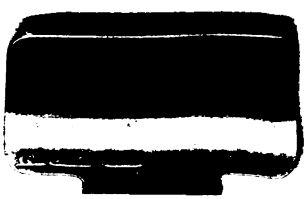
PATENTED TELEPHONY.

American Electrical
Engineering Association.



PATENTED TELEPHONY

A REVIEW OF THE PATENTS PERTAINING TO TELEPHONES AND TELEPHONIC APPARATUS.

BY THE

American Electrical Engineering Association.

CHICAGO, ILL., 1897.

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INTRODUCTORY.

A SMALL investment in telephone construction yields, at present prices, large profits. The unknown quantity is the patent situation. One class of capitalists declines the risk; the other recklessly plunges into blind speculation. The former is unnecessarily timid; the latter foolhardy. Proper examination will open to the first a golden opportunity and save the second from becoming dangerously involved.

This treatise is designed for both these classes of investors, as well as a reference book for the inventor, engineer and patent lawyer.

The United States patents now in force which cover devices and systems used in telephony, are in number about four thousand. The following pages illustrate merely the salient features, the high lights in the art, which are revealed by the study of both expired and unexpired patents.

The labor involved in this research has been excessive. It is presumable there are errors and omissions; but we believe it gives a fairly correct view of what, to a great majority of people, appears a hopeless tangle.

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PATENTED TELEPHONY.

In investigating this subject it is well to consider the value of an invention that has passed the ordeal of the Examiner and been regularly issued as a United States patent, but has not been passed upon by any higher tribunal.

The greater part of the patents mentioned in this volume were issued prior to 1892, and it is not supposable that since that time there has been so radical a change of procedure as materially to alter the conditions antedating that year. A good deal of light is thrown on this subject by the report of the Commissioner of Patents for the year 1893, and from that report is made the following extract:

A study of eighty-one patent cases, recently before the courts, wherein the claims were held to be invalid, discloses that in twenty-six there was no evidence that the references before the court, in view of which the patents were found to be invalid, were ever cited by this office; in twenty-nine some, but not all, of the references were cited, and only in the remaining twenty-six were the same references before the office as were before the court.

Of 988 court cases reported in the Official Gazette between 1886 and 1892, wherein patents were in litigation, 436 patents were sustained and 552 were declared invalid in whole or in part. Of the number declared invalid, 428 were by reason of some fault in the Office, and 124 on account of evidence brought to light of which the Office had no knowledge before granting the patents.

These figures do not furnish the basis for a general estimate of the proportion of patents granted, which, if contested, would be declared void, for all those in which there is a general acquiescence in their validity and which consequently never are contested in courts, must be reckoned upon the side of the proper actions of the Office. Candor compels the admission, however, that an indefinite number of patents are never contested, because out of weakness they are never insisted upon in court as valid.

Approaching the subject from another side, I am furnished with the result of examinations as to the validity of the claims in ten patents, taken at random, where searches in this Office were made by a well-known law firm. These patents contain fifty claims, of which thirty-five were considered and were reported to be old.

With the exception of the litigations culminating in the Supreme Court decision of March 19, 1888 (see Drawbaugh), it must be remembered in regard to telephone patents that for a long period, say from 1880 to 1891, there was but very little interest taken in them except by the personnel of companies controlled by the American Bell Telephone Company, and there were few contests. The original Bell patent for the telephone receiver was found to be impregnable, and the general public was patiently awaiting its expiration. Inventors could find but one customer for telephonic patents; there was no chance for competition; for interference cases; for judicial contests of any kind; it is, therefore, the inference that a great many of the patents owned by the Bell monopoly or its licensees will, whenever they are brought into court, be declared invalid.

It will be useful also to refresh the memory with two decisions made in recent years by the United States Supreme Court; and also to consider the practice of inventors and their attorneys prior to such decisions.

The first, in chronological order, is that rendered Jan. 8, 1894, on appeal from the Circuit Court in the case of Miller vs. Eagle Mfg. Company. A division of the original application for a patent which had been granted in 1879, was issued as a second patent in 1881. The decree of the lower court, which had sustained the patents in suit, was reversed, the Supreme Court finding that "the prior invention covered the means, and the only means, by which the results sought by the patent of 1881 were to be accomplished." "It is not," said the Court, "the result, effect or purpose to be accomplished which constitutes invention, or entitles a party to a patent, but the mechanical means or instrumentalities by which the object sought

is to be attained; but a patentee cannot so split up his invention for the purpose of securing additional results or of extending or of prolonging the life of any or all of its elemental parts." "A single element or function of a patented invention cannot be made the subject of a separate and subsequent patent."

Previous to this decision it had been the custom to make what were called "divisional patents." Sometimes one application would issue in a series of patents of different dates. The effect of the Supreme Court decision was to put a stop to this practice and also to render invalid all of the patents in the series except the one first issued.

The second is the decision of March 4, 1895, in the case of the Bate Refrigerator Co. vs. Sulzberger et al., interpreting that section of the United States Revised Statutes which reads as follows:

Sec. 4887. No person shall be debarred from receiving a patent for his invention or discovery, nor shall any patent be declared invalid, by reason of its having been first patented, or caused to be patented, in a foreign country, unless the same has been introduced into public use in the United States for more than two years prior to the application. But every patent granted for an invention which has been previously patented in a foreign country shall be so limited as to expire at the same time with the foreign patent, or, if there be more than one, at the same time with the one having the shortest term, and in no case shall it be in force more than seventeen years. [1]

The interpretation was that the statute means what it says, that a United States patent expires with a foreign one granted to the same inventor for the same invention, prior to the date of that which is issued in the United States.

It had been the almost universal practice among attorneys to understand Sec. 4887 to mean that a domestic patent expired with a foreign one granted to the same inventor for the same invention prior to the date of application for the United States patent. Consequently, for a great number of inventions an application was first made for United States Letters Patent, and afterwards for foreign ones, the latter being allowed to issue before the American grant.

1. *Amended. See Official Gazette, Vol. 78, No. 11, Page 1742.*

THE BERLINER CASE.

On May 10, 1897, the Supreme Court of the United States handed down a decision in the Berliner suit in favor of the American Bell Telephone Company.

Herewith are reproduced in full three letters patent, to which frequent reference will be made in the description and consideration of the Berliner litigation which immediately follows them.

UNITED STATES PATENT OFFICE.

ALEXANDER GRAHAM BELL, OF SALEM, MASSACHUSETTS.

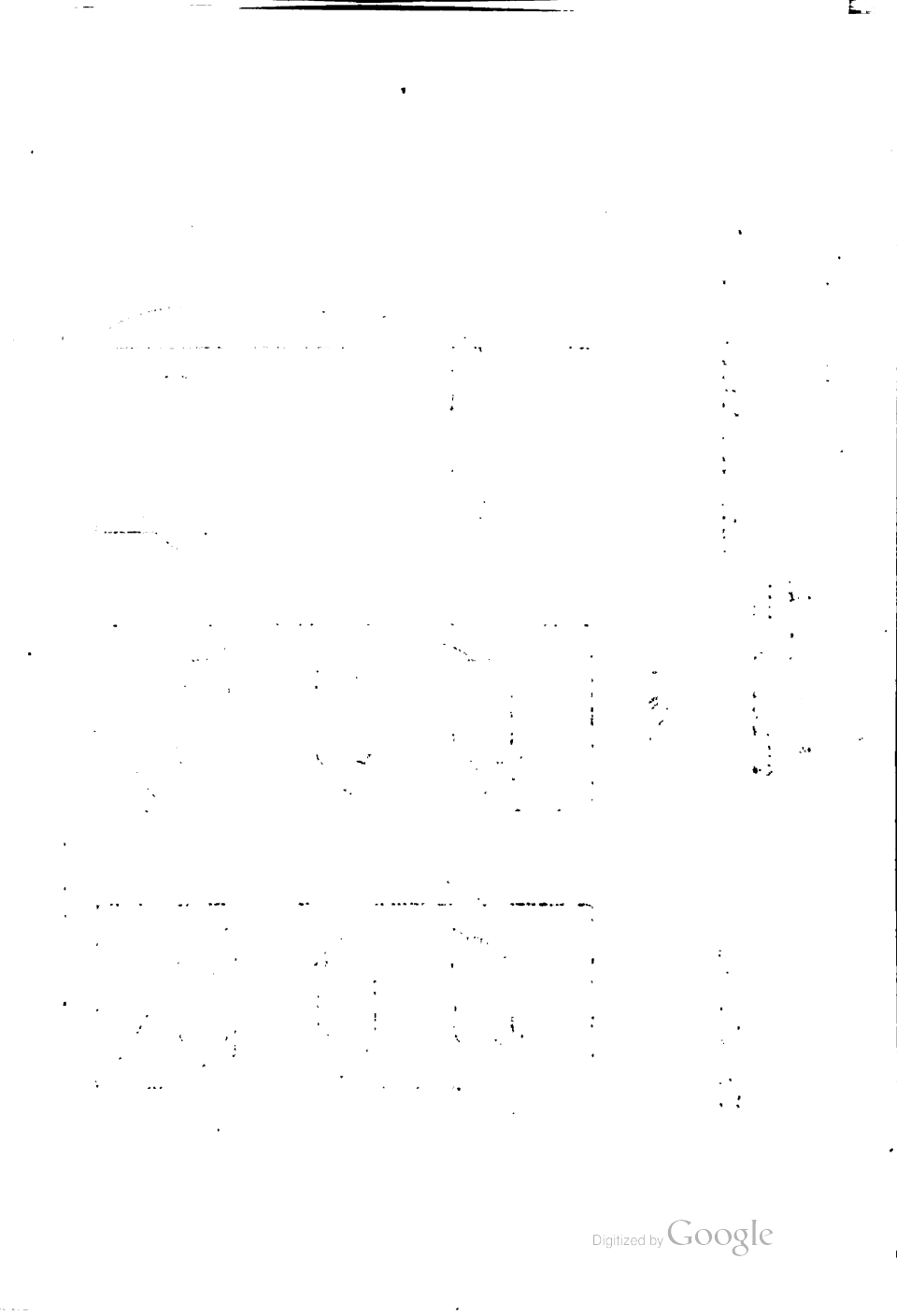
IMPROVEMENT IN TELEGRAPHY.

Specification forming part of Letters Patent No. 174,465, dated March 7, 1876; application filed February 14, 1876.

To all whom it may concern:

Be it known that I, Alexander Graham Bell, of Salem, Massachusetts, have invented certain new and useful Improvements in Telegraphy, of which the following is a specification:

In Letters Patent granted to me April 6, 1875, No. 161739, I have described a method of, and apparatus for, transmitting two or more telegraphic signals simultaneously along a single wire by the employment of transmitting-instruments, each of which occasions a succession of electrical impulses differing in rate from the others; and of receiving-instruments, each tuned to a pitch at which it will be put in vibration to produce its fundamental note by one only of the transmitting-instruments; and of vibratory circuit-breakers operating to convert the vibratory movement of the receiving-instrument into a permanent make or break (as the case may be) of a local circuit, in which is placed a Morse sounder, register, or other telegraphic apparatus. I have also therein described a form of autograph-telegraph based upon the action of the above-mentioned instruments.



In illustration of my method of multiple telegraphy I have shown in the patent aforesaid, as one form of transmitting-instrument, an electro-magnet having a steel-spring armature, which is kept in vibration by the action of a local battery. This armature in vibrating makes and breaks the main circuit, producing an intermittent current upon the line-wire. I have found, however, that upon this plan the limit to the number of signals that can be sent simultaneously over the same wire is very speedily reached; for, when a number of transmitting-instruments, having different rates of vibration, are simultaneously making and breaking the same circuit, the effect upon the main line is practically equivalent to one continuous current.

In a pending application for Letters Patent, filed in the United States Patent Office February 25, 1875, I have described two ways of producing the intermittent current—the one by actual make and break of contact, the other by alternately increasing and diminishing the intensity of the current without actually breaking the circuit. The current produced by the latter method I shall term, for distinction sake, a pulsatory current.

My present invention consists in the employment of a vibratory or undulatory current of electricity in contradistinction to a merely intermittent or pulsatory current, and of a method of, and apparatus for, producing electrical undulations upon the line-wire.

The distinction between an undulatory and a pulsatory current will be understood by considering that electrical pulsations are caused by sudden or instantaneous changes of intensity, and that electrical undulations result from gradual changes of intensity exactly analogous to the changes in the density of air occasioned by simple pendulous vibrations. The electrical movement, like the aerial motion, can be represented by a sinusoidal curve or by the resultant of several sinusoidal curves.

Intermittent or pulsatory and undulatory currents may be of two kinds, accordingly as the successive impulses have all the same polarity or are alternately positive and negative.

The advantages I claim to derive from the use of an undulatory current in place of a merely intermittent one are, first, that a very much larger number of signals can be transmitted simultaneously on the same circuit; second, that a closed circuit and single main battery may be used; third, that communication in both directions is established without the neces-

sity of special induction-coils; fourth, that cable dispatches may be transmitted more rapidly than by means of an intermittent current or by the methods at present in use; for, as it is unnecessary to discharge the cable before a new signal can be made, the lagging of cable-signals is prevented; fifth, and that as the circuit is never broken a spark-arrester becomes unnecessary.

It has long been known that when a permanent magnet is caused to approach the pole of an electromagnet a current of electricity is induced in the coils of the latter, and that when it is made to recede a current of opposite polarity to the first appears upon the wire. When, therefore, a permanent magnet is caused to vibrate in front of the pole of an electro-magnet an undulatory current of electricity is induced in the coils of the electro-magnet, the undulations of which correspond, in rapidity of succession, to the vibrations of the magnet, in polarity to the direction of its motion, and in intensity to the amplitude of its vibration.

That the difference between an undulatory and an intermittent current may be more clearly understood I shall describe the condition of the electrical current when the attempt is made to transmit two musical notes simultaneously—first upon the one plan and then upon the other. Let the interval between the two sounds be a major third; then their rates of vibration are in the ratio of 4 to 5. Now, when the intermittent current is used the circuit is made and broken four times by one transmitting-instrument in the same time that five makes and breaks are caused by the other. A and B, Figs. 1, 2 and 3, represent the intermittent currents produced, four impulses of B being made in the same time as five impulses of A. c c c, etc., show where and for how long time the circuit is made, and d d d, etc., indicate the duration of the breaks of the circuit. The line A and B shows the total effect upon the current when the transmitting-instruments for A and B are caused simultaneously to make and break the same circuit. The resultant effect depends very much upon the duration of the make relatively to the break. In Fig. 1 the ratio is as 1 to 4; in Fig. 2, at 1 to 2; and in Fig. 3 the makes and breaks are of equal duration. The combined effect, A and B, Fig. 3, is very nearly equivalent to a continuous current.

When many transmitting-instruments of different rates of vibration are simultaneously making and breaking the same circuit the current upon the main line becomes for all practical purposes continuous.

Next, consider the effect when an undulatory current is employed. Electrical undulations, induced by the vibration of a body capable of inductive action, can be represented graphically, without error, by the same sinusoidal curve which expresses the vibration of the inducing body itself, and the effect of its vibration upon the air; for, as above stated, the rate of oscillation in the electrical current corresponds to the rate of vibration of the inducing body—that is, to the pitch of the sound produced. The intensity of the current varies with the amplitude of the vibration—that is, with the loudness of the sound; and the polarity of the current corresponds to the direction of the vibrating body—that is, to the condensations and rarefactions of air produced by the vibration. Hence, the sinusoidal curve A or B, Fig. 4, represents, graphically, the electrical undulations induced in a circuit by the vibration of a body capable of inductive action.

The horizontal line a d e f, etc., represents the zero of current. The elevations b b b, etc., indicate impulses of positive electricity. The depressions c c c, etc., show impulses of negative electricity. The vertical distance b d or c f of any portion of the curve from the zero-line expresses the intensity of the positive or negative impulse at the part observed, and the horizontal distance a a indicates the duration of the electrical oscillation. The vibrations represented by the sinusoidal curves B and A, Fig. 4, are in the ratio aforesaid, of 4 to 5—that is, four oscillations of B are made in the same time as five oscillations of A.

The combined effect of A and B, when induced simultaneously on the same circuit, is expressed by the curve A plus B, Fig. 4, which is the algebraical sum of the sinusoidal curves A and B. This curve A plus B also indicates the actual motion of the air when the two musical notes considered are sounded simultaneously. Thus, when electrical undulations of different rates are simultaneously induced in the same circuit, an effect is produced exactly analogous to that occasioned in the air by the vibration of the inducing bodies. Hence, the coexistence upon a telegraphic circuit of electrical vibrations of different pitch is manifested, not by the obliteration of the vibratory character of the current, but by peculiarities in the shapes of the electrical undulations, or, in other words, by peculiarities in the shapes of the curves which represent those undulations.

There are many ways of producing undulatory currents of electricity, dependent for effect upon the vibrations or motions of bodies capable of inductive action. A few of the

methods that may be employed I shall here specify. When a wire, through which a continuous current of electricity is passing, is caused to vibrate in the neighborhood of another wire, an undulatory current of electricity is induced in the latter. When a cylinder, upon which are arranged bar-magnets, is made to rotate in front of the pole of an electro-magnet, an undulatory current of electricity is induced in the coils of the electro-magnet.

Undulations are caused in a continuous voltaic current by the vibration or motion of bodies capable of inductive action; or by the vibration of the conducting-wire itself in the neighborhood of such bodies. Electrical undulations may also be caused by alternately increasing and diminishing the resistance of the circuit, or by alternately increasing and diminishing the power of the battery. The internal resistance of a battery is diminished by bringing the voltaic elements nearer together, and increased by placing them farther apart. The reciprocal vibration of the elements of a battery, therefore, occasions an undulatory action in the voltaic current. The external resistance may also be varied. For instance, let mercury or some other liquid form part of a voltaic circuit, then the more deeply the conducting-wire is immersed in the mercury or other liquid, the less resistance does the liquid offer to the passage of the current. Hence, the vibration of the conducting-wire in mercury or other liquid included in the circuit occasions undulations in the current. The vertical vibrations of the elements of a battery in the liquid in which they are immersed produce an undulatory action in the current by alternately increasing and diminishing the power of the battery.

In illustration of the method of creating electrical undulations, I shall show and describe one form of apparatus for producing the effect. I prefer to employ for this purpose an electro-magnet, A, Fig. 5, having a coil upon only one of its legs b. A steel-spring armature, c, is firmly clamped by one extremity to the uncovered leg d of the magnet, and its free end is allowed to project above the pole of the covered leg. The armature c can be set in vibration in a variety of ways, one of which is by wind, and, in vibrating, it produces a musical note of a certain definite pitch.

When the instrument A is placed in a voltaic circuit, g b e f g, the armature c becomes magnetic, and the polarity of its free end is opposed to that of the magnet underneath. So long as the armature c remains at rest, no effect is produced upon

the voltaic current, but the moment it is set in vibration to produce its musical note a powerful inductive action takes place, and electrical undulations traverse the circuit g b e f g. The vibratory current passing through the coil of the electromagnet f causes vibration in its armature h when the armatures c h of the two instruments A I are normally in unison with one another; but the armature h is unaffected by the passage of the undulatory current when the pitches of the two instruments are different.

A number of instruments may be placed upon a telegraphic circuit, as in Fig. 6. When the armature of any one of the instruments is set in vibration, all the other instruments upon the circuit which are in unison with it respond, but those which have normally a different rate of vibration remain silent. Thus, if A, Fig. 6, is set in vibration, the armatures of A1 and A2 will vibrate also, but all the others on the circuit will remain still. So if B1 is caused to emit its musical note the instruments B B2 respond. They continue sounding so long as the mechanical vibration of B1 is continued, but become silent with the cessation of its motion. The duration of the sound may be used to indicate the dot or dash of the Morse alphabet, and thus a telegraphic dispatch may be indicated by alternately interrupting and renewing the sound.

When two or more instruments of different pitch are simultaneously caused to vibrate, all the instruments of corresponding pitches upon the circuit are set in vibration, each responding to that one only of the transmitting instruments with which it is in unison. Thus the signals of A, Fig. 6, are repeated by A1 and A2, but by no other instrument upon the circuit; the signals of B2 by B and B1; and the signals of C1 by C and C2—whether A, B2, and C1 are successively or simultaneously caused to vibrate. Hence by these instruments two or more telegraphic signals or messages may be sent simultaneously over the same circuit without interfering with one another.

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 in pitch, and the telegraphic transmission of noises or sounds of any kind.

When the armature e, Fig. 5, is set in vibration the armature h responds not only in pitch, but in loudness. Thus, when c vibrates with little amplitude, a very soft musical note proceeds from h; and when c vibrates forcibly the amplitude of the vibration of h is considerably increased, and the resulting

sound becomes louder. So, if A and B, Fig. 6, are sounded simultaneously (A loudly and B softly), the instruments A1 and A2 repeat loudly the signals of A, and B1 B2 repeat softly those of B.

One of the ways in which the armature c, Fig. 5, may be set in vibration has been stated above to be by wind. Another mode is shown in Fig. 7, whereby motion can be imparted to the armature by the human voice or by means of a musical instrument.

The armature c, Fig. 7, is fastened loosely by one extremity to the uncovered leg d of the electro-magnet b, and its other extremity is attached to the center of a stretched membrane, a. A cone, A, is used to converge sound-vibrations upon the membrane. When a sound is uttered in the cone the membrane a is set in vibration, the armature c is forced to partake of the motion, and thus electrical undulations are created upon the circuit E b e f g. These undulations are similar in form to the air vibrations caused by the sound—that is, they are represented graphically by similar curves.

The undulatory current passing through the electro-magnet f influences its armature h to copy the motion of the armature c. A similar sound to that uttered into A is then heard to proceed from L.

In this specification the three words "oscillation," "vibration," and "undulation," are used synonymously, and in contradistinction to the terms "intermittent" and "pulsatory." By the terms "body capable of inductive action," I mean a body which, when in motion, produces dynamical electricity. I include in the category of bodies capable of inductive action—brass, copper, and other metals, as well as iron and steel.

Having described my invention, what I claim, and desire to secure by Letters Patent is as follows:

1. A system of telegraphy in which the receiver is set in vibration by the employment of undulatory currents of electricity, substantially as set forth.

