No. 617,145. Patented Jan. 3, 1899.

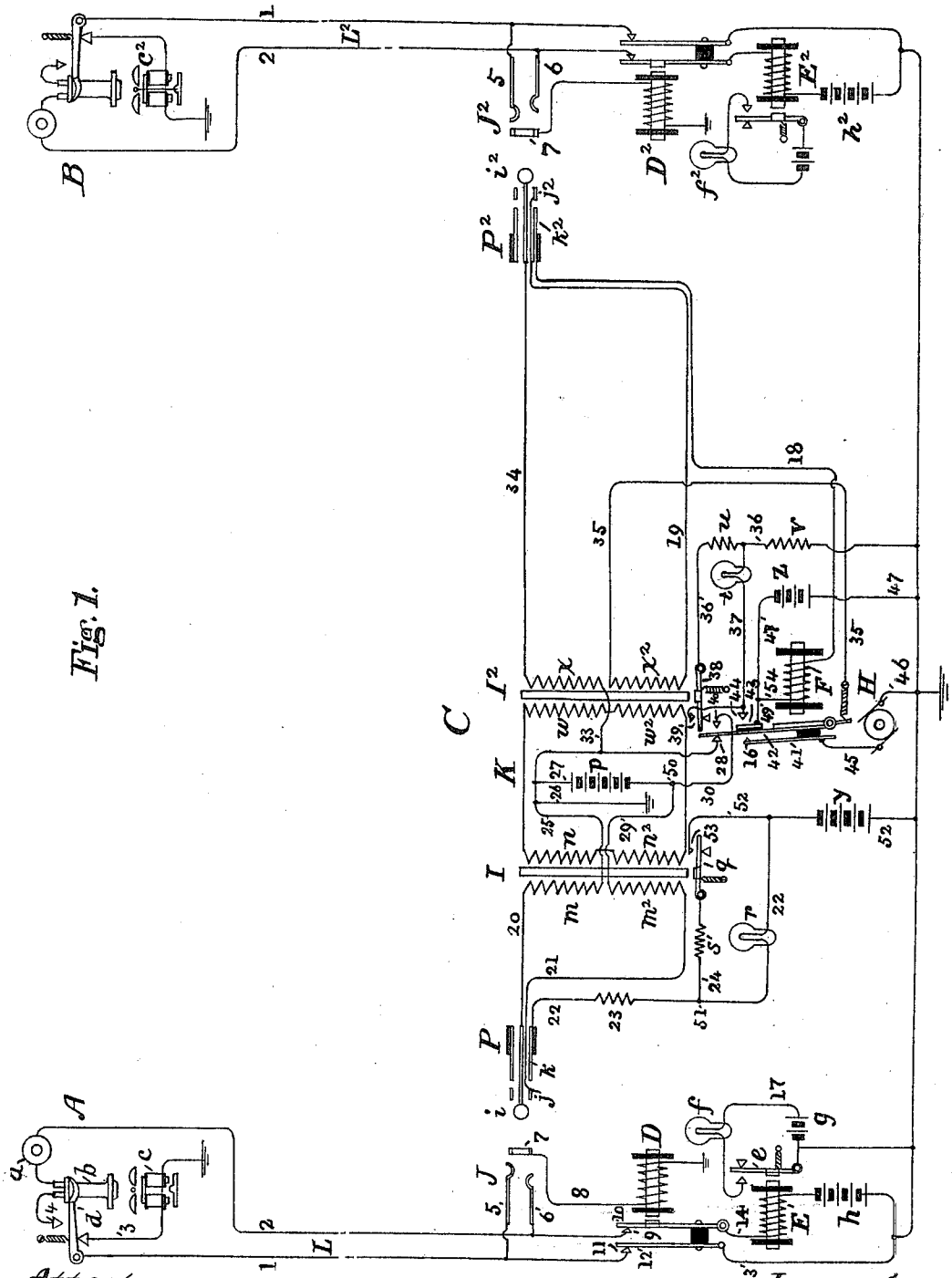
W. W. DEAN.

