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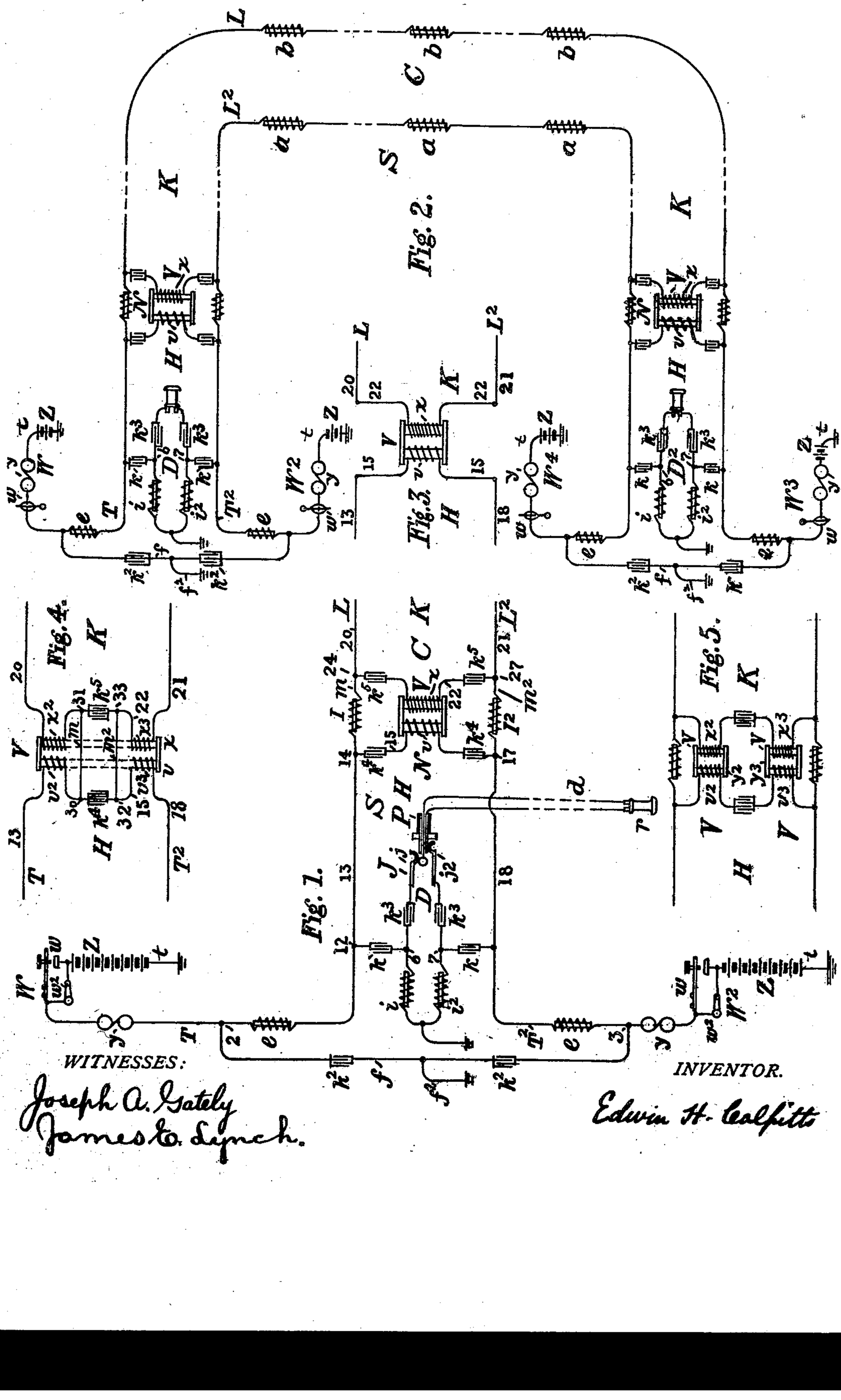
E. H. COLPITTS.

COMPOSITE TRANSMISSION OVER LOADED ELECTRIC CIRCUITS.

(Application filed June 13, 1902.)

(No Model.)



