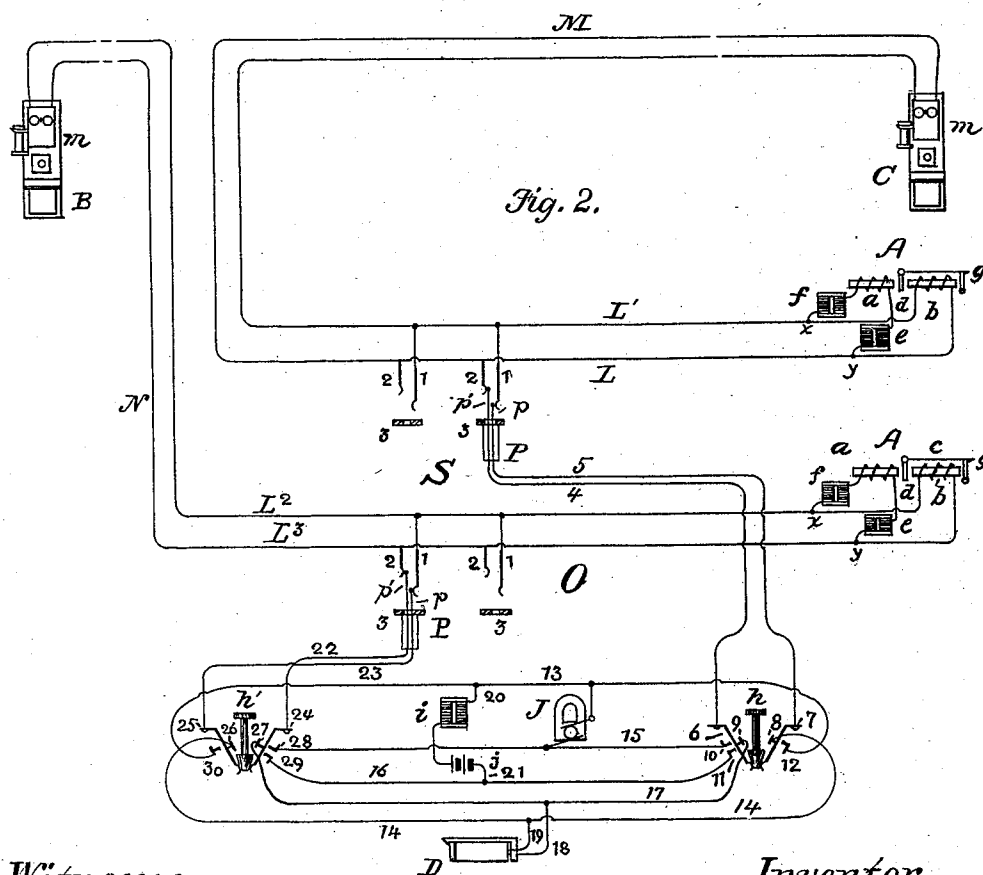
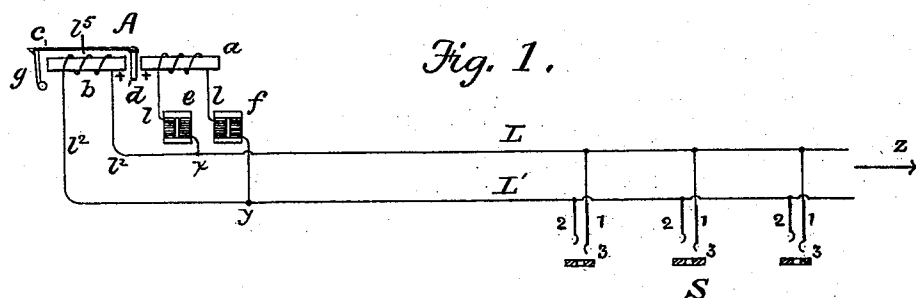


(No Model.)

A. H. McCULLOCH.
MULTIPLE SWITCHBOARD CIRCUIT.

No. 487,852.

Patented Dec. 13, 1892.



Witnesses.

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Inventor.

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UNITED STATES PATENT OFFICE.

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MULTIPLE-SWITCHBOARD CIRCUIT

SPECIFICATION forming part of Letters Patent No. 487,852, dated December 13, 1892.

