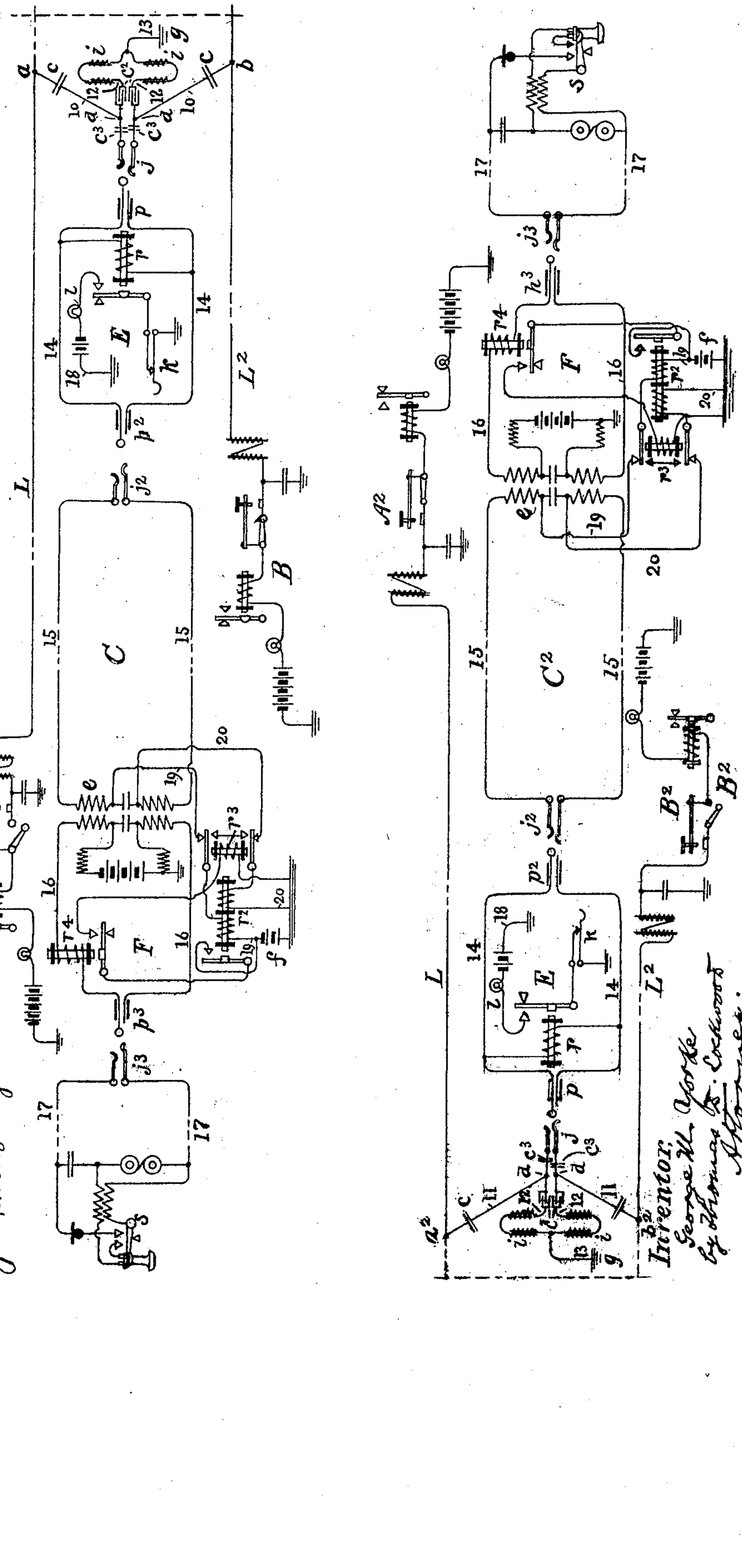
No. 845,157. PATENTED FEB. 26, 1907.

G. M. YORKE.

COMPOSITE TELEPHONIC AND TELEGRAPHIC CIRCUIT.

APPLICATION FILED JAN. 7, 1907.



UNITED STATES PATENT OFFICE.

GEORGE M. YORKE, OF NEW YORK, N. Y., ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

COMPOSITE TELEPHONIC AND TELEGRAPHIC CIRCUIT.

No. 845,157. Specification of Letters Patent. Patented Feb. 26, 1907.

Application filed January 7, 1907. Serial No. 351,231.

To all whom it may concern:

Be it known that I, GEORGE M. YORKE, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Composite Telephonic and Telegraphic Circuits, of which the following is a specification.

