(No Model.) 2 Sheets—Sheet 1.

J. J. O'CONNELL.

METALLIC CIRCUIT TEST AND TIME SIGNAL FOR TELEPHONE EXCHANGES.

No. 454,016. Patented June 9, 1891.

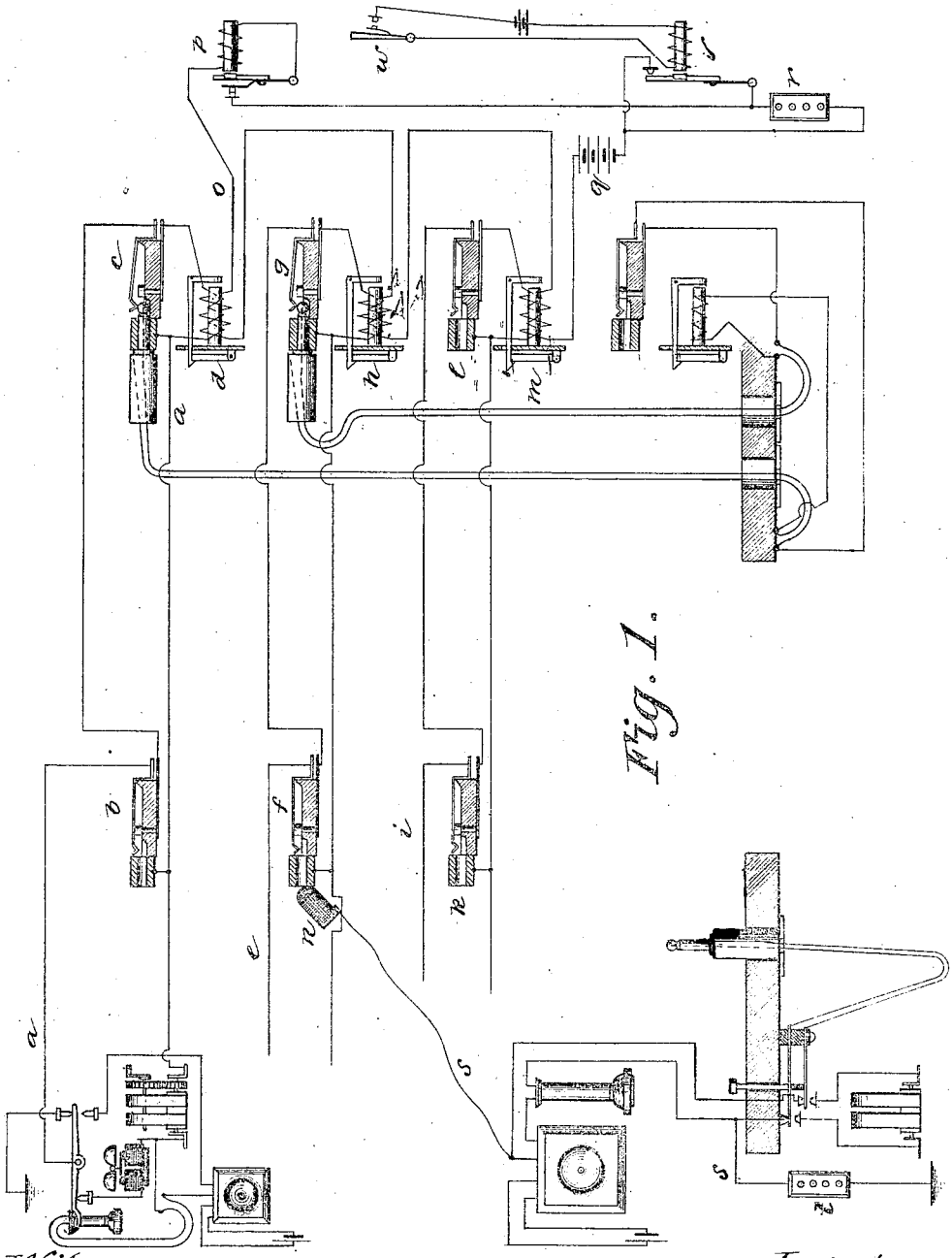

Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

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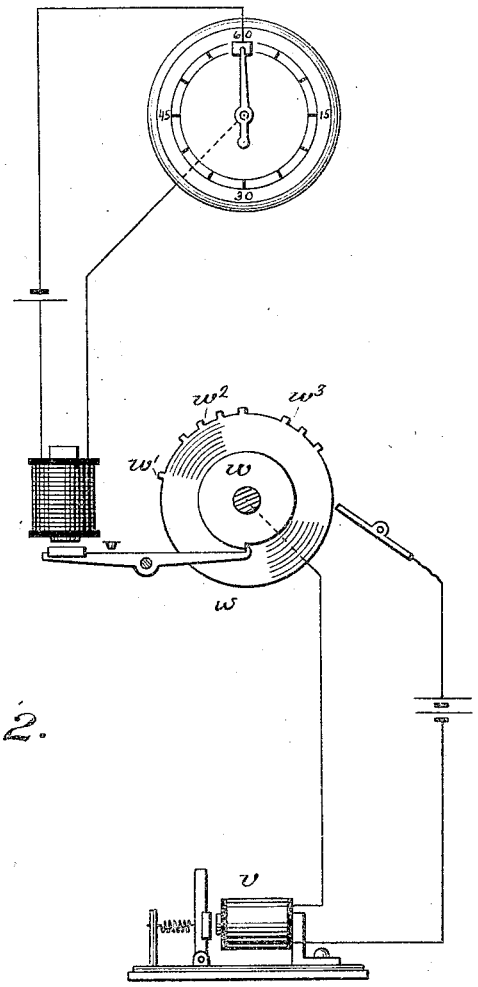

Fig. 2.

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UNITED STATES PATENT OFFICE.

JOSEPH J. O'CONNELL, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF SAME PLACE.

METALLIC-CIRCUIT TEST AND TIME-SIGNAL FOR TELEPHONE-EXCHANGE.

SPECIFICATION forming part of Letters Patent No. 454,016, dated June 9, 1891.

Application filed October 4, 1888. Renewed April 18, 1891. Serial No. 389,453. (No model.)

To all whom it may concern:

Be it known that I, JOSEPH J. O'CONNELL, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Metallic-Circuit Tests and Time-Signals for Telephone-Exchanges, (Case 3,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to telephone-exchange apparatus, and more especially to the system known as the "multiple switch-board system."

The principal object of my invention is to provide ready means for testing a line called for at one board to determine whether said line is connected or in use at any other of the boards.

My invention also includes a time-signal-transmitting device, by means of which any subscriber by simply taking down his telephone and listening may know the time of day.

These results have been heretofore accomplished in various ways. My invention therefore is limited to the apparatus and combinations of the devices herein described and claimed.