UNITED STATES PATENT OFFICE.

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COMPOSITE TRANSMISSION OVER LOADED ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 712,766, dated November 4, 1902.

Application filed June 13, 1902. Serial No. 111,558. (No model.)

To all whom it may concern:

Be it known that I, EDWIN H. COLPITTS, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Composite Transmission Over Loaded Electric Circuits, of which the following is a specification.

This invention concerns systems of composite telegraphy and telephony, and particularly those of the type wherein two line conductors are serially connected at the end stations to constitute a metallic telephone-circuit, while each of the said two conductors is provided with grounded terminal extensions to severally serve as independent telegraphic circuits, so that three communications, two of which are telegraphic and one telephonic, may be simultaneously transmitted over but two line conductors. Such systems are well known, and the art of constructing and operating them has been practiced for a considerable period of time. Thus an important use of many of the long telephone-lines is for that of simultaneously-operated telegraphy, each wire of the metallic circuit being employed separately as a Morse circuit.

A more recent improvement is that of loading the conductors of telephone-circuits with inductance or reactance coils placed at determinate intervals in the circuit of said conductors to counteract the attenuating effects of electrostatic capacity.

In connection with loaded lines to prevent adverse results from "reflection," so called, which occurs when rapidly-changing currents are required to pass between differently-constituted portions of a non-uniform transmission-circuit, as between the line or loaded and the terminal or instrument or unloaded portions of such circuit, transformers (step-up in the direction of transmission) have been and are employed, these being interposed in the circuit at a point outside of the telephone instruments. The circuit is by the interposition of these transformers divided into terminal and line sections, which include the windings, respectively, of the transformer.

The advantages accruing to the metallic telephone-circuit and its operation from the introduction of the loading-coils and the concomitant transformer have, however, been gained, in part at least, at the expense of the telegraphic circuits of the system, which, unless remedial measures are applied, necessarily have their continuity impaired at the point of and by the interposition of the transformer.

The object of the present invention is to permit of the loading of the circuit and the effective introduction of terminal transformers without any break or discontinuity in the telegraphic circuit-conductors and without impairing the operation of the said telegraphic circuits. To this end the metallic circuit loaded and divided into line and instrument or loaded and unloaded sections by the interposition of the transformer is provided with conductive connections of or having high inductance and uniting the main conductors of each section to the corresponding main conductors of the other section, and is also provided with conductively discontinuous inductostatic connections extending between the two main conductors of each circuit-section, in the circuit of which the windings of the transformer are respectively connected. By such means the telegraphic conductors are made continuously conductive for the slowly-changing telegraphic currents, but are rendered impervious to the rapidly-varying telephonic currents, which cannot pass through the high inductance of the conductive connections, while, on the other hand, the rapidly-varying telephonic currents can readily manifest themselves through the inductostatic connections completing the line and instrument circuit sections, and can therefore when acting in either section produce their like through the intermediation of the transformer in the other section, the telegraphic currents being, however, prevented from circulating in said sections or from passing from one main line conductor to the other in either section by the conductive discontinuity of such inducto static connections. The high-inductance device of the said conductive connections may be an electromagnetic coil constructed in a manner well understood to offer a high impedance to or choke the passage of voice-currents and may

have an inductance magnitude ranging from one to two henries, and the conductively discontinuous inductostatic connection completing the instrument and line-sections for voice-currents, but preventing the passage of telegraphic currents or signals, may be arranged by inserting a condenser of sufficient size or capacity—for instance, of from two to three microfarads on one or preferably on both sides of each winding of the transformers.

In the drawings which accompany and illustrate this specification, Figure 1 represents the application of the present invention to one end of a loaded composite circuit fitted with a transformer. Fig. 2 shows a complete composite circuit with both terminal stations similarly fitted. Fig. 3 illustrates the transformer and the connection of its windings in the two circuit-sections, respectively, before combination with the characteristic feature of the invention. Fig. 4 is a detail illustrative of a modified arrangement of the said characteristic feature of the invention in association with a transformer, and Fig. 5 represents a further slight modification of the same.

