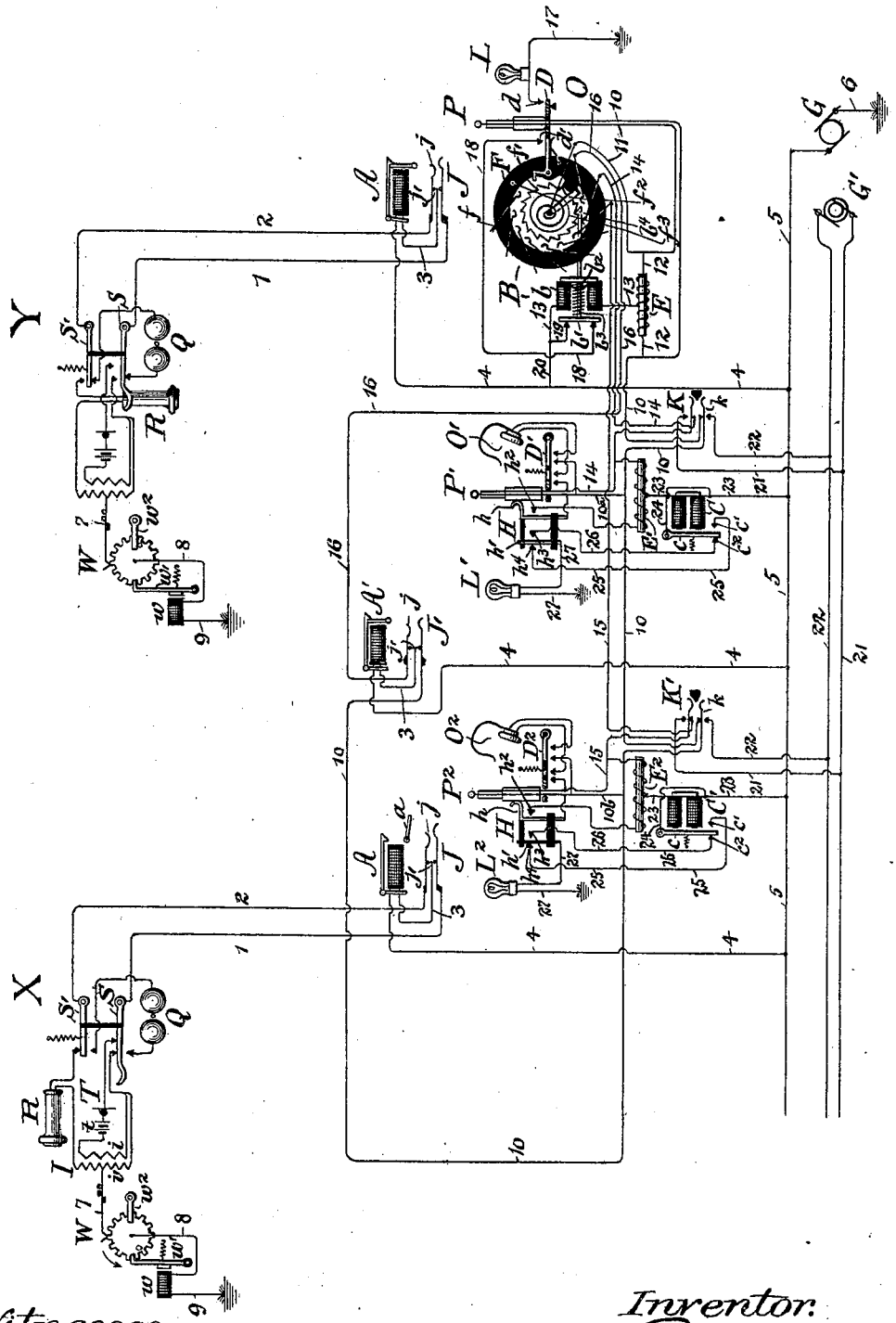
No. 646,682. Patented Apr. 3, 1900.

E. E. CLEMENT.

TELEPHONE EXCHANGE SYSTEM.

(Application filed Apr. 21, 1899.)

(No Model.)



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UNITED STATES PATENT OFFICE.

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TELEPHONE-EXCHANGE SYSTEM.

