(No Model.) 2 Sheets—Sheet 1.

B. THOMPSON.

MULTIPLEX TELEGRAPH.

No. 265,645. Patented Oct. 10, 1882.

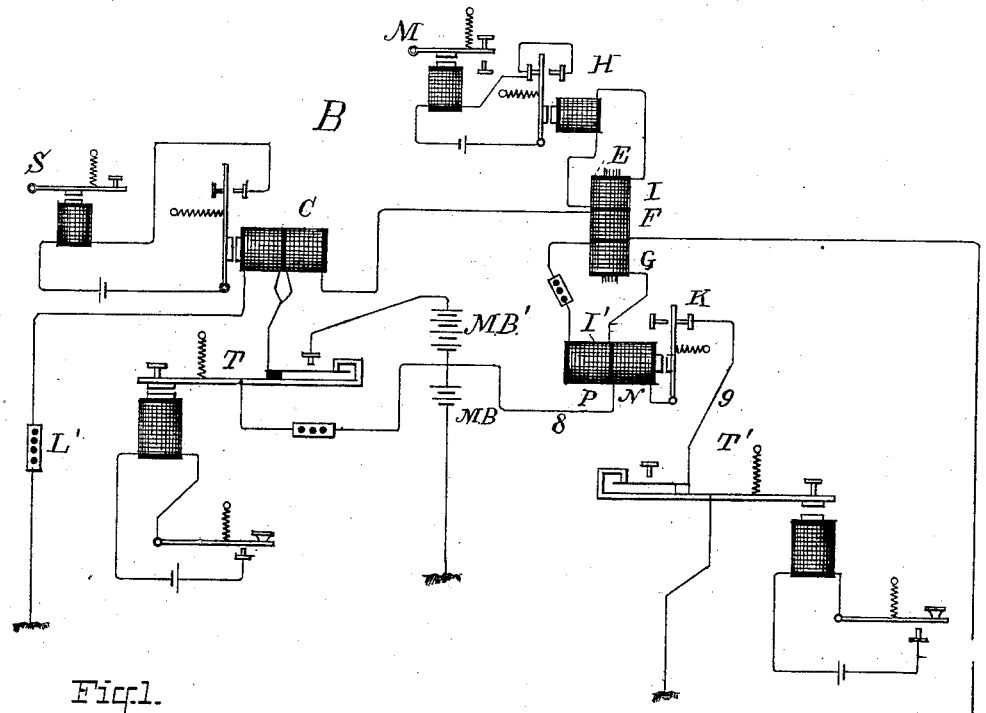
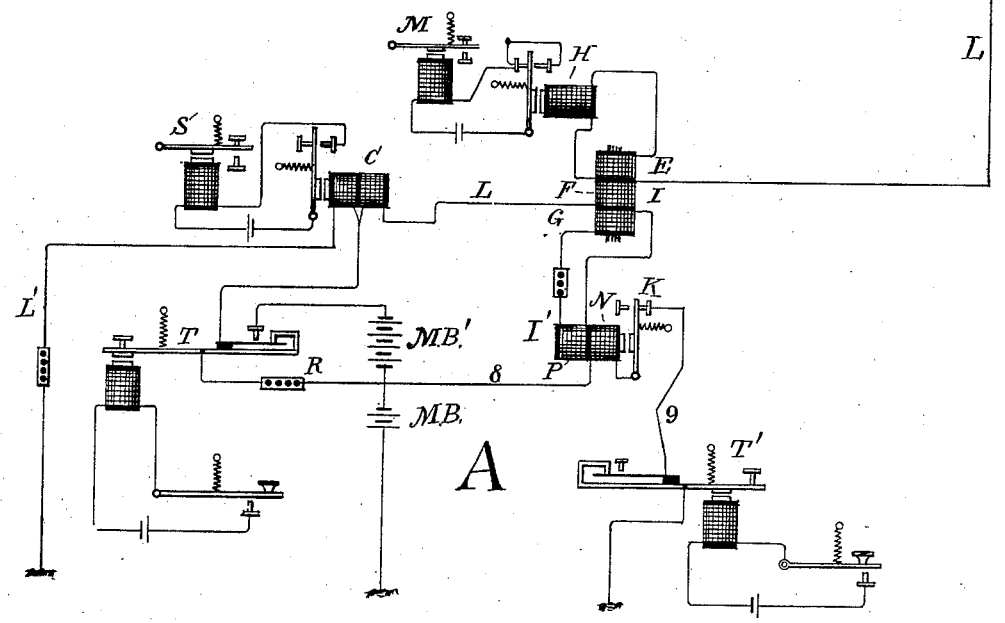


Fig. 1.



