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TELEPHONE CONNECTING APPARATUS.

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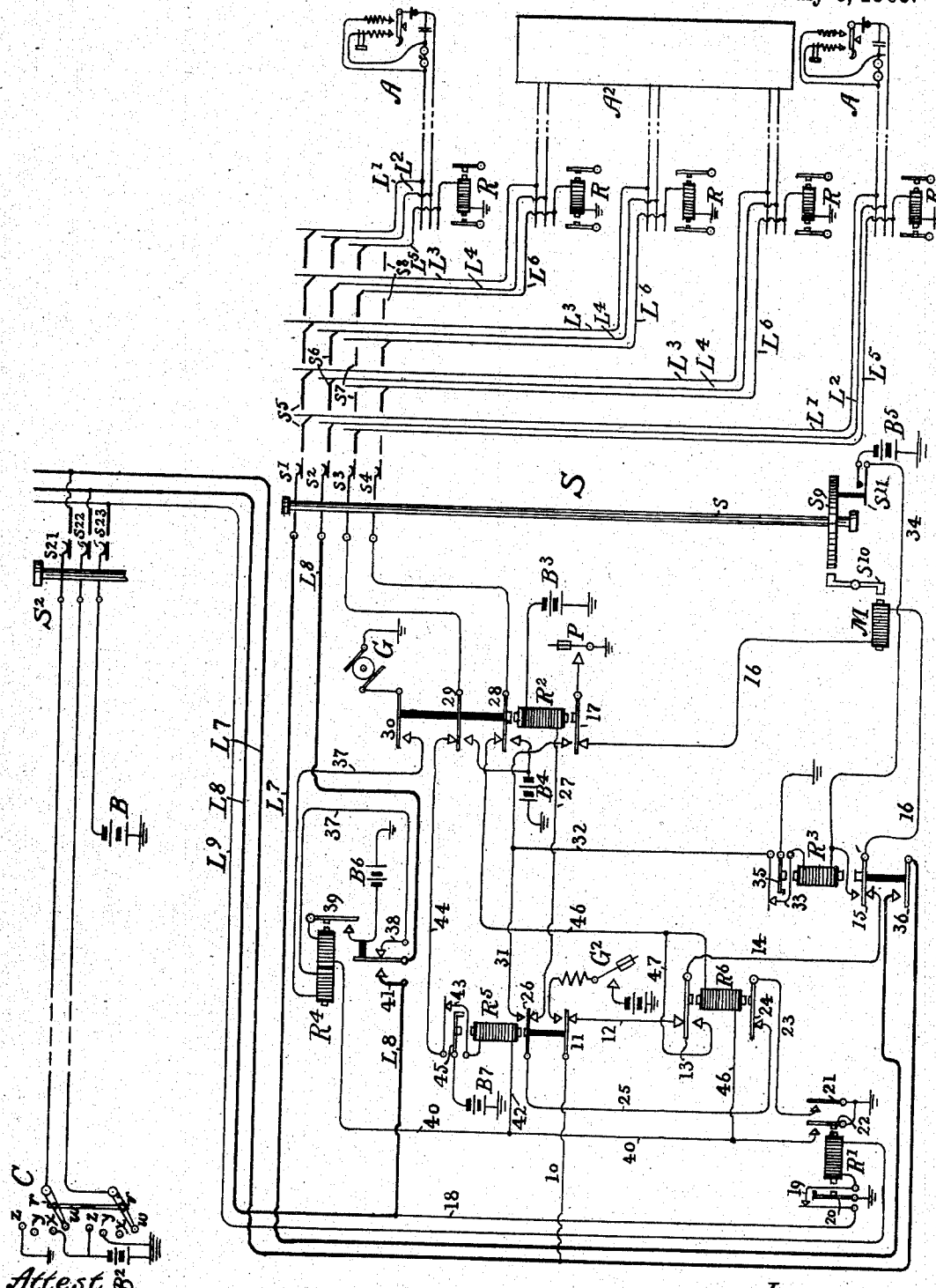

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TELEPHONE-CONNECTING APPARATUS.