TELEPHONE EXCHANGE SWITCH AND SIGNAL APPARATUS.

(Application filed Mar. 19, 1898.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.



Attest.

Frank C. Lockwood.

Geo. Willis Pierce

Inventor,

Wm. W. Dean

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Fig. 2.

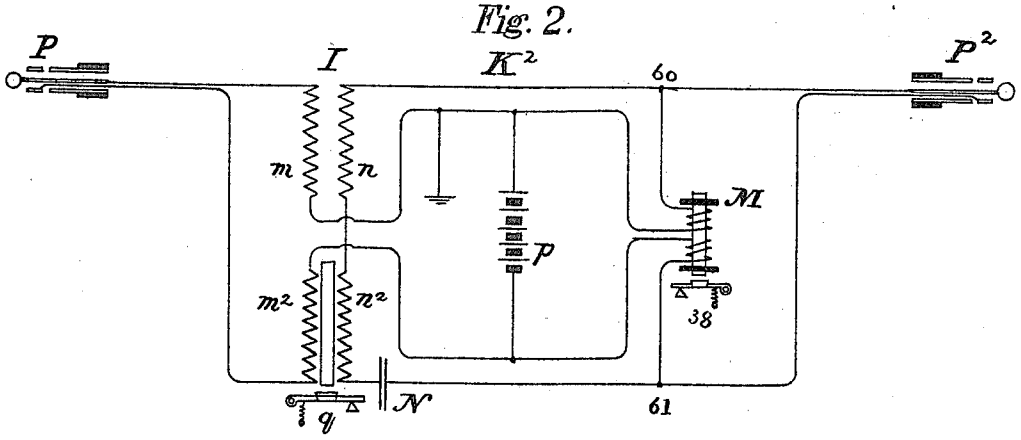


Fig. 3.

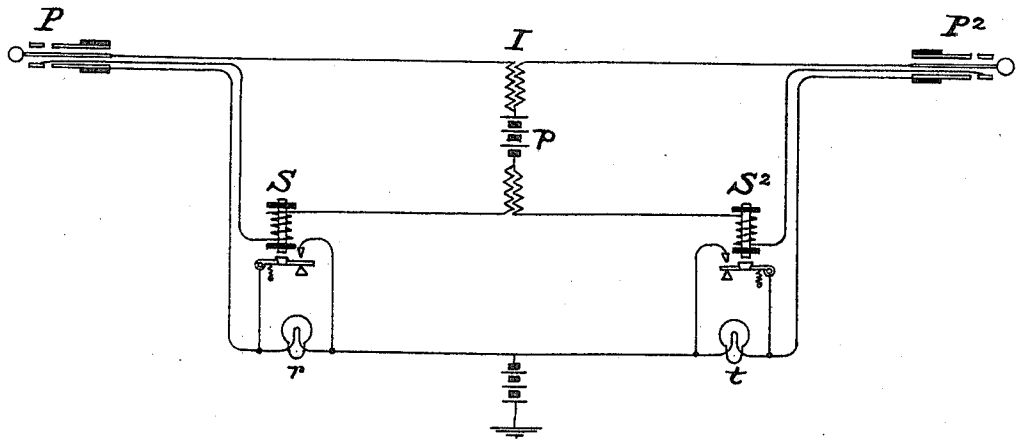
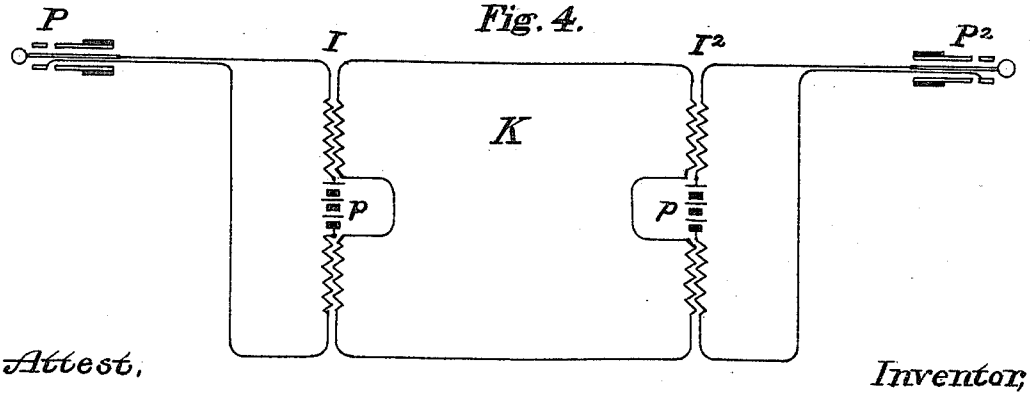


