difficulty in the multiple arc system was equally disheartening, looked at from a financial standpoint. As was stated, in such system each lamp depends upon and receives a portion of the whole of the electrical current for its own wants and separate use. The "supply current," so called, must therefore, at the outset, be very large in quantity. Each lamp diminishes the whole by a certain

percentage. To operate, therefore, successfully, a system constructed on this theory, and covering an extensive area, and a very large number of lamps, the conductor wire must be quite equal in size to the sum of all the wires which would pass from the source of electrical energy separately to and from each lamp in the system. In other words, to carry the excessive volume of electrical current required for the supply of the lamps in the multiple arc system over a large area, would necessarily require conductors enormous in size,—in bulk equal to the combined bulk of all the small conductors that would be used in carrying the current to each separate lamp, if separate illumination was attempted. The cost of such enormous conductors, if the area of lighting was extensive, and the lamps very many in number, became simply prohibitory. Financially, the multiple arc system, as a means of extensive electrical lighting, was doomed to failure by this unfortunate necessity.

There remains yet another difficulty inherent in all systems of electric lighting,—in fact, in all systems or methods of transmission of electric energy or current,—which still further complicated the problem which we have been considering, and it arose from what is technically called "drop in tension." "Drop in tension" means "loss of the propulsive force which measures initially the forward movement of the electrical energy or so-called 'current' as it leaves the generator, and seizes upon and follows the conductor." This "drop in tension" is the necessary resultant of the obstructive operation of the molecules of the conductor to and upon the electrical energy or "potential," as it is called, as it forces its way through the conducting matter. Whatever the primary force may be that generates these phenomena to which is given the concrete name "electricity," it makes its presence known through a rapid vibration of the molecules of matter. What the exact character of those vibratory motions is can hardly be stated with scientific precision. It is quite enough to know that they differ in form, in direction of vibration, and in rapidity of movement.

Now, electrical energy can be utilized the more readily by being placed, to a certain extent, in confinement, and thus be compelled to exercise its power within certain defined limits; in other words, through the medium of a conductor, which simply means the substance or matter or thing which usually receives the electrical energy, and whose molecules readily respond to its resultant vibratory movements. Now, scientists declare that such electrical vibratory movements in a conductor depend, not only upon its specific character, but as well upon its size,—that is, its sectional area and length,—and that, the smaller the area in which these vibratory motions are propagated, the greater is the resistance offered. Accepting this as a law of electrical energy, it follows that, the larger the conductor in diameter, the less the resistance to the electrical energy as it passes through it; and, conversely, the smaller and more confined the space in which the vibrations are to be propagated, the greater the resistance to be encountered. In overcoming this resistance the current of electricity—or, more properly, the "electro-motive force or tension"—uses up a certain proportion of

itself, necessarily. This is true whether the resistance to be overcome is that obtruded in its path by the nature and character of the conductor, or arises from the work performed,—that is, the translation of the current into illumination, or other useful purpose. This inevitable loss or waste of tension caused by the self-expenditure of the force in subduing and overcoming the obstructions of the conductor is called "drop." The longer the wire, the smaller its sectional area; the greater the number of translating devices upon it, the larger the loss or waste. Hence, it would follow that the difficulty arising from these causes in the lighting by electricity of large areas, including a great number of lamps, would be almost prohibitory. The rule which governs the loss or "drop in tension" was given, on the argument, as this:

"With a given expense for conductors of a multiple arc system, the proportion or percentage of drop in tension increases, approximately, directly as the number of lamps and as the square of the distance."

Thus, twice as many lamps at twice the distance cause eight times the percentage of drop. It is quite apparent, then, that not a very great length of conductor, nor very many lamps, would be necessary speedily to cause a system to be wholly inoperative. The electro-motive force would be unequally used up in its effort to overcome the resistance, resulting in great inequality of action of lamps.