In composite systems of transmission of that type in which two grounded lines, each having terminal telegraph-stations, are bridged between said stations by conductors including telephone instruments to constitute a metallic telephone-circuit it is customary to place in the bridges at opposite sides of the telephone-stations condensers, which exclude from the telephones the slowly-varying telegraph-currents, while permitting practically the passage of the rapidly-changing voice-currents. This is shown in United States Patent No. 323,239, Van Rysselberghe, July 28, 1885. In using this arrangement it was found that the operation of the two telegraph-circuits caused such differences of potential at the extremities of the bridges that a flow of current occurred through the telephone instruments, which not only impaired their efficiency, but also produced mutual interference between the telegraph-lines. To obviate this difficulty, the bridges have been connected to ground through a retardation-coil at each side of the telephone-station instruments and between them and the bridge-condensers. While the impedance of the coils prevented the passage of the telephone-currents to ground, it gave for the disturbing currents points of approximately zero potential, so that interference with the telephones and telegraphic cross-interference were both reduced. Now, though these earth branches excluded voice and magneto or like ringing currents when steady signaling-currents, such as those of central-energy systems, were applied to the telephone branches they found free paths to ground. To overcome this, condensers were inserted in the bridges between the instruments and the points of connection of the earth branches, thus confining the steady signaling-currents to the portions of the branches containing the telephone instruments, but still allowing the voice-currents and pulsatory signaling-currents to pass out over the line.

The amount of condenser capacity which should be placed in series between the telegraph-lines and the telephone instruments to give good telephonic transmission is controlled by two considerations—it must be sufficiently great to enable voice-currents to pass without material impairment and yet be so small that telegraph-currents are substantially excluded. It has been found in practice that a capacity of about two microfarads is most effective. In the first arrangement of the composite system mentioned a single two-microfarad condenser was placed in the bridge at each side of the telephone instruments. Therefore when the ground branches were added and the condensers to keep from them the steady signaling-currents it was found necessary to give each condenser a capacity of four microfarads, so that the total value in series between the telephone instruments and the telegraph-line might remain at two microfarads. In this way good telephonic transmission was attained, but at the expense of telegraphic transmission, since there was in the condensers between the lines and the ground branches a grounded capacity of four microfarads for each line and at each bridge where before there was only two microfarads. The telegraph-lines were therefore rendered more sluggish and the efficiency of transmission lowered.

My invention has for its principal object the abatement of this difficulty and a genral improvement in both telegraphic and telephonic transmission.

The accompanying drawing shows diagrammatically an application of my invention, there being a single figure shown in separated sections for convenience in illustration.

Line conductors L L^2 extend between pairs of terminal telegraph-stations A B and A^2 B^2, at which they are grounded, said stations being equipped with the apparatus usua lin composite systems. Between the telegraph-stations conductors 10 and 11 bridge the lines and lead into telephone-stations C C^2 respectively, which are thus connected by a metallic circuit furnished by the bridges and intermediate portions of the two telegraph-lines. The telegraph-currents must be barred from the telephone instruments, and to effect this and at the same time allow the passage of telephone-currents

condensers *c* are included in each bridge-conductor between its junctures with the line conductors at *a b* and a^2 b^2 and the telephone instruments. These condensers, while being freely permissive to telephone-currents, should practically exclude the slowly-varying telegraphic impulses, and the capacity which has been found to best perform this double function is about two microfarads for each condenser. There will, however, in the operation of the telegraph-lines be fluctuating differences of potential between the points *a b* and a^2 b^2, respectively, that would tend to cause pulses of current to traverse the bridges, disturbing the telephone instruments and giving cross-interference between the telegraph-lines. To avoid this, earth branches 12 are joined to the bridge-conductors at points *d* between the condensers *c* and the telephone instruments, they being grounded in pairs at *g* through common conductors 13. A suitable inductive resistance *i* is placed in each earth branch, these offering so high an impedance that the voice-currents cannot flow through them. The trespassing currents, however, change with such comparative slowness that the coils *i* for them approximate simple resistances, and for said currents there is thus established at *d* a condition of potential approaching zero. They therefore cannot pass through the telephone instruments and will flow to ground without reaching the companion telegraph-line.

The telephone-station associated with the bridge-conductors may and under the present practice usually would be of a type in which a common battery is employed, the steady current from which in operating lamp-signals and the like would have access to the bridge-conductors. In the present instance there are illustrated portions of standard telephone-circuits comprising toll and switching cord-circuits, interoffice trunks, and subscribers' lines, only such elements being retained as are necessary to show the application of this invention.

The bridges 10 and 11 each include the contacts of a jack *j*, with which coöperates a plug *p*, terminating one end of a cord-circuit 14 at the toll-operators' position E. At the opposite end of the toll-cord is a plug p^2, adapted to engage a jack j^2, connected by a trunk-circuit 15 through a repeating-coil *e* to the cord-circuit 16 of a switching-operator's position at F. The switching-cord has a plug p^3 for coöperation with a jack j^3, to which is connected a subscriber's line 17, having the usual substation set *s*. The toll-cord circuit has bridged across it a relay *r*, controlling upon its front contact the local circuit 18 of a lamp *l*, said circuit including a normally closed contact in the toll-operator's listening-key *k*. Associated with the switching-cord 16 is a double-wound relay r^2, having a winding included in a conductor 19, leading from the free pole of a grounded battery *f* through one armature and back contact of a relay r^3 to the trunk 15, thence through the jack j^2 and plug p^2, the toll-cord 14, relay *r*, and back through the cord, jack, plug, trunk, conductor 20, and another armature and back contact of relay r^3 to ground through the second winding of the relay r^2. The winding of the relay r^3 is connected from ground through the normally open front contact of a relay r^4, having its winding in one side of the switching-operator's cord and through the front contact and armature of relay r^2 to the free pole of battery *f*.

