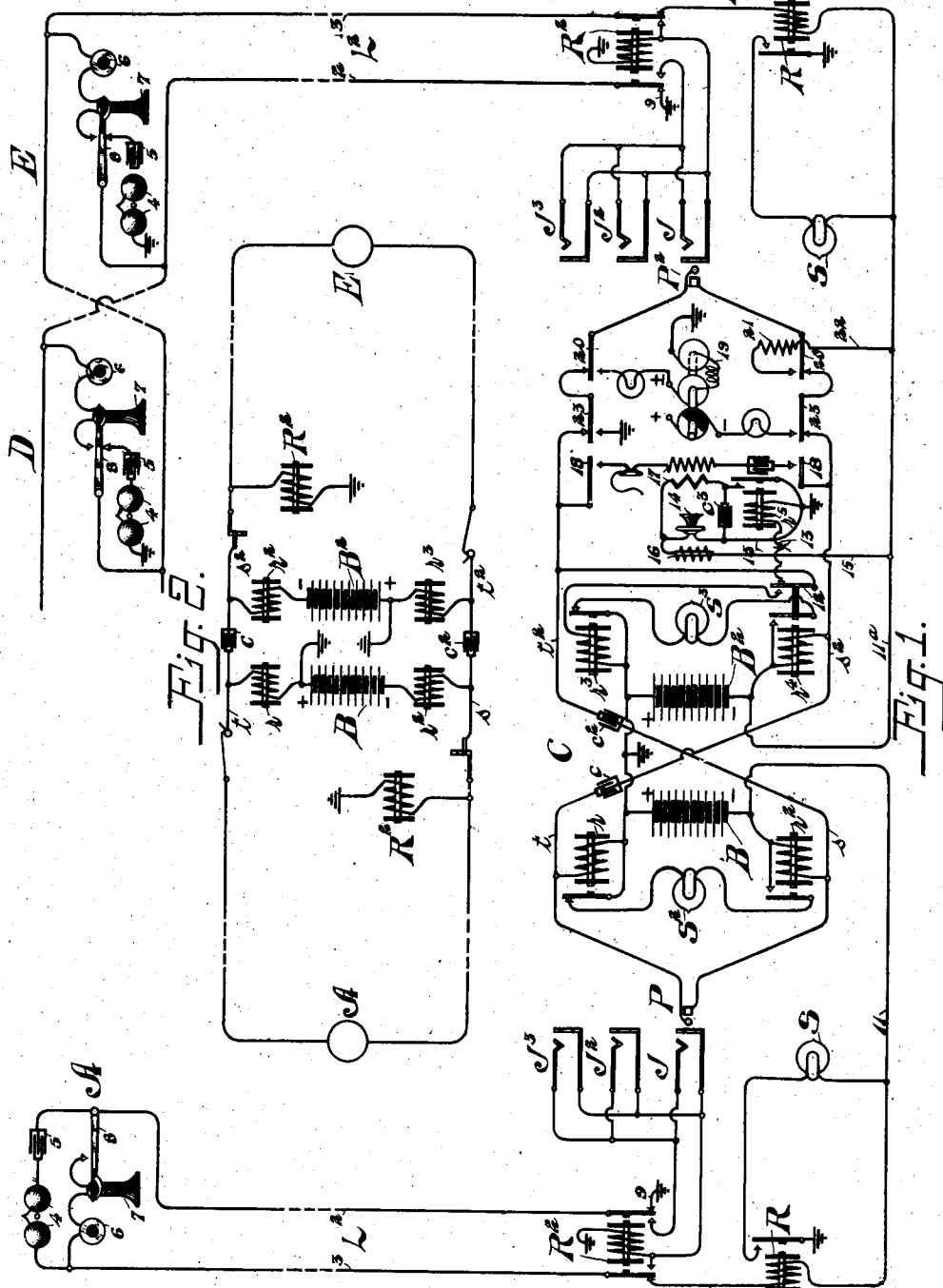


W. W. DEAN.
TELEPHONE SYSTEM.
APPLICATION FILED DEC. 29, 1902.

2 SHEETS—SHEET 1.



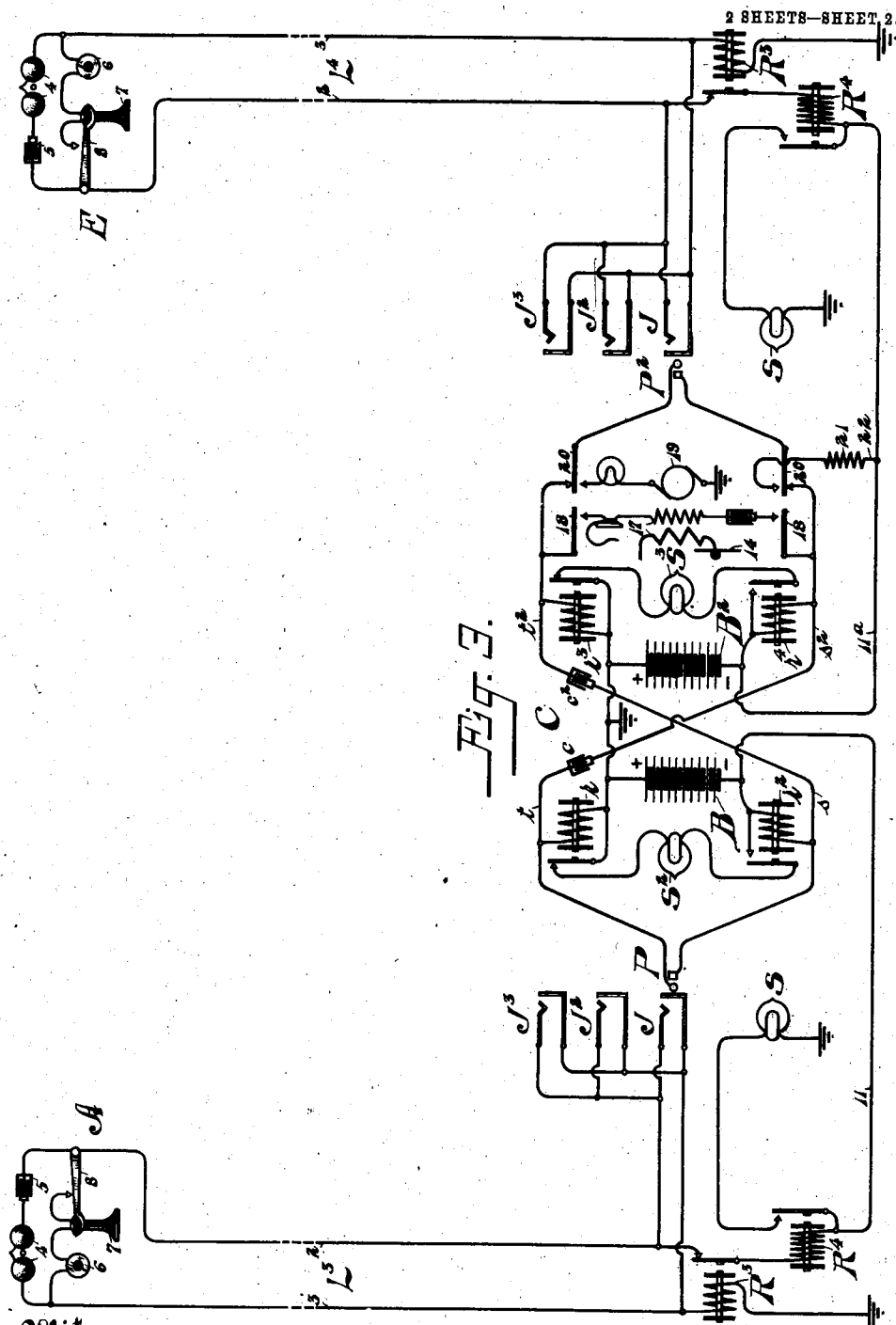
Witnesses.
R. H. Burfield
Gazelle Rader,

Inventor:
William W. Dean,
by Robert Lewis Ames
Attorney.

No. 834,272.

PATENTED OCT. 30, 1906.

W. W. DEAN.
TELEPHONE SYSTEM.
APPLICATION FILED DEC. 29, 1902.



Witnesses.

R. H. Burford
Gazelle Beder.

Inventor:

William W. Dean.

by Robert Lewis Ames
Attorney.