SPECIFICATION forming part of Letters Patent No. 646,682, dated April 3, 1900.

Application filed April 21, 1899. Serial No. 713,883. (No model.)

To all whom it may concern:

Be it known that I, EDWARD E. CLEMENT, a citizen of the United States, residing in Washington, in the District of Columbia, have invented a certain new and useful Improvement in Telephone-Exchange Systems, of which the following is a specification, reference being had to the accompanying drawing, forming a part thereof, in which the same letters and figures of reference point out the same parts throughout.

My invention relates to telephone-exchange systems of the type described in my prior application, Serial No. 683,652, filed June 16, 1898. I have chosen to call such systems "semi-automatic," because in making a connection between two subscribers one of the two selections usually required to be performed by the operators is performed by mechanism placed under the control of the calling subscriber in making connection with his line—that is to say, instead of an answering operator having to ask the number of the line wanted and from that number deduce the number of the board-section upon which the wanted-line terminal is located (the invention applying particularly to divided central or trunking systems) one of the two selections, preferably that of the board-section, is performed by mechanism controlled from the subscriber's station, leaving the operator upon that section to ask the number wanted and to complete the connection.

The main object of the present invention is to separate the signaling from the talking circuits. It has been found somewhat undesirable to talk through contacts which might be somewhat uncertain in their action; but by care in manufacture and the use of platinum points wherever possible the objections to this are reduced to a minimum. It has been found more undesirable, however, to signal over the same circuits for various reasons. Moreover, it is possible by substituting a normally-closed for a normally-open signaling-circuit to use the same circuits and a portion of the same mechanism which performs the selection in the first place for purposes of supervision and clearing out.

In designing the present system the signaling-circuits while they embody in part the same wires or conductors as the talking-circuits utilize the latter in such a relation that the effect of signaling-current upon the balance or the general efficiency of the talking-circuits is practically *nil*. Stated more specifically, the signaling-circuits are really phantom circuits formed of portions of the talking-circuits in multiple relation.

In my former case, referred to above, several generators were required. In the present case but two are utilized, one being a common source of current for all incoming and supervisory signals and the other furnishing alternating current for outgoing calls.

Referring to the accompanying drawing, the figure is a diagram of a system embodying my invention, the apparatus throughout being shown in a simple conventional form.

X and Y are two subscribers' stations, each connected with a central office by line-wires 1 and 2. As the apparatus at the two stations is identical in every particular, the parts being lettered the same throughout, a description of the station X will suffice for both. At this station T is the usual transmitter; R, the receiver; I, the induction-coil; Q, the ringer, and S S′ the switch. The switch consists of two movable members connected together mechanically, but insulated from each other, each connected to one of the line-wires and normally, when the receiver is upon the hook, serving to connect the line-wires with the circuit of the ringer Q and disconnect them from the talking set. This condition is shown at station Y. The induction-coil I has two windings *i i′*, the latter of which—the secondary—is in series with the receiver-windings and connected with the upper contacts of the switch-hook, so as to be connected to the line-wire when the hook rises. The other winding *i* is in a local circuit with the transmitter T and a battery *t*, this circuit also being closed by the switch-hook when it rises. From the middle point of the secondary winding *i′* a ground-tap 7 8 9 is led. Included in this ground-tap is a variable signal mechanism W. This consists, essentially, of a toothed wheel adapted to be set to send any desired number of impulses, a detent-lever *w′* for retaining the wheel in its set position, a magnet *w*, controlling the detent-lever, a stop w^2, determining

the zero-point of the wheel, and a pen 7, normally resting upon a solid portion or tooth of the wheel, but adapted to pass into its notches as it revolves, thus breaking the circuit a predetermined number of times. This signaling mechanism is only shown in a diagrammatic way, as it is supposed to be of any desired pattern, various mechanisms for the purpose being well known in the art. Any closed-circuit signal movement having a properly-wound detent-magnet will answer.

I have shown the receiver R connected to one side of the secondary winding of the induction-coil. While this is the usual arrangement, it is only adopted here for illustration, as in practice it is necessary that the receiver should occupy a balanced position with regard to the line-wires, and this can only be secured by either interposing it between the two halves of the secondary winding and tapping the middle point of its winding or bridging it across the secondary terminals.