Application filed March 9, 1892. Serial No. 424,298. (No model.)

To all whom it may concern:

Be it known that I, ALFRED H. McCULLOCH, residing at Boston, in the county of Suffolk and State of Massachusetts, have invented certain Improvements in Multiple-Switchboard Circuits, of which the following is a specification.

My invention relates to signaling apparatus for telephone-circuits, and especially to an apparatus and arrangement of circuits whereby the call-receiving device at the home station, though permanently connected with the circuit, is prevented from responding to signals sent from the said home station to the distant station, while it remains fully responsive to signaling-currents of similar character sent by and from the said out-station.

For several practical reasons it has become desirable to employ "branch-terminal" multiple switchboards in preference to those which loop through separable spring-contacts in the several successive sections of the switchboard; but in branch-terminal switchboards the electro-magnet of the calling-annunciator remains bridged across from one conductor to the other of the circuit, and in the practical operation of the switchboard, therefore, two necessities have presented themselves, the first being that of so arranging and constructing the circuits and apparatus that when a connection exists at a central station between two sub-station lines, the call-annunciator of both lines and a special "clearing-out" or disconnecting annunciator being both bridged across or connected in multiple with the compound main circuit, clearing-out or disconnecting signals sent from either sub-station shall be capable of operating the disconnecting-annunciator only, the two call-annunciators remaining perfectly irresponsive to such signals. Several methods have been devised of providing for this requirement, and in this respect I may mention that disclosed in the United States patent of Frank A. Pickernell, granted November 17, 1891, No. 463,544, which consists in so proportioning the relative resistances of the call and clearing-out annunciator coils that when they are all presented at the same time to the currents of the disconnecting-signal, the major part of said

currents, in conformity with well-established laws, will take the lower-resistance route through the clearing-out helix. The second necessity involved in the operation of such multiple switchboards, and that to which my invention especially addresses itself, is that of so arranging and constructing the circuits, apparatus, and appliances at the home or central station that when the said station sends signals to operate the bell at the sub-station such signals will not also actuate the central-station call-receiving annunciator, although the character of the current employed is the same as is that employed by the sub-station in calling, to which the annunciator is perfectly responsive. At the central station each sub-station circuit is branched into a plug-socket at each of a number of sections, where it may be connected with any other circuit and where calling devices may be attached to it for sending outgoing signals. The call-annunciators of the several lines, however, are divided up between the sections, a given number of circuits and their annunciators being assigned to each switchboard-section and the calls of such circuits being answered only at the section where their annunciators are located. Whenever a call is sent over a given line from any other section than that where its annunciator is located, the said call, in addition to ringing the bell at the sub-station, would also operate the line-annunciator at the switchboard-section where the calls of such line are answered, unless means for prevention were provided, and the attendant at such answering-section would not be able to distinguish false calls of this kind from true calls actually sent in by the sub-station. The presence of the second requirement to which I have referred is thus clearly manifested.

The object of my invention is to provide a highly-efficient means of maintaining inert the call-annunciator of a line over which signals are sent with respect to outgoing signals, while its responsiveness to incoming signals is also maintained.

The invention consists in combining a peculiarly-constructed call-annunciator and the main circuit within which it is included with

two sources of electricity and means for connecting both with the circuit at the same time by the act of sending the outgoing signals, the said two sources being enabled to act oppositely upon the annunciator, whereby it is made irresponsive to the outgoing calling-currents.

It consists, also, in providing a call-annunciator having two helices in parallel branch circuits of a main circuit, one of which branches permits rapidly-alternated currents to pass with facility, while it presents a relatively-high resistance to the passage of continuous currents of uniform direction, the other having a relatively-low resistance to a steady current of uniform direction, but a high apparent resistance to rapidly-alternated currents, and in combining the same with an electrical generator constructed to develop alternating currents, a second generator constructed to develop continuous uniformly-directed currents, and circuit-closing devices for connecting both of the said sources at the same time with the main circuit.

The invention consists, also, in means for preventing the short-circuiting of the alternating-current generator through the steady-current generator; also, in combining these devices with a distant call-signal responsive to the alternating currents; also, in so constructing the foregoing combinations that the call-annunciator irresponsive to outgoing signals shall be capable of responding to incoming signals and in combining the said annunciator, generators, and connections with a multiple-switchboard system.