2. The combination, substantially as set forth, of a permanent magnet or other body capable of inductive action, with a closed circuit, so that the vibration of the one shall occasion electrical undulations in the other, or in itself, and this I claim, whether the permanent magnet be set in vibration in the neighborhood of the conducting-wire forming the circuit, or whether the conducting-wire be set in vibration in the neighborhood of the permanent magnet, or whether the con-

ducting-wire and the permanent magnet both simultaneously be set in vibration in each other's neighborhood.

3. The method of producing undulations in a continuous voltaic current by the vibration or motion of bodies capable of inductive action, or by the vibration or motion of the conducting-wire itself, in the neighborhood of such bodies, as set forth.

4. The method of producing undulations in a continuous voltaic circuit by gradually increasing and diminishing the resistance of the circuit, or by gradually increasing and diminishing the power of the battery, as set forth.

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 sound, substantially as set forth.

In testimony whereof I have hereunto signed my name this 20th day of January, A. D. 1876.

ALEX. GRAHAM BELL.

Witnesses:
THOMAS E. BARRY,
P. D. RICHARDS.

UNITED STATES PATENT OFFICE

EMILE BERLINER, OF BOSTON, MASSACHUSETTS.

ELECTRIC TELEPHONE.

Specification forming part of Letters Patent No. 233,969, dated November 2, 1880. Application filed September 3, 1880. (No model.)

To whom it may concern:

Be it known that I, Emile Berliner, a resident of Boston, County of Suffolk, State of Massachusetts, have invented a new and useful Improvement in Electric Telephones, which improvement is fully set forth in the following specification.

My invention consists in a new and useful improvement

in telephonic receivers for producing sound by means of varying electrical currents, of which the following is a specification.

It is a fact and a scientific principle that if two electrodes be placed in contact to form part of a circuit and a current of electricity be passed through them a repulsion is exerted between them. Based on this fact I have constructed a simple receiver for an electric-telephone apparatus.

In Figure 2 of the drawings, A is a metal plate well fastened to the wooden box or frame, but able to vibrate. Against the plate and touching it is the metal ball c, terminating the rod B, which rests on the bar or stand d and presses against the plate, which pressure, however, can be regulated by the thumb-screw attached to the ball.

If a current of electricity passes through the plate and the point of contact, or vice versa, a repulsive movement will take place between the plate and the ball, because both are charged with the same kind of electricity. This force of repulsion may be weakened or strengthened by varying the strength of the current. As that strength is varied by any appropriate form of electric speaking-telephone transmitter (especially that shown at A B of the various figures of the drawings, and more particularly described and claimed by me in another application filed June 4, 1877, of which this is a division), so will also the force of repulsion at the point in the receiver be alternately weakened and strengthened as many times accordingly, and will therefore cause its plate to vibrate at the same rate and measure. The latter vibrations being communicated to the surrounding air, the same kind of sound as uttered against the transmitter, Fig. 1, will be reproduced at the receiver, Fig. 2, or in as many other receiving instruments as are situated within the same electric circuit.

In Fig. 2 I have shown the receiver as consisting of a diaphragm in contact with a ball. In Figs. 3 and 4 I show it as somewhat differently mounted, and with the contact-piece in the form of a pin instead of a ball, and in Fig. 6 in a still different form with a carbon contact. In this figure, W is a piece of carbon.

In Fig. 5 two plates in contact at their edges are shown.

In the drawings, the letter A represents a diaphragm or plate, preferably of thin metal of limited conductive capacity, such as iron, steel, German silver, platinum, and also carbon secured in the frame m m in the box f in any convenient manner.

The letter y represents a ring resting against one side of said diaphragm, and capable of being made to bear upon the same with more or less force by means of set-screws n, in order that the tension of the diaphragm may be regulated.

The letter B represents a screw or piece of metal or carbon, pointed at one end and mounted in a cross-piece d, in such position that the point will be in contact with the diaphragm A. The diaphragm A is connected with one pole of a battery by means of a wire, and the pin or screw B with the other pole.

Fig. 4 shows the manner in which the complete apparatus, consisting of the transmitter A B and the receiver A B, is connected up in the circuit.

It will be observed that the transmitter is of the same construction as the receiver. When a sound is uttered in the neighborhood of the transmitter its plate will vibrate accordingly, and the pressure between the plate and the pin or ball at the point of contact a will become weaker or stronger, according to the vibrations, and this variation of pressure will cause the current passing to become weaker or stronger, and thus effect the changes which operate the receiver, as already described.

As shown in Fig. 3, the box f is provided with a tube K, to which the ear of the operator may be applied in order to hear the sounds produced by the vibratory diaphragm when the instrument is employed as a receiver, and a tube, O, through which he can speak when employing the instrument as a transmitter, so that the operator is not in need of moving the instrument or moving his head while carrying on a conversation. This combination, with the sound-chamber of a telephone provided with the usual sound-passage or mouthpiece, of an additional sound-conveyer or hearing-tube forms, however, no part of the invention.

I claim—

1. The herein-described method of producing sound-vibrations in a plate by causing a varying electric current to pass to the plate, or to an electrode connected therewith, from a second electrode in contact therewith, substantially as described.

2. An apparatus for producing sound by means of a varying electric current, which consists of a plate forming or carrying an electrode placed in contact with another electrode, from one to the other of which the electric current is caused to pass.

3. An electric-telephone receiver to be operated by varying electric currents, and consisting of two contact-pieces within

an electric circuit, one or both of which pieces consist of or are connected with a vibratory diaphragm, whereby one electric current passing through said circuit exercises a repulsion between said two electrodes corresponding to its strength, and thus produces corresponding motions in the diaphragm.

4. A system of two or more telephone-instruments in electrical connection with each other, each consisting of two or more poles of an electrical circuit in contact one with the other, either or both poles of each instrument being connected with a vibratory plate, so that any vibration which is made at one contact is reproduced at the other, substantially as set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

EMILE BERLINER.

Witnesses:
C. H. GREAVES,
ALFRED J. MAYO.

UNITED STATES PATENT OFFICE.

EMILE BERLINER, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

COMBINED TELEGRAPH AND TELEPHONE.

Specification forming part of Letters Patent No. 463,569, dated November 17, 1891. Application filed June 4, 1877.

To all whom it may concern:

Be it known that I, Emile Berliner, of Washington, in the District of Columbia, have invented a new and useful Improvement in Combined Telegraph and Telephone, of which the following is a specification.

My invention consists in a new and useful improvement in transmitters for electrically transmitting sound of any kind, of which the following is a specification.

It is a fact that if at a point of contact between two conductors forming part of an electric circuit and carrying an

electric current the pressure between both sides of the contact becomes weakened the current passing becomes less intense—as, for instance, if an operator on a Morse instrument does not press down the key with a certain firmness the sounder at the receiving-instrument works much weaker than if the full pressure of the hand had been used. Based on this fact I have constructed a simple apparatus for transmitting sound along a line of an electric current in the following manner.

In Figures 1 and 2 of the drawings, A is a metal plate well fastened to the wooden box or frame, but able to vibrate if sound is uttered against it or in the neighborhood of said plate. Against the plate and touching it is the metal ball C, terminating the screw-threaded rod B, which is supported by the bar or stand d. The pressure of the ball C against the plate A can be regulated by turning the rod B. The said ball and plate are included in circuit with an electric battery, so that they form electrodes, the current passing from one of them to the other. By making the plate vibrate the pressure at the point of contact a becomes weaker or stronger as often as vibrations occur, and the strength of the current is thereby varied accordingly, as already described. By placing now, as is shown in the drawings, one such instrument in the station Fig. 1, and another instrument capable of acting as a telephonic receiver in the station Fig. 2, both situated on the same electric circuit in which a current is passing (as shown by the wire connections following the arrows), sound uttered against the plate of the instrument Fig. 1 will be reproduced by the plate of the instrument Fig. 2, for as the vibrations of the transmitter Fig. 1 caused by the sound will alternately weaken and strengthen the current as many times as vibrations occur, the diaphragm of the receiver will be caused by these electrical variations to vibrate at the same rate and measure. The latter vibrations being communicated to the surrounding air, the same kind of sound as uttered against the transmitter Fig. 1 will be reproduced at the receiver Fig. 2, or in as many other receiving-instruments as are situated within the same electric circuit.

It is not essential that the plate should be of metal. It can be of any material able to vibrate, if only at the point of contact suitable arrangement is made so that the current passes through that point. The plate may be of any shape or size, or other suitable vibratory media may be used—a wire, for example. Any other metallic point, surface, wire, etc., may be substituted for the ball. There may be more than one

point of contact to be affected by the same vibrations. Both of the electrodes may vibrate, although it is preferable that only one should. If the uttered sound is so strong that its vibrations will cause a breaking of the current at the point of contact in the transmitter, then the result at the receiving-instrument will be a tone much louder, but not as distinct in regard to articulation.

I have also embodied my invention in and used it in connection with some other forms of apparatus.

In the drawings, Fig. 4 represents a detached view of the vibratory diaphragm, showing its relative situation to the poles of the galvanic current. Fig. 3 represents a view of a complete apparatus; Fig. 5, a view of the diaphragms arranged to receive and transmit the sound waves; and Figs. 6, 7 and 8 modifications of the vibratory diaphragm.

In the drawings, the letter A represents a diaphragm or plate of thin metal, of limited conductive capacity, such as iron, steel, German silver, platinum, secured in the frame m m in the box F in any convenient manner.

The letter y represents a ring resting against one side of said diaphragm and capable of being made to bear upon the same with more or less force by means of set-screws n, in order that the tension of the diaphragm may be regulated.

The letter B represents a screw or pin of metal, pointed at one end and mounted in a cross-piece d in such position that the point will be in contact with the diaphragm A. The diaphragm A is connected with one pole of a battery by means of a wire a', and the pin or screw B with the other pole by means of a wire b'.

The box F of Fig. 3 is provided with a tube K, to which the ear of the operator may be applied, in order to hear the sounds produced by the vibratory diaphragm when the instrument is employed as a receiver, and a tube O, through which he can speak when employing the instrument as a transmitter, so that the operator is not in need of moving the instrument or moving his head while carrying on a conversation.

Instead of employing a single vibratory plate, as shown in Figs. 1, 2, 3, 4 and 5, in each instrument, two such plates may be employed, as illustrated in Fig. 8, said diaphragms being connected to the respective poles and in contact with each other at their edges, as shown in Fig. 8.

The diaphragm of my improved receiver or the diaphragm of any magneto-receiver (such as those described by Alexander Graham Bell in his Patent No. 174465 of March 7, 1876, and in

his Patent No. 186787 of January 30, 1877) will receive a particularly strong shock at the setting in and sudden cessation of the current when a ticking sound will be heard from the plate; but a weakening of the current alone can also be observed most distinctly and accurately by making, for example, a connection within the same circuit by a wire and the blade of a knife k, Fig. 4. When scraping the wire end over the blade of the knife, this scraping is distinctly audible on the plate. Here the current is never entirely interrupted, yet the minute elevations and cavities on the blade, caused by the structure of the steel and which again cause minute alterations in the intensity of the current, are sufficient to shake or vibrate the plate with varying intensity, thus rendering again the same peculiar scraping noise. If, now, the plate of one instrument, as in Figs. 1 or 5, is vibrated by sound-waves (which happens whenever any kind of sound is uttered or is produced by musical instruments in its neighborhood) every wave or vibration that strikes the plate produces between the two sides of the contact a variation of pressure, which causes a variation of resistance at that point, and therefore a variation in the strength of the passing current, and if the sound is sufficiently strong it will break the circuit at said point of contact, the variations in the current thus produced causing similar vibrations in the plate of the receiving-instrument. The essential part of the apparatus is the point of contact, which must offer a resistance to the current.

It is not necessary in the transmitting apparatus that the plate should be of conducting material, for any substance capable of vibration will answer, if only at the point of contact provision is made for the current to pass. It is sometimes convenient to use a vibrating plate in the form of a reflector, as shown in Fig. 6, for concentrating the sound, or the diaphragm may be provided with a number of apertures to disperse the sound, as shown in Fig. 7. These apertures prove advantageous with strong sounds, particularly the hissing sounds, as while the sound-waves are rushing toward the diaphragm, those touching the plate are repelled and partially destroy the following waves, just as sea-waves when forced against a cliff will be thrown back, destroying those directly behind. The holes permit most of the waves to pass to the other side of the plate, making the vibration of the plate more perfect and even.

I will here describe a recording apparatus, which, however, I do not claim.

In Fig. 3, G is a galvanometer, which is located in circuit

with the contact-pieces or electrodes A B, and which serves as a convenient means for ascertaining the adjustment of the contact-pieces of the transmitter, so that a current shall pass. i p i is a Ruhmkorff coil or induction apparatus. When a current passes through the primary coil p and suddenly is broken, a spark will rush over between the ends of the secondary coil i i at q. This spark is accompanied by a peculiar sound due to the electric discharge, and if we bring between the ends of the secondary the connecting points r r r r a spark will occur between each of them, provided they are near enough to each other, and the peculiar sound will be heard between each of them. I now arrange a strip of chemically-prepared paper or other substance n to be drawn by clock-work T between the ends of this secondary wire at q. Said strip can be prepared in such a way that each spark will produce a mark upon it. If, therefore, the plate A vibrates by sound, each vibration causing a break of contact will produce a spark at q, and the strip being drawn through, a succession of marks will be produced upon the strip according to the number of vibrations caused by the sound; but at the same time the sound which was uttered at the plate A will be heard from the sparks rushing over the points r, r, r, r, and q, because every spark produces one wave in the atmosphere in which it occurs, and a certain number of waves will therefore produce certain tones. Therefore the same sound which is uttered against the plate A will be heard from the sparks. The scraping of the wire end on the knife-blade k, as in Fig. 4, in the primary current will also be heard between the wire ends of the secondary current at r, r, r, r, and q. This permits a number of designs for a receiving apparatus within the secondary current. For instance, initials, ornaments, etc., consisting of a number of metal pins can be constructed in such a way that whenever a tone is produced against the plate A a spark will rush over said metal pins, and at the same time their sound is produced will render the design visible in illuminated characters.

By making the person of the operator a part of the secondary circuit and discharging the sparks in the body in the neighborhood of the ear the sound will be more particularly apparent.

It will be observed that in Figs. 1 and 2 one of the electrodes presents a convex curvilinear surface like a rounded knob. This possesses some advantages, among which are ease of construction and durability, because it does not wear away the opposing electrode as much as a sharp one would, and

when the contact with the vibrating body is made of such a form the freedom of the vibration is less interfered with.

I do not claim that I am the first inventor of the art of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the sound-waves accompanying said sounds. Neither do I claim that I am the first who caused such electrical undulations by varying the resistance of an electric circuit in which a current was passing.

I do not herein claim the novel form of vibratory-plate receiver which I have described, because that is a subject of claim in another application.

I claim—

1. The method of producing in a circuit electrical undulations similar in form to sound-waves by causing the sound-waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

2. An electric speaking-telephone transmitter operated by sound-waves and consisting of a plate sensitive to said sound-waves, electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate.

3. The combination, with the diaphragm and vibratory electrode, of a rigidly-held opposing electrode in constant contact with the vibratory electrode, substantially as described.

4. In a telephonic transmitter, a vibrational plate made concave for condensing the sound, substantially as set forth.

5. In a telephonic transmitter, a vibrational plate provided with one or more apertures, as and for the purposes set forth.

6. A speaking-telephone transmitter comprising a diaphragm or disk sensitive to sound-waves, combined with a rigidly-held but adjustable electrode in contact with the same, whereby the electric current is transformed into a series of undulations corresponding with the vibrations of said diaphragm.

In testimony that I claim the foregoing I have hereunto set my hand in the presence of the subscribing witnesses.

EMILE BERLINER.

Witnesses:
J. A. RUTHERFORD,
JAMES L. NORRIS.

Following is a summary of the litigation in the Berliner case to date:

It is claimed by the Bell Company that Berliner first conceived the idea of the battery transmitter in January, 1877. On April 14, 1877, he filed in the Patent Office a caveat and on June 4th of the same year made application for a patent which, after various amendments (the entire specification and drawings having been twice stricken out and new ones substituted), was finally, on Nov. 17, 1891, issued to the American Bell Telephone Company, having been in the Patent Office fourteen years five months and thirteen days. In its decision the Court of Appeals says that while the delay in the Berliner case before the Patent Office was unusual, it was not unprecedented.

The delay in issuing is accounted for as follows:

On July 20, 1877, forty-six days after Berliner, Edison filed an application covering broadly the use of carbon as a material for the electrode contact in a transmitter. In March, 1878, interference proceedings between Edison and Berliner were begun, and they ended in 1882. From 1882 to 1888 the patent was withheld on account of Drawbaugh's claims and suits; in 1888 the Patent Office rejected the application of Berliner on the ground that his original application was bad and because of intermediate patents; but in 1889 reversed this decision. The next two years were spent in public use proceedings in connection with Drawbaugh's claims. In 1891 the patent issued.

On Feb. 1, 1893, the Attorney General, in behalf of the United States, began a suit before Judge Carpenter in the Circuit Court of the District of Massachusetts, asking that patent No. 463569 be cancelled.

On Jan. 3, 1895, Judge Carpenter entered a decree that the patent be cancelled. His decision was made upon the grounds, first, that the Bell Company "intentionally delayed" the prosecution of the Berliner application and that the delay was a fraud on the public; second, that the 1880 Berliner patent

(No. 233969) covered the same invention described in the subsequent patent granted in 1891 (No. 463569).

From the decision of Judge Carpenter the American Bell Telephone Company appealed to the Circuit Court of Appeals, which, on May 18, 1895, sent down this order: "The decree of the Circuit Court is reversed, and the case remanded to that Court, with directions to dismiss the bill." (See Official Gazette, Vol. 71, No. 13, page 1916.)

This was a decisive victory for the Bell Company, and on Sept. 3d its counsel made a motion for a mandate dismissing the bill in the original suit, which was allowed; but upon motion by the counsel for the Government an appeal to the United States Supreme Court was also allowed, the effect of which was to supersede the mandate and leave the case to be heard anew by the Supreme Court at Washington.

The Court of Appeals' opinion said of the delay that it resulted from something in the Patent Office system which should be corrected by Congress and cannot be reached by the courts.

The question of substantial identity of the respective claims of the two patents, or any of them, the Court said it would not undertake to determine, preferring to leave it without prejudice in the event it hereafter involves other individual or corporate rights. It said that at the best it must be admitted by the United States that there is a *reasonable doubt* on the point of identity. (The italics are ours.)

The Supreme Court decision of May 10, 1897, in the case of the United States vs. American Bell Telephone Company and Emile Berliner can be found in full in No. 8, Vol. 79, page 1362 of the Official Gazette, issued May, 25, 1897.

Mr. Justice Brewer delivered the opinion of the court. Mr. Justice Harlan dissented, but filed no opinion. Justices Gray and Brown were not present at the arguments, and took no part in the decision.

The case was taken up on an appeal from the United States Circuit Court of Appeals for the first circuit. As stated by

counsel for the appellant, four grounds for relief were presented and discussed in the Circuit Court. Those grounds are:

1. That the delay of the application in the office for thirteen years was, under the circumstances alleged in the bill, unlawful and fraudulent.

2. That a patent, issued November 2, 1880, upon a division of the original application, covers the same invention as that covered by the patent in suit, and exhausted the power of the Commissioner as to that invention.

3. That the patent is not for the same invention which was described in the application as filed.

4. That, taking the application to date from the time when it was made by amendment to cover the invention described and claimed in the patent as issued, it was barred by public use for more than two years.

By that court only the first two were considered, and the argument in the Court of Appeals was confined to those questions.

Following is the brief, given in the Official Gazette, of the Supreme Court decision:

Letters Patent No. 463569, granted November 17, 1891, to Emile Berliner, for a combined telegraph and telephone, cannot be declared invalid on the ground that the delay of the application in the Patent Office for thirteen years was unlawful and fraudulent.

Congress has established a department with officials selected by the Government to whom all applications for patents must be made, has prescribed the terms and conditions of such applications, and intrusted the entire management of affairs of the department to those officials. When an applicant for a patent complies with the terms and conditions prescribed and files his application with the officers of the department, he must abide their action, and cannot be held to suffer or lose rights by reason of any delay on the part of those officials, whether reasonable or unreasonable, unless such delay has been brought about through his corruption of the officials, or through his inducement, or at his instance. Proof that they were in fault, that they acted unwisely, unreasonably, and even that they were culpably dilatory, casts no blame on him and abridges none of his rights.

Before the Government is entitled to a decree canceling a patent for an invention on the ground that it had been fraudulently and wrongfully obtained it must establish the fraud and the wrong by testimony which is clear, convincing, and satisfactory.

When the evidence does not tend to show any corruption by the applicant of any of the officials of the department or any undue influence exerted by it upon them, and, on the other hand, does affirmatively

show that it urged promptness on the part of such officials and that the delay was the result of the actions of those officials, no presumption of fraud arises.

If circumstances show that there were reasons for official delay in the prosecution of an application, even though they do not make it clear that such delay was wholly justified, such reasons deserve consideration.

Suits may be maintained by the Government in its own courts to set aside one of its patents not only when it has a proprietary and pecuniary interest in the result, but also when it is necessary in order to enable it to discharge its obligations to the public, and sometimes when the purpose and effect are simply to enforce the rights of an individual. In the former cases it has all the privileges and rights of a sovereign. The statutes of limitation do not run against it. The laches of its own officials does not debar its right. But when it has no proprietary or pecuniary result in the setting aside of the patent, is not seeking to discharge its obligations to the public, when it has brought the suit simply to help an individual, making itself, as it were, the instrument by which the right of that individual against the patentee can be established, then it becomes subject to the rules governing like suits between private litigants.

The objection to the validity of a patent on the ground that it was already covered by another patent is a defense which, under the statutes, (sec. 4920, Rev. Stats.,) is open to every individual charged by the patentee with infringement, whether the proceeding against him be an action at law or a suit in equity. The Government, therefore, if seeking simply to protect the right of an individual, ought not to be permitted to maintain a suit in equity to cancel that against which the individual has a perfect legal defense available in any action brought by or against him.