This statement, condensed from briefs of counsel in this case, discloses the problem which in 1880 electricians everywhere were trying to solve. How to light, not only economically, but how to light under any conditions, large areas, by the subdivision of electric force; how to overcome the resistance without the use of conductors so large as to be enormously expensive; how to prevent "drop in tension," so that its effect upon the lamps in the circuit should relatively be negligible. Only Mr. Edison seems to have found the solution, and by this alleged invention. In the specification forming part of the letters patent in this case, he thus states by what method and means he grappled with the difficulties, and overcame them:

"This invention," he says, "relates to a method of equalizing the tension or 'pressure' of the current through an entire system of electric lighting, or other translation of electric force, preventing what is ordinarily known as 'drop' in those portions of the system the more remote from the central station, and also to other features in systems for the utilization of electricity, as hereinafter explained.

"As is well known from patents already granted me, and prior applications pending, I use in my system an electric light formed of a continuing, incandescing conductor, large numbers of which are grouped into one system, supplied and regulated from a central station; main conductors leading from and to the central station; each lamp or translating device being in a derived circuit to the main conductors; the entire system being what is known as a 'Multiple Arc' system. From a central station the main conductors may proceed, and it is intended that they should, to a great distance, and supply a large number of translating devices. In such cases there is inevitably a difference in tension between various parts of the circuit, due to the resistance of the main conductors. This may be partially remedied by making the conductors very large near or at the station, gradually decreasing their size or conducting capacity; but such plan only lessens slightly the ratio of fall. To

obviate the difficulty I provide feeding conductors, which extend from the generator or generators to the main conductors of the lamp or consumption circuit or circuits; such feeding conductors not having any translating devices connected therewith, and being connected with the main conductors of the consumption circuit or circuits at the center, ends, or other points on such main conductors. From a central station several sets of such feeding conductors may run; each set feeding into its own lamp or consumption circuit or all the sets feeding into a connected system of lamp or consumption circuits. It will be seen that the drop upon the feeding conductors has no effect upon the relative candle power of the lamps of the system; the relative candle power of the lamps being affected only by the drop upon the main conductors of the consumption circuit or circuits between the end of a set of feeding conductors and points most distant from any feeding conductors. In order to maintain, practically, the same candle power throughout the system, the main conductors of the consumption circuit or circuits should be so proportioned that the drop in tension upon them shall not exceed a definite, small limit,—for example, five per cent. This drop will make a difference of less than a candle power in all the sixteen candle power lamps of the system, which difference is not perceptible to the eye. Upon the feeding conductors, however, any loss can be made. This loss will be varied according to localities, and the relative cost of copper for conducting purposes, and horse power for generation. This loss upon the feeding conductors in large and extended systems will generally be greater than upon the main conductors of the consumption circuit or circuits. It may be, for example, about fifteen per cent.; but circumstances might make it desirable to diminish the loss upon the feeding conductors down even as low as that upon the main conductors of the consumption circuit or circuits, or to increase the loss upon the feeders to more than fifteen per cent. * * *

"When it is desired to use a few lamps near the central station, they may be placed upon a direct circuit therefrom, with resistance at the commencement or home end of the circuit sufficient to then reduce the tension of the current in such circuit so that it shall only be equal to that in the more distant circuits, and one or more of such circuits may be combined with the circuits before described. When large buildings or blocks of buildings, using many lamps, are to be supplied, it may be desirable to lay therefor separate feeders, insulated from each other. Where several central stations are used in a city, each having feeding conductors leading to lamp-circuit conductors of the description before noted, it may be advisable to connect the feeding circuits of all the stations, equalizing the tension or pressure throughout the entire system of the place where the central stations are located."

In other words, Mr. Edison claims that the difficulties before alluded to, inherent in, and apparently prohibitory of, any system or method of lighting large areas of electricity, were surely obviated by his device of transmitting from the generator in a central station the energy or current along and through a conductor upon or in which the only "drop in tension" would be caused by the action of that energy or current in overcoming the resistance offered by the conductor itself, to another and independent conductor, upon which the translating devices should be congregated, and which would supply such a relatively small area, or parcel of a larger area, that the drop in tension suffered between the furthest translating device and the point of connection of the conductor would be negligible.