My invention consists, first, in inducing vibratory currents upon the metallic circuits by means of a primary winding upon the cores of the individual annunciators, battery, and a rheotome, and preferably resistance being included in the primary circuit, the metallic circuits being each provided with a single branch circuit to ground at the subscriber's station thereon. The operator at any board, by means of a telephone included in a ground-circuit, may by completing this ground-circuit through his telephone, so as to include a portion of any metallic circuit to be tested, determine whether the line tested is busy. If the line is in use, the individual annunciator will not be in circuit, and hence there will be no buzz heard in the telephone. If, however, the line is free, a buzz caused by the induced current upon the line will be heard in the telephone. Thus, briefly stated, the test consists in determining the presence or absence of the vibratory current upon the line tested, this vibratory current being induced by means of an extra coil included in a local circuit containing a battery and a rheotome or vibrator.

My invention consists, second, in a local circuit containing a battery and the coil of the electro-magnet of a relay, a circuit-closer included in said local circuit and operated in the usual way by the clock-work of a time-repeater to close the said local circuit, and thereby operate the relay to shut out for the moment resistance included in another local circuit containing battery and a vibrator and converters for inducing vibratory currents upon the telephone-lines. The resistance being thus removed from the local primary circuit at proper times, the strength of the induced current will be increased at those times, and the subscriber listening at his telephone and noting the signals thus caused will know the time of day.

My time-signal system is especially adapted to be used in connection with my test system herein described, since the local primary circuit including the primary coils of the individual annunciators may be utilized as a part of the time-repeating signal-circuits.