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To all whom it may concern:

Be it known that I, EDWARD C. MOLINA, residing at Arlington, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Telephone-Connecting Apparatus, of which the following is a specification.

The number assigned to a telephone subscriber may be either that of a single line, as one connecting a central station with the usual substation, or it may be that belonging to the first of a group of trunk lines which extend from the central station to the switch apparatus of a private branch exchange, such as is often installed for subscribers using several instruments. In manual practice the operator upon receiving a call for a single-line substation needs only to test the proper jack in the multiple, and either complete the connection and ring the called subscriber or notify the calling subscriber that the line is busy, and remove the plug from the answering jack. If the call is for a private branch exchange the operator must, as its trunks are found to be in use, successively test the remainder until an idle one is reached, or, if the entire group is busy, so inform the calling subscriber. In systems in which mechanical switching apparatus is employed these acts of the operator, varying according to the class of service for which the lines are adapted, must have their analogue in the operations of the connector or final selector. That is, when the movable contact members reach the terminals of the desired single line, they must either, when this is idle, unite with and ring over it, or, when in use, apply a busy signal and restore the apparatus to its normal condition; while, if the call is to a private branch exchange having a plurality of lines, these must be successively tested until an idle one is found, or until the last trunk is reached, and if this is employed, bring the busy signal into play and release the apparatus.

The chief object of my invention is to provide a comparatively simple electro-mechanical apparatus which will effectively perform these functions.

The accompanying drawing represents diagrammatically a connector, arranged in accordance with my invention and with substations and a private branch exchange having their lines joined to it; there being also shown a portion of the switch preceding the connector in the chain of selecting apparatus, and a selection controlling means conventionally represented.

The final selecting or connecting switch S, which I have chosen to illustrate as a part of the organization, is of that familiar type in which a rotatable shaft s carries insulated from it movable contact members or arms, of which in the present instance there are four, two transmission or line members s^1, s^2, and two testing members s^3, s^4. These contact arms sweep over groups of relatively fixed contacts or terminals, s^5, s^6, s^7 and s^8, respectively, here shown as horizontally arranged and being in vertical sets of four, the individual members of the sets corresponding to the arms. Said arms are operated in the same direction, both in their search for the wanted terminals and in the restoration to their initial position, by motor mechanism comprising a ratchet wheel s^9 and a coöperating pawl s^{10}, to the latter of which driving strokes are imparted by successive energizations of a motor magnet M. Of the fixed terminals, five active sets are shown, the first and fifth being connected by lines L^1 and L^2 to separate substations A—A, while the second, third and fourth are joined by trunks L^3, L^4 to the switch apparatus A^2 of a private branch exchange. The substation lines have third conductors L^5 extending from the terminals s^7, corresponding to those to which the talking leads are connected, to ground through cut-off relays R, R, which, save to furnish a path for current, play no part in the present invention. The private branch exchange trunks also include third conductors L^6 with their individual cut-off relays R similarly grounded; but here the first two of these third conductors start at the second group of test terminals s^8, while the last, in order of contact by the switch arms therewith, is joined to the terminal s^7 of its set, or that in the group to which the third conductors of the substations A are connected. Where these third conductors are united to one or another of the two horizontal test groups the other test terminal of the vertical set is left blank. The switch S, whenever its arms leave their normal position, closes and maintains closed until the restoration of the arms a contact device s^{11}.

To the arms s^1 and s^2 of the switch talking leads or conductors L^7, L^8 are joined, these extending back through the entire chain of