It is unnecessary to determine whether there are two separate inventions in the transmitter and the receiver or whether the patent of 1891 is for an invention which was covered by the patent of 1880. The judgment of the Patent Office, the tribunal established by Congress to determine such questions, was adverse to the contention of the Government, and such judgment cannot be reviewed in this suit.

The conclusion of the opinion is as follows: "We see no error in the decision of the Court of Appeals, and its decree dismissing the bill is affirmed."

The whole decision contains some sixteen thousand words and nearly seven-eighths of these are employed in explaining the attitude of the Court on the first point of the Government plea, viz.: "That the delay of the application in the office for thirteen years was, under the circumstances alleged in the bill, unlawful and fraudulent."

A condensed representation of the conclusions reached by

the Court as to fraudulent delay, may be given in two propositions:

First, That a decree cancelling a patent on the ground that it has been wrongfully obtained must be made upon evidence that is clear, convincing and satisfactory.

Second, That the evidence in this case does not in the least tend to show improper influences exerted by the applicant; but on the contrary does show, affirmatively, that applicant urged promptness; that the delay was the result of the action of the officials of the Patent Office; and also that the action of these officials which caused the delay was not wholly unwarranted.

It is not necessary in this work to further enlarge on this question of delay in the Berliner case—right or wrong, it has been settled forever, and further argument cannot be profitable.

The three remaining grounds for relief are grouped together for consideration. Two extracts quoted verbatim from the decision will indicate their final disposition:

"that a patent issued November 2, 1880, upon a division of the original application covers the same invention as that covered by the patent in suit and exhausted the power of the Commissioner as to that invention."

The patent of 1880 is for a receiver; that of 1891 for a transmitter. It is claimed that the two instruments are alike in form and alike in function, save as they are operated at different ends of the telephone-wire. The transmitter can be placed at the other end of the wire and then becomes a receiver, and so vice versa. Popularly speaking, it may be said that the transmitter takes the varying sounds of the human voice and passes them on to the telephone-wire, to be borne along thereon by the undulatory electric current until they reach the receiver, which takes and passes them to the human ear. In a sense the receiver is also a transmitter, for it passes the sounds from the wire to the ear. We agree wth the Court of Appeals that it is unnecessary to determine whether there are two separate inventions in the transmitter and the receiver, or whether the patent of 1891 is for an invention which was covered by the patent of 1880. The judgment of the Patent Office, the tribunal established by Congress to determine such questions, was adverse to the contention of the Government, and such judgment cannot be reviewed in this suit.

* * * * *

"But while there was thus rightfully affirmed" (in a former case of the United States against Telephone Company) "the power of the Gov-

ernment to proceed by suit in equity against one who had wrongfully obtained a patent for land or for an invention, there was no attempt to define the character of the fraud, or deceit, or mistake, or the extent of the error as to power which must be established before a decree could be entered canceling the patent. It was not affirmed that proof of any fraud, or deceit, or the existence of any error on the part of the officers as to the extent of their power, or that any mistake in the instrument was sufficient to justify a decree of cancellation. Least of all was it intended to be affirmed that the courts of the United States, sitting as courts of equity, could entertain jurisdiction of a suit by the United States to set aside a patent for an invention on the mere ground of error of judgment on the part of the patent officials. That would be an attempt on the part of the courts in collateral attack to exercise an appellate jurisdiction over the decisions of the Patent Office, although no appellate jurisdiction has been by the statutes conferred. We are of opinion, therefore, that the question, as stated, is not open for consideration in this case."

It will conduce to a better understanding of the Berliner case if there is reviewed here a decision of some years ago.

On March 19, 1888, the United States Supreme Court passed upon the validity of patent No. 174465. This decision, which will be again referred to and at greater length in connection with the Drawbaugh case, can be found in No. 3, Vol. 43, Official Gazette of the United States Patent Office, and is profitable reading to persons interested in telephone patents. Its applicability to the Berliner case is found in the wording of claim 5 of Bell's patent, which reads:

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 sound, substantially as set forth.

In the specification various methods for causing these undulations are described, among which are: "By alternately increasing and diminishing the resistance of the circuit, or by alternately increasing and diminishing the power of the battery," "which," the opinion says, "is the variable resistance method," and speaking of claim 5, it further says: "The method as herein described includes both the magneto method and the variable resistance method." It will be remembered that this Bell patent was issued in March 1876, and that, according to the

contention of the American Bell Telephone Company, Berliner's first conception was in January, 1877.

The specification of Bell's original patent, speaking of varying the internal resistance, says:

For instance, let mercury or some other liquid form part of a voltaic circuit, then the more deeply the conducting-wire is immersed in the mercury or other liquid, the less resistance does the liquid offer to the passage of the current. Hence, the vibration of the conducting-wire in the mercury or other liquid included in the circuit occasions undulations in the current.

By looking at Berliner's claims in No. 463569 it will be seen that in comparison with the part of Bell's specification just quoted his invention rests upon the slender difference indicated by the words "constant contact" in the first and second claims; "rigidly held electrode" in the third claim; and "rigidly held, but adjustable electrode" in the sixth.

The Court of Appeals, in its decision of May 18, 1895, gave much more space to the consideration of the identity of the two Berliner patents of 1880 and 1891 than did the Supreme Court; but the conclusions of the two courts are substantially the same. Their position is fully explained in that portion of the opinion of the Court of Appeals which is here quoted. (See Official Gazette, Vol. 71, No. 13, page 1914, June 25, 1895.)

The main question, therefore, is whether the issuing of the second patent to the same applicant for the same invention, under such circumstances that it was not clearly manifest that the inventions were the same and that there might be a reasonable difference of opinion on the point of identity, involved, in the view of the statutes touching patents, such an excess of power as would justify a court in equity in rescinding the second patent thus issued. We cannot put the case more strongly than this in favor of the United States, because at the best it must be admitted by the United States that there is a reasonable doubt on the point of identity.

It will be seen that this question opens a broad field, because if this court can be called on in equity, on the suggestion of the United States, to rescind a patent merely on this ground, it may in the same way be required to investigate every question which lies behind the issue of a patent, including those of novelty, usefulness, public use, and anticipation. The distinction which the United States seek to make between the case at bar and cases which might involve the other issues—as of

novelty, usefulness, public use, and anticipation—are clearly not well founded. Some extreme supposed examples which the counsel put do not help in sustaining these distinctions, but only illustrate the fact, which must be freely admitted, that with reference to any of these various topics there may be such exceptional cases as to show a clear error within the meaning of this branch of the law, thus involving an excess of power. Such examples, for instance, as that of the Commissioner issuing two patents to the same applicant in identically the same terms are easily disposed of without involving any general principles.

It seems to the authors of this work that both the decisions are open to adverse criticism upon this very point. The two patents to the same applicant *are* identical, as Judge Carpenter held.

The Supreme Court opinion makes this assertion: "The patent of 1880 is for a receiver; that of 1891 for a transmitter. The first of these assertions is not strictly true because the *whole* truth is not told.

The patent of 1880 is not only for a receiver, but also for a method (claim 1), and also for a system (claim 4 and lines 84 and 85, page 1, of specification), which latter claim accurately describes the transmitter in that of 1891, and includes both a transmitter and a receiver. The drawings of the two patents are exactly the same, each representing two instruments in series. Are the instruments in either series both transmitters or both receivers?

For the purpose of illustrating the point at issue on the identity as to which the Court of Appeals thinks there is a reasonable doubt, we place herewith in parallel columns the salient features of the two patents under consideration.

Below them are quoted the words of the Supreme Court in the Miller vs. Eagle decision. (See Official Gazette, Vol. 66, No. 5, page 850.)

EMILE BERLINER.

ELECTRIC TELEPHONE.

No. 233,969. Patented Nov. 2, 1880.

Application Filed Sept. 3, 1880.

Fig. 1.

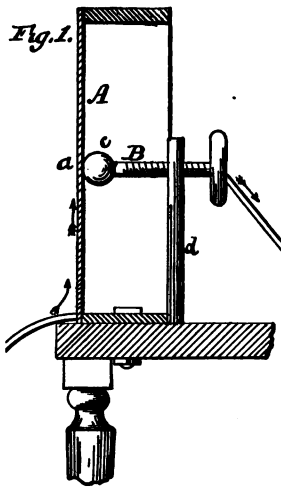
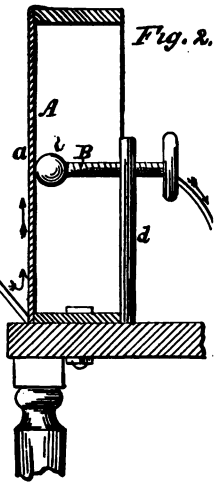


Fig. 2.



EMILE BERLINER.

COMBINED TELEGRAPH AND TELEPHONE.

No. 463,569. Patented Nov. 17, 1891.

Application Filed June 4, 1877.

Fig. 1.

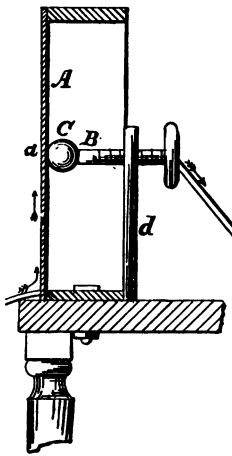
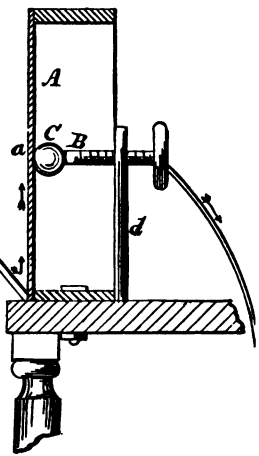


Fig. 2.



CLAIM 4. A system of two or more telephone instruments in electrical connection with each other, each consisting of two or more poles of an electrical circuit in contact one with the other, either or both poles of each instrument being connected with a vibratory plate, so that any vibration which is made at one contact is reproduced at the other, substantially as set forth.

Page 1, lines 84 and 85 of specification: "It will be observed that the transmitter is of the same construction as the receiver."

CLAIM 1. The method of producing in a circuit electrical undulations similar in form to sound-waves by causing the sound-waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

2. An electric speaking-telephone transmitter operated by sound-waves and consisting of a plate sensitive to said sound-waves, electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate.

Decision of the United States Supreme Court Jan. 8, 1894, Miller vs. Eagle Mfg. Co.:

In thus admitting the existence of a prior patented device, identical with that described in the second specification and drawings, it is difficult to understand upon what principle the patentee can be allowed to withdraw from the operation of such prior patent, one of its distinct elements, and make it the subject of a second distinct patent.

* * *

* * * a single element or function of a patented invention cannot be made the subject of a separate and subsequent patent.

The next regular step in this litigation will be for the American Bell Telephone Company to press to an issue some one of its suits against alleged infringers. The case will then be decided by the Circuit Court and appealed to the Circuit Court of Appeals, which tribunal will undoubtedly be the last resort.

In the former proceedings the time occupied was from February, 1893, when suit was brought before Judge Carpenter, to May, 1895, when the Court of Appeals handed down its decision.

Further it may be supposed that the Bell Telephone Company, even if it can get the courts again to decide in its favor, which is highly improbable, will be satisfied with its three years' extension, and not deem it wise further to tax the patience of the American people.

THE INDUCTION COIL.

The induction coil used in connection with the Berliner transmitter is described in patent No. 199141, the application for which was filed Oct. 16, 1877. It issued Jan. 15, 1878, and consequently expired in 1895. There was a reissue Dec. 14, 1880 (numbered 9499 and expiring at the same time with the original), which added two claims, Nos. 6 and 7, and as they cover the local battery and induction coil, we reproduce them here for the reader's information:

6. A telephonic transmitter which operates to vary the resistance of the circuit in which it is placed without interrupting it, in combination with a local battery, a short primary circuit of an inductorium which includes both, and a secondary circuit of said inductorium proceeding toward the distant station.

7. A combination of a primary circuit with a closed secondary circuit and a grounded tertiary circuit in which electrical undulations are produced by induction from the undulatory currents of the primary electric circuit.

If it should happen that No. 463569 be sustained by the court of final resort, it seems altogether probable that some of the methods of making an undulatory current by voltaic action, such as are described in Bell No. 174465, can be satisfactorily applied, the currents thus made intensified by the induction coil of reissue No. 9499, and so a good transmitter obtained that is not an infringement.

THE DRAWBAUGH CASES.

A little uneasiness has been caused among telephone companies of late by the attempt of the Drawbaugh Telegraph and Telephone Company, assignees of Daniel Drawbaugh, to obtain a patent for a telephone transmitter. It was so far successful that on June 3d, 1896, the United States Senate Committee on Patents made a favorable report on the "Bill for the Relief of Daniel Drawbaugh," directing the Commissioner of Patents to grant him protection. No further action was taken by Congress, and, as will be seen by reference to the decision hereafter quoted, the application to that body was withdrawn.

Following is a history of the cases:

On March 19, 1888, the Supreme Court handed down a decision grouping various cases of the American Bell Telephone Company, which had been contested in different Circuit Courts, with the following parties: Dolbear et al; Molecular Telephone Company et al.; Clay Commercial Telephone Company et al.; People's Telephone Company et al.; and Overland Telephone Company et al. Of this list the principal contestant was the People's Telephone Company, assignee of Daniel Drawbaugh, and the litigation is generally spoken of as the "Drawbaugh Case." Two members of the Court were not present at the arguments and took no part in the decision. Four of them decided all the cases in favor of Bell's patent. Three (Field, Bradley and Harlan) dissented from the opinion of the majority, claiming that

Drawbaugh produced and exhibited in his shop as early as 1869 an electrical instrument by which he transmitted speech so as to be distinctly heard and understood by means of a wire and the employment of variable resistance to the electrical current. This variable resistance was produced by causing the electrical current to pass through pulverized charcoal, carbon, and other substances acted upon by the voice in speaking. This was the whole invention so far as the principle of variable resistance is concerned. We are also satisfied that as early as 1871 he reproduced articulate speech at a distance by means of a current of electricity, subjected by electrical induction to undulations corresponding to the vibrations of the voice in speaking, a process substantially the same as that which is claimed in Mr. Bell's patent.

In regard to the instrument in which the principle of variable resistance was used, more than seventy witnesses were examined, who either testified to having seen it and heard it, or established such facts and circumstances in relation to it as to put its existence and date beyond a question.

As late as Sept. 29, 1896, the Court of Appeals of the District of Columbia, on an appeal from the decision of the Commissioner of Patents, made a final decision on two of Drawbaugh's applications for patents for telephone transmitters, one filed Nov. 12, 1883, and the other filed April 3, 1884. (See Official Gazette, Vol. 77, No. 2, page 313.)

The first claim of the first application reads:

As a tension regulator or means for varying the resistance to a telephonic current finely-divided conducting material in a loose or free state, substantially as described.

The other claims, of which there are fourteen in all, are modifications or combinations, in which the subject matter of claim 1 is an essential element.

The decision of the Appellate Court is summarized in the following quotations from the written opinion:

The oral argument was heard in November last, but time was given to file additional briefs as to a question of practice and of power in the Patent Office, and in the meantime the appellant, Drawbaugh, made application to Congress for relief in respect to his alleged invention of the speaking-telephone and operative apparatus, including the alleged inventions involved in these appeals. While that application was pending and being considered by a Congressional committee we deemed it proper to withhold the decision of this court, as our decision might possibly affect, prejudicially, the application to Congress. We have, however, been informed that the particular claim of invention involved in these appeals has been withdrawn from the application before Congress, and we now proceed to decide upon and dispose of the claims presented in the present application.

* * *

It is not for a moment supposable that if a device produced in an incomplete state by the defense in a court suit was or had been practically operative it would not have been produced in evidence in an operative condition. In view of this and in view of a finding by the Supreme Court that the original instrument did not disclose the complete invention and that all claims to the contrary are wholly unfounded in truth, such finding will be accepted as final and conclusive.

* * *

Applications of Daniel Drawbaugh * * * for telephone transmitters examined and *Held* to have been properly rejected by the Patent Office, as Drawbaugh was not the original inventor.

It is generally supposed that no further action in this matter will ever be taken.

THE HUNNINGS TRANSMITTER.

Another claimant to the use of finely divided material for varying the resistance to a telephone current, is Mr. Henry Hunnings, of England. The principle was patented by him in England on Sept. 16, 1878, and afterwards in the United States in two different patents. Under Sec. 4887, U. S. R. S., the latter expired on the same date as their English prototype, that is to say, on Sept. 16, 1892. Following are data and claims:

United States patent No. 246512, issued Aug. 30, 1881, application filed May 14, 1881, patented in England Sept. 16, 1878.

Claims.

1. As a tension-regulator or means for varying the resistance in telephone-transmitters, finely-divided carbon in a loose and free state, substantially as described.

2. The combination, in a telephone-transmitter, with a body of finely-divided carbon in a loose and free state, of a vibratory plate or diaphragm for varying the electrical resistance of said body in accordance with its own vibrations, substantially as described.

3. A telephone-transmitter comprising a thin metallic or metal-covered diaphragm, a back plate, a layer of finely-divided carbon or similar conducting material in a loose and free state inclosed between said diaphragm and back plate, and a suitable case, substantially as described.

United States patent No. 250250, issued Nov. 29, 1881, application filed Sept. 30, 1881, patented in England Sept. 16, 1878.

Claims.

1. As a tension-regulator or means for varying the resistance in a telephonic transmitter, finely-divided conducting material in a loose and free state, substantially as described.

2. The combination, with a body of finely-divided conducting material in a loose and free state, of a vibratory plate or diaphragm for varying the resistance of said body, substantially as described.

It will be seen that Hunnings' invention is exactly the same as that for which Drawbaugh asked for protection from the Commissioner and Court of Appeals.

No commercial value is represented now by either case. To whom belongs the glory of the discovery is a question. In 1888 three judges of the Supreme Court (out of seven acting) decided that Drawbaugh employed his device for transmitting speech in 1869; the Commissioner of Patents and Court of Appeals of the District of Columbia have since decided that he did not; but it should be remembered that these later decisions were influenced by the majority one of the Supreme Court in 1888. On the other hand, Hunnings has the dictum of the United States Patent Office that he is the original inventor.

AUXILIARY APPARATUS.

The telephone receiver, the induction coil and battery being clear of patents, and the status of the transmitter cases having been portrayed to the best of our ability, it will be useful to examine the field in regard to the protection on such important auxiliary apparatus as may be deemed indispensable for their proper working. These may be considered under "Subscribers' Calls" and "Switchboards."

SUBSCRIBERS' CALLS.

The patent of Roosevelt, No. 215837, which expired on May 27, 1896, and that of Phelps, No. 222201, which expired Dec. 2, 1896, covered the action of switching the telephone in and out of the circuit by the weight of the receiver when the latter is removed from or hung upon a supporting hook; and also the nonconducting cord which protects the conducting cords from being severed if the receiver is accidentally let fall. They did not, however, cover the method or the combination of devices necessary either to bring into or remove from the circuit the receiver and secondary coil of the transmitter, and at the same time either establish or open an electric circuit through the primary coil of the transmitter. This operation was covered by No. 270522 of Watson, dated Jan. 9, 1883. The latter patent also covered the opening and closing of a shunt circuit around the magneto generator by the action of pressing a button against a spring or releasing it. Watson secured eight claims, the essential parts of the invention being described in the first and fourth, which are here reproduced.

1. In combination with suitable contact-points and springs electrically connected with the call-circuit and the primary and secondary circuits of a transmitter, the latter circuit including the hand-telephone, a

lever electrically connected with the main line in a telephone-circuit, substantially as described, to bring in the hand-telephone and transmitter and break the call-circuit, or to cut out the hand-telephone and transmitter and establish the call-circuit, accordingly as the lever is moved in one direction or the other.

4. In combination with a magneto-generator, a main-line telephone circuit and a shunt-circuit passing through the magneto-generator, the push-button U to break the shunt-circuit, substantially as described.

In a suit brought before Judge Showalter, of the United States Circuit Court at Chicago, on behalf of the Western Electric Company, of that city, against the Western Telephone Construction Company, of Chicago, alleging infringement of the Watson patent (No. 270522), the Court, on Nov. 7, 1896, granted an order to the effect that the patent in controversy expired on July 30, 1895. The ground for the order was that a similar patent had been taken out in Canada by Watson on July 30, 1880, and under Sec. 4887, U. S. R. S., and the interpretation of the same by the Supreme Court in Bate Refrigerator Co. vs. Sulzberger, the American patent had expired by limitation. The Canadian patent is No. 11575, and duplicates claims 6, 7 and 8 of the American patent, which are as follows:

6. In a telephonic circuit, the spring-hook D, adapted to support the weight of the hand-telephone, in combination with the contact-springs s1, s2, and s3, connected with the transmitter hand-telephone and signaling-circuit, substantially as described, for the purpose specified.

7. In a telephonic circuit, the spring-hook D, adapted to support the weight of the hand-telephone, in combination with contact-springs s1, s2, and their connections, substantially as described, to automatically establish the primary local circuit through the transmitter, and at the same time bring into the main line the circuit through the hand-telephone and the secondary circuit through the transmitter by taking the telephone from the hook.

8. A switch-lever connected with the main line of a telephonic circuit and movable in either direction, in combination with the contact-springs s1, s2, s3, the transmitter, the hand-telephone, a signaling-circuit, and suitable contact-wires, substantially as described.

Claim No. 5 of the American patent reads as follows:

5. A switch-lever and contacts for connecting with the line-wire either a telephonic circuit or a call-circuit, according to the position of the switch-lever, in combination with the magneto-generator, its shunt and push-button, the said magneto-generator being connected with the call-circuit, substantially as described.

This and claim 4, as we understand, were, after the decision of Nov. 7, 1896, still in force, but it will be noted that they were exceedingly limited in their application, being confined to the specific device, the push-button "U."

A further decision by Judge Showalter, which was handed down on Feb. 10, 1897, held that all the claims are invalid. It declares that in claim 4 the function of the press-button "U" lacks novelty, citing as a prior use the short-circuiting of the secondary part of the transmitter induction coil as disclosed in Edison No. 203017, and that claim 5 is not a true combination as "no modified result follows from any combination of the push-button in the call-circuit with the switch-lever." The Court also decided against all the claims for want of novelty or invention, the written opinion ending in these words:

> In view of the state of the art * * * my judgment is that there is no novelty or invention in any of the eight claims, nothing more than the use of clever mechanical expedients in arranging a subscriber's outfit. The bill is therefore dismissed for want of equity.