At the central office the line-wires are connected to springs *j* of line-jacks J, which normally rest upon contact-anvils *j'*, from which conductors 3 are led to line-annunciators A, having signals *a*, and thence by wires 4 to the bus-bar 5 of a direct-current generator G, which is grounded through the wire 6. The magnets of the annunciators A are of higher resistance than magnets *w*, and the voltage of the generator G is such that when a complete ground-circuit is closed with these magnets in series the line-magnet A, having a greater number of turns, will be energized sufficiently to display its signal, whereas the magnet *w* will be powerless to release the signal-wheel as long as the series relation continues.

The line-annunciators and line-jacks of stations X and Y are supposed to be located upon different board-sections, although, as will appear later, the operation would be precisely the same if they were upon the same section and were to be connected. The annunciator A' and its jack J' are supposed to be located at the desk of the chief or trouble operator. The annunciator A' is connected, as will be seen, in a very similar manner to that in which the signals of the other operators are connected, with this difference that the wire 16, which is the individual wire for the chief operator, may be common to all of the switching mechanisms at any one answering-board, thus giving the chief operator a single annunciator for each board-section or any desired number.

The basic idea underlying the present invention and forming the subject of the previous application above referred to is that of connecting a cord-circuit to a calling-subscriber's line, said cord-circuit containing selective mechanism which thereupon passes under the control of the subscriber and by means of his signal mechanism is operated to prolong his line to a terminal device at the wanted board without any further act on the part of the operators. In this case P is an answering-plug forming the terminal of a cord-circuit 10 11, B is the selective mechanism connected with this cord-circuit, and P' P² are calling or connecting plugs adapted to be connected by said selective mechanism to the plug P each when the board at which it is located contains the terminal of the wanted line. The cord conductor 11 is connected through the mechanism of the selector to an arm f^2, carried on the spindle of a toothed wheel f', adapted to be rotated in one direction by a pawl b^4 on the end of a spindle b^3, attached to an armature b', normally retracted from the magnet b by a spring b^2, the wheel f' being adapted to be rotated in a reverse direction in order to bring it around again to the point shown, with arm f^2 resting against a suitable stop, by a spring f^3.

F is a ring frame of insulating material having saw cuts in its face arranged so as to be tangential to the outer circle swept by the arm f^2. This ring frame serves as a point of attachment for the fixed end of the retracting-spring f^3 and also for a stop-pawl D, of which more will be said hereinafter. In each saw cut is secured a contact-spring having a curved end adapted to form a good contact with the end of the arm f^2.

The conductor 10 of the cord-circuit passes directly from the sleeve of the plug P to all of the other board-sections, passing at each through the spring-contact *k* of a ringing-key K and having at each a branch leading to the individual plug thereat, the branches being lettered 10^a 10^b, &c. This conductor 10 constitutes a common return for the cord-circuit, being adapted to be paired with any of the other cord conductors, of which one is provided for each board-section. These individual conductors 14 15 16, &c., are connected to the springs *f*, the conductor 16, extending to the chief operator's board, being always connected to the first spring.

Connected across the wires 10 11 at the answering-board is a conducting-bridge 12, containing the windings of a coil of high impedance E, from the middle point of which a wire 13 is led to the magnet *b* and thence by wire 20 to the ground-wire 4, through the generator G, and to ground. From the wire 13 a short wire 19 is led to one of two back contacts of the armature b', the other of which is connected through wire 18 with a contact *d'* within the range of movement of the lever D, which carries the selector stop-pawl. A twin contact *d*, also within said range of movement, is connected by wire 17 through lamp L to ground.