UNITED STATES PATENT OFFICE.

WILLIAM W. DEAN, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TELEPHONE SYSTEM.

No. 834,272.

Specification of Letters Patent.

Patented Oct. 30, 1906.

Application filed December 29, 1902. Serial No. 137,001.

To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented new and useful Improvements in Telephone Systems, of which the following is a specification.

My invention relates to means for more perfectly balancing the talking-circuit when two lines are connected together for conversation. In certain classes of lines the cut-off relays or other auxiliary devices are connected with one side of the lines, whereby when they are connected for conversation by the usual cord-circuit the metallic talking-circuit is thrown out of balance. My invention is designed to balance such lines during conversation, which I accomplish by transposing the connections of the strands of the cord-circuit—that is, by connecting the tip-contact of one plug with the sleeve-contact of the other cooperating plug. When the lines are connected together by this cord-circuit, the said cut-off relays or other auxiliary devices are connected with the opposite sides of the metallic talking-circuit and the balanced line results, thereby improving transmission and avoiding cross-talk and other injurious or deleterious effects.

A further object is to provide a system in which the testing to determine the idle or busy condition of the wanted telephone-line is carried out in a simple and convenient manner.

My invention is illustrated in the accompanying drawings, in which the same reference characters are used to designate like parts throughout, and in which—

Figure 1 is a diagram of a system embodying my improvements. Fig. 2 is a simplified diagram of the talking-circuit, and Fig. 3 is a diagram of a different system including my improvements.

In Fig. 1, L and L² indicate subscribers' lines extending in two limbs 2 and 3 from their respective substations to the central office C. At the substation A a bell 4 and a condenser 5 are located in a preferably permanent bridge of the line conductors, while a transmitter 6 and receiver 7 are placed in a

bridge that is normally open at the switch-hook 8. At the central office the line conductor 2 is normally grounded through a branch 9, while the conductor 3 is normally connected with a conductor 10, including the winding of the line-relay R, and is then joined by the common lead 11 with the live pole of a preferably common battery B. The line-relay R controls, through its normally open contacts, the circuit of the line-signal S, which is preferably in the form of a small incandescent lamp. Each line is further provided with an answering-jack J and with any suitable number of multiple jacks, such as J² and J³. The tip and sleeve contacts of these jacks are connected with the forward contacts of the springs of the cut-off relay R² of the line, the winding of which is grounded from the sleeve conductor of the said jacks. The line L² is of the same type as the line L except that the subscribers' bells are grounded from the opposite line conductors.

At the central office each operator is provided with a plurality of cord-circuits each of the kind illustrated in the drawings and which is provided with an answering-plug P and a calling-plug P², having tip and sleeve contacts adapted to register with the corresponding contacts of the spring-jacks or connection-terminals of the telephone-lines. The tip of the plug P is joined by the flexible strand t, condenser c, and the flexible strand s² with the sleeve of the plug P², while the sleeve of plug P is connected by strand s, condenser c², and tip-strand t² with the tip of plug P². The connections between the contact-surfaces of the plugs are therefore transposed, cross-connected, or "diagonally" joined, as it is sometimes called. The battery B is, together with supervisory relays r and r², bridged across the answering end of the cord-circuit, the former relay controlling, through its normally closed contacts and the latter through its normally open contacts, the circuit of the supervisory lamp S², which is preferably lighted from the battery B. The battery B², together with the supervisory relays r³ and r⁴, are likewise bridged across the calling end of the cord-circuit and similarly control the circuit of the supervi-

sory signal S^3 , associated with the calling-plug P^2 . The branch containing the supervisory relay r^3 is severed at spring 12 of sleeve supervisory relay r^4 and is normally connected thereby with the conductor 13, leading to the high-resistance and high-impedance test-relay r^5 , the opposite pole of which is grounded. This relay serves when energized to ground a portion of the operator's transmitter-circuit to thereby cause inductively a click in her receiver. The operator's transmitter 14 is connected in a conductor 15, joined to the common wire 11^a , connected with the live pole of the battery B^2 , said conductor 15 including the retardation-coil 16. The primary winding of the operator's induction-coil 17, together with a condenser c^3 , are connected in shunt of the transmitter 14. The operator's receiver, a secondary of her induction-coil 17, and a suitable condenser are adapted to be connected across the calling end of the cord-circuit by means of the springs 18 of any suitable listening-key. A ringing-generator 19 is arranged to deliver alternating current to the tip side of the line by the depression of springs 20 of any suitable ringing-key, the sleeve side being at the same time connected, through a resistance 21 in wire 22, through an auxiliary path, with the live pole of said battery B^2 . By the operation of springs 23 of the ringing-key pulsating current from the generator 19, preferably of negative polarity, is directed over the sleeve conductor of the line, while a tip conductor is simultaneously grounded.