It may be said, therefore, that there is now free to the public that form of subscriber's call in which the hanging up and taking down of a telephone receiver is automatically used to cut in and out of the circuit the signalling and telephonic apparatus, respectively, and at the same time open or close the battery circuit of the primary coil of the transmitter; and that to cut in and out the generator coil of the magneto bell there may be used in combination with the automatic hook switch (without infringement) some form of hand switch other than the push-button "U" or its equivalent.

The reservation on account of the push-button "U" (claims 4 and 5) is made because it is probable the Western Electric Company will appeal the case, and until a decision is rendered by the Appellate Court it cannot strictly be said that the subject matter of these claims is open to the public.

If, however, it is attempted *automatically* to cut in and cut out the generator coil of the magneto bell, there acts as a bar patent No. 309617 of Elisha Gray, dated Dec. 23, 1884.

It is not the specific device shown and described which

makes this patent troublesome, but the allowance by the Patent Office of the first claim, which reads:

1. The combination, with a magneto or dynamo electric machine, of a main circuit and a shunt or short circuit around said machine, and means for automatically breaking such short circuit upon and continuously during the operation of the machine.

While all of Watson's claims were in force they applied not only to magneto bell calls but pretty well covered either magneto or battery calls when used in connection with a battery transmitter, but with the use of a battery for calling the expired Watson claims furnish the public with good non-infringing methods for subscribers' calls.

With the use of magneto calls, however, some ingenuity will be required to avoid infringing the fourth and fifth claims of Watson, and the first claim of Gray; it should be possible, however, to make up a good form of magneto call which shall be free from all infringements. It is also possible that the Watson and the Gray patents may be found to have expired on account of foreign ones, as Sec. 4887 U. S. R. S., seems not to have been properly understood until the Bate Refrigerator decision in 1895.

SWITCHBOARDS.

The telephone switchboard in its primitive form is a combination of the telegraph switch and the hotel or burglar alarm annunciator. The "Western Union pin switch," having a spring jack, plug and flexible cord attachment; and the hotel annunciator, both perfected prior to the invention of the telephone, include all the principal elements in the switchboard of to-day.

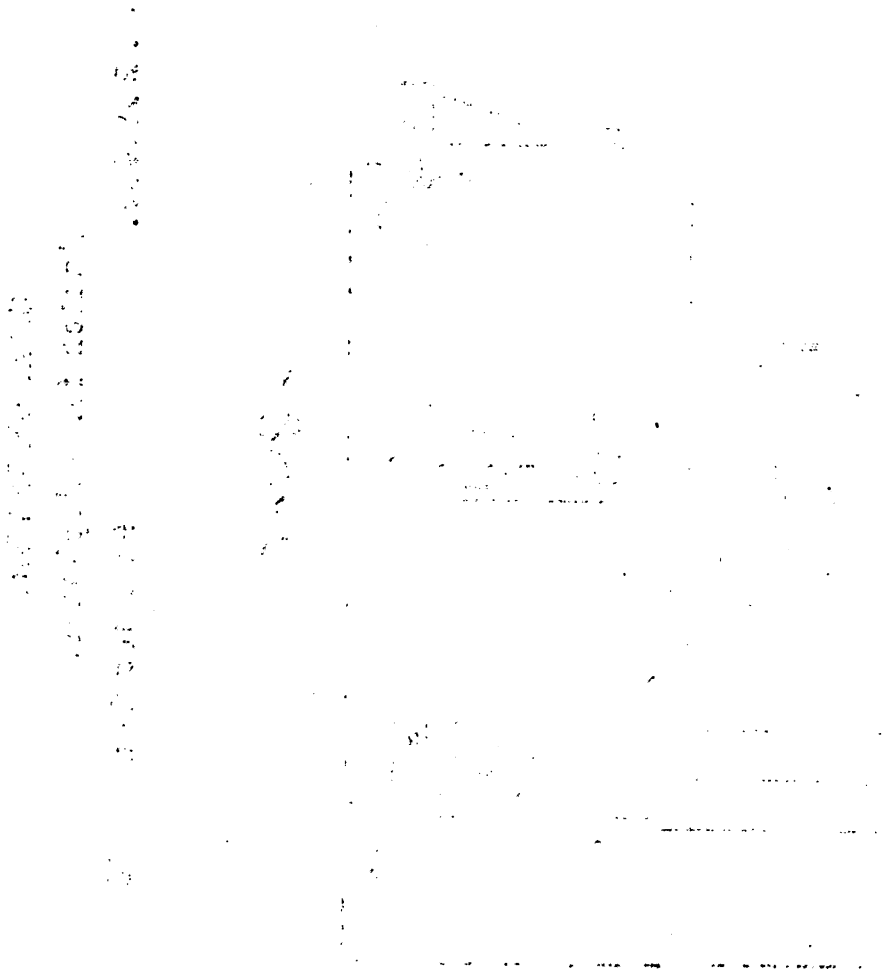
Judging from the claims allowed in United States patent No. 208463, of Oct. 1, 1878, Mr. Chas. A. Cheever was the first to combine these elements. His application was filed Aug. 23, 1878, and the three claims allowed show his invention. The drawing (See Plate 6), represents a form of spring-jack which was used prior to those made in connection with the pin switch, called the "plug cut-out." His drop was the burglar alarm or hotel annunciator which operated by dropping a shutter and disclosing a number in a window behind the shutter.

Following are the claims:

1. In combination with a transmitting-telephone, a receiving-telephone, a battery, and a signaling apparatus, a plug-switch having one side of the plug insulated, substantially as and for the purposes described.

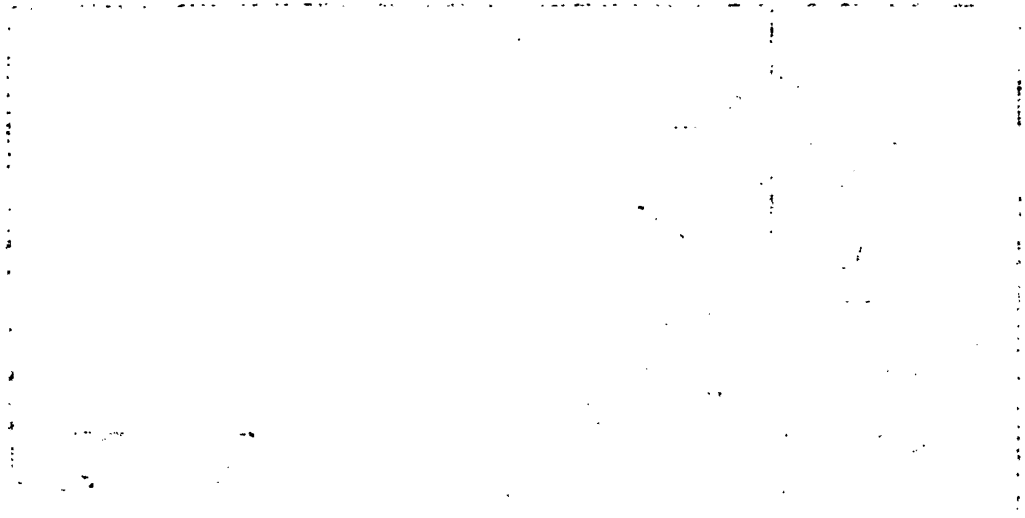
2. The combination of the transmitting-telephones T, switch-board K, annunciator A, battery B, and receiving-telephones R, whereby a less number of receiving-telephones is used to receive messages from a greater number of transmitting-telephones, substantially as described.

3. The combination of a series of telephones connected with the switch-board K, which is provided with the spring-switches S, and receiving-telephones R and plugs P, when connected with the annunciator A, battery B, and return-wires, substantially as described, whereby the insertion of the plug P cuts out the annunciator and battery from the line through which the signal is to be received, but leaves the other lines intact, substantially as described.



C. A. CHEEVER.

PLATE 6.



The next important step is shown in the invention of Horace H. Eldred, who filed his application for patent June 9, 1880. It is numbered 303714, was issued Aug. 19, 1884, and consequently, unless affected by some foreign patent, will expire Aug. 19, 1901.

The reader will understand that, although there were many applications intervening between Cheever and Eldred for patents on telephone switchboards, Eldred's board is named here as the next important step on account of the claims allowed by the Patent Office, which is the only official means of designating an invention until some higher tribunal gives a decision. Eldred describes, and covers by claims, a workable switchboard without, so far as we can see, using any devices except such as are shown in Cheever's patent or such as existed prior to Cheever's application. All of the allowances are for combinations, nothing being claimed in the way of new devices.

Hoping to make the combinations more easily understood, we have designed a diagram with less complication of lines and figures than is shown in the original patent drawing (see Plate 7).

Herewith are reproduced (verbatim) all the claims:

1. The combination, substantially as hereinbefore set forth, of a series of telephone-lines converging to a central or exchange station from different sub-stations, a series of spring-jacks—one for each line—for the insertion of connecting wedges, and a series of visual signals or calling-annunciators, W' W2 W3 W4 W5 W6, one of which is placed in each line at a point between its spring-jack and the earth, whereby the annunciators are cut out while talking.

2. The combination, substantially as hereinbefore set forth, of a series of telephone-lines converging to a central or exchange station from different sub-stations, movable switches and conductors 7 8, &c., at said central station, whereby direct communication can be established between any two sub-stations by connecting both their respective lines together, and an auxiliary or supplemetal signaling apparatus, R' &c., included in each of said connecting-conductors, whereby the sub-stations so connected, or either of them, may notify the attendant at the central station to disconnect the said lines.

3. The combination, substantially as hereinbefore set forth, of a series of telephone-lines converging to a central or exchange station from different sub-stations, movable switches and conductors at said

central station, whereby direct communication can be established between any two sub-stations by connecting their respective lines together, a spring-jack in each of said connecting-conductors, an apparatus for transmitting and receiving calls or signals, and telephonic apparatus included in a loop which is provided with a wedge for insertion into said spring-jack, and a circuit-changer whereby said loop may be divided and the leg containing the signaling apparatus and telephone connected directly with the earth.

4. The combination, substantially as hereinbefore set forth, of a switch-board, an auxiliary table, telephonic or electric apparatus located upon said table, and devices for establishing temporary electrical connection between one or more lines centering in said table, communication between sub-stations and the central station or between different sub-stations being established through the table apparatus.

5. The combination, substantially as hereinbefore set forth, of a series of visual indicators at a central station, a series of independent sub-station lines converging to said central station, each passing through its respective indicator, and thence to a normal connection with an earth common to all of said lines, an operator's table, and devices for temporarily disconnecting one or more of said lines from the earth and simultaneously connecting them with said table.

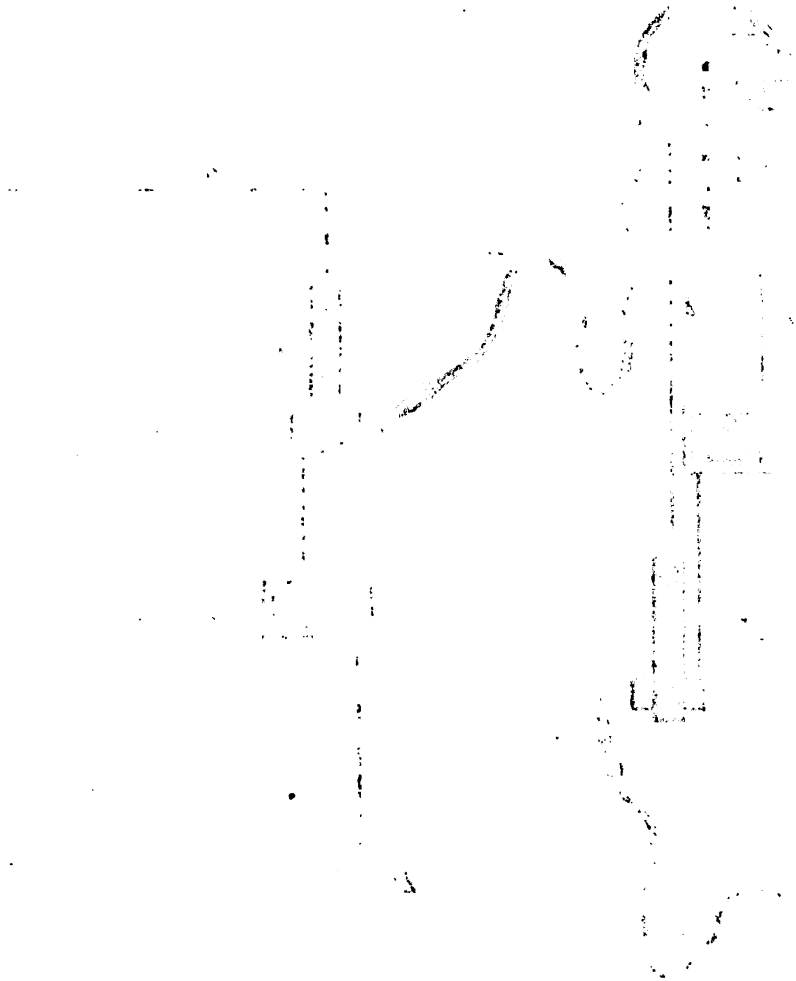
6. The combination, substantially as hereinbefore set forth, of a series of sub-station lines converging to a central station, a series of conducting bars or strips permanently connected with an operator's table, and devices for temporarily connecting one or more of said lines with said bars or strips.

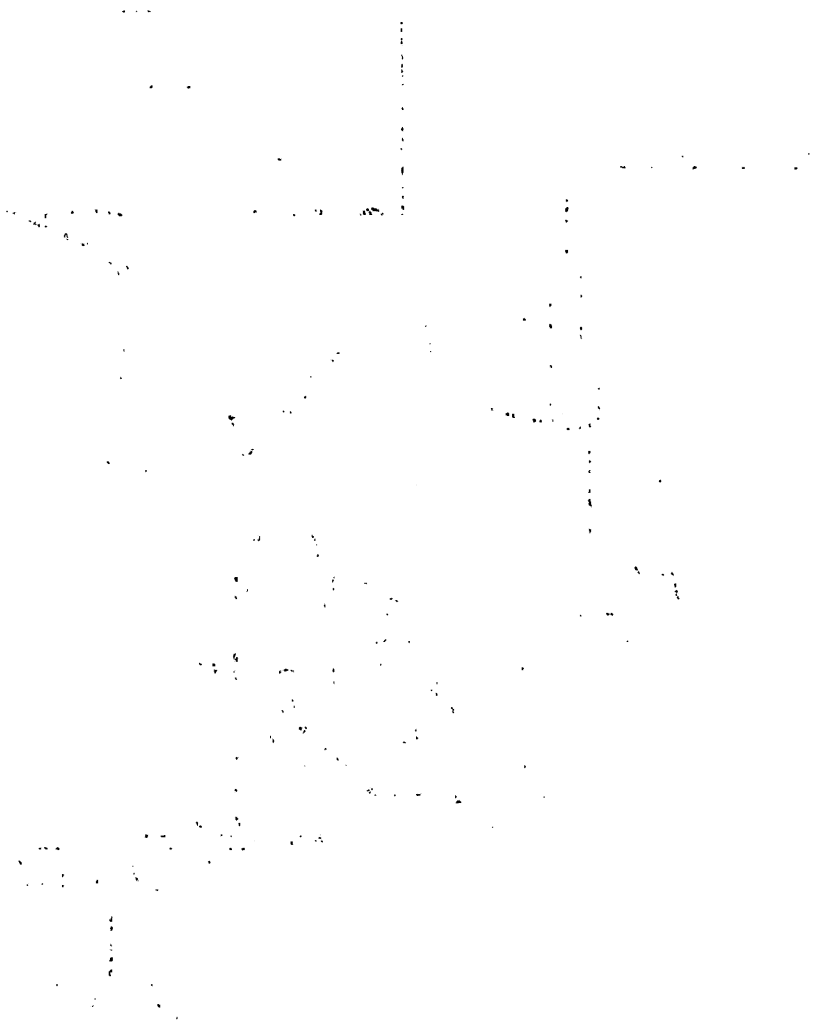
7. The combination, substantially as hereinbefore set forth, of a series of sub-station lines converging to a central station, a series of spring-jacks—one for each line—a series of conducting bars or strips, and flexible conductors armed with suitable plugs or terminals for temporarily establishing electric connection between one or more of said lines and said bars or strips.

8. The combination, substantially as hereinbefore set forth, of a series of sub-station lines converging to a central station, a series of annunciators or indicators—one for each line—a series of spring-jacks—one for each line—a series of conducting bars or strips, and flexible conductors armed with suitable plugs or terminals for temporarily establishing electric connection between one or more of said lines and said bars or strips.

9. The combination, substantially as hereinbefore set forth, of a series of sub-station lines converging to a central station, a series of conducting bars or strips, a series of branch or loop circuits, each uniting a single pair of said bars or strips, and means for forming a temporary electrical connection between any two lines and a pair of bars or strips.

10. The combination, substantially as hereinbefore set forth, of a series of conducting bars or strips, a series of branch or loop circuits, each uniting a single pair of said bars or strips, a series of spring-jacks—one in each branch or loop circuit—a telephonic apparatus, and a flexible con-





ductor armed with a suitable terminal plug for connecting said apparatus with any of said branch or loop circuits.

11. The combination, substantially as hereinbefore set forth, of a number of spring-jacks, a plug for insertion into said spring-jacks, a switch, central office instruments, and connections from said instruments to the points of said switch.

12. The combination, substantially as hereinbefore set forth, of a series of sub-station lines converging to a central station, an operator's table, devices for temporarily connecting one or more of said lines with said table, an electric generator, and key and switch mechanism upon said table for connecting said generator and key with any of the lines connected with said table.

13. The combination, substantially as hereinbefore set forth, of a series of indicators with a series of corresponding spring-jacks, each indicator being placed in proximity to its respective spring-jack.

14. The combination, substantially as hereinbefore set forth, of one or more operator's tables, one or more indicators, and controlling mechanism therefor located upon said tables.

15. The combination, substantially as hereinbefore set forth, of a series of independent lines or conductors, one or more branch or loop circuits, one or more central office instruments, means for uniting any two of said lines or conductors with each other through one of said branch or loop circuits, and means for switching one or more central-office instruments into or out of such branch or loop circuit.

16. The combination, substantially as hereinbefore set forth, of a series of main lines converging to a switch at a central station, devices for uniting any two of said lines for oral communication, apparatus included in each line at the central station to indicate a call or signal, and independent devices for connecting either line to a pole-changing apparatus for transmitting outgoing signals.

Referring to Plate 7, illustrative of Eldred's claims, A A are the lines of two subscribers, B B their respective spring-jacks, and W' W2 their visual signals or calling annunciators. E is the earth, K K are conducting bars or strips into which can be connected by plugs the single strand cords L L, which upon their outer ends are furnished with plugs having one side of conducting and the other of insulating material, the conducting part being designed to connect the upper part of spring-jacks B B with the conducting cords, while the lower contacts of the spring-jacks are insulated, thus cutting off the calling annunciator and ground.

7 8 are wires leading from the strips K K to the clearing-out drop R1, and spring-jack F respectively. N is a double-faced plug terminating a double strand cord, and is used to

loop in the wires H, h and h1, connecting with the generator G. The switch P upon generator G changes the circuit from generator and bell to transmitting telephone M and receiver. J is a switch in the cord circuit by which the operator's set may be put in circuit with one subscriber and the other subscriber cut off (as shown in the diagram); or the same set may be placed in connection with both subscribers by moving the switch arm to the right.

It is possible that a few of the claims, and the broadest ones, Nos. 1, 2 and 16, for instance, might be successfully defended by the establishment of evidence showing prior public use.

The Eldred patent is owned by the Western Electric Company, of Chicago. In September, 1896, suit for infringement of it was brought against the Standard Telephone and Electric Company, of Madison, Wis., but so far no judicial decision has been given. The Standard Company assert that they have excellent defenses.

The next important patent in proper order is that of Thos. A. Watson, No. 256258, issued April 11, 1882; the application was filed April 20, 1880. See Plates 8 and 9. The claims are here given in full:

1. The combination, with a switch-board, of an independent key-board with spring-keys for manipulating circuits, and devices for temporarily connecting lines centering in said switch-board with the key-board, substantially as described.

2. A key-board having circuit-keys for connecting electrical conductors in circuit with each other through their bridges or back contacts, and ground-keys connected with the anvils of said circuit-keys for grounding the same, substantially as described.

3. In an electric key-board, the combination of circuit-keys with their bridges or back contacts electrically connected in pairs, and ground-keys connected with the anvils of the circuit-keys for grounding the same, substantially as described.

4. The combination, with two or more pairs of circuit-keys, of a pair of ground-keys connected with the anvils of each pair of circuit-keys for grounding said anvils separately or together, substantially as described.

5. The combination, with circuit-keys for connecting electrical con-

ctors or circuits with each other through their bridges or back contacts, of a local-instrument circuit connected with the anvils of said circuit-keys, substantially as described.

6. The combination of circuit-keys for connecting electrical conductors or circuits with each other through their bridges or back contacts, of a local-instrument circuit connected with the anvils of said circuit-keys, and ground-keys connected with said anvils for grounding the same, substantially as described.

7. The combination, with line-circuits emanating from a central office, of a series of spring-keys and a telephone circuit or branch connected with the anvils of the circuit-keys and thus adapted to be brought into connection with the several lines by means of said keys, substantially as described.

8. A pair of circuit-keys having their back contacts connected with each other, combined with means for temporarily connecting said keys with line-circuits, substantially as described.

9. A pair of circuit-keys having their back contacts connected with each other, in combination with keys normally grounded having their anvils connected with those of the first-named keys, substantially as described.

10. The combination, with circuit-keys, of a local circuit provided with branches and connected with the anvils of said keys, and a switch for closing the local circuit through the required branch, substantially as described.

11. The combination of ground and circuit-keys, local circuit provided with branches and connected with the anvils of said keys, and a switch for connection in the required branch, substantially as described.

12. The combination, with a series of line-circuits emanating from a central office and a key-board, of a magneto-generator and battery located in separate branches, a switch, and electrical connections, substantially as described, whereby either of said sources of electricity can be connected temporarily with any of said lines through the key-board, as set forth.