ATTEST:

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Thos. Toomey.

INVENTOR:

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Atty

(No Model.) 2 Sheets—Sheet 2.

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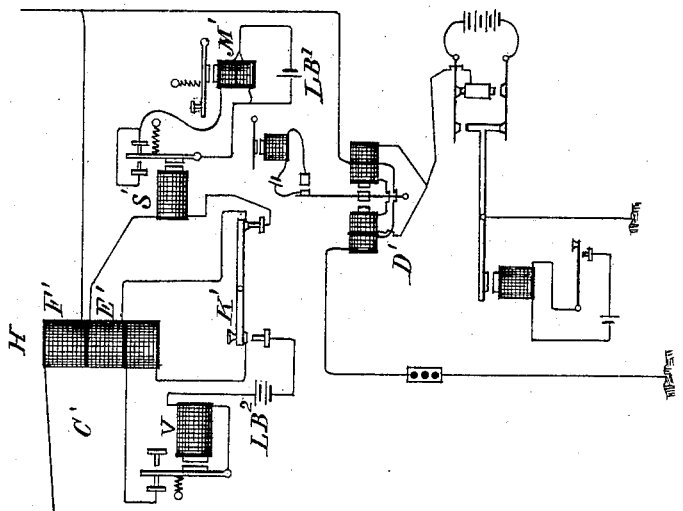
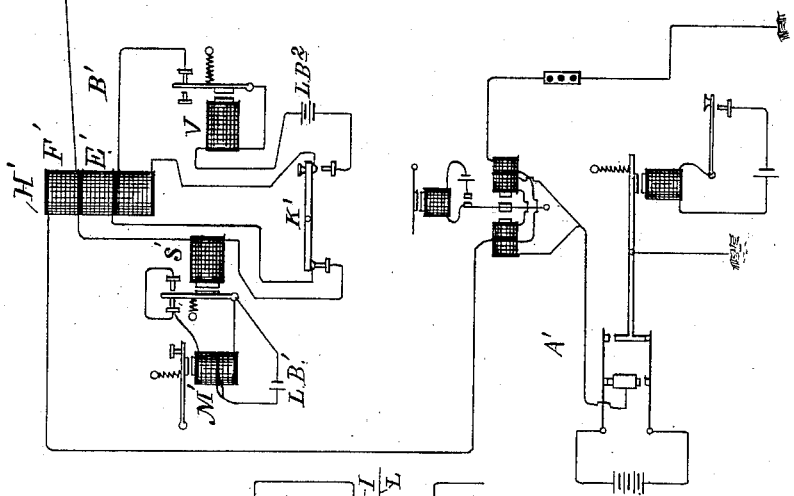


Fig. 2.



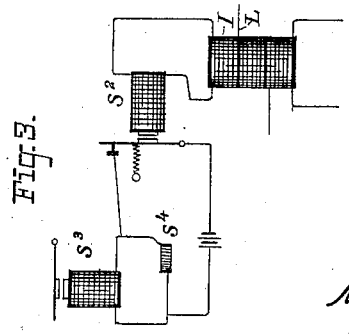


Fig. 3.

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UNITED STATES PATENT OFFICE.

BENJAMIN THOMPSON, OF BUFFALO, NEW YORK.

MULTIPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 265,645, dated October 10, 1882.

Application filed July 22, 1882. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN THOMPSON, a citizen of the United States, and a resident of Buffalo, in the county of Erie and State of New York, have invented certain new and useful Improvements in Multiplex Telegraphs, of which the following is a specification.

The object of my invention is to increase the number of messages that may be sent simultaneously over the same line-wire without confusion; and to this end my invention consists in combining with an ordinary duplex, quadruplex, or other system of telegraphy in which the line-circuit is constantly closed during the transmission of signals a system in which the receiving apparatus is operated by induced currents set up in the secondary of an induction-coil whose primary or inducing coil is in the main-line circuit, and in which signals are sent by introducing into or withdrawing from the main-line circuit electric waves, vibrations, or pulsations produced by any suitable means, and acting through the induction-coil upon apparatus placed in the secondary circuit of such coil, and suitably constructed to respond to electric vibrations or waves.

My invention further consists in a novel combination upon the same circuit of induction-coils, each of which has a primary coil in the line-circuit and a secondary connected to suitable receiving apparatus, vibratory or wave signal transmitting apparatus and a local equating-coil combined with each induction-coil apparatus and connected thereto and to the wave-signal apparatus in such a way that vibratory currents set up in said local coil by the wave-signal apparatus shall act inductively to neutralize in the induction-coil circuit containing the receiver the effects of the vibratory currents coming from the home station and passing through the line primary coil. By a suitable arrangement of two sets of wave-signal transmitters and induction-coil receivers thus connected two messages may be sent in opposite directions.