In the drawings which form a part of this specification, Figure 1 is a diagram of the call-annunciator and the connection of its two helices with the main circuit; and Fig. 2 is a diagram of two telephone-circuits united at a central station to form a compound circuit, showing the arrangement at said central station of the line and clearing-out annunciators and the signal-sending apparatus illustrative of the features of my invention.

Referring to Fig. 1, L and L' are the outgoing and incoming conductors of a metallic telephone-circuit leading to a supposed substation in the direction of the arrow z , and from these branch terminals are shown extending to socket-contacts 1 and 2, normally out of contact with each other, but both adapted to register and connect with corresponding plug-contacts when a suitable plug is inserted in the socket 3. Each pair of contacts in this case represents a separate section of the multiple switchboard S , the circuit branching at each section to a plug-socket, so that it may be conveniently accessible for connection with other circuits. At some one of these switchboard-sections (it matters not which) is placed the call-receiving annunciator A , which has two independent helices a and b , each provided with its own magnetic core, these being mounted axially in line with

each other and having an armature d , which controls the signal drop or shutter g , interposed between them in such a way that it can be acted upon by both. These helices are in parallel branch or derived circuits l and l' of the main circuit, branching from each other at x and y . When the magnetism in the core of b is the stronger, the armature d is attracted thereby, its lever c is raised, and, releasing the drop g , permits it to fall and give the signal. On the contrary, when the magnetism of the core of a is the stronger its pole attracts the armature d , which is therefore maintained inert and is prevented from giving the signal. This is also the case if both poles are of equal strength and exercise an equal attraction on the armature.

The coil or helix b , which will for convenience hereinafter be termed the "releasing-coil," is wound with a fine wire of great length and of relatively-high resistance—say two thousand ohms—and is so designed and constructed that its coefficient of self-induction to currents which alternate at the frequency ordinarily found in telephone-bell generators is not specially high. Such currents, being developed under a high electro-motive force, will readily circulate through this coil without being materially weakened by its high resistance, and in consequence of the numerous convolutions will make the core thereof strongly magnetic.

The coil a will hereinafter be termed the "retaining-coil" and is wound with a relatively short and coarse wire having comparatively-few convolutions, and which in virtue of these conditions offers but a low resistance. Its resistance, for example, need not exceed twenty ohms. By this construction the said retaining-coil is adapted to develop a high magnetic strength in its core, even though there be other resistances in its circuit, when it is traversed by the current of a battery or uniform-direction magneto or dynamo machine having an electro-motive force so low that any current it could evolve through the much higher resistance of the releasing-coil might be disregarded and would have practically no effect on the core thereof.

On the two sides of the retaining-coil a are placed electro-magnetic resistances or retardation-coils e and f , which offer a certain amount of real resistance to steady currents, while their only function is to present a very much higher apparent resistance to alternating or intermittent currents. The real resistance of each of these coils may preferably be about sixty ohms, while their apparent resistance to currents which alternate with the rapidity of those of the average central-office or subscriber's magneto-generator is very much higher and should preferably amount to about one thousand ohms, this being made up partly of the real resistance, as aforesaid, and partly of the counter-electro-motive force of self-induction. The apparent resistance in a man-

ner well understood is dependent with a given amount of copper wire upon the amount and arrangement of the iron of the retardation-coil. The windings of the magnet-coils *a* and *b* are preferably arranged so that with the same current like poles are excited on both sides of the armature. The resistance of the releasing-coil branch now being two thousand ohms and the apparent resistance of the retaining-coil branch (disregarding the small resistance of the coil *a* itself) being also two thousand ohms, it is evident that an alternating current will divide itself into substantially-equal portions between them; but the magnetizing effect in coil *b* will by reason of its many convolutions be by far the greater. Therefore a suitable alternating call-current reaching the annunciator will, if not checked by some additional means, actuate the said annunciator and cause the drop to fall; but the real resistance of the releasing-coil branch is two thousand ohms, while that of the retaining-coil branch is but one hundred and forty ohms, or thereabout, so that if a steady current from a battery or uniform-direction dynamo of suitable electro-motive force reach the annunciator it will divide between the branches directly as their conductivities, by far the larger portion taking the route through *a*. The core of *a* will be strongly magnetized, while that of *b* will scarcely be affected, and the armature being powerfully attracted toward the core of *a* will prevent the drop from falling. Thus the alternating magneto-current finds coil *b* easy and coil *a* difficult of access, and therefore tends to give the signal, while the steady current of low electro-motive force finds coil *b* difficult and coil *a* easy of access, and therefore tends to prevent the signal from being given, and supposing the two kinds of current both reach the annunciator *A* together the steady or uniform current will still have the advantage and will prevent the signal from being given, it being obvious that such portion of the alternating current as passes through the retaining-coil *a* assists the steady current in attracting the armature to the core of said coil. It is now evident that incoming alternating signals from a sub-station, being unaccompanied by the steady or uniformly-directed current, will give the signal, while outgoing alternating coil-currents can be prevented from giving a false signal on the annunciator by causing them to be accompanied by a sufficiently-strong current of uniform direction and low electro-motive force.