Fig. 4.



Attest,

Frank C. Lockwood.

Granville Pierce

Inventor,

Wm. W. Dean

UNITED STATES PATENT OFFICE.

WILLIAM W. DEAN, OF BOSTON, MASSACHUSETTS, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF SAME PLACE.

TELEPHONE-EXCHANGE SWITCH AND SIGNAL APPARATUS.

SPECIFICATION forming part of Letters Patent No. 617,145, dated January 3, 1899.

Application filed March 19, 1898. Serial No. 674,484. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM W. DEAN, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Telephone-Exchange Switch and Signal Apparatus, of which the following is a specification.

The present invention relates to the central-office apparatus of a telephone-exchange, and particularly to the switchboard-connecting devices, the section of the conversation-circuit thereof, and the signal receiving and controlling devices connected therewith.

While applicable to switchboards generally which employ plugs and cords to form the connecting-link whereby any two main circuits are joined together for through communication, my invention is especially useful when associated with a form of switchboard known as the "relay-switchboard," and I describe it herein with reference to switchboards of that type in which a centralized battery supplies current for incoming call-signals, for clearing-out or supervisory signals, and for the substation-transmitters. I have found it convenient, likewise, to send the outgoing call-signals automatically, arranging devices which as soon as the switch-plug is inserted in the switch-socket of the desired subscriber's line act to transmit over the said line impulses of calling-current, which, reaching the substation, operate to ring the bell there, thus giving the call, and other devices controlled by the telephone-hook switch at the called station which when the said switch is actuated by the removal of the receiving-telephone from the hook operate to disconnect the central-station call-generator from the circuit, and thereby to automatically discontinue the transmission of the call-signal as soon as it is responded to. My present invention is adapted to operate harmoniously with this automatic ringing apparatus, and I have shown and described it as being organized in association therewith.

In the switch-cord-circuit arrangement of the relay-switchboard apparatus it is customary to employ a repeating induction-coil and relays connected in one of the talking-circuit cord-strands, together with the signals controlled by the said relays in a third and local circuit strand of the said switch-cord. The said relays, however, introduce undesirable resistance into the talking-circuit and require extreme care in their adjustment in order that they shall work satisfactorily. My invention enables me to dispense with the said special signal-controlling relays, which I find to be an advantage. I associate with the talking-circuit switch-cord strands an additional repeating induction-coil, or preferably a retardation or obstruction coil, which does not appreciably deteriorate or interfere with the perfectly satisfactory circulation of the voice-currents concerned in the transmission of speech, and so organize the two electromagnetic coils thus provided—to wit, the original repeating-coil and the additional coil—that they are enabled to exercise the auxiliary or superimposed functions which heretofore have made the presence of the special relays requisite. The cores of the said electromagnetic coils become highly magnetized by reason of the circulation of the transmitter-current from the centralized battery in the surrounding convolutions, and in consequence of the length of the winding and the amount and disposition of the iron in the said cores their impedance to rapidly-varying currents is very high. Thus they become virtually high-impedance relays of abundant attractive power and wide range of action, and by their employment not only can the special relays be abandoned, but actually abandoned with advantage, since the repeating or impedance coils perform the work heretofore performed by the said special relays in a more efficient and satisfactory manner.

When in pursuance of my invention two repeating induction-coils are employed, the voice-currents experience two inductive transformations in the central-station switch connection. This does not in any sense interfere with perfect transmission, and my invention can under such an arrangement be practically and satisfactorily carried out. I prefer, however, to embody the invention in a system where instead of an additional induction-coil an impedance-coil is introduced, since this arrangement is less complex and

involves but one induction transformation of the voice-currents.