My invention consists, further, in combining such an arrangement of two sets of induction-coils and vibratory-current transmitters with an ordinary duplex or quadruplex telegraph, whereby a quadruplex or a sextuplex telegraph may be produced. In such a combination each system may work independently of the others, because the electric vibrations or waves are adjusted and the ordinary duplex or quadruplex telegraph apparatus is so constructed that said apparatus is not affected by the vibratory currents, while, vice versa, the vibratory-current-receiving apparatus is not affected by the currents of the ordinary duplex or quadruplex transmitters, because the currents induced in the wave-signal-receiving apparatus by the action of said transmitters accompany only the beginning and end of a signal, are but momentary, and occur at irregular intervals.

In order that the nature of my invention may be more fully understood, I will first describe the same as arranged for the purpose of sending signals in opposite directions by vibratory currents and as applied to an ordinary duplex telegraph, thus producing in effect a quadruplex telegraph. Its application to other systems of telegraphy will be obvious from the description of it as applied to a duplex telegraph.

In Figure 1 of the accompanying drawings, A and B represent two distant stations equipped so that two messages may be sent in each direction simultaneously and without interference.

C C represent the differentially-wound relays of an ordinary duplex telegraph, one of the differential coils of each relay being in the main-line circuit L and the other in an artificial circuit, L′, to earth, adjusted to equal the resistance of the main line, said coils being so wound, in the well-known way, that the current from the home station, dividing between them, will be neutralized in the home relay.

T T indicate the ordinary continuity-preserving duplex telegraph-transmitters, one at each station, which are controlled by a local electro-magnet key and battery in the ordinary way, and each of which controls a main-line battery, M B′. Each is constructed so that when at rest its insulated spring is against the hook, so that the main-line battery M B′ is cut out, and the circuit to earth is through a resistance, R, adjusted to equal the section of battery M B′, while when the key is operated the connection through the hook is broken

and the spring is in contact with a stop, so as to introduce the main battery M B′ into the main-line circuit, the operation of the key T being, however, always unattended with any rupture of the general circuit. In the present instance the circuit includes a second section of main battery, M B, the function of which is to produce the vibratory currents; but the effect of this is only to render it necessary to adjust the retractors of the relays C C above the tension of sections M B, so that whenever the latter are allowed to flow uninterruptedly the relays C C shall not be affected.

S S are the sounders for the relays C C. These sounders are controlled and operated in the ordinary way by the relay-contacts and a local battery. The arrangement of the batteries M B at the opposite ends of line is such that they will re-enforce one another. The operation of this class of duplex telegraphs, being well understood, need not be described in detail.

I I indicate the induction-coils of the vibratory or wave signal system, each of which is wound with three independent coils, which are placed either beside or over one another in any suitable manner, and which I shall term, for the sake of distinction, the "line primary," the "local or equating primary," and the "receiver secondary" coils.

F indicates the line primary, which is of the usual resistance, and is directly in the line-circuit.

E indicates the receiver secondary coil, which is of any desired resistance, but is preferably a quantity or low-resistance coil, and which is included in circuit with a receiver electro-magnet, H, properly wound to be operated by means of the currents induced in the coil E by the coil F and by the equating-coil G, to be presently described. The armatures of the receivers H are suitably constructed or adjusted in a well-known manner to vibrate by the action of vibratory or pulsatory currents induced in the receiver-secondary E by the vibratory currents flowing on the main line, and each plays between two electrically-connected contact-points, as shown, firmly adjusted, so that the movements of the armature shall be as small as possible in passing from one to the other, but shall be sufficiently large to break for an instant the local circuit containing the sounder M, so that when the armature is rapidly vibrating there shall be practically a break of the local circuit, and the sounder will be demagnetized, but when said armature is against either its front or its back stop the local circuit shall be closed. The armatures of H H at both stations are so constructed and adjusted that they will vibrate with currents or pulsations of the same rapidity.

I′ is a second induction-coil, the core of which serves in the present instance as the attracting-core of an automatic electro-magnetic vibrator.