Referring now to Fig. 2, which exhibits the practical arrangement of the foregoing system, *M* and *N* are two circuits extending from the sub-stations *B* and *C*, respectively, to a central station *O*, where they, together with any number of like circuits, are terminated in a branch-terminal multiple switchboard *S*. Each branches to a plug-socket 3 at the several sections by its branch contacts 1 and 2, and each at some one of the sections where

its incoming calls are attended to is provided with an annunciator *A*, constructed and connected as already described. At each sub-station is the regular telephone apparatus, comprising telephones, call receiving and sending appliances, and the usual automatic switch; the call-sending device being the usual magneto-generator organized to send alternating currents. At the central station the two circuits *M* and *N* are united at one of the switchboard-sections for through communication by means of a pair of plug-connectors *P*, linked in the ordinary way by two conductors, one uniting the conducting-tips *p'* of the said plugs and the other uniting the sleeve-conductors *p* thereof. The plugs to connect with the main circuits are inserted in the sockets 3 when the tip-conductor makes contact with one of the terminal contacts of the circuit—say 2, which branches from the line conductors *L* and *L*³—while the sleeve-conductors *p* make contact with the other contacts 1, which branch from the remaining main conductors *L'* and *L*². The double conductor-link between the two plugs includes two ringing-keys *h* and *h'*, whereby alternating currents from the magneto-generator *J* may be transmitted over either circuit, according to the key pressed, to ring the polarized bell *m* at the sub-station. When neither key is depressed, the circuit through is continuous, the route between main conductors *L* and *L*³ being from line-contact 2 of circuit *M* by way of plug-conductors *p'* of plug *P*, link-conductor 4 by key-spring 6 of key *h*, resting-contact 9, conductor 17, resting-contact 27, and spring 24 of key *h'*, link-conductor 22, and plug-conductor *p'* of plug *P* to line-contact 2 of circuit *N*. The two main conductors *L'* and *L*² are united in the same manner by way of line-contact 1 of circuit *M* to plug-conductor *p*, link-conductor 5, spring 7, and resting-contact 8 of key *h*, conductor 14, resting-contact 26, and spring 25 of key *h'*, link-conductor 23, and plug-conductor *p* of plug *P* to contact 1 of circuit *N*. The clearing-out annunciator *D* is by wires 18 and 19 bridged between the wires 14 and 17, and thus is bridged between the two conductors of the through circuit. The call-annunciators *A* of the circuits *M* and *N*, with their two helices *a* and *b* in parallel, are also permanently bridged across the circuit, as shown. From one pole of the alternating-current generator *J* a conductor 13 branches to the outer ringing contact-points 12 and 30 of the keys *h* and *h'*, respectively. From the remaining pole of the said generator a wire 15 branches to the inner ringing contact-points 10 and 28 of the keys *h* and *h'*. Both of these wires may be of course also branched to any number of pairs of keys, there being a pair of keys to each pair of plugs. A battery *j* of suitable electro-motive force and internal resistance connects by one of its poles 20 to the magneto-wire 13 and by the other 21 to an extra wire 16, branching to independent ringing

contact-points 11 and 29 of the keys, and by this expedient the pressure of either ringing-key closes the circuit, not only of the alternating-current generator, but also of the uniform-current generator.