It will be noted that the filing date was twenty days prior to that of the Eldred patent just mentioned, and a good deal that is shown in Eldred's is also shown in this issue of Watson.

The arrangement automatically to take up the slack in conducting cords by a movable weight suspended in the loop or bight of the cord, was afterward made the subject of another patent to Watson, No. 280266, issued June 26, 1883, the application for which was filed March 9, 1882, with the following claims:

1. The combination, with flexible cords provided with switch-plugs

or connectors at their ends, of means, as indicated, for automatically taking up the slack in said cords, substantially as described.

2. The combination, with a series of switch-plugs and flexible conducting-cords, of movable weights suspended in the bights of said cords, substantially as described.

Both of these Watson patents were found to be invalid during the progress of a suit of the Western Electric Company against the Standard Telephone and Electric Company, of Madison, Wis. There was discovered an Italian patent granted to Watson Sept. 30, 1880. The farthest limit of this Italian patent was fifteen years, which terminated the American patent in 1895; and consequently the apparatus described in the claims is now free to the public.

Patent of C. E. Scribner, No. 266319, issued Oct. 24, 1882, the application filed Nov. 3, 1880, is briefed by the following quotation from the specification and its only claim:

My invention consists in placing a clearing-out annunciator in the line d, d', which connects the central points c, c, of two plugs connecting any two subscribers, whether provided with complete metallic circuits or otherwise, in such manner that either of the subscribers may notify the central office when they are through talking.

* * *

Claim.

The combination, in the circuit of two connected telephone-lines, of double-pointed plugs, one plug inserted in the spring jack-switch of each of the lines, respectively, and an annunciator-magnet included in the strand of the cord which connects the central points of the plugs, whereby the annunciator is included in the circuit, whether the plugs are used for connecting single lines or metallic circuits.

Patent of Leroy B. Firman, No. 283334, dated Aug. 14, 1883, application filed March 26, 1881, covers the principle of leaving one of the subscribers' annunciator drops in the circuit to act as a clearing-out drop; the line drop of the other subscriber being removed from the circuit during the time connection is made. There are reproduced here the drawings (see Plate 10) and the claims in full:

1. The combination of telephone-lines L' and L3 with connecting-plates A C, each provided with two plug-bales, the branch circuits, in-

cluding annunciators 1 and 3, and switching apparatus, as described, whereby either of said annunciators may be included in the circuit of said telephone-lines when connected, as and for the purpose specified.

2. The combination of the telephone-lines with switches, one for each line upon the central-office switch-board, branch circuits, one branch circuit for each line, each branch including an annunciator and switching apparatus, whereby any two telephone-lines may be connected together through the annunciator of one of the lines, while the annunciator of the other line is not included in the circuit.

Patent of Milo G. Kellogg, No. 247199, was issued Sept. 20, 1881, application filed April 4, 1881. The drawings and claims are herewith reproduced in full:

1. The combination of normally-closed ground-circuits with switches, one switch for each line, and annunciators, one annunciator in each line between the switch and the ground-connection, and a pair of cords and plugs, and a clearing-out annunciator and keys, one key for each cord and one key or its equivalent for obtaining a derived circuit, whereby the ground and respective annunciators of any two lines may be cut off and the circuits of said lines diverted from the switches through the clearing-out annunciator, and the listening operator enabled to determine whether the subscribers have stopped talking.

2. The combination of normally-closed ground-circuits with switches, one switch for each line, and annunciators, one annunciator in each line between the switch and the ground-connection, and a pair of cords and plugs, and a clearing-out annunciator and keys, one key for obtaining a ground-circuit through the telephone, and means for signaling, whereby the ground and respective annunciators of any two lines may be cut off and the circuits of said lines diverted from the switches through the clearing-out annunciator, and the listening operator be enabled to signal to one of the lines, or to determine whether the subscribers have stopped talking.

3. In a telephone-exchange, two lines connected together for conversation, in combination with a key for grounding the lines through the central-telephone, and key 1, whereby the lines may be disconnected and one of them closed to ground through the signaling-battery, as and for the purpose set forth.

4. In a telephone-exchange, two lines connected together for conversation, in combination with two keys, one for each line, either of which, on being depressed, disconnects the lines and grounds its own line through the central-office signaling-battery.

5. The combination of normally-closed ground-circuits with switches, one switch for each line, and annunciators, one annunciator in each line between the switch and the ground-connection, and a pair of cords and plugs, and a clearing-out annunciator, whereby when the plugs are inserted in the switches which belong to any two lines their annunciators are disconnected from the lines and the lines connected together through

the circuit of the clearing-out annunciators, substantially as set forth.

6. In a telephone-exchange, two lines connected together for conversation, in combination with two keys, one for each line, either of which, on being depressed, disconnects the lines and grounds its own line through the central-office signalling battery, and a third key, which, on being depressed grounds the lines through the central-office telephone.

Tracing the course of switchboard invention up to this point, it appears that Eldred had placed the clearing-out drop on bars with which cords could be connected. Watson had placed ringing keys and a listening switch in the cords. Scribner put the clearing-out drop on one strand of the double cords. Kellogg combined the clearing-out drop and ringing keys and added the listening key, virtually completing what is called the "cord circuit" of the single line switchboard.

Another patent of Kellogg's, No. 308315, filed May 5, 1881, and issued Nov. 18, 1884, seems to be the original "busy test." As described by the patent it consists "in independent local circuits and electric apparatus, whereby a switchman at any board may readily determine whether the line of a subscriber called for is in use at either of the other boards, and is adapted to any of the known methods or combination of methods of sending in the calls or connecting the terminal stations with or through the central office."

Claims Nos. 13 and 16 briefly cover the invention. The "purpose specified" being set forth in the extract from the specification just given. The other (fourteen) claims merely ring changes on the subject matters described in the following:

13. The combination, with a spring-jack switch, of an insulated contact spring operated thereby, whereby a local circuit may be closed, substantially as and for the purpose specified.

16. In a telephone-exchange system, the combination of two or more switch-boards, two telephone-lines connected together for conversation, and electric apparatus and circuits, whereby an attendant at either of said boards may readily determine that either of said lines is in use.

Another invention of C. E. Scribner, patent No. 330058, filed June 11, 1883, issued Nov. 10, 1885, was an important advance in telephone switchboards. We reproduce the second sheet of the drawings as Plate 12, and quote two portions of the specifications; also the claims in full:

My invention is designed to enable the operator to converse at once with a subscriber as soon as one of a pair of plugs is inserted in the said subscriber's switch without further work on the part of the operator, and also to enable the operator to disconnect his telephone automatically when the second plug of the pair is lifted for insertion in the switch of the second subscriber, while at the same time the operator is provided with all the facilities heretofore employed for receiving the calls, signaling, and making the connections and disconnections.

* * *

I have thus described my invention in connection with a single switch-board. It is, however, apparent that my invention may be applied to multiple systems by simply duplicating the apparatus herein described, or with such modifications as an ordinary mechanic would readily understand and suggest.

In multiple systems each operator's telephone would be connected with a common connecting-piece, with which all the plugs of the switch-board of said telephone would be normally in contact.

* * *

Claims.

1. The combination, with a pair of cords and terminal plugs, of a subscriber's switch, in which one of said plugs is inserted, a telephone in a circuit, extending to a ground-connection from a connecting-piece common to the circuit of said telephone, and to the other of said pair of plugs, whereby connection is maintained from said subscriber's switch with the telephone, said connection being broken when said other plug is lifted from the common connecting-piece.

2. The combination, with the switch-board of a telephone-exchange, of a pair of plugs and flexible cords, one of said plugs being adapted to be inserted in a switch upon the switch-board, while the metallic portion of the other plug remains in contact with the common connecting-piece of the operator's telephone, said telephone being placed in the circuit between said common connecting-piece and the ground at the central office, whereby the circuit is closed through said telephone, substantially as and for the purpose set forth.

3. The combination of pairs of plugs each provided with a metallic portion, said portions being adapted to be held in contact with a common connecting-piece by means of weights, conducting-cords, and the telephone-switches upon the switch-board, whereby when one of a pair of plugs is inserted in a switch the line of said switch will be connected through the operator's telephone, said telephone being disconnected automatically when the other plug of said pair is raised to be inserted in a second switch.

By comparison with Kellogg 247199 (Plate 11), the point of Scribner's invention can be more readily understood. In the Kellogg organization the central operator had first to plug the jack and then press listening key to connect calling subscriber's line with her head telephone. In the Scribner plan, when calling subscriber's jack is plugged the head telephone is in circuit without pressing the listening key. When called subscriber's jack is plugged the head telephone is disconnected. That is to say, Scribner's improvement, while retaining all the advantages which Kellogg had contributed, simplified and quickened the operation by dispensing with pressing, holding, and releasing the listening key. (See claim 1.)

The improvements by Scribner are continued in his patent No. 330059 of Nov. 10, 1885, in which "the frames of each series of switches, though connected together, are normally open to earth. The insertion of a plug in any switch of a series crosses all the switches of the series with the line which is connected with said plug," and * * * "designed to enable an operator to test to determine whether there is such a cross on a line wanted by means of the same plug with which he is about to establish a connection with the line wanted."

Also patent No. 330060 of the same date, "to furnish the means whereby such a test may be made with the same plugs with which the connections are made, the test being made at the *first contact* of any connecting-plug with the switch into which it is to be inserted." (The italics are ours.)

Also No. 330061, same date, "designed to avoid the resistance of these contact points" (in the spring-jacks) "by the use of circuits and apparatus more simple than any heretofore devised, while the operators are enabled to make the usual tests to determine whether any line wanted is already in use at another board."

The latter (No. 330061) is the subject of a pending suit brought by the Western Electric Company of Chicago against the Home Telephone Company of Mobile, Ala., for infringement of claims 2, 4 and 6.

The defense pleads that the prior art discloses all of the improvements described in the three claims, citing Ross, No. 252259, in combination with previous patents of Scribner himself; that in the Ross patent (which is again referred to in this volume under "Multiple Switchboards") there is shown and described, but not claimed, a spring-jack, and plug which, if used in connection with Scribner, Nos. 330059 and 330060, "will give in every particular the exact combination of the claims in suit"; and "it having been clearly shown by the proofs referred to that there was absolutely no 'busy test' upon defendants' board, it follows that they cannot be charged with trespassing upon any claims in the patent in suit in which testing apparatus is made an element."

Patent of C. E. Scribner, No. 300144, issued June 10, 1884, application filed Feb. 25, 1884, covers the principle of connecting the instruments of the central station operator in a shunt circuit, or what the patent describes as a "derived circuit," around the clearing-out annunciator. The drawings are here inserted as Plates 13 and 14, and the claims reprinted in full:

1. The combination, with conducting-cords and terminal plugs for connecting two subscribers of a telephone-exchange, of a clearing-out annunciator connected permanently in circuit between said plugs, and switching apparatus whereby an operator's telephone may be connected in a derived circuit around said clearing-out annunciator.

2. In a telephone-exchange, the combination, with telephone-lines emanating from a central office, and a branch line containing a signal device, and provided with means for temporarily connecting it at opposite ends with any two of said telephone-lines, of a telephone and switching apparatus whereby said telephone may be connected into a derived circuit around said signal device.

3. The combination, with the telephone-lines and a branch line provided with means for temporarily connecting it at opposite ends with any two telephone-lines, of a signal device, and a telephone and switch, said signal device being connected permanently with the circuit of said branch, and said switch being adapted to connect the said telephone in a derived circuit around the said signal device.

An application for patent on telephone exchange apparatus was filed Sept. 30, 1889, by Joseph J. O'Connell, of Chicago, Ill.,

and issued as No. 430747, under date of June 24, 1890. It consists, as stated by the inventor, first, in a double thimble socket for metallic telephone lines on multiple switchboards; second, in a pair of loop plugs, one for the answering jack and the other for the test plug and for insertion in the double thimble socket of a called subscriber; third, in a high resistance individual annunciator in each metallic circuit; fourth, in a condenser in a shunt around the grounded test battery, to prevent disturbances by induced currents; fifth, in the key-board apparatus; sixth, in a special shelf at the rear of the board to support the key-board apparatus.

Claim No. 1, which seems the most important, reads as follows:

1. A socket for switch-boards, consisting of two insulated portions, in combination with a metallic-circuit telephone-line connected therewith, one side to one portion of the socket and the other side to the other portion thereof, and a loop-plug having two terminals inserted in said socket, one terminal of the plug being closed to one portion of the socket and the other terminal to the other portion of the socket, said sides of the telephone-circuit extending beyond the socket and including a high-resistance annunciator, and the terminals of the inserted plug being connected together through an electric instrument of low resistance as compared with the resistance of the said annunciator, whereby the said annunciator is shunted, substantially as and for the purpose specified.

We understand the "high resistance annunciator" to mean the clearing-out drop, and the "electric instrument of low resistance" the operator's telephone set. An issue could be made as to whether a system with common return is a metallic circuit within the meaning of this claim. It might be held that a circuit that is all of metal is a metallic one in contra-distinction to one completed by connection to the earth. On the other hand, this specification implies, and it was and is common technical parlance to describe only a circuit in which each subscriber has two separate and individual wires as a "metallic" one.

Claim 4 is another arrangement of the clearing-out drop, and is as follows:

4. The combination, with two metallic-circuit telephone-lines looped together for conversation, of a high-resistance clearing-out annunciator

bridged across said circuit at the central office and a branch circuit from between the two coils of said clearing-out annunciator to ground, and a grounding-key and generator at each of the two connected stations, whereby either of the two connected subscribers may open the circuit on one side and close the same to ground on the other side to include his generator and one coil of the clearing-out annunciator in a grounded circuit.

There is another claim (No. 18) of this patent which will be taken up in connection with the multiple switchboard.

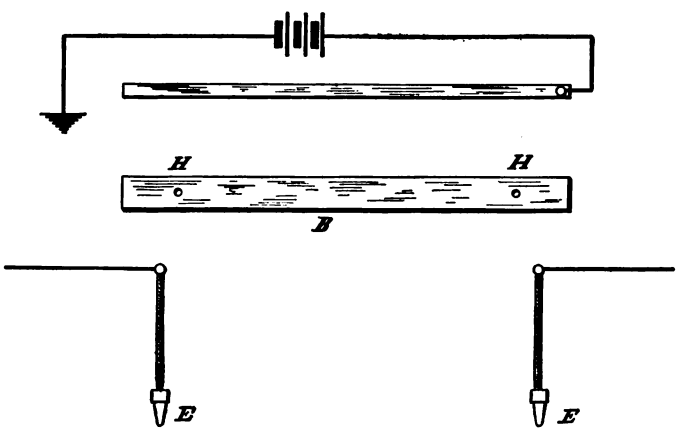
Up to this point are shown all of the very important patents applying either to a switchboard of one section or to a plain trunk line board. The principle of trunking is described, but not claimed, in No. 220874, Shaw, Oct. 21, 1879 (further noticed under "Law System"), and is apparently free to the public. All that is claimed in Cheever's patent of 1878, and in the Watson key-board and pulley weight patents is also free. The general details of a trunk line board, which are of any considerable importance, and covered by patents, are included in the issues of Eldred, Firman, Kellogg, Scribner and O'Connell, which have just been described. Eldred (claim 1) covers the placing of the calling annunciators between spring-jack and earth (and also, we suppose, between spring-jack and common return); Eldred (claim 2) covers the clearing-out drop connected in series circuit with the cords; Kellogg, 247199 (claim 3), the listening key and (claim 4) the ringing keys direct to cord; and O'Connell the high resistance clearing-out drop bridged and grounded. Attention is also called to Eldred's claim No. 15, which, as switchboards are now made, seems to cover the apparatus for switching the operator's set at "central" into or out of the branch or loop circuits which unite the subscribers, and Scribner covers the necessary means for shunting around the clearing-out drop; that is to say, if in a telephone exchange the operator's set is switched directly into the connecting circuits between the lines of two connected subscribers, the combination covered by Eldred in claim 15 is used, and if this is avoided by putting the operator's set around the clearing-out drop, then Scribner's method must be employed.

If it is attempted to avoid the clearing-out drop of Eldred's claim 2 by leaving one annunciator in circuit and the other cut out, then the combination claimed by Firman must be used.

Kellogg, 308315, claim 16, pretty effectually covers the usual application of the "busy" test.

THE LAW SYSTEM.

This is based upon the invention of Mr. Frank Shaw, of New York City, who filed an application for a patent on Aug. 11, 1879. The patent issuing as No. 220874, under date of Oct. 21, 1879. We show in Plate 15 a part of the drawings to illustrate the "trunking" principle.



NOTE.—The wires are connected at the central station by inserting the plugs *E E*, into the holes *H H*, in the bar or strip *B*. Subscriber is called by touching plug *E* to battery bar.

PLATE 15.

The following from the specification is a good brief:

My invention consists in the several combinations, methods of operation, and systems set forth in the several claims annexed hereto.

From each subscriber's station I run two wires to a common central office, one of which wires I preferably run to no other station or stations, although several stations may be located thereon; and the other wire I run to as many other subscribers' stations as the amount of business done by them warrants. The first is the private and the last is the call or signal wire. These wires are provided with a battery or other source of electricity, and with a suitable switch-board and instruments at the common central office, and suitable instruments and batteries or other source of electricity at all the stations. Then any one subscriber can at any time obtain private and direct telephonic communication with any other subscriber by requesting the common central office, by means of the last-mentioned call or signal wire, to connect together the private wires of the two subscriber-stations, and afterward, having finished their communications, can signal in like manner the common central station to disconnect said private lines, so that either may be in readiness to be connected at any moment with the private line of any other station.

The call or signal wire being common to a considerable number of subscribers' stations, and the instruments there, the result is, that a subscriber, on going to his instruments, is able to learn whether or not any other subscriber is signaling, and to wait his turn, or until the call or signal wire is not in use before attempting to signal. The result is, that the subscribers, as it were, form themselves in cue, each taking his place in succession. At the office end of the signal-wire I place a receiving operator, who sits with the receiving-instrument or telephone constantly at or near his ear, ready to receive the name or number of any subscriber desiring to communicate, and of the correspondent with whom he desires to be placed in communicaton. The names or numbers so received he repeats, so as to be heard by the subscriber calling through the transmitting-instrument in front of him, and at the same time, by another operator at the switch-board in the central office, who instantly connects the two private wires and subscribers so indicated. As he does so the operator at the switch-board notifies both subscribers by means of a bell in circuit on the wire. The same course is pursued when the conversation is concluded and disconnection is desired, except as to the ringing of the bell.

Another application for a patent under the same general system was filed Jan. 24, 1880, by W. A. Childs, and issued as No. 225797 under date of March 23, 1880. It covered the use of an office circuit for communicating orders from one section of the switchboard to another, and also for communication between what was called the switchboard operator, who

manipulated the connecting apparatus at the switchboard, and the table operator, who received the answered calls. The switch was more on the "plug" board order, differing from Shaw's, which was a "cord and plate" board.

Both of the preceding patents on the Law system have expired.

On Jan. 19, 1883, Shaw and Childs, as joint inventors, filed an application which issued as No. 278613, under date of May 29, 1883.

Inserted herewith are the more important claims:

12. In a telephone-exchange system, a trunk-signal line consisting of a line extending between two central offices for giving and receiving signals for connections and disconnections between two central offices, a subscriber's signal-line consisting of a line extending between a subscribers' station and a central station for giving and receiving signals for connections and disconnections between subscribers, provided with a listening-operator's outfit normally located in the subscriber's signal-line, and a switch combined and arranged to switch the operator's outfit at will from the subscriber's signal-line into the trunk-signal line.

13. In a telephone-exchange system, a subscriber's signal-line consisting of a line extending between a subscriber's station and a central station, for giving and receiving signals for connections and disconnections, trunk-signal lines consisting of lines extending between two central offices, one for giving and another for receiving signals for connections and disconnections between two central offices, provided with a listening-operator's outfit, normally located in one trunk-signal line, and a switch combined and arranged to switch the operator's outfit at will from that trunk-signal line into another trunk-signal line.

19. In a telephone-exchange system, a trunk-signal wire, consisting of a line extending between two or more (a series of) central offices or tables, provided with an operator's outfit, located in the trunk-signal line at one of the central offices of the series only, and provided at each of the other central offices with one or more switches (one for each operator), arranged to switch the outfit (one or more) of one or more subscribers' operators into the trunk-signal line, for the purpose of transmitting orders for connection and disconnection to one central office from all the others of the series.

20. In a telephone-exchange system, subscribers' wires normally grouped and brought directly to one or more common ground-plates or conductors, without the intervention of annunciator, telephone, or other coils or devices offering resistance to the electrical current on or in the wires between the central office common ground-plate or conductor and the subscribers' offices.

21. In a telephone-exchange system provided with a call-wire and with an independent private wire, the call-wire provided with a sub-

scriber's operator's outfit at the central office, and the private wire provided with battery-plate for signaling to the subscriber in reply to a call for connection or disconnection, as shown, or its equivalent.

The same inventors jointly filed an application June 2, 1884, which issued June 9, 1885, as No. 319856. The perusal of this patent will be profitable to any person interested in switch-boards, and we reproduce it in full.

Claims 1 to 10 inclusive are intended carefully to cover the Law system as it stands to-day.

UNITED STATES PATENT OFFICE.

FRANK SHAW, OF NEW YORK, N. Y., AND WILLIAM A. CHILDS, OF ENGLEWOOD, NEW JERSEY.

TELEPHONE-EXCHANGE SYSTEM AND APPARATUS.

Specification forming part of Letters Patent No. 319,856, dated June 9, 1885. Application filed June 2, 1884. (No model.)

To all whom it may concern:

Be it known that we, Frank Shaw and William A. Childs, citizens of the United States, and residents, respectively, of New York, in the county of New York and State of New York, and Englewood, county of Bergen, and State of New Jersey, have invented certain new and useful Improvements in Telephone-Exchange Systems and Apparatus, of which the following is a specification.

Our invention relates to telephone-exchange systems and apparatus; and its object is to provide a central-office switch-board upon which the operations of connecting any two subscribers' lines for oral communication may be facilitated.

A further object of our invention is to provide a simple and effective means whereby a central-office operator may ascertain whether a line with which connection is desired by a subscriber of the exchange is already connected upon some portion of the switch-board or in some portion of the central office with some other subscriber.