In the accompanying drawings, Figure 1, which is illustrative of my invention, I have shown three telephone-lines connected each with a different spring-jack switch on each of two multiple switch-boards, the subscriber's apparatus in detail of one of the lines, the testing apparatus at one of the switch-boards, the primary circuit, including the rheotome, battery, and the extra windings, on the individual annunciators of the three telephone-lines, and the local circuit of a relay, including battery and a circuit-closer, the relay being connected with the primary circuit in such manner as to shut out the resistance included therein whenever the relay is closed. Fig. 2 is a view illustrative of the manner of operating the local battery-circuit.

Apparatus adapted to transmit time-signals is also shown more in detail in Letters Patent No. 328,055, granted John M. Oram October 13, 1885. The telephone-circuit *a* may be traced from ground at the subscriber's station thereon through spring-jack switch *b* on the first board, and thence nor-

mally through the spring-jack *c* on the second board, and thence through the secondary winding of the individual annunciator *d*, and thence to the ring or test-piece of each of the switches *c b*, and thence to the subscriber's station and through the generator and bell at said station to the telephone-switch, and thence to the ground branch. Telephone-line *e* is shown connected in a similar manner with spring-jack switches *f* and *g*, the individual annunciator or converter *h*, and the test-pieces of switches *g f*. Telephone-line *i* is in like manner connected through spring-jack switches *k l*, the individual annunciator *m*, and thence to the test-pieces of said spring-jack switches *l k*. The local primary circuit *o* includes an extra winding on each of the annunciators *d h m*. A rheotome *j*, included in this circuit with battery *q*, causes a vibratory current to be coutinuously sent through the primary coils of the annunciators or converters *d h m*. The resistance *r*, included in circuit *o*, is designed more especially as a part of the time-repeating apparatus. I have shown the lines *a* and *e* looped together by means of loop-plugs and cords, the pair of loop-plugs being inserted in spring-jack switches *c g* of the lines at the second board. When thus inserted, it is evident that the two lines will be looped together, forming one complete metallic circuit, while the individual annunciators *d h* will be disconnected therefrom. When thus disconnected, no current will be induced upon either of the lines *a e* from the primary circuit *o*. At the first board I have shown a ground-circuit *s*, including a telephone and resistance *t*, the terminal *n* of this circuit being in the form of a thimble and adapted to be closed upon the test-piece of any one of the spring-jack switches *b f k* of the first board.

In order to test any line, it is only necessary to touch the terminal *n* to the test-piece of the spring-jack of the line and listen at the telephone included in ground-circuit *s*. Thus suppose the operator desires to test line *a*. By simply touching terminal *n* to the test-ring of switch *b* the electrical condition of line *a* may be determined by simply listening at the telephone included in circuit *s*. If a plug be inserted in a spring-jack of the line—for example, as shown at switch *c*—the converter *d* will be out of circuit and no sound or buzz will be heard. If, however, the line should not be in use, the annunciator *d* would be in circuit, and the operator listening at the telephone would hear the buzz caused by the vibratory current induced on the line through the medium of the annunciator *d*, acting for the time being as a converter or induction-coil. Suppose terminal *n* touching test-ring of switch *b*, and suppose the plug removed from switch *c*. The circuit then formed would be from ground at subscriber's station on line *a* over the limb of the metallic circuit *a*, including the spring and contact of each of the switches *b c*, thence through the secondary winding of the annunciator *d*, thence to the test-piece of switch *b*, thence to the terminal *n*, and thence through circuit *s*, including the telephone, and thence to ground, completing the circuit. Resistance *t* is preferbbly included in the circuit *s*, as it is desirable in metallic-circuit systems to have no more connection with the ground than is necessary. The operator listening at the telephone under these conditions will hear the buzz or hum caused by the vibratory current induced upon line *a* through the medium of the annunciator-coils of the annunciator *d* of the line. If a plug be inserted in any one of the spring-jack switches *d c* of the line, the portion of line *a* leading to the subscriber's station thereon will be open to the portion of said line containing the annunciator *d*. Hence when the test is made no complete circuit will be found through the annunciator *d* and no sound will be heard in the telephone.