At each switchboard-section to which the circuits from plug P extend a signal-controlling relay C C', &c., is provided, having its windings included in a circuit 23, extending from the bus-bar 5 to the middle point of the winding of a suitable impedance-coil E' E², &c. Each of these impedance-coils has one

extremity of its winding permanently connected to the individual wire leading to its board from the selector, while the other extremity is connected to a normally-open contact in a switch adjacent to and intended to be operated by the corresponding calling-plug. Thus coil E′ is connected between conductor 14 and contact h^3 in the switch H. This switch proper consists of two spring-arms h and h', connected together mechanically, but insulated electrically. The spring h is permanently connected to the conductor 10^a, while spring h' is permanently connected to a lamp L′ and by wire 27 to ground. The latter spring normally rests, when the plug P′ is in its seat, against a contact h^4, connected through wire 25 to the front contact c' of the relay C. The spring is adapted when the plug is removed from its seat to leave the contact h^4 and rest upon contact h^3, connected by wire 26 to the back-stop c^2 of armature c of the relay C. This armature is connected by wire 24 to wire 23 and so to bus-bar 5. The spring h, constituting a normally-open terminal for the wire 10^a, is adapted when the plug is removed from its seat to rest against contact h^2, thereby connecting the open end of the winding E′ to said wire 10^a.

The ringing-key K, besides the contacts included in the circuit of wire 10, has a second pair included in the individual wire 14, and when its springs k are spread both said conductors 10 and 14 are broken and the plug P′ is connected directly through wires 21 22 to the alternating-current generator G′.

As a convenient means for listening in I have shown the operators' telephones O′ and O^2 as connected to pairs of contacts underlying pivoted switch-arms D′ and D^2, extending into the seats of plugs P′ and P^2, respectively. Twin contacts are connected, respectively, to conductors 10^a and 14. The normal position of the levers D′ D^2 is as shown; but if either plug be depressed in its seat before being removed therefrom its lever-switch will be depressed to connect the operator's set across its cord conductors.

The operation of the system thus described is as follows: Suppose subscriber Y desires to converse with subscriber X. He looks in his directory and finds that X's number is "2—56," which means that X's jack is No. 56 on the second section. Y sets his transmitter W so as to send three impulses. This is not necessarily known to him, as his actual manipulation consists merely in moving around a pointer until it stands at the figure "2." It will be observed that the pens of the signaling mechanisms normally rest upon teeth, and the parts are so arranged that whenever a mechanism is set its pen will rest upon a tooth. It is the number of breaks and not the number of makes which determines the movement of the selector. Having set the instrument, Y removes his receiver from the hook S, whereupon a circuit is immediately closed and current flows from the generator G by wires 5 and 4 to annunciator A, by wire 3 to line-wires 1 2, in parallel through the switch-arms S and S′ and the local talking-circuit, through the wire 7, the signal-wheel, wire 8, magnet w, wire 9, and ground back to the generator by wire 6. The magnet A, having, as before described, a greater number of turns than the magnet w, attracts its armature and displays its signal. The magnet w, however, having few turns, is powerless to attract its armature with the small current which the resistance in the circuit permits to flow. The operator at the right-hand switch-board, perceiving the signal, inserts the plug P in the jack J and turns to other business. The entrance of the plug spreads the springs j away from the anvil j' and forms a new circuit as follows: from generator G, by wires 5 and 4, to wire 20, wire 13, magnet b, winding of coil E in both directions, bridge-wires 12, conductors 10 and 11, line-wires 1 2, switch-levers and local circuits, wire 7, signal-wheel, wire 8, magnet w, wire 9, and by ground and wire 6 back to the generator. The magnet b and the magnet w are approximately of the same resistance, both being low-wound. Consequently there is a sufficient flow of current to energize both magnets. The armature b' is attracted and moves the tooth b^4 to the right far enough to engage the next succeeding tooth of the wheel f', while the armature w' is removed from engagement with the signal mechanism and the wheel starts to return to normal under the influence of its driving-spring. At the first break the armature b' is retracted by its spring, drawing the spindle b^3 and the pawl b^4 with it and turning the wheel f' the space of one tooth, which is sufficient to bring the arm f^2 into contact with the first one of the springs f, connected to wire 16. At the second break the wheel and arm are moved another step and at the third break still another step, the arm then resting upon the third spring, which is connected with the wire 15, leading to plug P^2. The wheel of the mechanism W having then reached zero, the circuit remains closed and the armature b' remains attracted, the magnet b thenceforth serving as a clearing-out relay. With the apparatus in this position a new circuit has been formed from generator G to lamp L^2 as follows: from the generator by wire 5 to conductor 23 and relay-magnet C′, thence through one-half of the winding of coil E^2 to conductor 15, and through the selector mechanism by way of the spring and the arm f^2 to conductor 11, line-wire 2, and so to subscriber's station and ground back to generator. The relay C′ attracts its armature, closing the following circuit: from the generator G, by bus-bar 5, to conductor 23, to branch 24, through the armature c, contact c', wire 25, contact h^4, spring h' to lamp L^2, wire 27, and ground back to the generator. It will be understood that no such action as this took place at the other sections as the arm f^2 passed over successive springs, because the movement of the