Referring in the first place to Figs. 1 and 2, C is a metallic telephone-circuit extending between central switching-stations D D^2, and L L^2 are its direct and return line conductors, each provided with grounded terminal extensions t at both ends, and thus constituting grounded telegraphic circuits T T^2, (in the manner disclosed by Letters Patent of the United States granted to F. Van Ryssel-berghe July 28, 1885, No. 323,239, to which reference is made.) The whole forms a composite circuit or system of circuits S. At the telephone-exchange stations D D^2 by means of suitable switchboard devices (represented by a plug-socket J and switch-plug P) the metallic telephone-circuit C may be switched to any substation-circuit d to establish through communication with substations whose apparatus of the ordinary type is symbolized by a receiving-telephone r. In Fig. 1 the switch apparatus is indicated as above; but in Fig. 2 the substation-telephones are shown as being connected directly to the central-station condensers, the switchboard being assumed. Electromagnetic resistances e are placed, as shown, in each telegraphic extension to serve as graduators and to so modify the abruptness of the telegraphic currents that their tendency to produce disturbing noises in the telephone-receivers is much lessened. A cross branch f extends from the main conductors L L^2 at points 2 and 3 to earth and includes the condensers k^2 k^2, these being introduced to aid in individualizing the operation of the two systems and to further smooth out the telegraphic current impulses. The earth connection f^2 is attached at a point midway between said condensers.

W, W^2, W^3, and W^4 are the telegraph-stations, each fitted, as usual, with a suitable source of current Z, with sending instruments w, having circuit-closers w^2, Fig. 1, and with receiving instruments y.

At the telephone central stations D D^2 the switch devices or telephone instruments are connected with the two main conductors L L^2 through condensers k k^3. The condensers k are arranged to prevent conductive connection between the two telegraphic circuits, and the condensers k^3 possess the same function and also open the main telephonic circuit to prevent current which might produce false signals from reaching said circuit when central-battery substation-lines are connected therewith. The impedance-coils i i^2 act to neutralize discharges from the condensers k and are in branches to earth from points 6 and 7.

The construction and arrangement which thus far have been described are not new, although it has seemed expedient to refer to the same in a somewhat extended manner in order that the present invention may the more easily be comprehended.

Loading-coils a b are connected or inserted in the main line conductors L L^2 of the metallic telephone-circuit at suitable determined periodic points to counteract by their inductance the attenuating effects of capacity in accordance with established principles, and to improve the operation of the telephone-circuits thus loaded and facilitate the transition between differently-proportioned portions of such circuits they are provided at each terminal station with a transformer V, interposed in the circuit at points N on the lineward sides of the terminal-station instruments. The interposition of these transformers divides the main circuit into two sections H K, one of which, H, contains the station instruments and may be termed the "instrument-terminal" or "unloaded" section, while the other, K, is the line portion of the circuit and may be termed the "line" or "loaded" section. The shorter winding v of the transformer, that which is the primary during outward transmission, is connected in the instrument-section, and the longer winding x is connected in the line-section. The length of these windings may properly be in a ratio of one to three. In a composite circuit thus constituted the telephone-circuit in the unloaded or terminal section H (referring to Fig. 1) may be traced from one side of the telephone instruments r to one spring j of the switch-socket J, through condensers k^3 and k, point 12, conductor 13, point 14, conductor 15, including transformer-winding v, point 17, conductor 18, condensers k and k^3 on the other side, socket-spring j^2, thus to the other side of the telephones r, and the loaded portion of the said telephonic circuit passes by way of conductor 20, representing line L, to conductor 21, representing line L^2, through the uniting-conductor 22, which contains the transformer-winding x. Voice-currents originated in this circuit-section H will reproduce themselves in the line-section K

by means of inductive action exercised by the winding v upon winding x of the transformer V, and will thus be conducted over the line to the distant station, and, similarly, voice-currents originating at the distant station and circulating in the line-section K will be inductively transferred by winding x of the transformer V to winding v and reproduced in the instrument-section.

Fig. 3 illustrates the arrangement of the two circuit-sections H and K and the transformer V inductively uniting them and having its shorter winding v in the instrument-section H and its longer winding x in the line-section K, the characteristic features of the invention thus far not having been added.