And this expresses, I think, what Mr. Edison intended should be comprehended in the three "claims" of his patent involved in this suit. To justify this statement it will be necessary to examine briefly the claims themselves. Regarding them in the most general way, they are simply claims for a combination. The combination

consists of two circuits,—the one, a consumption circuit; the other, a feeder circuit. But the consumption circuit is peculiar in its characteristics. It is a consumption circuit in the main conductors of which the drop in tension is not sufficient to vary, practically, the candle power of the lamps connected therewith. And the feeding circuit is equally peculiar, in that it has upon it no translating devices, and is of such nature and character, so far as its construction goes, that the drop in tension upon it shall not affect the relative candle power of the lamps in the consumption circuit. But this statement of the claims would be highly inaccurate, if permitted to stand alone. Other limitations must be regarded. Not only are the circuits, feeding and consumption, unique in their special characteristics, but, as well, are jointly applicable to the lighting by incandescent lamps, in multiple arc, of large areas, of which portions or parcels are very distant or remote from a central station, from which, however, emanates complete control. It is true that these latter limitations are not expressed in terms in the claims under consideration, or in either of them. But, in drafting the claims, Mr. Edison, by the words used, clearly referred to the descriptive phraseology of the specifications of his invention preceding them. This is apparent from his adding to each claim the words, "substantially as set forth." That is, he reads into each claim, and as a material part of it, by the admitted effect of those words which he uses, "substantially as set forth," the distinctive characteristics of the system of lighting by electricity which he had previously described with great particularity in the specifications. Those characteristics are: (1) The use of incandescent lamps; (2) the lighting of a large territory; (3) the unique service of the system of conductors; (4) the proportioning of the conductors for that service; (5) the forcing of the drop in tension to materialize where it was negligible; (6) the absolute equality of pressure on the mains.

It is wholly unnecessary to argue that this must be the effect of the use of these words, "substantially as set forth." They are clearly words of limitation, and they refer back to the descriptive specifications as the source of a qualification of the general statements of the claims, and so relegate the invention, as claimed, to a field within the purview and operation there specifically named. These descriptive limitations are expressed in the specification as follows:

"I use in my system an electric light formed of a continuous, incandescing conductor, large numbers of which are grouped into one system, supplied and regulated from a central station; main conductors leading from and to the central station; each lamp or translating device being in a derived circuit to the main conductors; the entire system being what is known as a 'Multiple Arc' system."

And again he says that his invention relates to—

"A method of equalizing the pressure or tension of the current through an entire system of electric lighting, or other translation of electric force, preventing what is ordinarily known as a 'drop' in those portions of the system the more remote from the central station."

These statements quoted from the specification show that the consumption circuit referred to as one of the elements of the combination stated in the claims is but a part of the whole system, of the specific character described in the specifications, and of which the characteristics are and were expressly intended to be such as stated.

And this construction, I think, is practically admitted to be the true construction of these claims by one of the principal expert witnesses produced by the defendants in support of their contention. I refer to the testimony of Mr. Pope in answer to ×-Q. 87, which is as follows:

"Is it not implied by the patent in suit that the systems of distribution to which the invention relates are only those in which some portions of the system are so remote from the central station that if all parts of the conductor and system of conductors from the central station to the extreme point or points of consumption were utilized for lighting purposes, by having lamps connected therewith, that such lamps would practically vary from each other in relative candle power by reason of excessive drop in tension?"

He says:

"I think it is implied by the patent, upon a fair construction, that the invention relates to a system of distribution in which many of the translating devices are quite remote from the central station, and that the patentee seeks to point out and describe such an arrangement of conductors as will avoid an unequal distribution of tension without incurring an inordinate expense for conductors. There can be no doubt, I think, that it was perfectly well known to electrical engineers long before August, 1880, that it was possible to avoid a variation in candle power in such a system, so far as candle power depended upon the quantity of current passing through a lamp, provided that the conductors might be made large enough to bring about such a result, and the question which presented itself at that time was how to secure these advantages without unnecessary waste of material."

"102 ×-Q. Are not the consumption circuits referred to in the patent circuits which, in extent, approximate the limit beyond which drop in tension is not negligible? A. It would be good engineering practice to make them so, and this is what I think the patent contemplates."