Our invention consists, first, in giving to subscribers' lines that are represented upon a switchboard or section of board two switch-terminals, one of said terminals being readily movable, while the other is preferably fixed, and is adapted for connection with the first, thereby permitting one subscriber's line to be connected with another by simply bringing the movable terminal of the subscriber calling into connection with the fixed terminal of the subscriber called for.

Our invention consists, secondly, in a telephone central-office switch-board having the line-terminals arranged in a horizontal plane upon a table, around which any desired number of operators may group themselves, each of the lines terminating in said board having a movable or extensible switch-terminal, and a complementary switch-terminal (one or more), preferably fixed, said terminals being adapted for connection with one another, so that any line may be connected with any other by simply bringing the movable terminal to the fixed terminal, and so that, further, such operation may be performed by any one of the operators arranged about the table.

Our invention consists, further, in a central-office switch-board having for the subscribers' lines grouped thereupon two switch-terminals, one of which consists of a plug-socket, while the other consists of an extensible flexible connecting-cord provided with a plug adapted for insertion in a socket, and also with means whereby it may be automatically retracted below the surface of the table when disconnection is made.

Our invention consists, further, in the novel arrangement for testing hereinafter described, and consisting, essentially, of an automatic vibrator at each subscriber's station, adapted to automatically make and break the subscriber's line when a battery is upon the line, and at the central office a signal electro-magnet and a battery in a normally-open ground, combined with means whereby said battery and magnet may be connected to any line or lines.

In carrying out this portion of our invention, we provide at the subscriber's station a switch, preferably automatic, that switches out the contacts of the vibrator when the telephone at the subscriber's station is switched into circuit, the arrangement being preferably such, however, that the magnet of the vibrator shall be retained in circuit, in order to permit a signal to be given to the subscriber to indicate that the connection desired has been made at the central office, or for any other purpose. By this arrangement the central-office operator may ascertain whether a line is in use by a subscriber, or

whether it is in connection with some other line, by simply connecting the test-battery and magnet to said line, or to any one or portion of one of the switch-terminals for said line. If the telephone be not in use, the automatic vibrator at the subscriber's station will make and break the line-circuit, thus causing the armature of the test-magnet to vibrate; but if the subscriber's line be connected at the central office to another line and the telephone of the subscriber's station be in use, and the vibrator-contacts therefore cut out, the test-magnet's armature will give a single tap upon its bell.

Our invention consists, further, in a central-office switch-board having for each subscriber's line one or more movable switch-terminals for each line and a series of fixed terminals grouped in proper relation to the movable terminals.

Our invention consists, also, in certain novel arrangements and combinations of apparatus, whereby the operation of the switch is facilitated and the business of connecting subscribers is properly systematized, and that will be more specifically stated in the claims.

In carrying out our invention we prefer to assign a certain number of subscribers' lines and the movable terminals for said lines to each operator, and give to said operator the business of answering calls from any one of the lines connected to said movable terminals. We also, by preference, group in proximity to said operators' fixed movable line-terminals fixed terminals for all the other subscribers' lines assigned to other operators on the board, thus permitting the operator to connect any one of the lines assigned to him to any other of said lines or to any other of the lines assigned to other operators, leaving, however, the duty of making similar connections for other lines of the board to those operators to whom the care of the movable line-terminals of said lines may be assigned.

In illustrating the principles of our invention we have shown it as carried out in connection with the system of Patent No. 220874, in which separate call or signal and private wires are used for the various subscribers' stations, the business of calling and communicating with the central-office operator being done over the signal-wire, and the conversation between subscribers taking place over the private wire. We do not, however, wish to be understood as limiting ourselves to this system, but may apply our invention to any form of telephone-exchange apparatus.

In the accompanying drawings, Figure 1 is a diagram of circuits and apparatus illustrating one manner of carrying out

our invention. Fig. 2 is a detail diagram illustrating the nature of the circuits and apparatus at a subscriber's station. Fig. 3 illustrates a detail of construction.

Referring to Fig. 1, A indicates a switch-board or section of switch-board at a central station of a telephone-exchange system, which board is arranged in a horizontal plane, and has the switching appliances located upon its top and accessible to two or more operators placed at the sides of the board. Four lines only of a system are shown in the drawings, those being amply sufficient to illustrate the principle of the invention. The lines are numbered, respectively, 1 2 3 4, and each is supposed to be the wire or conductor leading from a subscriber's station over which conversation is held between one subscriber and another of the system. In the present case each wire constitutes the private wire of the system described in Patent No. 220874, and is therefore supposed to be employed in combination with a call or signal wire, two of which, W' W2, are herein shown. Each subscriber's wire, 1 2 3 4, terminates on the switch-board in an extensible and automatically-retracted connecting device—such, for instance, as that described in our Patent No. 278613—and also in a second or complementary switch device or terminal preferably fixed and adapted for connection with the extensible terminal. The fixed terminals are here shown as metallic strips or plates, a' a2 a3 a4, mounted in any suitable manner upon the board, and provided with one or more sockets adapted to receive the plugs upon the ends of the extensible terminals. Two such sockets are shown in each strip, because in this instance the system hereinbefore mentioned is supposed to be employed —viz., one in which certain lines and movable terminals therefor are assigned to an operator whose duty is to manipulate solely such movable terminals. As indicated, two such sets of terminals and operators therefor are supposed to be employed, lines 1 and 2 being assigned to one operator, and lines 3 4 to another. Lines 1 and 2 are therefore represented in the fixed terminals at two socket-holes in their respective plates a' a2, one such socket being in proximity to each operator. Lines 3 4 are similarly represented. In practice it will of course be understood that continuous plates connecting the sockets would not be used, but that, for the sake of economy in room, each socket would be formed in a small block or plate, and the blocks corresponding to a line properly connected by a conducting-wire carried beneath the board. The connection from any line-wire to its fixed socket or sockets may be made

by wires carried up through boxes constructed and arranged in casings or boxes like those shown in our Patent No. 278613.

The extensible terminals are made, as indicated in Fig. 3, each of a flexible conducting-cord provided with a plug at one end and attached at its other to a weight, W5, sliding in a tube beneath the surface of the board, and provided with a spring, W6, that will slide in contact with the tube, and thus make connection therewith, said tube being itself connected with a subscriber's line.

To make connection between any two lines of the board, it is simply necessary to take the extensible line-terminal for one line and insert its plug into a complementary or fixed socket connected to the other line. In any ordinary exchange of say, five hundred subscribers, this may be done by any operator beside the board, it being preferable in exchanges of this size to provide but one fixed socket or switch-terminal for each line, and to mass the flexible or extensible terminals, so as to be accessible to any operator, and so that any extensible switch line-terminal may be brought into connection with any fixed line-terminal. With larger exchanges it may be desirable to multiply the number of fixed sockets for each line, and to follow strictly the plan of assigning a certain set of extensible terminals to each operator, fixed terminals for all other lines being placed within his reach. In the present instance it is supposed that the sockets at the left of the board are arranged with special reference to extensible line-terminals 1 and 2, although it is obvious that if the flexible cords were made of sufficient length the lines might be connected by placing an extensible terminal into connection with a fixed terminal at a greater distance therefrom.

We do not limit ourselves as to the form of the devices whereby actual connection is made between an extensible line-terminal and a fixed line-terminal, and it is obvious we might use other devices instead of a plug and socket, or might transpose the plug and socket, so that the socket should be upon the extensible and the plug upon the fixed terminal. Nor do we desire to be understood as limiting ourselves to the manner of constructing the automatically-retracted terminal, other arrangements besides that shown being obviously adapted to the purposes of our invention.

Although we have spoken of the plates a' a2 a3 a4 as the fixed terminals, it is to be understood that the portion of said plate that contains the socket for the plug in the end of the flexible cord constitutes, in fact, the fixed terminal of a line,

and that, in fact, there are in each plate shown two fixed line-terminals for each subscriber's line.

The several subscribers' stations of the system herein illustrated are indicated at A B C D. Stations A and B are upon call or signal wire W', and stations C D upon call or signal wire W2. At the central office each call-wire passes through the receiving-telephone of an operator who has the telephone constantly at his ear, and also includes the usual transmitting-telephone for use by said operator in communicating over the call-wire with a subscriber. The latter telephone and its connections are omitted for the sake of simplicity. It may be mounted and arranged as shown in Patent No. 278613, or in any other desired manner.

TT, etc., indicate the telephones at subscribers' stations. An ordinary magneto-telephone only is illustrated in the drawings, the battery telephone-transmitter and its local battery and connections being omitted for the sake of simplicity. The manner of connecting and arranging such parts is, however, well understood in the art.

S S, etc., indicate the usual hand-switches employed for shifting the telephone apparatus at a subscriber's station from a private wire to a call or signal wire, so as to permit the subscriber to speak to the central-office operator and notify him of the connection desired upon the switch-board. Each switch consists of a reciprocating block carrying the three conducting plates, c d e, insulated from one another. Upon plate c rest normally a pair of springs, f f, which complete the circuit for the call-wire, while upon plates d e, respectively, rest pairs of springs g g h h, the first pair being connected, as indicated, to the private wire and the pivot of a gravity switch, M, while the latter pair is connected to the telephone and contact-stops of the switch, and also to a vibrator, N, and switch controlling the circuits of the same. The switches are held in the position shown by suitable springs, so that the circuit for the call-wire is complete through each station, while the telephone is cut out of the circuit for the private wire by means of the switch M. The automatic vibrator consists of an electro magnet and automatically vibrated armature therefor, which, so long as current is supplied to the magnet, is kept in vibration by automatically breaking and making the circuit, after the manner of an electro-magnetic alarm, through the means of contacts Q, which are together when the armature is retracted by its spring, but are separated when the armature is drawn up by the magnet. The circuit for the magnet is normally through

said contacts, and is a part of the private-wire circuit to earth, as indicated, the path being through springs g g and plate d to switch-lever M, lower contact for the latter when the telephone T is hung up, springs h h, plate e, contacts Q, armature-lever magnet of vibrator, and to earth.

In addition to the switches and circuits so far described, we provide suitable means whereby the contacts Q of the vibrator shall be cut out or shunted, either automatically or by hand, when the telephone is in use at a subscriber's station, leaving, however, the circuit through the magnet of the vibrator intact, so that a single tap or signal may be given on the bell of the vibrator by the central-office operator to indicate that the desired connections have been made on the switch-board. The shunting device here shown consists of contacts Q2, one insulated from but carried by the switch-lever M, and located so as to be out of contact with the other when the telephone is out of use—that is, resting upon the switch-lever. When the telephone is, however, removed from its hook, the contacts Q2 come together, and, as they are connected, respectively, to the armature-lever of the vibrator and the back contact therefor, complete a circuit around the vibrator-contacts, thus rendering the vibrator incapable of making and breaking the circuit of the private wire. The circuit through the telephone T is completed when the telephone is removed from the support in the obvious and well-known manner.

By the above arrangement of the vibrator it may act either to make and break the private-wire circuit rapidly to give an alarm, or may serve as the tap or alarm bell after the telephone has been removed from its support, so as to indicate to the subscriber that he is connected on the central-office switch-board with the subscriber called for. The arrangement also permits the central office to ascertain by suitable apparatus, operating in conjunction with the vibrator as a test apparatus, whether a subscriber is using his line or not.

The apparatus used at the central office consists simply of a battery, M B, a magnet and bell or other sounder, P, a flexible cord, H, and a tip or conducting-piece, R. The battery has one pole connected to ground and the other to the cord and tip, so that by simply touching the tip to any line-terminal, preferably one of the fixed terminals, the battery and bell will be included in a circuit formed of the private wire, the vibrator-magnet at the subscriber's station, and the earth. If the telephone at the subscriber's station be out of use and upon its support and the contacts Q2 open, the circuit will include the

vibrator-contacts, and a rapid make and break of circuit will be produced, which will cause a vibrating signal in the bell-magnet P at the central office, indicating the existence of the conditions stated at the subscriber's station. If, however, the telephone be in use, the vibrator-contacts will be shunted and a single stroke only will be given on the bell at the central office.

The general operation would be as follows: The subscriber communicates with the central office in the usual way over the signal-wire running to his station, after having pushed in the switch S against the spring, so as to throw the telephone into the signal-wire circuit, and the central-office operator, after having called the subscriber asked for, by touching the tip R upon a fixed line-terminal block of that subscriber's line, so as to cause the vibrator-bell at that subscriber's station to ring, proceeds to connect the lines by placing the extensible line-terminal of the subscriber calling into the fixed line-terminal of the subscriber called for (and, by then again touching the tip R upon the fixed line-terminal, may cause the bells at both subscribers' stations to ring, in order to indicate that the connection has been made upon the board). The subscribers having taken up their telephones, the latter signal will be given by a single tap upon the bell at the stations, because the contacts of the vibrators will have been shunted by the removal of the telephones from their supports. The signal that disconnection has been made at the central office may be given in the same way.

The above would be the general operation irrespective of the action which would take place by reason of the provisions for testing employed. It is of course important to the operator to know whether a line called for is already in connection with some other line, and this information is given by the character of the signal given in his test-bell on placing the plug R upon the fixed terminal of the subscriber called for. If the operator's bell give a vibrating signal, this will indicate that the line is not in use, because under such conditions the contacts Q2 are open, and the vibrator-contacts are in circuit, and will therefore produce an automatic rapid interruption of the circuit so long as the battery M B is applied. If, however, a subscriber's line be connected to some other on the board and the telephones at either or both of their stations be in use, the battery-current from M B will find a continuous circuit to earth through the apparatus at one or the other or both of the stations, and a single tap will be given on the bell. The same

means enable the operator to ascertain whether two connected lines are still in use, since if both telephones be hung up the only circuit for the main battery will be through a vibrator, and the bell of the operator will ring intermittently. No such signal will, however, be had so long as one of the subscribers' telephones is in use, since a continuous circuit will then be furnished through the contacts Q2 at the station with said telephone.

We are aware that it is not new to use an automatic vibrator at a subscriber's office for the purpose of vibrating an indicator at the central office; but in such case the test-bell and battery were in constant circuit between the connected lines, and did not furnish to the central-office operator a means of testing to ascertain whether a line wanted was already in connection with some other upon the board. Moreover, no provision was made for cutting out or shunting the contacts of the electro-magnetic vibrator at the subscriber's station, while at the same time leaving the circuit through the vibrator-magnet or bell-magnet complete.

We do not limit ourselves to the use of a bell and magnet in connection with the test-battery at the central station for giving an indication to the operator, but may use in connection with said battery any indicating or signaling device that will give to the eye or ear of the operator notice that the line of the subscriber wanted is already connected upon the central-office switch with some other subscriber's line; nor do we limit ourselves to the particular means shown whereby the test apparatus at the central office may be connected or disconnected with any line, the essence of our invention consisting in providing suitable switch appliances, whereby the test-battery and devices may be applied or withdrawn at pleasure at any time and under any condition of the lines.

What we claim as our invention is—

1. In a telephone central-office switch-board, the combination of movable line-terminals, consisting of flexible and extensible automatically-withdrawn switch-cords, and fixed line-terminals arranged in proximity thereto, and consisting of complementary switch devices adapted for connection with the cord ends, said fixed terminals including the lines connected to the movable line-terminals, and also including other lines of the system with which it may be desired to connect the movable line-terminals.

2. The combination, in a telephone central office system, of subscribers' lines, each terminating at the central office in a

normally-connected movable or extensible terminal, and in one or more fixed terminals properly constructed for forming connection with the tips of the extensible terminals when the latter are moved to them.

3. A telephone central-office switch-board having its switching devices arranged in a horizontal plane upon a table, so as to be accessible from two or more sides, each of the lines which terminate in said board in a movable or extensible terminal being provided with a complementary switch-terminal, preferably fixed, said terminals being adapted for connection with one another, as and for the purpose described.

4. In a telephone central-office switch-board, the combination, upon a horizontal switch-table accessible on two or more sides, of extensible line-terminals and fixed line-terminals, as and for the purpose described.

5. In a telephone central-office switch-board, the combination, upon a horizontal table having its switching appliances accessible upon two or more sides, of a series of subscribers' lines and switch-terminals for subscribers' lines adapted for connection with one another, whereby two of the lines upon said horizontal table may be electrically united by simply placing the line-terminal of one line into union with a complementary line-terminal of the other line.

6. In a telephone central-office switch-board, the combination of extensible line-terminals, furnished with connecting-plugs, and line blocks or plates, also connected with said lines, and adapted to receive the plugs or similar connecting devices on the extensible terminals.

7. A telephone-exchange central office having for each line two line-terminals—one an extensible or movable line-terminal, and the other a complementary terminal adapted for union with the extensible or movable terminal of one or more other lines.

8. A telephone-exchange central office having for the several individual lines two line-terminals—one an extensible or movable terminal, and the other a fixed terminal adapted to receive the tip of the movable terminals of other lines.

9. In a telephone central-office switch, the combination of movable or extensible line-terminals, consisting of sliding weights and connectors, and flexible cords and tips, and fixed or stationary line-terminals, consisting of socketed plates or blocks adapted to receive said tips, whereby lines may be connected by simply placing a cord-tip in a fixed block.

10. A telephone central office having for each subscriber's

line a movable or extensible terminal, consisting of a flexible conductor having an automatic retractor, and one or more complementary line-terminals, preferably, though not necessarily, fixed, but adapted for union with the first said terminals.

11. The combination, in a central-office telephone-exchange system, of automatic vibrators at subscribers' stations, a bell and battery at the central station, and suitable connecting devices for connecting and disconnecting said bell and battery from any line of the exchange without disturbing the connection between the lines, if said line be connected to any other at the time the test is made.

12. The combination, in a central-office telephone-exchange system, of automatic vibrators at subscribers' stations, and a bell and battery at the central station in a wire normally independent of the connecting devices for connecting two lines together, said bell and battery being combined with switching apparatus, whereby it may be introduced into and taken out of circuit with a line, whether such line be connected with any other line or not, so as to permit a test of the line's condition to be had at pleasure.

13. The combination, with a series of subscribers' lines centering at a common switch-board, of automatic vibrators controlled by switches at the subscribers' stations which cut out the contacts for said vibrators when the telephone apparatus is in use, a bell and battery at the central station, and switch devices for placing said bell and battery into a ground-circuit from a line at the central office.

14. The combination, with automatic vibrators at subscribers' stations, of switches for cutting out the contacts of said vibrators when the telephones are in use, and at the central office a test-bell and battery independent of the connecting-circuit between two connected lines, as and for the purpose described.

15. The combination, in a telephone-exchange, of automatic vibrators at subscribers' stations, and at the central office a test-battery and indicator having a movable switch-terminal, adapting them for connection to any line of the exchange, as and for the purpose described.

16. The combination, substantially as described, of automatic vibrators at subscribers' stations and a test-battery and indicator independent of the line-connecting wires or strips at the central station, and having means whereby said battery and indicator may at the central office be connected into a cir-

cuit that shall be formed through the subscriber's station apparatus.

17. The combination, with a central office of a telephone-exchange having automatic vibrators at subscribers' stations, of a test-battery and indicator and switch apparatus for including the battery and indicator in a circuit formed through a subscriber's station and the central office.

18. The combination, with subscribers' stations having automatic vibrators and switches for switching out said vibrators, as described of a test-battery and indicator at the central office, and switch apparatus for connecting the same to a subscriber's line, whether connected or unconnected at the central office with some other subscriber's line, whereby a switchboard operator may ascertain whether any line is or is not connected with any other.

Signed at New York, in the county of New York and State of New York, this 19th day of May, A. D. 1884.

FRANK SHAW.
WM. A. CHILDS.

Witnesses:
THOS. TOOMEY,
GEO. C. COFFIN.

THE MANN SYSTEM.

A plan somewhat similar to the Law system is used in Scotland, and is called the "Mann." We have not seen any American patent that covers it. Plate 18 is a diagram showing the general scheme. It will perhaps be understood by American electricians if we say that in the Mann system the calling wire is a branched arrangement and works on open circuit, while in the Law system the calling wire is a loop upon which the subscribers are connected in series working on closed circuit. As in the "Law," the subscriber switches from his individual talking wire to the common calling wire and vice versa accordingly as he desires to talk with "Central," or with other subscribers.

Referring to the diagram, the heavy irregular line ending in ground at central station, and into which is looped the telephone receiver, corresponds to the "calling circuit" of the "Law" system, while the lines ending in plugs are the switchboard ends of the subscribers' talking wires. The little circles which face each other are respectively the ends of the talking and calling wire at each subscriber's station. (See description of Shaw's patent, No. 220874, page 54.)

THE MULTIPLE BOARD.

The principle of the multiple switchboard is broadly covered by the first claim of patent No. 252576, dated Jan. 17, 1882, issued to Leroy B. Firman, of Chicago, and assigned to the Western Electric Mfg. Company; application filed Jan. 7, 1881. We reproduce the drawing as Plate 19. The block marked B is a dummy board which has no particular significance at this date. There are but two claims. No 2 refers to the dummy board and is unimportant. Claim 1 reads as follows:

1. The combination of two or more switch-boards at the central office of a telephone-exchange system, to each of which the same telephone-lines are connected, whereby any two of these lines may be connected together upon either of the multiple switch-boards.

To illustrate more forcibly the application of this claim to the multiple switchboard, there is shown here Plate 20. 1, 2 and 3 are sections of the common Western Union pin switch, such as is used in way stations. The horizontal lines of buttons are all connected together upon the back of each board and between the different sections, as shown by the dotted lines. To the top row of buttons is connected a ground wire. To each of the other rows of buttons is connected the line of a subscriber. 4, 5 and 6 are operators' sets furnished with cords and plugs for each of the sections 1, 2 and 3. It will be seen that if any one of the plugs x1 No. 5 for instance, is connected

with the line of ground wire buttons, and the other plug, x, is connected with the row of buttons attached to subscriber's line D on strip c, that subscriber is in connection with the central office instruments. Now, if plug x1 is removed from the ground row to row A on strip d then subscriber A will be in connection with subscriber D through the central office-set 5; and then, if pin y1 is inserted to connect D and d, and plug x1 removed from connection A, d and replaced by pin y, that subscribers D and A are in permanent connection, and the office-set free to be used for a different pair of lines.