Considering for the purposes of this description that the call to be handled is incoming to the telephone-office C, the plug *p* would first be placed in the jack *j* by the toll operator, who after communicating with the switching operator over an order-wire (not shown) would insert the plug p^2 in the designated jack j^2. This would have been preceded by the placing by the switching operator of the plug p^3 in the jack j^3. The called subscriber should now be rung by the toll operator, and she is apprised of the fact and governed in discontinuing the ringing by the lamp *l*, which receives current from its local battery after the relay *r* has drawn up its armature. The actuation of this relay *r* occurs after the association of the plug p^2 and jack j^2 by current from the battery *f* over the circuit previously indicated and including the toll-cord, trunks, and conductors 19 and 20. The relays r^3 and r^4, which act to extinguish the lamp *l* upon the removal of the receiver from the hook at the called substation, do not concern the present invention and need not be further considered.

It will be seen that if the bridge 10 and its earth branches 12 were arranged as has been described a shunt would be placed upon the relay *r*, and the relative resistance would be such that the lamp *l* would not light. To prevent this, condensers c^2 are placed in the earth branches, preferably each having a capacity of about two microfarads. These impassably bar the steady current flowing from the battery *f*, and the relay *r* operates without interference. On the other hand, the trespassing telegraph-currents, which have already passed the condensers *c*, readily pass through the condensers c^2 to ground.

As has been previously indicated, the condensers c^2 might be placed in the bridge-conductors 10 and 11, as shown in dotted lines at c^3, between the points *d* and the telephone instruments and the desired result in a measure secured; but by the arrangement here described important advantages are gained. If the condensers were inserted in the bridge at c^3, to get that capacity of two microfarads, which gives most efficient telephonic transmission, one must make *c* and c^3 of four mi-

crofarads each, thus giving in series one-half this amount, and then we should have connected with each line at each bridge a grounded capacity of four microfarads furnished by the condensers *c*, and this total of sixteen microfarads added to the capacity of the lines themselves would materially impair telegraphic transmission.

The present invention places between the lines L and L^2 at *a*, a^2, *b*, and b^2 and the earth at *g* two capacities *c* and c^2 of two microfarads each in series, or one microfarad, increasing the total capacity of both lines but four microfarads. At the same time it should be remembered that we have the standard capacity of two microfarads in the bridges at each side of the telephone-offices.

Furthermore, my improved system reduces both the disturbance in the telephone instruments and the mutual interference between the telegraph-lines, for though the impedance of the earth branches has been increased by the placing of the condensers c^2 therein rather than in the bridges, which in itself would tend to augment these difficulties by shunting more current through the telephone apparatus, the total impedance of the paths from *a* to *b* and from a^2 to b^2 and from each of the points *a*, *b*, a^2, and b^2 to earth is increased. This follows because although the total capacity of the bridge-conductors passing through the telephone-offices remains the same (approximately one microfarad) that of the paths from *a*, *b*, a^2, and b^2 to ground is one microfarad instead of four microfarads, so that the impedance as a whole to the slowly-varying currents entering the bridge is increased to a much greater extent than the increase in the relative impedance of the earth branches to that portion of the bridge-conductors within the points *d*. Therefore a considerably-reduced telegraph-current passes the condensers *c*, and the disturbing portion, or that traversing the bridge-conductors from *d* to *d*, is less than if the condensers c^2 were between these points and the telephone-offices

Having thus described my invention, I claim—

1. A composite telegraph and telephone system comprising line conductors provided with telegraph-stations, intermediate bridge-conductors connecting the lines and containing telephone instruments, said instruments having associated with them sources of steady current having access to the bridge-conductors, earth branches joined to the bridges at each side of the telephone instruments, and means situated in the earth branches for preventing the passage of steady currents.

2. The combination with line conductors having terminal telegraph-stations, of bridge-conductors connecting the lines and leading to telephone instruments, condensers included in a bridge at each side of the telephone instruments, earth branches joined to said bridge between said condensers and the telephone instruments, and a condenser in each earth branch.

3. In a composite telegraph and telephone system, the combination with line conductors provided with terminal telegraph-stations, of bridge-conductors connecting the lines and leading to telephone-stations, said telephone-stations having sources of steady signaling-current which may be connected with the bridges, condensers included in the bridges at each side of the telephone-stations and being of such capacity as to most effectively exclude telegraph-currents while permitting the free passage of telephone-currents, earth branches joined to the bridges between said condensers and the telephone-stations, and a condenser in each earth branch, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 4th day of January, 1907.

GEORGE M. YORKE.

Witnesses:
EDWARD BLAKENEY,
W. E. ATHEARN.