By the use of the words, therefore, referred to in the claims, this adaptability of the circuits—consumption and feeder—to these distinctive objects and purposes is thus indissolubly welded to, and made portion of, the elements of the combination called for and made requisite in the claims under consideration. If this construction of the scope and meaning of the claims be correct, it follows that Mr. Edison not only described, but properly claimed, a system, the general characteristics of which are that—

"It supplies electricity to 'consumers' using 'large numbers' of incandescent lamps in 'multiple arc,' requiring the maintenance of relatively equal difference of potential at their terminals, and so located with reference to each other, and to the station from which they are supplied, that, if supplied at one end of the circuit, the drop in tension between the nearest and most remote end could not be tolerated; that the supply is from a central station, separated from and uncontrolled by the consumers, or they by it; that these large numbers of lamps are connected with one or more 'consumption circuits,' the 'main conductors' of which consist of direct and return wires, so proportioned to the number and distance of such lamps that any fall in tension between the lamps nearest the feeder and those more remote is always negligible; that the lamps are of the kind described and referred to in previous patents and applications of Mr. Edison as giving light by means of a continu-

ous incandescent conductor; that the means of supply and regulation, so as to compensate for the uncontrollable actions of separated consumers, shall be from the central station, and through the feeding conductors, upon which all nonnegligible drop in tension is localized, and which, being free from connections with any lamps except upon the consumption circuit, are so situated with reference to the lamps that any desired drop in tension required by necessary economy in the size of conductors may be made upon them without harmfully affecting any lamps, or disturbing the equality of the candle power throughout the whole system; that the exclusive control over the feeding conductors is insured to the central station by the omission of all direct connections of the feeders with translating devices of any kind."

I quote the above summary from the brief of the complainant, and adopt it, as expressing fairly and justly what Mr. Edison accomplished.

It may be proper at this state of the discussion to consider whether this union of distinctive elements contemplated and described by the claims in suit forms a patentable combination, or amounts to a mere collocation or aggregation. The defendants strenuously insist that it is the latter, only; that the elements are all old, their action independent, their final effect not the result of coaction, and not in any sense novel. If this contention is well founded, these letters patent are worthless, for it is a well-settled principle that a mere aggregation of elements is not patentable.

What, then, is a patentable combination? Considered as a generic term, the combination may be defined to be a co-ordination of individual functions so as to constitute a common function. Co-ordination necessarily implies some modification of individual functions of each element as it existed prior to the combination. To be patentable, a combination must be in harmony with this definition, and as well, and as necessarily, must be possessed of novelty and utility. In the very able work of Prof. Robinson on the Law of Patents, he thus enlarges the definition just given of a patentable combination, and distinguishes between it and a mere aggregation:

"A combination is an instrument or operation formed by uniting two or more subordinate instruments or operations in a new idea or means. In one sense, every invention is a combination, since every art and article is composed of elements which, by inventive genius, have been brought together to serve a common use; but the distinction between a combination in this general sense, and that in which the term is technically employed in patent law, seems to be this: That in a patentable combination every subordinate element must, in its separate state, have been an operative means, capable of discharging its own peculiar functions, and producing its own physical effects, and also must, while in the combination, still perform its individual functions, and retain its individual identity. Where operations or instruments are thus united, one of two results must follow: Either each element remains unchanged in function and effect, or by the action of the elements upon each other, or their joint action on their common object, they perform additional functions, and accomplish additional effects. The former union is a mere collocation or aggregation of the elements. Although they have been brought together in an apparent organism, and rendered more available for use, they still remain the same distinctive and independent means, still acting as so many separate units, and not co-operating with each other to perform additional functions, and accomplish additional results. Such unions, therefore, are not a creation of new means. They do not involve the exercise of the inventive faculties, nor can they be protected by a patent. But when those elements are so united that by their reciprocal influence upon each other, or

their joint action on their common object, they perform additional functions, and accomplish additional results, the union is a true combination." 1 Rob. Pat. 216 et seq.

This gives a safe criterion. If the new combination accomplishes results that could not have been achieved either by the individual or collective elements separately, then union must inevitably have brought into action some new, or as yet some unawakened, energy, which constitutes a new and independent means.