It is apparent, then, that the circuit, as far as it has been described, is a telephone metallic circuit of two sections inductively united for the reciprocal transmission of voice-currents, but that its line conductors L L^2 severally considered are no longer capable of being independently employed as separate telegraphic circuits T T^2 and that there are two reasons coöperating in such incapacitation. One of these reasons is that there is no longer any conductive continuity between the main conductors 13 and 18 of section H and the corresponding main conductors 20 and 21 of section K, so that the two telegraphic circuits are discontinuous at the point of insertion of the transformer, and the other is that the two main conductors of each section are conductively united with each other, making an actual, but undesired, conductive connection between the telegraph stations or instruments W W^2 of the telegraphic circuits T T^2 at the same end of the line through winding v of the transformer V and also between the two line portions of said circuits T T^2 through the other winding x of said transformer; but in accordance with the principles of this invention a conductive connection m of high inductance or containing a high-inductance device I is now arranged to connect the points 14 and 24 of the conductors 13 and 20 of sections H and K to render the main conductor L conductively continuous, and thus to reconstitute the telegraphic circuit T, while the telegraphic circuit T^2 is similarly made continuous by a like conductive connection of like qualifications arranged to unite points 17 and 27 of the conductors 18 and 21 of sections H and K, respectively. The resistance of these connections m and m^2 or of the inductance devices I included therein is preferably as low as possible, so as to oppose and reduce the telegraphic working currents as little as possible; but the inductance of said connection must, in accordance with well-established principles, be made high in order that a great impedance or choking effect shall be opposed to the voice-currents of the telephonic circuit C, which are thereby prevented from being diverted to the telegraphic extensions and are exclusively directed through the transformers, and the conductive connection between the two main conductors 13 and 18 of section H and 20 21 of section K is then severed by connecting a condenser k^4 in series with transformer-coil v and a condenser k^5 in series with transformer-coil x, or preferably two condensers in series with each—that is, a condenser k^4 on each side of winding v in the conductor 15, which extends between main conductors 13 and 18 of the circuit-section H, and a condenser k^5 on each side of winding x in the conductor 22, which extends between main conductors 20 21 of circuit-section K. By the means thus recited and described the two sides of a loaded telephonic metallic circuit are made conductively continuous for telegraphic currents, notwithstanding the introduction of an interposed terminal transformer, while the said telegraphic circuits remain impassable and practically open as regards telephonic currents and the currents of either telegraphic circuit are prevented from passing to the other, while the condensers which exercise such prevention, being, as hereinbefore stated, of appropriate capacity, freely allow the required circulation or operation of the telephonic currents in the instrument and line circuit sections.

In the modification illustrated by Fig. 4 the two transformer-windings are centrally severed and a condenser introduced between the two portions of each. The conductive connections m m^2, moreover, instead of joining the section-conductors 13 20 and 18 21 at points altogether exterior to the transformer, unite points 30 31 and 32 33 of the conductors 15 and 22, which contain the transformer-windings, respectively. By this arrangement the telegraphic circuit T is made to pass from conductor 13 of section H through one half v^2 of transformer-winding v, conductive connection m, and one half x^2 of transformer-winding x to conductor 20 of section K, and telegraphic circuit T^2 in the same way passes from conductor 18 of section H through the remaining half v^3 of winding v, conductive connection m^2, and the remaining half x^3 of winding x to conductor 21 of section K. The transformer V is in this instance shown as being provided with a core having a closed magnetic circuit extending through both halves of both windings.

The modification illustrated by Fig. 5 differs only in that the transformer V is shown as having its iron core as well as its coils divided, half-windings v^2 and x^2 being wound over the closed magnetic-circuit core y^2 and half-windings v^3 and x^3 being wound over a second closed magnetic-circuit core y^3.

Having thus described the invention, the several claims of the application are as follows:

1. The combination with a metallic telephone-circuit divided at a terminal station into line and instrument circuit sections, and a transformer associated with said circuit at said terminal station and interposed between

said circuit-sections; of conductive connections having high inductance uniting the conductors of each section to the corresponding conductors of the other; and conductively-discontinuous inductostatic connections, one for each of the said circuit-sections, including the two windings of said transformer respectively, and extending each between the conductors of its own section to inductively complete the same; substantially as described.