In the operation of the system the subscriber at station A takes up his receiver, and thereby closes a path for current from the battery B, located at the central office, over the conductor 11, through line-relay R, conductor 10, sleeve-limb 3 of the telephone-line, through the substation instruments, and back over limb 2 of the telephone-line to the central office, and thence through branch 9 to ground. The current in this path energizes the line-relay R, causing it to close the circuit of the line-signal S, which is lighted to indicate the subscriber's call. Upon observing the signal the operator inserts the answering-plug P in the answering-jack of the line and connects her head-telephone with the cord-circuit to receive the order from the subscriber. The insertion of the plug P completes a local circuit for the cut-off relay R^2 over the sleeve-strand s of the answering-cord and the sleeve conductor of the jacks. This relay is therefore energized to disconnect the tip-line conductor from the ground and the sleeve-line conductor from the relay R, while the switchboard conductors are connected with the external-line circuit for conversation. The sleeve supervisory relay r^2 is likewise energized to close a local circuit of the supervisory lamp S^2 , which, however, is

prevented from operation at this time by reason of the actuation of relay r by current flowing over the metallic telephone-line.

Upon receiving the order for the connection the operator tests the condition of the wanted line in the usual manner by touching the tip of the plug P^2 to the test-ring of the line. If the line is idle, the test-rings are grounded through the cut-off relay, and no flow of current over the testing-circuit results, since the tip of the plug is likewise connected, through the said test-relay, with ground. If the line is connected for conversation, however, the test-rings are raised to the potential of the battery B or B^2 by the application of the tip of the plug therefore results in a flow of current over the tip-strand t^2 , through the branch connected with the spring 12 of relay r^4 , and thence over conductor 13 to the test-relay r^5 and to ground. The flow of current over this path energizes the said test-relay, causing it to complete a circuit through the primary winding of the operator's set, whereby a click is inductively caused in the operator's receiver. Owing to the high resistance and high impedance of the test-relay, a change of current upon the tested lines is neither great nor sudden, so that the subscribers' receivers are not harmfully affected.

Assuming that the line is found idle, the calling-plug of the cord-circuit is inserted and the ringing-springs 20 or 23 actuated to call the wanted subscriber. The depression of springs 20 serves to call subscriber E, whose bell is connected with the tip side of the line, the cut-off relay R^2 of the said line being maintained actuated by current over conductors 11^a and 22 during ringing, while the operation of the ringing-springs 23 serves to call subscriber D, since his bell is grounded from the other side of the line, the cut-off relay now being energized by the pulsating current from the ringing-generator and which is preferably of the same polarity as that impressed upon the line by the battery B^2 .

After calling the subscriber and before his response the sleeve supervisory relay r^4 is actuated to close the circuit of the supervisory signal S^3 and to also close, through its spring 12, a branch from the tip conductor t^2 of the tip supervisory relay r^3 . The supervisory lamp is therefore lighted to indicate the fact that the subscriber has not yet responded. As soon as the subscriber replies current from the battery B^2 flows over the metallic circuit of the wanted line, thus operating the tip supervisory relay r^3 and extinguishing supervisory lamp S^3 .

The subscribers are now in communication, and the batteries B and B^2 are furnishing current to the respective lines for transmission purposes and for the operation of the

various supervisory and other relays associated therewith. By the transposition of the cord-circuit conductors the cut-off relays R^2 of the two lines are now legged to ground from the opposite sides of the metallic talking-circuit. This condition is more clearly indicated in Fig. 2, in which the talking-circuit is indicated by the rectangular outline, from which it is seen that the cut-off relays are legged to ground from the opposite sides of the metallic circuit. Likewise the central batteries are grounded upon the opposite sides, and a fully-balanced circuit throughout is thus provided.