In the way-station switch of the Western Union telegraph, however, the line-wires were brought to the top of the strips a b c d and instruments cut in by connecting to the horizontal rows of buttons.

Firman's application for patent was filed Jan. 7, 1881, and we have already seen the cord, plug and strip connection in Eldred's patent (Plate 7, page 43), the application for which was filed June 9, 1880, so that it may be said that the whole foundation for Firman's claim is in the fact that he simply reversed the arrangement of the telegraph switchboard. The dividing of the board into sections was not new, for that had already occurred in the main telegraph offices of large cities.

It might be argued that, of organizations already existing and complete, such a reversal did not constitute invention; but the owners of the patent would probably take the ground that it was analogous to the decision of the United States Supreme Court March 19, 1888, which has already been alluded to in connection with the Drawbaugh case. Speaking of the alleged anticipation by Philip Reis of Bell's first telephone patent, the Court says:

> It is not contended that Reis had ever succeeded in actually transmitting speech, but only that his instrument was capable of it, if he had known how.

On the other hand, there might be set up as a defense a plea based on some such ground as that suggested by Judge Showalter's decision in the Watson case:

> In view of the state of the art * * * my judgment is that there is

no novelty or invention * * * nothing more than the use of clever mechanical expedients in arranging, etc.

While the patent of Firman, just described, covers the principle of connecting in multiple two or more switchboard sections, there is another invention which uses divided boards, accomplishing multiple connections by an arrangement of the connecting cords.

This was patented by Chas. W. Ross, of Columbus, Ohio, assigned to the Western Electric Company of Chicago, and is numbered 252259 under date of Jan. 10, 1882, application filed Sept. 24, 1881.

The first claim is as follows:

1. The combination of one or more sets of conducting-cords and plugs with the different switch-boards and connecting-wires permanently connecting each set to all the boards, whereby any given switch of one board may be connected directly with any given switch of any other board.

It will be seen that by the use of Firman's organization one operator can, without aid, complete a connection between any one of the subscribers' lines in her charge and that of a subscriber in charge of any of the other operators at the same exchange; while the combination in the Ross patent requires the service of two operators to attain the same result.

Both of these patents expire in 1899. Until they are free to the public it is difficult to understand how any form of multiple board, not subsidiary to one or the other of them, can be designed.

Patent of J. J. O'Connell, No. 430747, previously alluded to as containing features of a trunk line board, is really founded upon a modification of the multiple system. Its claim 18 quite accurately describes the multiple board as it is used to-day, called the "bridging multiple" system. It is as follows:

18. The combination of two metallic-circuit telephone-lines, each having the different sides thereof connected with a different portion of each of its metallic sockets on the different switch-boards, one of said lines after passing through its different sockets extending to an answering spring-jack switch, a pair of loop-plugs and their double-stranded cords, the answering-plug of the pair being inserted in the said answer-

ing spring-jack, and the other plug of the pair being inserted in the socket of the other line on the same board to loop the two telephone-lines together in metallic circuit.

THE EXPRESS SYSTEM.

What is known as the San Francisco "Express" system is described and claimed in a series of eleven patents issued to J. I. Sabin and William Hampton, of which the following are the dates of filing of application, dates of issue and numbers:

Dates of Filing.	Dates of Issue.	Nos. of Patents.
March 3, 1893	April 17, 1894	518333
March 13, 1893	March 27, 1894	517243
April 13, 1893	April 17, 1894	518334
Aug. 18, 1893	Jan. 30, 1894	513534
Nov. 14, 1893	April 17, 1894	518332
Jan. 19, 1894	April 17, 1894	518331
Feb. 12, 1894	May 22, 1894	520083
April 14, 1894	Nov. 20, 1894	529465
April 14, 1894	Jan. 29, 1895	533142
July 25, 1894	Jan. 1, 1895	531650
Nov. 9, 1894	March 26, 1895	536233

The system as a whole seems to be broadly covered by claim 3 of patent No. 536233, which reads as follows:

3. The combination with a telephone line terminating upon a divided board of the exchange, of a trunk line extending between said divided board and the board of an auxiliary or intermediate operator, and adapted to be connected with said telephone line to extend the circuit to the auxiliary board, a telephone line terminating upon a second divided board, a trunk line extending between said second divided board and the board of said auxiliary operator and adapted to be connected with said telephone line to extend the circuit to the auxiliary board, and means at the board of the auxiliary operator for uniting the two trunk lines, substantially as described.

We have made a diagram, Plate 21, to illustrate the system of devices covered by claim 3. The same patent in other claims covers the principle of locating the "A" board in an exchange at a distance from the "B" station.

To describe the operation of the system, suppose the subscriber who is connected to spring-jack c on divided board "B1" desires to talk with the subscriber who is connected with spring-jack d on board "B3." Upon receiving the signal at "B1" the operator there plugs trunk line e into spring-jack c, and this operation is made to automatically signal on board "A1." The operator at board "A1" then ascertains from the calling subscriber the number of the called subscriber, and knowing at which "B" board this called subscriber is connected, she plugs trunk e, which terminates in a cord and plug on both "B1" and "A1" boards, into trunk f, which terminates in the "A1" board at a spring-jack and in "B3" board in a cord and plug. The operator at "B3" then plugs trunk f into spring-jack d and the connection is complete. There is a separate talking circuit, called the "order wire," extending between the "B" and "A" boards which, in the case just referred to, is used by the operator at "A1" to inform the operator at "B3" as to the number of the called subscriber.

The fourth patent of the Express system series covers broadly what is known as the "automatic signal." Apart from its connection with that system, it has a most important bearing upon telephone switchboards in general. The application was filed Aug. 18, 1893, and issued as Letters Patent No. 513534 on Jan. 30, 1894. Plate 22 is a copy of the drawings complete.

The claims are as follows:

1. Individual calling-indicators on a local battery circuit, in combination with subscribers' metallic circuits each composed of two line-wires connected to opposite sides of the said local circuit at the switch-board to form part of said local circuit, and means for uniting the two line-wires at the subscriber's telephone to close the battery upon the said indicators, substantially as described.

2. In a telephone-system, a subscriber's circuit composed of two line-wires normally separated at the subscriber's station, in combination with a calling-indicator circuit at the switching-station consisting of a battery and a calling-indicator in circuit with said battery through the subscriber's line and a shunt or short-circuit adapted to connect the two wires of the subscriber's line and close the circuit of the indicator, said shunt including the subscriber's hand-telephone and his telephone-switch, substantially as described, for operation as set forth.

3. In a telephone-system, the combination of a subscriber's circuit composed of two line-wires normally separated at the subscriber's station, a local circuit at the switching-station in which is included a calling-indicator and a battery, and four-point spring-jack connections at the switch-board by which the two wires of the subscriber's line are connected to and made a part of the said local circuit, a shunt or short circuit adapted to close the two sides of the subscriber's line, and a switch-lever having two anvils, or "contacts," to one of which said shunt is connected, and to the other of which is connected a bell-signal and a "ground," the lever of said switch being the subscriber's telephone-hook; whereby the circuit of the indicator-battery is closed through the indicators by the act of removing the telephone from its hook, and one side of the subscriber's line is "grounded" through the bell-signal when the telephone is hanging on its hook, as hereinbefore described, for operation as set forth.

Other patents in this series describe various methods of operating both line drops and clearing-out drops by the acts of taking the telephone from its hook at the subscriber's station, and by replacing it. The ingenious and useful feature of these methods is the location of all motive power at the central exchange. Each subscriber is provided with a small battery for his transmitter circuit, but with that exception there is no

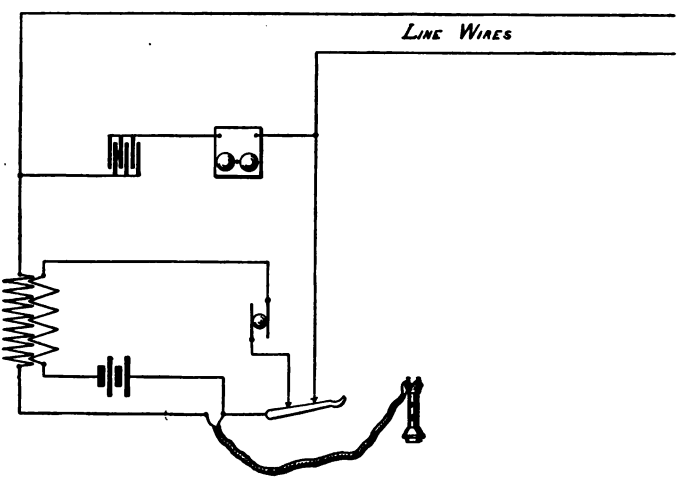


PLATE 23.

energizing agent at his end of the line. As he lifts the telephone from its hook he actuates the line drop at the exchange; as he hangs it up again he gives the clearing-out signal. In some of the methods this is accomplished by leaving a metallic circuit at the subscriber's end with the telephone circuit open and the bell circuit made through a condenser. (See Plate 23.) An alternating current from a generator will ring up the subscriber as it will "pass readily through a condenser." This arrangement admits of leaving a number of subscribers' lines connected at the central station through line-drops and a common battery; for the circuit, so far as direct current is concerned, is open when the subscriber's telephone is hung up; but when he takes his telephone from its hook, the battery comes into circuit long enough to actuate the line drop, being quickly relieved from duty by the central station operator.

There is described also an arrangement so devised that while two subscribers are talking a clearing-out signal is held in a certain position by being bridged across the cords with a battery in the bridge circuit, the indicator magnet remaining energized during the conversation. When the subscribers hang up their telephones they open the circuit, and the release of the indicator from its position when on a closed circuit gives the clearing-out signal.

Another method (the one covered by claim 3 of 513534 and shown in Plate 22) is to leave the subscriber's ringing bell in circuit with a ground through one limb of a metallic circuit and to ring the subscriber from a grounded generator (not shown in the plate). On lifting the telephone, the switch lever separates limb 2 of the metallic circuit from the ground branch and makes contact at G to limb 1, closing the line drop C through battery B.

No. 531650, of the Sabin & Hampton series, covers an arrangement of annunciator drops. In the language of the specification it "relates to telephone indicating apparatus, and its object is the provision of means for conveying to the operator

at the central station definite information as to the action of the subscriber in calling for disconnection." Five of the claims are given to indicate the scope of the patent:

1. In a telephone-system, the combination with a self-restoring visual indicator, of a non-restoring indicator, and means for actuating the non-restoring indicator when the self-restoring indicator is actuated, substantially as described.

2. In a telephone system, the combination with a self-restoring visual indicator, of a non-restoring indicator, and a pair of contacts adapted to be closed by the actuation of the self-restoring indicator to complete the circuit through and thereby actuate the non-restoring indicator, substantially as described.

3. In a telephone system, the combination with a self-restoring indicator, of a non-restoring indicator, means for actuating the self-restoring indicator to cause the same to convey a signal, and means operated by said self-restoring indicator for actuating said non-restoring indicator to cause the same to convey a second signal, substantially as described.

4. In a telephone system, the combination with a telephone line extending from a sub-station to the central station, of an electric lamp, a key adapted to be depressed to complete circuit through said lamp, a self-restoring indicator in circuit with said sub-station and adapted to be actuated therefrom, and means actuated by said indicator for opening the circuit through said lamp; whereby the lamp is lighted before the subscriber actuates the indicator, and extinguished after the indicator is operated, substantially as described.

5. The combination with an electromagnet, of a key for closing circuit therethrough to complete the circuit through a lamp, a self-restoring indicator, a second electromagnet, and contacts controlled by said self-restoring indicator for completing the circuit through said second magnet to thereby open the lamp circuit, substantially as described.

The plan of using a condenser to complete an alternating current circuit while leaving a direct current circuit open, is applied to a trunk line in patent No. 520083, and throughout the series the claims ring changes on the various devices just described in automatic signaling, and which may be designated in brief as

A normally open metallic circuit with the subscriber's receiving bells in ground branch on one limb;

A normally open metallic circuit with the subscriber's receiving bells in series with a condenser bridged across the metallic circuit;

The visual self-restoring indicator of patent No. 531650.

THE RAVEROT–HESS SYSTEM.

This has recently been tried in a small exchange in Berlin, Germany. While possessing features of both the Multiple and Express systems, its working principle is radically different from either. The application for a United States patent was filed July 8, 1896, by Pierre Emile Raverot and George Albert Hess, both of Paris, France, and issued on Oct. 13, 1896, as No. 569470. It was also patented in France Aug. 8, 1893; in England April 30, 1894; and Germany June 2, 1895. The earliest date of expiration (which limits the protection given by the United States) will be April 30, 1908.

We shall confine our explanation principally to the ground covered by the United States patent; and have made a special diagram to facilitate description.

Referring to Plate 24, A B C and D have subscriber's answering drops, jacks 1, 2, 3 and 4, and local talking circuits to each of the connecting boards which contain their respective letters. The connecting boards AB, AC, AD, BC, BD and CD have calling drops on each of the talking wires which reach them, and answering jacks for all of the subscribers of the two groups which they represent. For instance, the board BC has jacks for all the subscribers' lines which come to the B board as well as for all of those which come to the C board. Now, if subscriber No. 1 B calls and wishes to be connected with No. 4 C, operator B signals on talking wire C to operator BC that No. 1 B wishes No. 4 C, and the latter operator, having in front of her the jacks of both the B group and the C group, makes the desired connection. If, however, No. 1 B desires to talk with No. 4 D then operator B signals to operator BD and the connection is made at that board.

Reference to the first claim of Firman's patent, No. 252576 (expiring Jan. 17, 1899) will show that the Raverot-Hess system is subsidiary to it. It is restated here:

1. The combination of two or more switch-boards at the central office

of a telephone-exchange system, to each of which the same telephone-lines are connected, whereby any two of these lines may be connected together upon either of the multiple switch-boards.

Returning to the patent under consideration (569470) the specification explains in effect that if the number of groups (represented by drop boards A, B, C and D in Plate 24) be multiplied by one less than that number, and the product divided by two, the last result will represent the number of section boards shown in the diagram by AB, AC, etc. In the Plate there are four groups; if the number (4) be multiplied by one less than itself (3) and the product (12) be divided by 2, the result will be 6.

In the patent itself the illustration given is of six original groups. 6x5=30, and this divided by 2 gives 15. Consequently with six drop-boards there must be fifteen section-boards.

There is but one claim in the United States patent. It reads as follows:

A system of connections for telephone-exchange switch boards based on the principle of arithmetic combinations, the subscribers of the exchange being divided up in groups a b c d e to n, each of which is represented in the exchange by jack-boards aaa, bbb, ccc, ddd, eee, with one jack for every subscriber of the group, and those jack-boards being combined in pairs forming section-switchboards ab, ac, ad, ae to an; bc, bd, be to bn; cd, ce to cn; de to dn, the total number of said sections being $\frac{n\ (n-1)}{2}$

In the present experimental exchange, an Electrical World article says, there are 800 subscribers in a group. If this grouping is applied to our diagram each of the boards A, B, C and D will have 800 answering drops and jacks, and each of the section boards AB, AC, AD, BC, BD and CD will have 1,600 answering jacks, the board accommodating 3,200 subscribers.

COMPARATIVE ADVANTAGES.

To further illustrate the reasons which led to the invention of the "Express" and "Raverot-Hess" systems, and the relative importance of the various claims cited in connection therewith, the comparative merits of the "divided board" and the "multiple" systems are here briefly discussed.

It has been concluded by many telephone engineers, and is probably true, that the number of subscribers connected to any one exchange should not exceed 3,500. Considering a switchboard on the multiple plan having that number, and that every line is connected to every third section (allowing 100 to a section), then there will be twelve connecting jacks on each subscriber's line, and 3,500 answering jacks, a total of 45,500 spring-jacks. If these are connected in what is known as the "series-multiple," each jack being "looped" in on one side of a metallic circuit, then a bad contact at any jack will open or weaken the circuit beyond that jack; if they are connected in "bridging-multiple," a branch from each side of the metallic circuit being connected to the plug when in use, as described in claim 18 of O'Connell (see page 72), then there is danger of short-circuits. That there is great liability of troubles in either of these arrangements can be easily seen, and, as a matter of fact, extraordinary precautions are necessary to keep the system in fair working order. It is also true that there is great difficulty in locating switchboard troubles; that the cost of installing a large board is enormous; and subsequent maintenance very expensive.

The one advantage gained by all this expense and complication is that one operator can complete the entire process of connecting the subscribers' lines that are in her charge, with those of any other lines in the exchange. At first glance it would seem that such an arrangement is quicker and incurs less operating expense than any that can be devised, and we believe that such is the fact; but the advocates of the Express

system claim that in San Francisco, where that system has been in use for a long time, the act of connecting is done in less time and the operating expense not increased.

In the "Express" there are two sets of operators, one at the B boards and one at the A boards, but the service being more quickly performed each operator can attend to a greater number of subscribers. Each subscriber's line (when at rest) is connected to one spring-jack only, making a total of 3,500 (plus 350 trunk jacks) or 3,850 jacks as against 45,500 in the multiple. It is much easier to install such a switch-board; much less trouble to keep it in working order, and the expense of installation and maintenance is in direct proportion to the number of subscribers, considerable advantages in financing a telephone system.

If it is true that the San Francisco service on an Express board has been quicker than in other cities on multiple boards, the advantage in speed is undoubtedly due to the automatic signals, and not to the Express board *per se.* If equipped with automatic signals, we believe the multiple board will be found to be considerably faster than any system yet devised.

It is possible that the next important advance in switch-board engineering may combine the good features of both the Multiple and Express systems; but whether the great cost of installation of the Multiple system can be further endured is a serious question.

So far this discussion has been confined to that form of switch-board which is almost universally known as the "cord" board. As a matter of interest there is reproduced here the first sheet of drawings (see Plate 25), and two claims of patent No. 258886, issued to M. J. Carney, of Toledo, Ohio, June 6, 1882. The application was filed Oct. 14, 1881.

With the exception of the attachments to the operator's telephone receiver, no cords are used. Claim 1 reads as follows:

1. The combination, in each section of a sectional telephone switch-board, of line strips or plates connected to the lines assigned to that sec-

tion, connecting strips or plates adapted to be connected to said line-strips, a series of supplemental line-strips interposed in the circuit of the lines assigned to and connected with line-strips on another section of the apparatus, and a connecting-strip common to said supplemental strips, and with which any one of said supplemental strips may be connected, said latter connecting-strip being joined to the plate or strip which is adapted to make connection with principal line strips or plates of the first-named section.

The connections are made by means of a plug (see Fig. 3, Plate 25) which is described as follows in claim 8:

8. A switch-plug consisting of a stem or spindle having attached to its lower end two semi-cylindrical springs embracing the stem and free at their upper ends, substantially as described.

Brief mention may be made of four patents auxiliary to the switchboard.

No. 299926, C. H. Haskins, issued June 3, 1884, application filed June 24, 1881, has acquired some prominence on account of a suit brought by the Western Electric Company against one of the independent telephone companies. It covers the use of a pole changer adapted for continuous operation as a ringer from the central exchange. The one claim of the patent is as follows:

In a telephone system, and in combination with the central-office switch-board thereof, a pole-changer adapted for continuous operation, bells adapted to be operated by reversed electric currents, electric circuits connecting said bells with the switch-board, and means for connecting the pole-changer to any line centering in said switch-board, substantially as described.

The following quotation from the specification may prove interesting:

Any ordinary form of switch-board may be used with my apparatus. So with the signal, which is usually a bell, and the principle of operation of said bell is substantially that described in English Patent No. 2,462 of 1860; but said English Patent shows or describes no connection between said signal and a telephone or switch-board.

The appliances for connecting the subscribers' lines are those usual in telephonic systems.

Another is a patent of Lytle and McCoy, No. 313828, dated March 10, 1885, application filed April 26, 1884. It is simply for suspending a variable contact transmitter without rigid guides or suports, and for counterweighting it; thus arranged it is hung in front of a telephone switchboard, and is therefore adapted to be adjusted as to height with the mouth of the operator, and is protected from jarring. Following are the claims in full:

1. The combination of the flexible suspending cord or cords or the equivalent thereof with a variable-contact telephonic transmitter suspended freely thereby out of contact with rigid guides or supports, substantially as described, whereby jarring of the electrodes of the transmitter is prevented.

2. The combination, with the flexible longitudinally-adjustable cord or cords or the equivalent thereof, of the variable-contact telephonic transmitter suspended freely thereby out of contact with rigid guides or supports, suitable guides over which said cord or cords pass above the transmitter, and counter-weights arranged upon said cord or cords for balancing said transmitter, as set forth.

In the specification the inventors admit that *magneto* telephones, used as transmitters, "were so suspended prior to this invention." This being the case, the substitution of a *variable contact* transmitter cannot be classed as a high order of the inventive faculty, and probably the patent would not be sustained in court.

A third patent is that of Frank Shaw, of New York, No. 268554, issued Dec. 5, 1882, filed Oct. 18, 1882. The first claim reads:

1. A head-telephone consisting of the receiving-telephone A, combined with the flexible band or strap B, adapted to encircle the head of the listener and hold the telephone firmly against the ear.

The designating letters are explained in the specification as follows:

A indicates a receiving-telephone of any desired form, but preferably of the disc form shown.

B indicates a flexible strap, preferably of some elastic material which is secured to the back of the telephone by screws C, C, or by any other suitable devices. Said strap is of sufficient length, as indicated, to completely encircle the head of the user, and by its elasticity will hold the telephone firmly against the ear without any other aids. By prefer-

ence said strap is provided with a buckle D, or with any other suitable device by which it may be lengthened or shortened at will to adjust it to the head, or to compensate for the stretching of the band, if said band is made of elastic material.

Very likely this patent would be invalidated for lack of inventive merit.

Patent of F. G. Beach, No. 245931, issued Aug. 23, 1881, application filed July 1, 1881. When the annunciator drop falls it completes a local circuit upon which is an alarm. Such an apparatus can be so arranged that any of a large number of drops sound, in falling, a common alarm; this is convenient as a night call when one operator is watching many drops.

A series of patents to Mr. John J. Carty, of New York City, have, of late years, been a very important feature in the progress of the art of telephony. We do not understand that they have yet been fully approved in actual practice, and we have not thought an exhaustive review of them within the scope of this work, but they certainly deserve mention.