signaling mechanism W is sufficiently rapid not to leave the arm for more than a fraction of a second on any one spring. The lamp L^2 becoming incandescent apprises the operator that a connection has been initiated on the plug-line c^2. The operator thereupon depresses the plug in its seat, thus bringing the lever D^2 onto its contacts and bridging her telephone set across the circuit. Inquiring the number wanted, the subscriber, who has been waiting with his receiver at his ear, responds "56." The operator then removes the plug P^2, on which, it will be observed, she already has her hand, and places it in the jack of X's line. Having done this, she depresses the key K', and thereby throws calling-current upon the line to ring X's bell. A button may be provided and preferably is provided in connection with the lever D^2 for the purpose of enabling the operator to listen in from time to time; but as that forms no part of the present invention it is not shown. By the removal of the plug P^2 from its seat the switch H is allowed to shift over, connecting the normally-open end of the coil E^2 to the conductor 10^b, and the lamp-wire 27 to the wire 26 through contact h^3. Both magnets C' and b hold up their armatures during the continuance of the conversation, and as the coils E^2 and E constitute bridges of the through metallic circuit neither subscriber by hanging up his receiver can operate these magnets to give a clearing-out signal. Both receivers must be hung up and both grounds removed from the united circuit before the magnets will release their armatures, for obviously if there is a ground at either end of the circuit it is sufficient to permit generator-current to continue flowing. When, however, both subscribers have hung up their receivers, and thus cut off their grounds, both magnets b and C' will release their armatures and the following circuits will be closed: from generator G, by bus-bar 5, to wire 4, branch 20, branch 19, armature b', wire 18, contact d', lever D, contact d, lamp L, and wire 17 to ground and back to generator; also, from generator, by bus-bar 5, to wire 23, branch 24, armature c, wire 26, contact h^3, spring h', wire 27, lamp L^2, and ground back to generator. Both lamps L and L^2 will thus be lighted, and each will continue lighted until its corresponding plug has been removed from the line-jack. When the plug P is replaced in its seat, it depresses the lever D and breaks the circuit of the lamp L, also removing the stop-pawl from the wheel f' and permitting the wheel to return to zero. It should here be stated that when in its retracted position the pawl b^4 is disengaged from the teeth of the wheel. When the plug P^2 is returned to its seat, it again displaces the switch H and breaks the lamp-circuit 27 between spring h' and h^3, returning the spring to the contact h^4 for further calls.

Having described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. In a telephone-exchange system, a subscriber's station, a central station and a metallic circuit interconnecting the two, a telephone set at the subscriber's station connected in the metallic circuit, a signal-transmitting apparatus at the subscriber's station adapted to be connected to both limbs of the metallic circuit to determine a flow of signaling-current therethrough in parallel, a telephone-circuit at the central station adapted to be connected to the subscriber's metallic circuit to form an extension thereof, a plurality of signals associated with said circuit, and a selective signal mechanism also associated therewith, controlling said signals, and adapted to be brought into connection with both sides of the subscriber's metallic circuit to respond to the signaling-current therein, substantially as described.

2. In a telephone-exchange system, a plurality of switchboards and subscribers' metallic circuits connected thereto, a telephone set at each subscriber's station included in the metallic circuit, a source of current, and a signaling device at each subscriber's station adapted to be connected to both limbs of the metallic circuit to control the flow of current therethrough in parallel, connective telephone-circuits for the switchboards each having one terminal at one board, and a plurality of branch terminals at other boards, a signal associated with each branch terminal, and a selective mechanism adapted to control said signals and connected to both sides of the connective circuit, the whole being so arranged that when a connective circuit is connected to a subscriber's line in answer to a call the selecting mechanism is placed under the control of the subscriber's signal mechanism, substantially as described.