The drawings which illustrate the invention consist of Figures 1, 2, 3, and 4. Fig. 1 is a diagram showing two telephone substation-circuits in association with a pair of connecting or linking cords at a central office, and Fig. 2 illustrates an important modification of the cord-circuit. Fig. 3 is a diagram of a cord-circuit as heretofore ordinarily arranged and is shown here for comparison with the improved cord-circuits embodying my invention, and Fig. 4 is a diagram of the cord-circuit shown in Fig. 1 when in active use as a conversation-circuit.

The substation-circuits L and L^2 are of the type usually known as "relay-circuits," one of their conductors, 2, being normally open at the substation, though closed and grounded at the central station C through one side of the armature 10 of the cut-off relay D, the relay E for closing the local signal-circuit, and the battery h, while the second conductor, 1, is closed through the hook-switch d and high-resistance call-bell c to ground at the substation and connects with the first, being also grounded at the central station through the lever 12, carried by the said armature 10.

J represents a switch-plug socket provided with normally open spring main terminals 5 and 6, branched from the respective conductors 1 and 2, and 7 is the test-ring, which connects by wire 8 with the helices of relay D and to ground.

The cord-circuit shown in Fig. 1 consists of the plugs P and P^2 for answering and calling purposes, each of which is provided with three contacting portions, viz: the tip, the forward sleeve, and the rearward sleeve. The tip i of plug P is connected by wire 20, one winding m of repeating-coil I, wires 25 and 33, winding x of repeating-coil I^2, and wire 34 to the tip i^2 of plug P^2, while the forward sleeve-contact j connects by wire 21, one winding m^2 of the induction-coil I, wire 29 to point 50, and wire 30 to the front contact 40 of armature 42 of relay F. The battery p is in a bridge 27 between the wire 25 and the point 50 of wire 30, and a grounded wire 26 extends from the wire 25. The sleeve-contact k of plug P connects by wire 22, resistance 23, and clearing-out lamp-signal r to wire 52, which contains the battery y, is grounded on one side, and leads to front contact 53 of the repeating-coil armature q on the other side. The wire 24 connects the wire 23 with resistance s and armature q to constitute the relay-controlled shunt of the lamp r. The forward contact-sleeve j^2 of plug P^2 connects by wire 19, winding x^2 of repeating-coil I^2, and wire 35 to the armature 42 of relay F, which armature carries an insulated spring-bar 41, connected by wire 45 with one pole of the calling-generator H, whose other pole under these conditions is grounded, and the inner sleeve k^2 of plug P^2 connects by wire 18 with the coils of relay F and by wire 54 to wire 47, battery z, and ground. A wire 49 unites the wire 47 to an insulated contact-plate 43, carried by the armature 42. The armature 38 of repeating induction-coil I^2 is connected by wire 36 and resistances u and v to ground, and a wire 37 connects the front contact 39 of armature 38 and the front contact 44 of armature 42 and clearing-out signal t with wire 36 at a point between the resistances, as shown.

K is a closed circuit including the two windings n and n^2 of the induction-coil I and the two windings w and w^2 of the induction-coil I^2. The two induction-coils I and I^2, as hereinbefore stated, are adapted to perform the functions of repeating-coils and also to serve as relays controlling the clearing-out signals r and t, and the relay F is adapted to automatically close the calling-generator H to the called-for line.

In Fig. 3, which shows the cord-circuit arrangement heretofore largely employed in linking together substation relay-circuits, a repeating-coil I is employed, and relays S S^2, connected in the talking-circuit with the forward sleeve-contacts of each plug, operate to shunt the clearing-out signals r and t when the subscriber removes his telephone from the hook. These relays, as hereinbefore stated, bring considerable resistance into the talking-circuit and have otherwise been found to introduce certain practical difficulties, which by my present invention may be overcome.