It may be guessed that the inventor believes that he can so improve and simplify the telephone switchboard as to be able successfully to use single instead of double subscribers' circuits; to dispense with the generators at the subscribers' stations (this has already been accomplished by the Sabin and Hampton automatic signals); to use a common source of energy at the central station in place of all the transmitter batteries at the subscribers' stations; and to dispense with annunciator drops at the exchange.

It will be readily understood that if this ambitious program is carried to a successful conclusion, it will be possible to do away with a great part of the expense now incurred by the employment of inspectors who regularly visit subscribers' stations; and possibly with one-half of the labor expense now necessary to keep the switchboard in running order.

For the information of those of our readers who desire further to study these improvements, we herewith give data of three patents which are important landmarks in the series. The order is of the filing of applications.

No. 505188, John J. Carty, issued Sept. 19, 1893, called "Case No. 4," application filed Feb. 2, 1889, and renewed Oct. 16, 1891. Dispenses with the test circuits.

No. 473911, John J. Carty, issued May 3, 1892, called "Case No. 8," application filed Nov. 25, 1889. No generators are required at subscribers' stations, no annunciator drops at central station.

No. 518392, John J. Carty, issued April 17, 1894, called "Case No. 11," application filed April 14, 1891, and renewed Nov. 7, 1893. Uses one source of energy for a number of transmitter circuits.

In reference to the patent last mentioned, No. 518392, we suppose it to be the substructure upon which is to be built the necessary organization which shall dispense with transmitter batteries at subscribers' stations. Herewith the claims in full:

1. The combination with a battery or other source of electricity, having very low internal resistance, of telephone transmitters connected in parallel between the poles of the battery, and deriving current therefrom, substantially as dscribed.

2. The combination with a storage battery or secondary battery of low internal resistance, of telephone transmitters connected in parallel between its poles, and deriving current therefrom, substantially as described.

3. The combination with a battery or other source of electric current, having very low internal resistance, of several parallel branches between the poles of the battery, and a telephone transmitter and a primary helix of an induction coil in each branch, substantially as described.

4. In combination, a source of electric current of very low internal resistance, separate parallel branches joining the poles of the source of battery, a telephone transmitter and a primary helix of an induction coil included in series in each of the branches, and a telephone line circuit connected with a telephone receiver, including the secondary helix of each induction coil, substantially as described.

Many years ago, long before the telephone was invented, there was known in the art of telegraphy what was called a "combination local." It is very well illustrated in "Pope's Mod-

ern Practice of the Electric Telegraph," edition of 1871, page 58. It has primary batteries connected in parallel, and it has also relay points and sounder magnets connected in parallel.

If this organization is compared with Mr. Carty's claim 1, it is necessary only to substitute telegraph transmitters (relays with local points) in place of telephone transmitters, to make them identical. In the second claim, to further substitute "battery" for "storage battery," and so on. Now, as neither the telephone transmitter, nor the storage battery, nor the primary nor the secondary helices of an induction coil, nor the arrangement of batteries in parallel with transmitters (telegraphic) is new, what is novel in the combinations, and will they be sustained as a valid patent in a court of law? Can they not be classed with the suspended transmitter of Lytle and McCoy, and the head band of Shaw, previously mentioned as examples of that class of patents which are shown by the Commissioner's report of 1893 (see ante) to be in the majority, viz.: those which are passed by the Office, but will be declared invalid by higher courts?

In connection with Mr. Carty's inventions, it may be stated for the information of the reader that the famous "bridging bell" patent is No. 449106, issued March 31, 1891. It belongs to the class of party lines, which have not been discussed in this volume.

THE AUTOMATIC SWITCHBOARD.

Sept. 10, 1879, M. D. Connolly, Thos. A. Connolly and Thos. J. McTighe filed application for Letters Patent on an automatic telephone exchange. The objects of this invention, quoting from their specification, were, "The employment, in lieu of manual labor and the necessary skill and intelligence to apply it, of the capabilities of electricity and electro-magnetism," and that a telephone subscriber be "enabled to signal the person to be communicated with, and in fact to place his own and the other line into the most desirable and convenient relation to each other, and to the balance of the exchange as the most urgent demands of the telephone exchange system require." They further state that though they "have specifically described apparatus at the central office capable of effecting the objects sought, we wish it to be clearly understood that we do not confine the scope of our invention to the mechanical arrangements set forth herein, as we believe ourselves to be the first to have invented an apparatus by which the present manual labor system at the central office is supplanted by an automatic machine operated directly from the local stations by means of electro-magnetism." There are in this patent twelve claims, from which it appears that the Patent Office fully recognized the inventors as pioneers in this art. We give here the first one:

1. An automatic telephone-exchange or series of independent stations having means of electrical communication with each other, and combined with mechanism controlled from the different stations and adapted to automatically establish communication between any disengaged pair at any and all times, while securing individual privacy between each pair.

The patent issued Dec. 9, 1879, and is No. 222458; it expired, therefore, in 1896.

Connolly and McTighe took out another patent in 1881, and there are two others by M. D. Connolly, issued in 1882.

No. 447918, issued March 10, 1891, to A. B. Strowger, seems to cover the principal features of the present Strowger system. The application was filed March 12, 1889. Claim 1 is as follows:

1. In a system of telephone, telegraph, or other electrical exchange, the combination, with a series of wires leading to different stations in the system and having their ends insulated and held in curved rows, of a contact needle supported at the axis of the rows, mechanism for moving the needle from row to row, mechanism for moving the needle along the row, magnets for actuating said mechanisms, and wires leading from a sub-station for conducting electricity to energize the said magnets, substantially as set forth.

Strowger has another patent, No. 486909, issued Nov. 29, 1892, the application being dated Feb. 19, 1892. The first claim is fairly descriptive, and is as follows:

1. In an automatic electrical exchange, the combination, with a series of wires the ends of which are arranged in a horizontal plane, of a switch movably secured relatively thereto, said switch having its contact-head movable vertically, radially, and laterally, whereby it occupies a plane above the ends of the wires when moving and occupies the plane of the ends of the wires when at rest, and may be moved from the end of one wire to any other wire without coming in contact with the intermediate wires, substantially as set forth.

No. 540168, dated May 28, 1895, issued to Keith, Lundquist, Erickson & Erickson, and assigned to the Strowger Automatic Telephone Exchange, is apparently the product of the Strowger Company's factory experts. Perhaps the ninth claim is as good a condensed description as can be given. It reads:

9. An automatic electrical exchange comprising the combination with a switch-board provided with parallel wires, a series of connectors arranged transversely with the wires, each connector being provided with means for making electrical connection with the wires by a rotary and longitudinal movement, two levers for operating the connectors, one of which controls the rotary movement, and the other the longitudinal movement, substantially as set forth.

Of the above mentioned patents in the automatic series it is supposed that all are the property of the Strowger Automatic Telephone Exchange except the original Connolly and McTighe of 1879, which is now free to the public.

The connecting together of two subscribers by the Strow-

ger system, as it is now carried out in practice, is performed by means of a vertical rod having projecting contacts or "wipers," as they are technically called.

The manipulation of a key at the subscriber's end of the line serves to actuate the vertical rod to lower or raise or rotate it so as to bring a certain wiper in electrical contact with a certain plate, which is one of a bank of plates that are fixed within reach of the wipers. Each circuit is provided at the central station with a vertical rod having projecting contacts or "wipers," and placed within reaching distance of a separate bank of plates, each plate of a bank being electrically isolated from its fellows, and each wire of a subscriber connecting with one plate in each bank. It follows, therefore, that in an exchange having one thousand metallic circuits, the total number of plates in each bank must be two thousand; and, further, that as each of the moving vertical rods must be placed near one of these banks, that there must be one thousand *banks*, or two million *contacts*.

In an exchange having not more than 999 connections, each subscriber is furnished with three keys, or what is equivalent to three keys, viz., an apparatus automatically making contacts. The "hundreds" key is in connection with an electromagnet, which operates to actuate a hub rotating about the vertical rod to as many different positions as is indicated by the first figure of the called subscriber's number. The "tens" key operates to raise the rod by a step-by-step movement as many steps as are indicated by the second figure of the same number, and the mechanism is so contrived that the first upward step caused by the action of the tens key locks the hub to the shaft. By again manipulating the hundreds key to rotate the shaft and hub (which are now locked together) as many steps as are indicated by the unit figure of the number, the desired connection is reached.

By causing both the hundreds and tens keys to make contact at the same time, the rod is released from its state of connection, and by means of a spring sent back to its former posi-

tion, and is then ready for another connection. In the latest style or make of instruments, this is accomplished by simply hanging the receiver on the hook.

The apparatus at the central exchange which is individual to each of its patrons, is composed, in addition to the vertical rod, wipers and bank of plates just described, of two electro-magnets for operating these three step-by-step movements of the hundreds, tens and units systems, and a third electro-magnet called the "private magnet," which operates to protect the apparatus of the called subscriber from interference by parties connected to the exchange other than that one with whom he is talking. The calling subscriber's circuit is protected from interference by a disconnection from the other plates brought about by the movements of the rod and hub device.

Each patron of the exchange has two wires exclusively his own, which form the two limbs of his metallic circuit, and in addition he is connected to a third, called the "battery wire," which is used in common with other subscribers. This third wire is connected at the exchange with a strong battery and obviates the necessity of locating a source of energy with each subscriber.

Of other automatic systems there is an account in a foreign publication of that of V. Bartelous, of Brussels. It has been adopted by the Belgian Telephone Company, its principal use being that of a party line. A single telephone circuit can be carried from a central station in a city several miles to a relay station in the suburbs, and to this relay station may be connected by independent lines perhaps twenty-five different subscribers. The apparatus in connection with each is so devised that it can control switching apparatus at the relay station and so connect either with any other in the suburban system, or with the line whose distant end is in the central station of the city.

There is another, invented by Mr. D. Sinclair, of the National Telephone Company, Glasgow, Scotland, which is something like the original scheme of Connolly and McTighe.

There is also one in use by the Swedish Telephone Company, called the Ericsson and Cedergren. Another called the Oesterreich.

All of these European systems seem to be intended to accomplish the same purpose, that of a party line.

CALLENDER.

There have been taken out by Romaine Callender, of Brantford, Canada, United States Letters Patent No. 511874, Jan. 2, 1894; No. 511875, Jan. 2, 1894, and No. 530324, Dec. 4, 1894. The application for the first of these, No. 511874, was filed May 12, 1893; that of No. 511875 was filed Aug. 13, 1892. The third in the list is a division from 511875, the last application having been filed Dec. 18, 1893.

The first of the Callender patents has fourteen sheets of drawings and one hundred and fifteen claims; the second has twelve sheets of drawings and fifty claims; the third eight sheets of drawings and three claims, a total of thirty-four sheets of drawings and one hundred and sixty-eight claims.

The patent, which was the first to issue, No. 511874, we have briefed by selecting the following paragraph from the specification, and claims 1 and 2:

I provide a cross connecting switch-board with the usual cross connections and with automatic switching devices for adapting it for connections between any and all pairs of lines of the system. The usual plug connections in this switch-board are effected, as I have above indicated, by metallic or other conducting balls which are allowed to roll down and drop into the plug holes or upon exposed contacts in pairs, finding their way to the proper plug holes over stationary runways or conveyers connected to the movable switch arms of the numerical re-

ceiver switches and controlled by electro-magnets as are the corresponding numerical receiver switching arms described and shown in my prior application. With a limited number of such conducting balls which are released and restored automatically by electro-magnetic mechanism and carried by mechanical runways and an elevator back to the starting point for re-use, I am enabled to quickly effect any cross connection desired and to maintain any two lines in undisturbed relation as long as the subscribers may wish, while additional calls for either of them are temporarily stored, the balls for effecting the connections for such additional calls being held in check by mechanism controlled by the subscribers themselves.

* * * *

Claims.

1. An automatic exchange system for effecting intercommunication between any two of a series of telephone or analogous electrical circuits comprising a portable circuit closer adapted to be controlled by all of the incoming lines in common, in combination with means for conveying it to a point where it will unite the two lines to be connected.

2. An automatic exchange for effecting intercommunication between any two of a series of telephone or analogous electrical circuits comprising means whereby two portable gravity actuated circuit closing agents are released at will by any of the calling subscribers and are directed by their own weight to two points where they unite the two lines to be connected.

APOSTOLOFF.

Another automatic system, which it is thought deserves an extended description, is covered by United States Letters Patent No. 562064, dated June 16, 1896. Application was filed March 23, 1896. The inventor is one Solomon Berditschewsky, a Russian Electrical Engineer, and the specification states that he is called Apostoloff. Why he is so called is not stated, but perhaps because his other name is inconveniently long. The invention is assigned to an English syndicate, and is generally spoken of as the Apostoloff System. It is said that the devices will be tried by the British Postoffice for exchanges in localities where there are small groups of subscribers.

Two special diagrams have been made, Plates 26 and 27.

In diagram 26 the carriages designated A, B, C and D are placed on local circuits supplied with current by a strong local

battery. The comparatively feeble currents sent from the subscribers' batteries are used only to actuate relays. For the sake of clearness in the diagram we have not shown any of the relaying connections.

Plate 26 shows that subscriber No. 61 has put himself in connection with No. 24. By the closing of the circuit twice on the negative side of the battery (N), No. 61 has caused the carriage A in central office to leave its usual position (which is the same as that of carriage B) and sent it to the white square marked 2. Then by closing the circuit four times on the positive side of the battery (P), the carriage C has been sent from its normal position (which is correspondingly the same as that of D) to the white square marked 4. Now the squares 2 and 4 are respectively connected with the two wires forming the metallic circuit No. 24, and as the wires connected to the respective carriages A and C are the wires of metallic circuit No. 61, it follows that the two subscribers are connected with each other. A similar process of sending positive and negative impulses is used when the conversation is finished to send back the carriages to their usual positions and thus "disconnect." Each subscriber's wires are connected at the central station to what the inventor calls a "cell," and that cell contains two traveling carriages and a set of double and single contacts; that is to say, subscriber No. 24 has in his cell carriage B, with a single line of contacts immediately above it, and carriage D, with a double line of contacts immediately above it. In a similar manner No. 61's cell contains carriages A and C adapted to travel along their respective lines of contacts.

Now it will be seen that if all the contacts marked 7 on the positive side are connected together, and all the contacts marked 6 are connected with each other, and so on until all the contacts with the same designations, either on the positive or the negative side, are in electrical connection by sets (as shown by dotted lines in Plate 27), that the number of subscribers that can be connected together will be as many as the number of negative designations multiplied by the number of positive

designations, for it is obvious that No. 1 negative (referring to the diagram) can be connected with seven different positive points, and so can each of the others, and if we can connect each of seven different negative points with seven different positive points, it will be possible to make forty-nine different combinations. Consequently, if each subscriber is provided at the central station with two carriages and three sets of seven each of contacts, or twenty-one contacts, then there can be accommodated forty-nine different subscribers.

And if the number of carriages per subscriber at the central station remain the same, and the number of contacts per subscriber are increased from seven to one hundred in each line, or from twenty-one to three hundred contacts in all, then the number of subscribers that can work through the exchange will be one hundred times one hundred, or ten thousand.

The Apostoloff patent goes into minute details, presenting fifteen sheets of drawings; the specification, exclusive of claims, has thirteen pages. In describing the advantages of his system the inventor states that—

* * * of the means which have been proposed by their inventors to connect two subscribers without the intervention of any attendant at the central station there be used as many single pairs of switch-boards at the central station as there are subscribers' lines in connection with the exchange, and that it would follow that if the number of subscribers in connection with the same exchange were ten thousand the central station would require to be provided with ten thousand identically similar apparatus, each provided with twice ten thousand contacts, the grouping together of which, as above mentioned, would involve the employment of twice one hundred million connections between the contacts—that is to say, twice the square of the number of subscribers—so that such a system is obviously impracticable by reason of its mere bulk and the number of connections to be made where the number of subscribers in connection with the system approaches in any degree to that of the subscribers to existing telephonic systems in great cities.

The object of my present invention is to enable this great number of contacts and their connections to be so far diminished as to be brought within praticable limits. The extent of the diminution will be readily appreciated when it is understood that instead of employing a number of contacts equal to twice the square of the whole number of subscribers I am enabled to attain the same end with a number of contacts equal only to three times the square root of the same number of subscribers, since it will be seen that by the present invention each contact represents not

merely one subscriber, but a whole group of, say, one hundred subscribers, or more. Consequently the number of wires connecting the terminals of the groups in the several subscribers' apparatus at the central station is equal not to the whole number of subscribers, but only to three times the square root of the number of subscribers.

There are six claims, all of them long and complicated. We quote here the first one only:

1. A system of automatic telephone exchange wherein the members of each pair (constituting a subscriber's circuit entering the central station) terminate in independently movable switches capable of being electromechanically propelled along rows of insulated contacts, the positive members of all the pairs (and consequently the switches in which they terminate, and the contacts on which the switches normally rest), being connected in a certain order in groups, which groups are respectively connected to corresponding contacts of all the rows of contacts appropriated to positive members; the negative members of all the pairs being connected in a certain order (different to that in which the positive members are connected) in groups which are likewise respectively connected to corresponding contacts of all the rows of contacts appropriated to negative members; the difference between the orders of grouping the positive and negative members being such that any one group of positive members comprises the positive members of pairs or couples whose negative members are comprised each in a different group of negative members, and reciprocally, so that a different pair or couple corresponds to each of the different combinations formed by conjoining any one of the positive set of contacts with any one of the negative set of contacts, the numbers of the groups in the two sets of groups of which the contacts are the terminals, (and consequently the numbers of wires in the two sets of wires connecting corresponding contacts), being factors whose product equals the number of possible combinations and consequently the number of subscribers who may automatically intercommunicate through the central station, as specified.

In order better to understand the state of the art in automatic telephony, it may be profitable to consider the relative advantages of two systems, one of which, the Strowger, is being vigorously pushed in America; and another, the Apostoloff, which seems to find favor in England. Strowger's talking circuit is, when connected, apparently in absolute isolation from all the other circuits in the exchange. Apostoloff's system, however, uses in the exchange connecting wires, each

of which is common to a number of circuits, from which arrangement arises a danger of interference.

For small exchanges the Strowger is apparently but little more costly than the Apostoloff; but in considering exchanges of many connections, it would seem that a system like Apostoloff's has an enormous advantage in first cost. The Strowger organization for an exchange of four thousand connections, each equipped with a complete metallic circuit, requires for every subscriber a bank of eight thousand plates, or, in the entire exchange, a rather appalling sum total of thirty-two million contacts; under the same conditions Apostoloff's exchange will number seven hundred and sixty-eight thousand.

The language of the first claim of the Firman patent (see page 69), seems to cover the multiple connections of both the Strowger and Apostoloff systems.

Experts who are interested in the manufacture of switchboards on the manual system as well as disinterested observers of progress in the telephone art, believe that automatic systems will be developed as party lines and small exchanges. But those directly interested in the development of automatic systems, have abounding faith in their ability to adapt them to exchanges connecting thousands of subscribers.

CONCLUSIONS.

In closing this work it may be said that the following conclusions as to the telephone situation in general seem fairly well established, viz.:

That the receiver is free and the transmitter will be declared so whenever the validity of the Berliner patent is decided on its merits.

That a good non-infringing subscriber's call can be designed by any capable engineer who will study the patents and decisions mentioned and explained in this volume.

That in manual switchboards the desirability of a multiple system is now seriously questioned, and that from the material furnished by the expired patents of Cheever, Watson, Shaw and others, it will be easily possible to devise an exchange that is efficient and fast.

Further, it is our opinion that the automatic signal patent of Sabin & Hampton, No. 513534, is too broadly claimed, and cannot be sustained; and that the attempt at covering the use of one source of energy for a number of transmitter circuits, as discussed herein in connection with Carty No. 518392, will also fail.

While it cannot be said that any system of automatic exchange switching so far devised has been demonstrated as commercially practicable, it must be admitted there are great possibilities in that direction.

INDEX.

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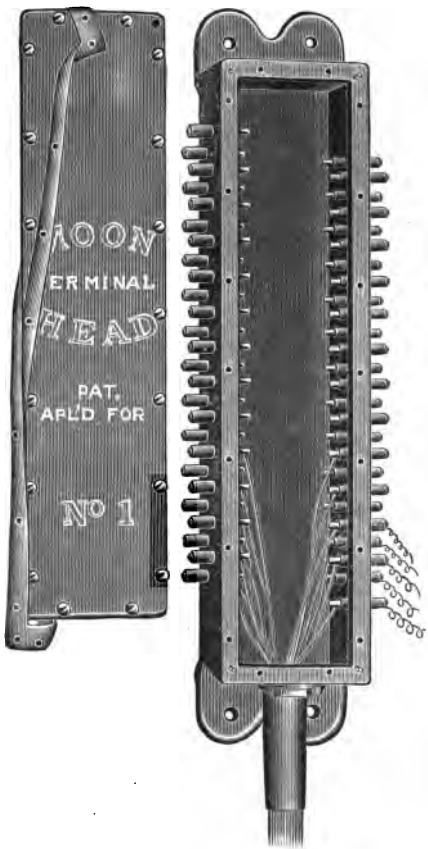

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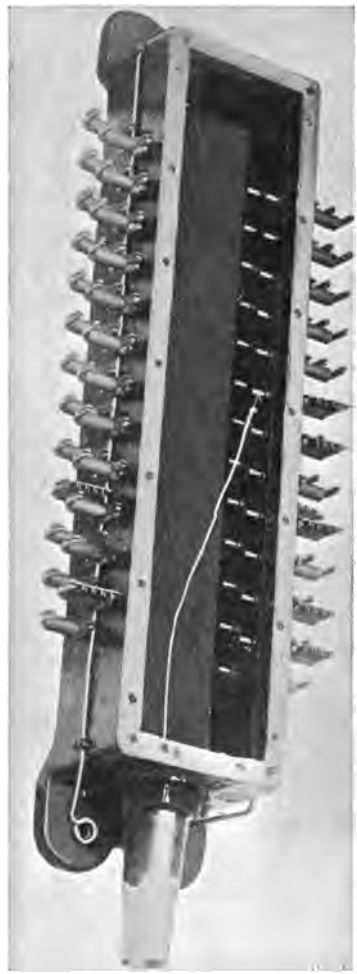

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