selecting apparatus to mechanism for controlling selection. Such series of electromechanisms for successively picking out a way to a wanted line are now common in the art, and besides the switch S only the preceding switch involved in the connection has been shown, this being conventionally represented at S^2. This switch, as is commonly the case in practice, has in addition to the main arms s^{21} and s^{22} forming a part of the talking circuit a single test arm s^{23}, which puts battery B upon an inter-apparatus test or third conductor L when the switch S^2 is off normal. At the calling end of the leads L^7 and L^8 is indicated an apparatus C by which the selector actuating and controlling impulses are transmitted. Many types of these controllers have been invented and used and it has seemed necessary to here show only enough of the apparatus to provide for the production of four successive conditions to which my improved connecting mechanism will respond to perform its various functions. Such conditions are furnished by the coöperation of a pair of movable arms v, connected to the talking leads, with four pairs of terminals w, x, y and z. In the first or normal position w, both sides of the line are open; in the second position x, pulsations of current from battery B^2 are sent over the lead L^7 to effect the advance of some one of the series of selectors to the proper terminals; in the third y, ground is applied to the lead L^8 to give a circuit transferring the action to the next apparatus of the series, or, if this be the connector, starting its testing and connecting operations, and in the fourth position z, or that during which the conversation may be carried on, lead L^7 is grounded while L^8 is connected to battery B^2.

Associated with the switch S by means of a system of local conductors, which will hereinafter be more particularly mentioned, and which are joined to the switch arms and to the leads L^7 and L^8 and the third conductor L^9, are shown a pulsator or intermittent circuit maker P, a ringing generator G, busy-signal mechanism g^2 and a battery, this latter, for convenience in illustration, appearing at a number of places and being designated by different reference characters.

Forming a part of the connecting apparatus is local controlling mechanism furnished by six relays. Of these, relay R^1, responsive to the third position y of the controller C after the motor magnet N, under the influence of the pulsations transmitted during position x, has driven the switch arms to the set of terminals belonging to the wanted substation line or the first trunk of the private branch exchange apparatus, prepares the circuits for the operation of the other relays. Relay R^2, which is sluggish and which may be termed the connecting relay since it more directly initiates the operations leading to the completion of the connection, when the selected substation line or trunk is not busy closes a portion of the ringing circuit from generator G, operates the cut-off relay R of the line and establishes a busy condition which prevents the appropriation of said line by some other switch in the multiple group with S^2. The ringing circuit is completed by a relay R^3, which also prepares for the return of the switch arms to their initial position when the conversation has been completed. Relay R^4, which is provided with two windings, establishes the talking circuit when the called subscriber responds to the ringing of his bell. If a busy substation line is selected, or a private branch exchange chosen and the last trunk reached, relay R^5, or substation test relay, connects to the lead L^7 the busy-signal mechanism, prevents the operation of the relay R^2 and coöperates with relay R^3 to secure the return of switch arms to zero. Upon the selection of a private branch exchange and the finding of other trunks than the last busy, the private branch exchange test relay R^6 similarly prevents the operation of relay R^2 and closes the circuit of motor magnet M to produce a continuation in the advance of the arms until an idle, or the last, trunk of this group is reached, in which case either relay R^2 or R^5 comes into play as just indicated. While the connection of the relays with the leads, switch arms and associated mechanisms will be completely developed in the description of operation of the system, it is desired to here call attention to a relation of the various elements which is of especial importance. This is, that the energizing circuit of relay R^2 from a ground provided by relay R^1 to battery B^3, and including conductors 23, 25 and 27, is controlled in the contacts of both test relays R^5 and R^6; and that the windings of the test relays are joined in multiple from the ground at relay R^1 by conductors 40, 42 and 44, and 40 and 46 to the groups of terminals s^7 and s^8, respectively, through contacts of the connecting relay R^2 and the test arms s^3 and s^4 of the switch. Consequently, if the test arms do not find battery at either test terminal of the selected set the connecting relay will operate and open circuits of the test relays, but if, on the other hand, either arm comes to rest upon a terminal to which potential is applied, one or the other of the test relays will attract its armatures before the sluggish connecting relay can operate, thus breaking the circuit of the latter. The importance of this will appear shortly.