Now, the patent in this case successfully stands the application of this critical test. The result obtained by this device of Mr. Edison is the transmission from a distant generator of electrical current to a remote independent conductor, along or through which it is sent for service to numerous lamps, with equality of pressure, with no perceptible loss of tension, and is restrained by regulative means, operative only at the central station. It may be admitted that the action of the current as it traverses the consumption conductor is exactly similar to that which would follow if the generator had been placed at, and connected directly with, the end of that conductor; but the crucial fact is that there neither is nor is to be any generator so placed at the end of the conductor. The result which Mr. Edison sought to achieve, and which he has achieved, is that the electrical current shall act exactly as if there was indeed a generator there, where there is none. His object is to compel precisely the same action which would result in the consumption conductors if the generator had been directly in contact with the ends of those conductors; and that, too, when the generator was not only not in close or immediate connection, but was placed a long distance away. And he so combined and used his elements that he accomplished what he sought with so great an economy in the use of copper that for the first time he made electrical lighting feasible. Such achievement is plainly the result of the coaction of all the elements of this combination. It is true that the action of these elements may be successive, rather than simultaneous, but the fact that such action is of such character does not in anywise militate against the conclusion. Newbury v. Fowler, 28 Fed. Rep. 454.

The weighty objections in this cause, however, to the validity of the letters patent, go upon other grounds. The defendants, with great vigor and ability, contend that the letters patent are absolutely void because the alleged invention claimed by Mr. Edison has about it no characteristics which would imply the least operation of inventive genius; that the state of the art clearly showed anticipation; that the systems in vogue of equalizing pressure in the distribution of gas and water for general consumption were strictly analogous to the proposed distribution and regulation of the electrical current as described by Mr. Edison as his invention, and had been in use many years; that especially did the prior patents to Werdermann and to Khotinsky and to Lane-Fox, for systems of electric lighting, clearly and substantially, if not literally, anticipate the letters granted to Mr. Edison; and that the treatise of Giroud upon Water and Gas Distribution made known, years before, to the whole world, just what Mr. Edison so many years later claimed

to have discovered with relation to the control and distribution of electrical energy. It will be necessary to examine into the merits of these defenses. If they are well founded, the case of the plaintiff must fall.

In testing them it is important to remember the construction given to the claims of this patent, and the conditions which limit them, as heretofore stated. The defendants insist that the real issue, so far as patentability is concerned, is whether the single circuit covered by the claims in suit, when taken in its simplest form,—such as, for instance, a circuit running from a generator to a single house, with but a dozen lamps for its work,—involves patentable novelty at the date of Mr. Edison's alleged invention. The defendants have the right to criticise and test the validity of the invention by considering it in its simplest form, but it must be the invention as described and claimed by the inventor, and not as it exists in the mind of counsel. To lop off from the invention the limitations and conditions which are embraced in the claims would be to destroy the real substance of the invention itself.

Let us, then, first consider the Werdermann patent, and see if it can be called anticipatory to the patent now under consideration. This is a British patent granted on June 21, 1878, to Richard Werdermann, for an improvement in apparatus for electric lighting. It concerned itself more with the actual mechanism for producing the light itself, than to the construction of the feeders and conductors which were to convey the electrical current to the lamps. It further concerned itself with an arrangement of the conductors so that the current for all the lamps which may be employed shall be compelled to travel exactly the same distance from the generator, so as to equalize the pressure at the lamps. To accomplish the first purpose he simply brings the points of two electrodes into contact under certain conditions. It is not necessary to discuss that part of the patent. To accomplish the other purpose he determined to adopt this method, (I quote his words from the letters patent:)

"So to arrange the parallel circuits in which the lights are included that the light which is the first one or the nearest to the source of electricity on a positive conductor is also the first or nearest to the source of electricity on the negative conductor. But I prefer the arrangement illustrated in the drawings, in which the lamp or light which is first with regard to its position on the positive conductor is last with regard to its connection with the negative conductor. With this arrangement, the electric currents for all of the lamps or lights will have to flow through the same distance."

Upon inspection of the figures and diagrams annexed to the patent itself, it is apparent that the arrangement described is wholly similar to the multiple arc or parallel arrangement, excepting in one particular; and that is that the outgoing current, instead of reaching the nearest lamp, doing there its work, and then returning from it by a conductor equal in length, is only returned after traveling beyond the point where the most distant lamp is situated. In other words, the arrangement is what is technically called the "reversed parallel;" so called because the position of the return conductor is reversed from its position in simple parallel.