The currents developed by the alternating-current generator J and the uniform-current generator j through like resistances should bear the following relations to each other, approximately: Let V equal the electro-motive force of J , and v that of j . Let C equal the strength of the current of J , and c that of j in a similar circuit. Then $V \times C$ should equal $v \times c$. To prevent the currents of the generator J from being short-circuited through the generator j , I include in the circuit of the latter a choking-coil or electro-magnetic resistance i , which, if desired, may be adjustable. It will be seen since in the ringing-keys the plug-conductors terminate in the springs 6, 7, 24, and 25 that the depression of either key disconnects the circuit with which it is connected from the other one and at the same time brings it into connection with the two poles of the two generators J and j , the wire 13 and contacts 12 and 30 being common to the currents of both. The generator j need not necessarily be a battery. A constant current from a dynamo would answer the purpose equally well, provided it be proportioned to the current of the alternating generator, as indicated above.

The operation of the invention may now readily be understood. Signaling from the sub-station to the central station is done by means of the alternating current developed by the sub-station generator. The said current, reaching the central station, divides at $x y$ into two substantially-equal parts. That half which circulates in the fine-wire helix b operates, for reasons previously stated, upon the armature more powerfully than does the remaining portion, which circulates through the steady-current coil a . The armature is attracted in the direction of coil b , the drop is released, and the call given. In signaling from the central station to the sub-station it is of course not desired that the annunciator shall be operated. The signal is to be sent by pressing the key h , to which the circuit is through the plug united. This throws upon the line at the same time the alternating current from generator J and the uniform-direction current from generator j . That portion of the alternating current which in consequence of the permanent connection of the annunciator flows therethrough, as before, divides into two substantially-equal parts between the two coils a and b , while another portion flows to line and rings the sub-station bell; but the steady current from generator j divides not into two equal parts, but into parts whose strength is inversely as the real resistances of the two branches l and l' , the much larger portion passing through the retaining-coil a , overpowering the other

coil b , which tends to attract the armature and release the drop. The said armature is therefore attracted toward coil a and the signal-drop remains unreleased. The sub-station can thereby be signaled from any section of the switchboard without the false announcement of a call at the section where the annunciator of the line is located. If it were not for the presence of the choking or retardation coil i , the alternating currents of J would tend to be shunted through j by way of 13, 20, j , 21, 16, the contacts of the key h or h' , and 15; but this is prevented by said coil. The current of j will not short-circuit through J , because the latter has the ordinarily-high resistance of the standard alternating generator.

My invention is of course not restricted in its application to a switchboard, but is applicable to any case where it is desired to operate one of two signals in multiple arc on a circuit without necessarily operating the others.

Having described my invention fully, together with its mode of operation, I claim—

1. In an electric signaling system, a main circuit, an alternating-current generator, a continuous-current generator, means for connecting both to the said main circuit simultaneously and by the same operation, and an annunciator having a signal-releasing electro-magnet in a branch of said circuit of high actual but relatively-low apparent resistance to alternating currents, and thereby made responsive to said alternating currents, and having, also, a signal-retaining electro-magnet in a parallel branch of said circuit of low actual resistance but relatively-high apparent resistance, and made thereby irresponsive to alternating currents and responsive to continuous currents of lower electro-motive force, substantially as and for the purposes described.

2. An electric signaling system comprising a main circuit, an annunciator having a signal-releasing electro-magnet and a signal-retaining electro-magnet in parallel branches of the said circuit, the actual resistance of the retaining-magnet branch offered to constant currents of single direction being much lower than that of the releasing-magnet branch, while the apparent resistance of both to alternating currents is substantially equal, an alternating-current generator for sending outgoing signals, a continuous or uniform-direction current generator, and a signal-sending key or circuit-controller interposed between the main circuit and both generators and adapted when operated to close the circuit of both through the said circuit simultaneously, substantially as and for the purpose set forth.

3. In an electric signaling system, a main circuit, an alternating-current generator and a continuous-current generator associated together at the same station of the said circuit, a circuit-closer for connecting both to the said main circuit simultaneously and by the same operation, a polarized electro-magnetic

bell at a second station, responsive to alternating currents only and adapted to give the signal upon the operation of said circuit-closer, and an annunciator adapted to respond and give a signal when alternating currents only traverse the main circuit, but to remain quiescent when the currents of the said two generators simultaneously traverse said circuit, substantially as described.