In considering the operation of the system there will first be described the connection with a non-busy line, this being equally applicable to a single-line substation or to the first of the plural trunks of a private branch exchange. When, in response to the operation of the controlling apparatus C in its sec-

ond position, the connecting switch S is selected by a switch S^2 of the preceding group, a circuit is closed from battery B^2 through lead L^7, conductor 10, armature 11 and its back contact in relay R^5, conductor 12, back contact and armature 13 in relay R^6, conductor 14, back contact and armature 15 of relay R^3, conductor 16, including winding of motor magnet M, back contact and armature 17 of relay R^2 to intermittent ground at the circuit maker P. Each time that the circuit just traced is closed, motor magnet M is energized and drives the arms s^1, s^2, s^3 and s^4 of the switch S step by step from one set of its fixed terminals to the next. The controlling apparatus having provided for the necessary number of pulses, the arms will reach the terminals of the substation line sought or the first trunk of the desired private branch exchange. Said controlling apparatus by assuming position *y*, disconnects battery B^2 from lead L^7 and lead L^8 is momentarily connected to ground. This completes a circuit for battery B at the switch S^2 from ground through lead L^8, conductor 18, spring 19 and winding of relay R^1 and conductor L^9, energizing relay R^1. This relay by its armature 20, locks its winding to a permanent ground and disconnects it from lead L^8 by separating spring 19 from its resting contact. Armature 21 and 22 close their front contacts and there is now a path from ground through armature 21, conductor 23, armature 24 and its back contact in relay R^6, conductor 25, armature 26 and its back contact in relay R^5, conductor 27 and winding of relay R^2 to battery B^3. If the selected line is not in use relay R^2 is energized and opens the back contact of its armatures 17, 28 and 29 and closes their front contacts and that of armature 30. Armatures 28 and 29 connect battery B^4 to test arms s^3, s^4, allowing current to flow through these arms to the cut-off relay R by the third conductor L^5 or L^6, depending upon whether the selected line is to an ordinary substation or is a private branch exchange trunk. Armature 17 closes a path from the intermittent ground at P through conductors 31 and 32, spring 33 and winding of relay R^3, conductor 34 and off normal contact device s^{11} of switch S to battery B^5. The closing of this circuit energizes relay R^3, which by means of its armature 35 locks its winding to a permanent ground and disconnects it from conductor 32 at the spring 33. Armature 15 of relay R^3 separates the winding of motor magnet M from conductor 14, through which it has been receiving selecting pulses, and joins it to conductor 34 in preparation for the restoration of the switch arms to zero. Armature 36 of relay R^3 closes the ringing circuit from generator G, including armature 30 of relay R^2, conductor 37 through one winding of relay R^4, spring 38 of said relay, lead L^8, arms s^2 of the switch, limb L^2 of the selected line, ringing circuit of the substation set, limb L^1 of the line, arm s^1 of the switch and lead L^7 to a ground which, in the final position *z* of the controlling apparatus C, will have been substituted for battery B^2 upon this side of the line. As this circuit includes the high resistance coils of the ringer of the called subscriber's set, relay R^4 does not receive sufficient current to energize it until the subscriber, by taking his receiver from the hook, short circuits the ringer. Then relay R^4 attracts its armature 39, which locks the relay by current from battery B^6 through its second winding, conductor 40 and armature 22 of relay R^1 to ground. It also disconnects at spring 38, the lead L^8 from the first-mentioned winding of relay R^4 and at spring 41 closes said lead L^8. The transmission circuit is now complete, talking current being supplied from the battery B^2, at this time connected to the lead L^8. At the termination of the conversation both sides of the line are opened at the calling end by a condition represented by the normal position *w* of controller C. This causes the release of the switch S^2 which removes battery B from the circuit of relay R^1 of the connector. The consequent falling off of the armature 21 opens the circuit of relay R^2 and armature 17 is then retracted. Since relay R^3 is still energized, we have a circuit from the intermittent ground of pulsator P to battery B^5 through conductor 16 and the winding of the motor magnet, armature 15 and its front contact in relay R^3, conductor 34 and contact device s^{11}. The resulting pulses of current drive the switch arms forward until they reach their normal position, when the opening of the contact s^{11} breaks the motor magnet circuit and that of relay R^3. The connecting apparatus is now ready for another selective operation.