3. In a telephone-exchange system, a central station having a plurality of switchboards and subscribers' metallic circuits terminating in spring-jacks thereon, a telephone at each subscriber's station in the metallic circuit, together with means to determine a flow of signaling-current through the telephone neutrally and through the limbs of the metallic circuit in parallel, a connective circuit at the central station having an answering-plug at one board and connecting-plugs at other boards, a selective mechanism having a connection to said answering-plug, and branch connections to all of the connecting-plugs, a signal for each connecting-plug controlled by a magnet connected to its branch and a magnet controlling the selective mechanism and so connected to the answering-plug that when said plug is inserted in a line-jack the magnet is thereby brought into connection with both limbs of the subscriber's metallic circuit to respond to the signal-current therein, substantially as described.

4. In a telephone-exchange system, a plu-

rality of switchboards and subscribers' circuits terminating in spring-jacks thereon, connective circuits for such switchboards each having an answering-plug at one board and connecting-plugs at the other boards, a selective switch connected with the answering-plug and adapted when actuated to complete the circuit to any desired one of the connecting-plugs, a magnet permanently connected to the answering-plug circuit and controlling said selective switch, a supervisory signal also under the control of said magnet, and means at each subscriber's station for determining the flow of signaling-current over the line both before and after a conversation, substantially as described.

5. In a telephone-exchange system, a central station, a subscriber's station, and a line-circuit connecting them; means at the subscriber's station for determining the flow of current in the line-circuit; a connective circuit at the central station adapted to be connected to the subscriber's line in response to his call, a supervisory signal associated with the connective circuit, a relay as C, and a switch as H, the relay being electrically connected to the said connective circuit and adapted to be placed under control of the subscriber when connection is made with his line; a calling-plug also connected to the connective circuit, and means whereby said plug will actuate the switch H when connection is completed to the desired subscriber's line; together with a local circuit for the supervisory signal having two parallel branches, one normally open at the switch and normally closed at the relay, and the other normally closed at the switch and open at the relay, whereby when the relay is first energized the signal is displayed, when connection is completed through the calling-plug to the line desired the signal is retired, and when the relay is finally deënergized by the cessation of current in the subscriber's line the signal is again displayed, substantially as described.

6. In a telephone-exchange system, a plurality of switchboards and subscribers' metallic circuits terminating in spring-jacks thereon, means at each subscriber's station to determine a flow of signaling-current over the line-wires in parallel, a circuit extending between the various switchboards, having an answering-plug at one board and connecting-plugs at other boards, a selective multiple-terminal switch, two conductors extending from said answering-plug, one to all the boards as a common return for all the connecting-plugs, and the other to the multiple-terminal switch from each of whose terminals an individual wire extends to one of the connecting-plugs, a signal-relay for each connecting-plug normally connected to its branch wire, and means actuated in the use of said connecting-plug to connect the relay to the common return of the answering-plug, whereby the relay may be controlled from the selective switch through the branch wire to give an advance signal, and is thereafter left in position to serve as the subscriber's clearing-out signal, substantially as described.

7. In a telephone-exchange system, subscribers' stations and a central station, and metallic line-circuits interconnecting them; means at each subscriber's station to determine a flow of signaling-current between the station and the central office over his two line-wires in parallel as a single conductor, a telephone at each subscriber's station adapted to be connected with the two line-wires so as to control talking-currents therethrough in series; switching mechanism at the central office adapted to prolong the metallic circuit of any subscriber to form a connection for talking purposes with another subscriber's line; and magnetic means for controlling said switching mechanism and operating the same, adapted to be controlled from the subscriber's line, being connected thereto neutrally, so as to be unaffected by, and in its turn not to affect the talking-current in the metallic circuit, but to be affected by the signaling-current passing over the line-wires in parallel, as described.

In testimony whereof I have hereunto set my hand, in the presence of two witnesses, this 20th day of April, 1899.

EDWARD E. CLEMENT.

Witnesses:
SPENCER B. PRENTISS,
W. BERTRAND ACKER.