K indicates the armature of the automatic vibrator, the circuit through whose back stop includes the primary or quantity coil N of the induction-coil I′, a wire, 8, leading to a point between the two sections of main battery and a wire, 9, leading to earth through the spring and hook of a key, T′, when said key is at rest and against its back stop. As will be readily seen, the action of the vibrator K is to alternately break and close a short circuit for the section of battery M B to earth, thus alternately allowing the same to flow to line and withdrawing it from line, so as to produce vibratory currents or pulsations on the main line. Key T′ is operated in the ordinary way by a local electro-magnet battery and key. The induction-coil I′ induces the local equating-currents which flow through the local equating-coil G of induction-coil I at same station, and serve to neutralize the effects of the main-line pulsations or vibrations flowing through coil F and produced by the vibrator K at same station, which currents would otherwise produce in the secondary E currents or vibrations that would disturb the proper operation of the apparatus. The neutralization is effected by the local equating-coil G on I, which coil is an intensity-coil and is in circuit with the secondary coil P on I′, which latter is also an intensity-coil and is properly connected with coil G, so that the currents generated in P by the makes and breaks of the current flowing through the primary N and the vibrator K shall flow in the coil G and tend to produce simultaneously in the receiver-secondary E currents the reverse of those which would be produced by the line pulsations or waves from battery M B at same station consequent upon the make and break of the battery short circuit through the vibrator and induction-coil I′. Vibrators K at both stations are adjusted or constructed to operate at the same rate of speed, and when operating each keeps in vibration the receiver H at the opposite end of the line, the effect of the pulsations or vibrations upon the receiver H at the same station being neutralized in the manner just described, so that if the vibrator at one end of the line stop acting the receiver at the distant end will cease to operate, although the vibrator at the same station with it may be working.

The general operation is as follows: The transmitters T at both stations being at rest, sections M B′ are cut out and the line-circuit is directly to the section M B. Transmitter T′ being also at rest, the circuits through the electro-magnetic vibrator are closed, and said vibrators both operate to alternately short-circuit and break the short circuit of section M B, thus producing in the main-line circuit rapid pulsations or vibrations. The pulsations or vibrations produced at station A, for instance, keep the vibratory receiver H at station B in constant operation by means of the currents induced from coil F at that station into coil E; but such pulsations have no effect at station A, because of the counteracting or neutralizing influence of the vibrations simultaneously

produced in the equating-primary G at that station. In a similar way the vibrator K at station B keeps the vibrating receiver H at station A in constant operation so long as the transmitter T′ at B is closed, but produces no effect upon the receiver H at B, for the same reason just stated with reference to vibrator K at station A. The vibratory receivers H being thus kept in constant operation, their armatures play between the contact-stops, and the circuit through sounder M is practically open. The relays C are not charged sufficiently to overcome the tension of their retractors, so that sounders S are not affected by the vibratory or wave currents. If now the transmitter T′ at station A, for instance, be operated, thus breaking the circuit through the vibrator and induction-coil I′, the vibratory or wave currents produced at A will be cut off, and section M B of battery will flow uninterruptedly to line. Vibrator-receiver H at the distant end of line will therefore cease to operate, and its armature-lever will remain at rest against its back stop, thus closing the circuit of sounder M. Vibrator-receiver at home station A will continue to operate by the action of the vibrator at station B, and the circuit of its sounder M will remain open. The relay C at station B is not affected by section M B of battery, its retractor being adjusted above the effects of such battery. If both transmitters T′ be operated together, the vibrating currents produced at both stations will cease to flow, and the receivers H coming to rest both sounders M will be operated. Neither of the relays C will be affected, for the reason already stated. If while either vibrator-receiver H at either station is at rest, owing to the operation of transmitter T′ at the other station, a transmitter T at either station be operated so as to throw section M B′ of battery to line, the sounder M of such receiver will not be disturbed, as the induced current produced in H merely carries the armature-lever from its back to its front contact so quickly that sounder M does not have time to discharge and open. The receiver C is operated by section M B′ of battery after the usual manner of a duplex receiving-instrument, the retractor being properly adjusted for current from section M B′, and the sounder S is thus caused to respond. It is of course to be understood that section M B′ of battery is sufficient to operate the relay C whether section M B be on or off the line.

It is obviously within the scope of the invention to operate the vibrator K by other means instead of by the induction-coil I′, and for this purpose a separate operating electro-magnet or other device such as is well known in the art might be used. So, too, it would be entirely within the scope of my invention to produce the vibratory currents by other means instead of by throwing the main-line battery into waves or vibrations. A triplex might be formed by the arrangement described by dispensing with the secondary circuit containing secondary coil P and equating-primary G. In this case, as before, the duplex could be worked by the differential relays, while the vibrators and induction apparatus I could be used for single transmission.