The diagrams Figs. 2 and 4 show the talking-circuit connections of cord-circuits of the modified form and of the plan of Fig. 1, respectively, when switched for conversation purposes, and in view of the description already given of the latter cord-circuit it does not require special or further elucidation, while the former is fully explained hereinafter.

The operation of the invention is as follows: A subscriber wishing a connection removes the telephone b from its switch-lever support d, which rises and closes the circuit, causing the line-signal circuit to close and to illuminate the lamp f in a manner well understood and forming no part of this invention. The operator inserts the plug P into the spring-jack J, whereupon its tip i makes contact with the spring 6, the forward sleeve-contact j with the spring 5, and the rearward sleeve k with the test-ring contact 7. Current from battery p now circulates through the windings m and m^2 of the repeating-coil I by way of wires 27 and 25, winding m, wire 20, tip-contact i, spring 6, conductor 2, through the telephones a and b, conductor 1, spring 5, sleeve-contact j, wire 21, winding m^2, and wire 29. The core of the coil I is thus magnetized and draws up the armature q to its contact 53, forming thereby a shunt around the supervisory lamp-signal r, which for the present prevents its lighting. A circuit is formed from ground via relay D, wire 8, ring 7, sleeve-contact k, wire 22, and re-

sistance 23 to point 51, and by the parallel paths 22 and 24 to wire 52, and through battery *y* to ground. The relay D is thus energized and attracts the armature 10 and 12, thereby opening the normal circuit of the line at points 9 and 11 and extinguishing the line-signal *f*. Having ascertained the number of the substation wanted, the operator inserts the plug into the jack J^2 of the line L^2, and a circuit is by such act established via battery *z*, wire 47, relay F, wire 18, sleeve-contact k^2, and ring 7 of the said jack or socket, and relay D^2 to ground, and current from battery *z* energizes the relay F and causes the attraction of armature 42, which brings about the breaking of the normal contact thereof at 28 and the making of contact at 16 between the end of the generator-terminal spring 41 and the armature itself, which by wires 35 and 19 connects with the forward sleeve-contact j^2 of plug P^2. The end of the armature 38 forms a mechanical obstacle in the path of armature 42, preventing it from reaching its ultimate forward limit. When the generator-terminal 16 is thus brought into contact with the armature 42, the circuit of the generator H is closed to the line and through the bell of substation B, and the call-current of the said generator traverses the circuit through the said armature-wire 35, winding x^2 of repeating-coil I^2, wire 19, sleeve-contact j^2 of plug P^2, spring 5 of plug-socket, conductor 1, and bell c^2 to ground at substation B. Upon the removal of the telephone there from its support the switch-lever rises and closes the circuit of the two conductors 1 and 2, thereby switching out the resistance of the bell c^2 and transferring the circuit and current from the generator from its return path through the substation-ground to conductor 2, spring 6 of jack, tip *i* of plug P^2, wire 34, winding *x*, wires 33, 25, and 26 to ground, and the increased current which in consequence of the lessened resistance now flows causes the core of the coil I^2 to attract the armature 38 to its front contact 39, thereby permitting the armature 42 to complete its forward stroke and to thereby break the generator-contact at 16. The generator is thus disconnected from the circuit, while at the same time the armature 42 establishes contact with 40, and its insulated plate 42 makes contact with 44. The talking-circuit is thus completed for the substation B through the battery *p*, and the supervisory lamp-signal is brought into operative position and shunted by the armature and wire 36. Upon the completion of conversation the subscribers hang the telephones upon their switch-supports, thereby again opening the substation-circuits and thus removing the current of battery *p* from the said circuits and from the coils I and I^2. As a consequence the armatures *q* and 38 fall back and the lamps *r* and *t* are lighted, owing to the removal of the shunts about them. When the plug P^2 is removed from its jack, the relay F loses its magnetism, and its armature 42 falls back and makes contact again at 28.

The talking-circuit of that form of my invention which is shown in detail by Fig. 1 is represented in diagram by Fig. 4, where I and I^2 are the repeating-coils, *p* the common battery, and K the intermediate circuit.