Now suppose that a single line to a substation A is wanted and that it is already in use. When the arms s^1, s^2 and s^3 of the switch have been brought to rest on the terminals connected to conductors L^1, L^2 and L^5 of the desired line, the terminals s^8 of the private branch exchange group with which the arm s^4 is in contact having no connection in this substation set, relay R^1 is energized as just described. This relay will not only complete at its armature 21 the circuit of relay R^2 but will also close a circuit from ground through its armature 22, conductors 40 and 42, winding and spring 43 of relay R^5, conductor 44, back contact and armature 29 of relay R^2, arm s^3 of the switch and the third conductor L^5 of the busy line to a battery, corresponding to B^4, placed thereon by the arm of the switch which is already in possession of the line. By means of this circuit relay R^5 is energized before sluggish relay R^2

has had time to open the circuit of R^5 at the back contact of armature 29. Relay R^5 therefore operates and its armature 45 locks the winding of this relay to battery B^7 making it independent of the path to battery given by the arm s^3 and the third conductor of the busy line. Armature 11 of relay R^5 disconnects lead L^7 from conductor 12, and therefore from the motor magnet and unites it to the mechanism G^2 which operates a busy signal at the controlling end of the circuit which leads to ground through arm v which at this time engages terminal z. Armature 26 of relay R^5 opens the circuit of relay R^2, thereby preventing its operation, and closes a path from ground to battery B^5 through armature 21 and its front contact in relay R^1, conductor 23, armature 24 and its back contact in relay R^6, conductors 25, 31 and 32, spring 33 and winding of relay R^3, conductor 34 and off normal device s^{11}. As previously set forth, relay R^3 locks itself by means of armature 35 and closes the front contact of its armatures 15 and 36. As relay R^5 has prevented relay R^2 from being energized, there is now a path from the intermittent ground at P to battery B^5 through armature 17 and its back contact in relay R^2, conductor 16, winding of motor magnet M, armature 15 and its front contact in relay R^3, conductor 34 and off normal device s^{11}. The motor magnet is therefore energized intermittently and advances the switch arms until they have made a complete revolution, that is, have arrived at their initial position. Then the off normal contact opens and battery B^5 is disconnected from the circuit of the motor magnet to stop the advance of the switch arms. Relay R^3 is simultaneously deprived of battery B^5. Relays R^1 and R^5 remain energized until, in response to the busy signal at the controlling end, battery B is removed from the lead L^9 by the release of the selecting train. When this takes place, relay R^1 is deënergized and in turn releases relay R^5 upon opening the front contact of armature 22. The apparatus is now in condition to effect a new connection.

If, instead of a single substation line, the busy line selected were the first of a group o, trunks leading to a private branch exchangef the arm s^4 would come into contact with the terminal s^8 of the third conductor of the selected trunk, since for this and all but the final trunk the terminals s^7 are blank, while the terminals s^8 are connected. So in this case, when relay R^1 has been operated, we have simultaneously with the closing by its armature 21 of the path from ground to battery B^3 through the winding of relay R^2, a second path from ground by armature 22, conductors 40 and 46 through winding of relay R^6, back contact and armature 28 of relay R^2, arm s^4 and third conductor L^6 of the selected busy trunk to battery placed thereon by the arm of the switch which has already selected the trunk. By this circuit relay R^6 will be energized before sluggish relay R^2 has time to attract its armature 28. Armature 24 of relay R^6 then opens its back contact, thus stopping the flow of current from battery B^3 through the winding of relay R^2 to the ground connection at armature 21 of relay R^1. Armature 13 of relay R^6 opens its back contact, which is in the circuit of the motor magnet and shunts its winding by a path from conductor 46 through conductors 47 and 14, back contact and armature 15 of relay R^3, conductor 16 through the winding of the motor magnet, back contact and armature 17 of relay R^2 to ground through the intermittent contact maker P. Thus we now have from arm s^4 two paths through which current flows from the battery connected to the terminal s^8 of the busy set through the winding of relay R^6 to a permanent ground and through the motor magnet to the intermittent ground connection at P. Relay R^6 will therefore remain energized, and the arms of the switch will be driven forward until arm s^4 makes contact with the terminal of a trunk, the third conductor L^6 of which is not connected to battery, that is, which is not busy; or until the arms arrive at the last trunk in the particular private branch exchange group, where the third conductor is joined to a terminal s^7. In either case motor magnet and relay R^6 will be deënergized and the circuit of relay R^2 closed by the armature 24 at its back contact. If the arms come to rest upon the terminals of a non-busy trunk, relay R^2 would operate and the connection would be established as in the case first described of selecting a non-busy line. If, upon the arms reaching the last trunk, this too were found busy, then arm s^3 would receive current from the terminal s^7. Therefore the conditions just described with reference to a busy substation line would be secured, and relay R^5 would operate to cause the application of the busy signal and the restoration of the switch.