It will be understood that the substation apparatus may be of any desired type, that shown being merely typical of any suitable common battery outfit, that the several grounds mentioned at the central office may be one and the same, or the common office return, and that various other modifications may be made throughout without departing from the spirit or scope of my invention. Different types of line-circuits may be employed—as, for example, those in which the switchboard-sections are permanently connected with the external line-circuits—since, broadly considered, my invention is not limited to this feature.

In Fig. 3 I have shown the diagonally-connected cord-circuit as used with the different type of line-circuit. In this line-circuit a low-resistance cut-off relay R^3 and a high-resistance line-relay R^4 are connected in series with the central source of current, the high-resistance line-relay only responding to current in the line when the subscriber takes up his receiver and calls the central office, since the cut-off relay does not receive sufficient current to actuate the same. When a connection is established with a line, however, the said cut-off relay is included in the local circuit over the sleeve-strand of the cord and the sleeve conductor of the permanently-connected jacks, with the result that a sufficient flow of current takes place through the said relay to actuate the same to thereby render inoperative a signal of the line. This action takes place whether or not the line-circuit is open at the substation. During conversation the said cut-off relays are connected with the opposite sides of the metallic talking-circuit the same as in Fig. 2, with the result that the talking-circuit is balanced throughout. This arrangement is accomplished by the connection of the tip-contact of one plug with the sleeve-contact of the opposite plug. The other apparatus shown in connection with Fig. 3 is well understood and in view of the specific description of Fig. 1 is not particularly described herein.

I claim—

1. In a telephone system, the combination with telephone-lines, of a common source of

current and signaling devices for the line-circuits, cut-off relays connected between the same sides of the lines and one pole of said source and adapted when operated to render said signals inoperative, a diagonally-connected cord-circuit to establish connections with the lines for conversation and arranged to close a balanced circuit for voice-currents during conversation, substantially as described.

2. In a telephone system, the combination of telephone-lines having signaling devices, of cut-off relays connected to a common point from one side of the circuits, a cord-circuit to establish connections with the lines for conversation, said cord-circuit having the conductors cross-connected, and means for feeding current out over the conductors of said circuit to actuate the cut-off relays, said arrangement of cord-circuit conductors placing the cut-off relays on opposite sides of the metallic talking-circuit, substantially as described.

3. In a telephone system, the combination with telephone-lines having cut-off relays legged to ground from one side of the lines, of a diagonally-connected cord-circuit to establish connections between lines for conversation, said cord-circuit having a condenser in each conductor, and current of like polarity applied to the corresponding conductors included between the said condensers and each plug, substantially as described.

4. In a telephone system, the combination of telephone-lines having cut-off relays legged to a common conductor from one of the sides of the lines, a diagonally-connected cord-circuit for establishing connections with the lines for conversation, said cord-circuit being divided by condensers into two independent battery-circuits, said portions of the cord-circuit being provided with supervisory apparatus so that the supervision of each line connection is independent of the other, substantially as described.

5. In a telephone system, the combination with telephone-lines having their cut-off relays legged to ground from one of the sides of the lines, a diagonally-connected cord-circuit for establishing connections with the lines for conversation, said cord-circuit being divided into two portions, each of which forms a separate circuit for the current actuating the signaling devices in that portion of the talking-circuit, substantially as described.

6. In a telephone system, the combination with telephone-lines having inductive devices adapted to form a portion of a local circuit legged from one of the sides of the lines to a common point, a diagonally-connected cord-circuit terminating in plugs provided with tip and sleeve contacts adapted to regis-

ter with the similar contact-points of the
line-terminals, said cord-circuit connecting
the said lines in a balanced system and hav-
ing condensers interposed in the talking-cir-
5 cuit, and supervisory signal apparatus in
each portion of the cord-circuit actuated in-
dependently from a common source of cur-
rent, substantially as described.

Signed by me at Chicago, county of Cook,
State of Illinois, this 17th day of December,
1902.

WILLIAM W. DEAN.

Witnesse :

ROBERT LEWIS AMES,
GAZELLE BEDER.