In practice better transmission can be obtained by employing a retardation or impedance coil in place of the repeating-coil I^2. This arrangement is shown in Fig. 2. In this modification the repeating-coil I is located in the side of the circuit adjacent to plug P, and its core is employed when energized to attract the armature *q*, and the retardation-coil M is placed in the opposite side of the circuit, and its core operates to attract the armature 38 to effect the results described in Fig. 1. The strands of the plug P extend through two windings of the repeating-coil I and by their inner ends to the poles of battery *p*, while the strands of the plug P^2 are continuous with the helices of the coil M and extend therefrom likewise to the opposite poles of battery *p*. The portion K^2 connects with the strands of the plug P^2 at the points 60 and 61 and includes the windings *n* and n^2 of the coil I, and a condenser N is placed in this circuit K^2 to further increase the efficiency and prevent the partial short-circuiting of the current of the battery *p*, which otherwise would occur.

I claim—

1. In a telephone-system switching apparatus, a metallic-circuit switch-cord connection having a switch-plug at both ends, and comprising two terminal loop-conductor sections one for each plug, independently closed through a source of current common to both, and an intermediate conductor-section placed between the said terminal sections and inductively uniting each with the other, to constitute the plug and cord section of a through circuit for voice-currents, combined with two high-impedance signal-controlling relays having their exciting-coils connected in the said terminal conductor-section respectively, one or both of the said relay-coils forming also one winding of an induction or repeating coil to establish said inductive union, the other winding thereof being connected in the said separate or intermediate conductor-section, substantially as set forth.

2. In a telephone-switchboard apparatus, the combination of two main or substation circuits, each having a spring-jack or switch-socket; with a switch-cord connection having at both ends a switch-plug coöperating with the switch-sockets of the said circuits to form a compound through talking-circuit, and comprising two terminal loop-conductor sections ending in the said plugs respectively, and each closed at its other end through a common battery, and an intermediate conductor-section between the said terminal sections, and inductively uniting them, to constitute the switch-cord connection of the said through

talking-circuit; and two high-impedance signal-controlling relays having their helices connected in the said terminal sections respectively, the said helices of one or both of the said relays being adapted to form also one winding of an induction-coil having its other winding connected in the said intermediate conductor-section to establish an inductive union between the sections; substantially as described.

3. In a double-conductor switch-cord circuit connection for a telephone switch apparatus, the combination of two loop-plug connectors, one at each end of the said circuit connection; two terminal loop-conductor sections ending in the said plugs respectively, and each closed at its other end through a source of current; an interposed conductor-section conductively united to one, and inductively united to the other, of said terminal sections; an impedance-coil in the conductively-united terminal section; and an induction-coil having its two windings in the other terminal section and in the interposed section respectively, to establish the said inductive union between them, the said impedance and induction coils being both organized to form signal-controlling relays; substantially as and for the purposes specified.

4. The combination in the double-conductor switch plug and cord connection of a telephone-switchboard, of two terminal loop-conductor sections, each extending between the two switch-contacts of their respective plugs, and a source of current, through which both are closed; an intermediate conductor-section conductively united to one, and inductively united to the other of said loop-sections and constituting with them a continuous circuit connection for voice-currents between the said plugs; a condenser interposed in the circuit of said intermediate section; an impedance-coil relay in the conductively-united terminal section; and an induction-coil relay having its windings in the other terminal section and the intermediate section respectively, and forming the said inductive union between them, said relays constituting signal-controlling devices, substantially as set forth.

5. A compound telephone-circuit extending from one substation to another through a central station and comprising the individual exchange-circuits of the said substations; switchboard connections uniting their central-station ends; a bridge at the central station containing a source of current, and dividing the said switchboard connection into two terminal sections; an impedance-coil in one of the said terminal sections; a shunt-circuit round the said impedance-coil; a condenser in the said shunt-circuit; and a repeating induction-coil having its windings included in the other terminal section and the shunt-circuit respectively, the said impedance and induction coils being organized with magnetic cores and armatures to form signal-controlling relays; substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 28th day of December, 1897.

WILLIAM W. DEAN.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.