4. The combination of an annunciator having two electro-magnets which act oppositely upon a common signal-controlling armature and a main circuit having parallel branches within which the said magnets are respectively included, a source of alternating currents for sending outgoing signals over said circuit, a source of continuous currents for counteracting the influence of said alternating currents upon the annunciator, whereby the said annunciator is prevented from responding to outgoing signals, and means for connecting both with the circuit simultaneously, substantially as described.

5. The combination, substantially as hereinafore described, of a closed main circuit, a polarized electro-magnetic call device included therein responsive to alternating currents, an alternating-current generator, a continuous-current generator associated therewith, an annunciator at the same station as the said generators, permanently connected with the said circuit and adapted to respond when alternating currents only traverse the said circuit, but to remain irresponsive when alternating and continuous currents traverse the said circuit simultaneously, and a compound circuit-closing device controlling the terminals of both generators and their connections with the main circuit, so that when operated to make such connections the home-annunciator will be prevented by the continuous currents from responding to the alternating currents transmitted to operate the said polarized bell.

6. In an electric signaling system, the combination of a main circuit, an alternating-current generator, a relatively-low-resistance continuous-current generator, a circuit-closer controlling branch terminals of the said main circuit and also the terminals of both generators and adapted when operated to connect both with the said main circuit, and an electro-magnetic resistance or retardation coil of low actual but high inductive resistance included in the circuit of the continuous-current generator to prevent the currents of the alternating generator from being short-circuited or shunted through the said continuous-current generator, while offering little opposition to the continuous currents developed thereby.

7. The combination, with a telephone-circuit extending between a central station and a sub-station, an alternating-current magneto-generator and a polarized bell located at the sub-station in the said circuit to receive and

send signals from and to the central station, an alternating call-generator at the central station to operate the said bell, and a call-annunciator at the central station, having a high-resistance actuating-magnet in the said circuit to receive signals transmitted by the sub-station generator, of auxiliary devices located at the central station and adapted to prevent the said annunciator from responding to outgoing signals, the said devices consisting of an electro-magnet of low resistance included in a parallel branch of the main circuit and adapted when energized to act upon the annunciator-armature in opposition to the actuating-magnet, retardation-coils in the said parallel branch, one on each side of said magnet, whereby the said branch is enabled to offer a high resistance to alternating currents but a relatively-low resistance to continuous currents, a continuous-current generator associated with the central-station alternating generator, an inductive resistance included in circuit therewith, as indicated, and a ringing-key acting to connect the central-station alternating generator with the circuit for the purpose of operating the sub-station bell and simultaneously to connect the continuous-current generator with the same circuit for the purpose of energizing the low-resistance annunciator-magnet, and thereby preventing the operation, also, of the said annunciator.

8. The combination, in a central telephone-board, of a branch-terminal multiple switchboard in which the several converging telephone-circuits are represented by normally-discontinuous branches at each of a number of switch-sections, a call-receiving annunciator for each line, actuated by a high-resistance electro-magnet and located at some one of the said sections, and means for preventing the said annunciator from responding to outgoing signals sent from the other sections over the circuit with which it is connected, while leaving it fully responsive to incoming signals, said means comprising a battery or other continuous-current generator associated with the switchboard alternating-current call-generator, a ringing-key adapted in sending outgoing signals to simultaneously connect both generators with the circuit, and thereby cause a continuous and an alternating current to traverse the said circuit together, and two electro-magnets in parallel branches of the circuit, adapted to act oppositely upon the armature of said annunciator, the releasing-magnet being wound with many convolutions of fine wire and having a high actual resistance but a relatively-low coefficient of self-induction and the retaining-magnet being wound with few convolutions of coarse wire and placed in circuit with inductive resistances, so that its branch circuit has a low actual resistance but a high coefficient of self-induction, whereby the first-named magnet is enabled to overcome the latter and give

the signal when the circuit is traversed by incoming alternating currents, while the last-named magnet is enabled to overcome the former and prevent the signal from being
5 given when the outgoing call-current, accompanied by its associated continuous currents, traverses the circuit.

In testimony whereof I have signed my name

to this specification, in the presence of two subscribing witnesses, this 5th day of March, 1892.

ALFRED H. McCULLOCH.

Witnesses:

WINSLOW WHITMAN,
OSCAR BUCKNAM.