I claim as my invention:

1. An exchange system comprising switching mechanism provided with a plurality of groups of relatively fixed line contacts, an independent movable contact member for cooperation with all of the contacts of each group, telephone lines adapted for one class of service and being connected to only one group of contacts, and telephone lines of another class not connected to said last-named group but connected to a different group of contacts.

2. An exchange system comprising a switching mechanism provided with a plurality of groups of relatively fixed line terminals, an independent contact member for coöperation with all of the terminals of each group, telephone lines adapted for one class

of service and having conductors connected only to one group of terminals, and telephone lines of another class having one or more conductors connected only to a different group of terminals and one connected only to the group just mentioned.

3. The combination with a telephone switching mechanism provided with transmission line terminals and two groups of testing line terminals and with independent movable members contacting with the respective groups of testing terminals, of substation lines having third conductors connected to one group of test terminals, and groups of trunks with their third conductors connected to the other group of test terminals.

4. The combination with a telephone switching mechanism provided with transmission line terminals and two groups of testing line terminals and with independent movable members contacting with the respective groups of testing terminals, of substation lines having third conductors connected successively to one group of test terminals, and groups of trunks with their third conductors connected to the other group of test terminals but with the final trunk of each trunk group joined to the group of terminals with the substation lines.

5. In a telephone connecting apparatus, the combination with switching mechanism provided with a plurality of groups of terminals and independent movable contact members coöperating with separate groups, of controlling means connected to one group of terminals whereby successive tests of busy terminals are secured, and means connected to another group of terminals for governing the restoration of the movable contact members to their normal position upon their coöperation with the first busy terminal.

6. The combination with a switching mechanism provided with a plurality of movable test members, of busy signal mechanism and ringing mechanism, means for controlling the busy signal mechanism through one of the test members, and means for controlling the ringing mechanism through a plurality of the test members.

7. A telephone system comprising a central station, substation lines and groups of trunk lines extending thereto, a selecting switch having movable contact members and separate groups of terminals to the latter of which conductors of the substation lines and trunks are respectively joined, motor mechanism for the selecting switch, and test relays for controlling the motor mechanism and being connected in multiple to the groups of terminals.

8. A telephone system comprising a central station, substation lines and groups of trunk lines extending thereto, a selecting switch having movable contact members and separate groups of terminals to the latter of which conductors of the substation lines and trunks are respectively joined, motor mechanism for the selecting switch, test relays for controlling the motor mechanism and being connected in multiple to the groups of terminals, and a sluggish connecting relay in circuit with the contacts of both test relays.

9. A telephone system comprising a central station, substation lines and a group of private branch exchange trunk lines extending thereto, a selecting switch having movable contact arms and separate groups of terminals, to the latter of which conductors of the substation lines and private branch exchange trunks are respectively joined but with a conductor of the last trunk united to a terminal in the substation line group, motor mechanism for the selecting switch, test relays for controlling the motor mechanism and being connected in multiple to the groups of terminals, busy-signal mechanism associated with the test relay of the substation group, a sluggish connecting relay in circuit with the contacts of both test relays, and a ringing generator governed by the connecting relay.

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

EDWARD C. MOLINA.

Witnesses:

GEO. WILLIS PIERCE,

JOSEPH A. GATELY.