2. The combination of a metallic telephone-circuit; an inductive device in each main conductor thereof at a terminal station and at a point exterior to the instruments of said station; a terminal transformer for said circuit having its windings connected between the said main conductors on the two sides of said inductance device respectively; and a condenser in series with each winding; substantially as and for the purposes set forth.

3. The combination with a loaded electric circuit having its two main conductors arranged serially to serve as a metallic telephone-circuit, and each provided with grounded extensions to severally constitute telegraphic circuits; a transformer at the terminal stations dividing the telephonic circuit into inductively-connected line and instrument circuit sections containing respectively the windings of said transformer; a condenser interposed in each section to complete the same for voice-currents, and to sever the conductors thereof conductively to maintain the separation of the telegraphic circuits; and a high-inductance conductive connection uniting the corresponding conductors of the said line and instrument circuit connections to maintain the conductive and discriminative continuity of the said telegraphic circuits; substantially as described.

4. In a composite system of simultaneous telephony and telegraphy over the same conductors, the combination of an electric transmission-circuit having two main conductors serving together in series as a metallic telephone-circuit, and severally as grounded telegraphic circuits; loading-coils systematically connected in the conductors of said telephone-circuit to counteract the capacity effects thereof; a transformer at each terminal station of said telephonic circuit to facilitate transmission of voice-currents between the loaded and unloaded instrument or terminal sections thereof, the windings of said transformer being included in said sections respectively; and means associated with said transformers for maintaining the continuity of the said grounded and metallic circuits, for their appropriate currents discriminatively or selectively; substantially as described.

5. The combination of a double-conductor transmission-circuit having its conductors connected serially to constitute the direct and return wires of a metallic telephone-circuit and provided each with grounded terminals to severally constitute independent telegraphic circuits, loading-coils systematically arranged at periodic intervals in the said telephone-circuit; a transformer at each terminal station of said telephone-circuit dividing said circuit into line or loaded and terminal or unloaded inductively-connected sections, and having its windings contained in said sections respectively; a condenser included in each section together with the transformer-winding thereof to maintain the inductive continuity of said sections while disestablishing conductive continuity between the telegraphic circuits; a conductive connection for each telegraphic circuit associated with each transformer uniting the corresponding conductors of said loaded and unloaded circuit-sections and establishing the conductive continuity thereof around the said transformers for the passage of telegraphic currents; and an electromagnetic resistance or high-inductance device included in said conductive connection to choke the passage thereof as regards voice-currents; substantially as described.

6. The combination of a combined or composite telegraphic and telephonic system of transmission-circuits wherein two main conductors together arranged serially constitute the direct and return wires of a metallic telephone-circuit, and severally constitute single-conductor telegraphic circuits; loading-coils systematically and periodically arranged in the said telephonic circuit; and a transformer at each terminal station connected in the said telephonic circuit and dividing the same into line or loaded and terminal or unloaded sections, containing the windings of said transformer respectively; with a condenser interposed in each section in series with the said transformer-windings and on each side thereof, to maintain the conductive separation of the telegraphic circuits; and a conductive connection of high inductance for each main conductor, uniting the main conductors of each section to those of the other between the points at which the said two transformer-windings are connected with said conductors; substantially as and for the purposes specified.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 10th day of June, 1902.

EDWIN H. COLPITTS.

Witnesses:

GEO. WILLIS PIERCE,

JOSEPH A. GATELY.

Correction in Letters Patent No. 712,766.

It is hereby certified that in Letters Patent No. 712,766, granted November 4, 1902, upon the application of Edwin H. Colpitts, of Boston, Massachusetts, for an improvement in "Composite Transmission over Loaded Electric Circuits," an error appears in the printed specification requiring correction, as follows: In line 13, page 4, the word "inductive" should read *inductance;* and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of November, A. D., 1902.

[SEAL.]

F. I. ALLEN,

Commissioner of Patents.