Evidently, Werdermann's idea was that in thus compelling the electrical current to pass over or through an equal length and sectional area of a conductor, in going to and returning from each lamp, he completely solved the difficulties of electric lighting arising from the harmful drop in tension. To insure the uniformity and brilliancy of his lamps he inserted at each lamp a "special resistance," as he called it; so that when the lamp was extinguished the special mechanical resistance would still have the same effect upon the electrical current as the lamp would have itself when burning. The idea of a division of a circuit into feeders and consumption conductors, to meet great difficulties, does not seem ever to have occupied his thoughts; still less, the proportioning of the feeder conductors or mains in such a way that all the drop in tension should be localized upon them. It is true that one of the diagrams attached to the patent, to some extent, seems to exhibit a circuit consisting of feeders, with their separate functions, and consumption mains, with illuminating devices. But Werdermann himself, in referring to the diagram in question, says that it does not represent the relative position of parts as they will exist in actual practice, but is only designed graphically to represent the arrangement of their lights, their arrangement of cables and conductors, and the manner in which the division of the current is effected in such manner that each light will be produced or extinguished independent of other lights.

The witnesses on behalf of complainant are very clear in their conclusions that the Werdermann patent is not an anticipation of the Edison patent, and give substantial reasons for their faith. Prof. Chandler says:

"I find that the Werdermann system differs in every important particular from that of the patent in suit: (1) It uses arc lamps, instead of incandescent lamps. (2) It uses a low-tension current, instead of a high-tension current. (3) It employs a constant current, no matter how many lamps are in use, instead of a variable current adjusted to the number of lamps in use. (4) It involves a uniform load upon the dynamo, no matter how many lamps are in use, instead of a variable load adjusted to the amount of energy required at different times. (5) It includes no central station regulation. The current being constant and the load uniform, there is no object in central station regulation. (6) There is no attempt to overcome the inevitable difficulties in distribution, due to distance, by dividing the circuit into two distinct parts,—a distributing or consumption part, and a feeding or supply part. (7) There is no such division of the circuit into (a) consumption circuit, upon which all the lamps are placed, so proportioned in size to its length, and to the number of lamps connected with it, that the drop in pressure will be so small as to be of no consequence, and that the nearest and the furthest lamps from the central station will receive, substantially, the same pressure; (b) feeding circuit, upon which no lamps are placed, designed to supply the current to the consumption circuit, and upon which all the drop in pressure due to distance will be intentionally located. (8) The Werdermann system would require so large a quantity of copper to distribute the current as to make the system absolutely impracticable. (9) The Werdermann system would also be altogether too expensive, as regards the supplying of electricity; there being no central station regulation, but, on the contrary, a constant current."

In this view, Sir William Thomson, Mr. Brevoort, and Mr. Jenks concur.

It seems to me that the design of Mr. Werdermann's invention was so to place the lamps at such equal electrical distance from the generator as to enable any sized consumption circuit to be used. Such invention cannot be adjudged an anticipation of what Mr. Edison did, for such was not his object.

The defendants also depend upon a French patent issued to M. De Khotinsky for improvement in electric lighting, dated March 19, 1875, as an anticipation. Khotinsky says his invention relates to improvements in electric lighting, with a view of obviating the inconvenience of the system proposed heretofore, by reason of which this mode of lighting has not been generally adopted. The first part of the invention is found in peculiar arrangement of the conductors of the electrical current, which permitted the current to pass into each lamp or light independent of the others, so that the variation or failure of light in one lamp has no effect upon the others; and, secondly, the arrangement of the burners of the electric lamps in such a manner that, after the consumption in service of one carbon or other luminous conductor, the current passes automatically into another luminous conductor, and from that into a third, and after the consumption of all the luminous conductors which had been provided the current travels automatically to a spiral, or a conductor of any form, whose resistance is equal to that of the lamp in connection, as described. It is to be noted that this patent was considered by the United States patent office when the Edison patent was granted, and was there overruled as an anticipation. There does not seem to be anywhere in the patent, so far as the phraseology is concerned, any indication that Khotinsky thought of dealing with the difficulties of "drop in tension" in an extended system of lighting. It is true that one of the diagrams attached to the patent seemed to illustrate to some extent, at least, the scheme of Edison; but there is nothing said in describing that drawing which would disclose the law for the proportions of the circuit in regard to the number of lamps connected therewith, nor any data given by which it might be concluded that the lamps would vary from each other in candle power, which variance was to be cured by this invention. Such failure of description or disclosure is fatal to the defendants' claim.