I will now describe the operation of the time-repeating apparatus. The armature-lever of relay *v* is included in a shunt-wire around resistance *r*. The circuit-closer *w* is operated in the usual way by clock-work and closed at such intervals as to indicate, for example, the zero-second of each minute, the minutes, and the hours of the day, forenoon and afternoon, according to any well-known code. I have not deemed it necessary to show clock-work for doing this work, since for the purpose of illustrating this invention it might be considered as closed by hand. Every time the circuit-closer *w* is closed the armature-lever of relay *v* is operated to close the shunt around resistance *r*. The resistance included in the local circuit of battery *q* is thus abruptly diminished, thereby abruptly increasing the current sent through the vibrator *p* and the primary coils of the converters. Suppose, then, the plug removed from switch *c* of line *a*, and suppose the subscriber at the station on line *a* wants to find out the time. He takes down the telephone, and the telephone is then in metallic circuit including the secondary winding of converter *d*. Now while the subscriber is listening we will suppose the circuit-closer *w* to be closed at the sixtieth second of each minute for a tenth of a second, and then after a space of half a second closed a number of times corresponding to the hour of the day, and after a short space a number of times to indicate the minutes. The subscriber listening at his telephone will hear an increased tone at each closing of the circuit-closer *w*, and he may thus note the hours, minutes, and seconds, or whatever signal may be indicated.

In Fig. 2 I have illustrated the seconds-hand of a clock connected in a local circuit containing an electro-magnet, the armature of which is connected with a detent of a circuit-closer *w* in such manner that said circuit-closer will be actuated to close the local circuit through the relay *v* at the end of each minute. Suitable contact-teeth w', w^2, and

w^3 are provided, which, coming against the contact in the local circuit, close the same at intervals determined by the spacing of the teeth. The teeth may be arranged in the usual manner, so that the hours, minutes, and seconds may be indicated. Thus the teeth shown might be considered as indicating one o'clock and forty-three minutes, the zero second being coincident with the time at which the circuit is closed at the tooth w'.

My invention admits of various modifications which will readily suggest themselves to those skilled in the art. I therefore do not limit myself to the construction shown.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

1. The combination, with the individual annunciator of a metallic multiple switch-board telephone-line circuit, of an extra winding on the core of said annunciator, said extra winding being in a circuit including a battery and rheotome, a telephone included in a ground-circuit having a terminal adapted to be closed to a test-piece of the telephone-circuit, and a ground connection for the telephone-line circuit at the subscriber's station thereon, whereby on closing the terminal of the ground-circuit containing a telephone to the terminal of the line the operator listening at the telephone in said ground-circuit may hear the hum caused by the vibratory current induced upon the line.

2. The combination, with a metallic circuit provided with a ground branch at the subscriber's station thereon and extending through the spring and contact of two or more switches on different switch-boards of a telephone-exchange through the individual annunciator of the line and thence to a test-piece of each of the spring-jack switches, of a local battery-circuit including a primary winding provided on the core of the said individual annunciator and the rheotome, a ground-circuit provided with a movable terminal adapted to be closed upon the test-piece of the spring-jack switch, and a telephone included in said ground-circuit, whereby on closing the terminal of the ground-circuit to the test-piece of the spring-jack switch the electrical condition of the line may be determined, substantially as and for the purpose specified.

3. The combination, with several metallic-circuit telephone-lines, each including a different individual annunciator and each including a different spring-jack switch on each of two or more multiple switch-boards, of an extra winding on the individual annunciators, and an electric circuit common to said extra windings, including a rheotome, whereby vibratory currents are induced upon the lines, substantially as and for the purpose specified.

4. A local battery-circuit containing a rheotome and the primary coil of each of several converters, a different metallic circuit connected through the secondary coils, respectively, of said converters, telephones, one in each of said metallic circuits, artificial resistance included in the local battery-circuit, and mechanism adapted to shunt said resistance at intervals to indicate the time of day, substantially as and for the purpose specified.

5. The combination, with a battery-circuit including a circuit-closer and a relay-coil, of a local primary battery-circuit including a rheotome and the primary coils of several converters and resistance, a shunt-wire around said resistance, including the armature-lever of the relay, metallic circuits, one for each of the converters and including the secondary coil thereof, and telephones, one in each of the metallic circuits, whereby on closing the circuit-closer the resistance is shunted out of the local primary battery-circuit to abruptly increase the vibratory current induced upon the metallic circuits, thereby indicating to one listening at the telephone in any metallic circuit the time or times of the closing of the circuit-closer.

In witness whereof I hereunto subscribe my name this 30th day of August, A. D. 1888.

JOSEPH J. O'CONNELL.

Witnesses:
GEORGE P. BARTON,
ELLA EDLER.