And for this cause alone the Khotinsky patent cannot be relied upon in this case as an anticipation of the plaintiff's patent. It does not anticipate, because it neither describes nor deals with, nor certainly provides for the difficulty, nor prescribes with precision the remedies which form the subject-matter of Edison's invention. In Powder Co. v. Parker, 16 Blatchf. 295, it was held:

"The prior description, to invalidate the patent, must be such as to show the article described in the patent can be certainly arrived at by following it."

In Cary v. Manufacturing Co., 31 Fed. Rep. 347, Judge Acheson says:

"In respect to the prior publications relied on as a defense, we need only say that, in our judgment, they do not fulfill the requirements of the estab-

lished rule that such publications must contain in themselves such a full, clear, and exact description of the invention as, without anything more, will enable one skilled in the art to practice the invention."

In Celluloid Manuf'g Co. v. Chrolithion Collar & Cuff Co., 31 O. G. 519, 23 Fed. Rep. 398, Judge Coxe says:

"The novelty of the invention is not negatived by any of the patents, American or foreign, introduced by the defendants. * * * No one describes, with anything like the accuracy required, the fabric of the complainants. The burden is upon the defendants to satisfy the court that the prior descriptions contain such a clear, full, and exact statement that a person skilled in the art, with the statement before him, could produce the fabric in question. * * * The law requires something more, beyond the mere suggestion, to defeat a patent. Prophecy will not do it. Facts, not theories, are needed."

In Seymour v. Osborne, 11 Wall. 516, it was held that—

"Patent inventions cannot be superseded by the mere introduction of a foreign publication of the kind, unless the description and drawings contain and exhibit a substantial representation of the patented improvement in such full, clear, and exact terms as to enable any person skilled in the art or science to which it appertains to make, instruct, and practice the invention to the same practicable extent as they would be enabled to do if the information was derived from a prior patent."

It is true that the expert witnesses for the defendants insist that the Khotinsky arrangement of circuits is wholly similar to that described and explained by Mr. Edison in the patent in this suit; but the evidence given upon the same point by the experts for the complainant, Sir William Thomson, Mr. Jenks, and Mr. Brevoort, is directly contradictory, and seems to be more weighty and conclusive. In speaking of the Khotinsky patent, Sir William Thomson says:

"Khotinsky does not suggest anything towards the illumination of towns, or the carrying of the electric energy to considerable distances. He does not contemplate any difference of pressure in the different parts of his circuit. He makes arrangements to provide for one lamp of his system being extinguished without disturbing the others, while the output of the engine remains constant. * * * The difficulties connected with supplying the current, and maintaining approximate enough quality of brilliance among all the lamps, through all the variations of numbers of lamps used in actual practice, * * * were not at all felt by Khotinsky, who in fact gives no indication of applying his system to working at a distance, or of there being any practical difference in the tension in the different parts of his conductors. There is certainly nothing in any part of his patent which gives any indication towards the solution of the problem discovered by Edison."

Prof. Chandler says:

"The Khotinsky patent does not deal with the problem of conveying electricity to a distance, for supplying a large number of lamps, scattered over a considerable area. * * * There is nothing in the language of the Khotinsky patent, when properly translated, to indicate that Khotinsky had considered the question of distance, or that he thought of locating his dynamo at any distance from his lamps. * * * Khotinsky evidently intends to do precisely what Werdermann does,—that is, to maintain a constant current in his system, and to offer to this a constant load,—for he has provided an equivalent resistance, which is to take the place of any lamp which goes out. * * * There is no suggestion of any attempt to overcome the inevitable drop due to distance by a system of feeders, devoid of lamps, upon which this drop is located where it could do no harm. There is no suggestion in the Khotinsky patent of dividing his system of conductors into two parts,—one of which is