I do not desire to limit myself to the combination herein shown and described, as there are many forms of duplex apparatus to which my vibratory or wave combination may be connected in order that a duplex may be formed into a triplex or quadruplex; or a quadruplex combined therewith may be formed into a quintuplex or sextuplex. In any case it is only necessary, in order to combine the above arrangement for sending signals by vibratory current with other systems of transmission, that said system should employ transmitting apparatus constructed in such a way that a continuity of the general circuit will be preserved, and a path thus always provided for the vibratory signals. Signals sent by such other system would in no case affect the vibratory arrangement described, for the reasons already stated.

I will now proceed to show and describe a modified form of the vibratory or wave combination that may be used to form a triplex—that is, Boston and New York may work duplex while New York and Hartford are working single on the same wire, or while Boston and Hartford are working single; or any number of intermediate offices may be placed upon the duplex wire; so that the intermediate stations may work with each other or with the terminals or the terminals with each other. Thus a duplex may be operated between any two points, while simultaneously a single-message system, forming an effective Morse circuit, may be worked on the same wire.

In Fig. 2, A′ B′ C′ D′ are four stations on a single wire. A′ and D′ are the terminals. B′ and C′ are the intermediates. A′ and D′ work duplex by a well-known method, which is a polarized duplex, the static charge and discharge of the line being eliminated by any suitable device. B′ and C′ are arranged to work single by a modified form of the induction arrangement shown in Fig. 1. At station B′, K′ is a four-pointed key, the front and back points being insulated from each other; L B′, a local battery; V, an electro-magnetic vibrator wound for quantity; H′, an induction apparatus wound with three coils of wire whose line-coil is of the ordinary resistance required in Morse relays, or about three hundred and fifty ohms. The other two coils are wound for quantity; S′, the electro-magnet of a vibrator-receiver wound for quantity whose local points are arranged to complete the local circuit of L B′ either through front or back contact-points.

M′ is a local electro-magnet wound with two coils of wire, each coil for quantity and of the same sized wire. Thus when S′ is unexcited the effect of L B′ on M′ is neutralized, as the current divides equally but oppositely through the two coils of M′. As described in the op-

eration of vibratory or wave currents in Fig. 1, nothing but vibratory or wave currents will actuate the armature of electro-magnet S′.

It will not be necessary to explain parts at station C′, as they are the same as shown at B′, and any number of stations may be arranged as intermediates or terminals on the same vibratory or wave plan. Referring to station B′, when operator closes key K′ battery L B² operates the vibrator V, which is placed in circuit with the lower coil of induction apparatus H′, thus inducing in the line-coil F′ vibrations or pulsations which pass over the line to station C′, and, circulating in its line-coils F′, induce in the local secondary E′ currents which pass through the back contact of key K′ and receiver S′ at that station, and, by putting its lever into vibration, disturb the balance between the coils on sounder M′ and allow the current from L B′ passing through the lower coil of said sounder to actuate the same. As will be readily seen, when the key K′ is operated at station B′ the circuit of the coil E′ and instrument S′ is broken, so that all of the inducing action of the coil connected to the vibrator is expended in producing currents in the line-coil. Were this circuit not broken, the induced currents would be absorbed by the low-resistance coil containing the instrument S′, and thus be prevented from forming in the line-coil and passing to line. The operation of the transmitters at the stations A′ and D′ does not interfere with the proper action of the apparatus at B′ or C′, since the receivers at the latter stations are not in the line-circuit and are only operated by vibratory currents, as before explained in connection with Fig. 1. It is obvious that this arrangement is applicable to many forms of duplex to form a triplex, and also to many forms of quadruplex to form a quintuplex, and also to work intermediates on a quadruplex line during the operation of the quadruplex.

Fig. 3 shows a modified form of the receiving arrangement shown in Fig. 1. I indicates the induction apparatus described in Fig. 1; S², an electro-magnet wound for quantity, with its local points on the back contact; S³, an ordinary sounder; S⁴, an electro-magnet whose function is to compensate for or neutralize the disturbing action of ordinary currents sent by the duplex or other apparatus and circulating through the line-coil of induction apparatus I, which may momentarily excite S² enough to separate the local points. At the moment, however, that the points separate the discharge-current from S⁴ circulates through the coil S³ with sufficient strength to prevent it from becoming wholly discharged before the armature-lever of S² drops back and restores the battery-current. Vibratory or wave currents will keep the armature of S² continuously vibrating, so that its local points will not remain in contact long enough to allow the local-battery current to flow freely and to keep sounder S³ charged, and the armature-lever of the latter will remain unattracted until such time as the armature of S² comes to rest.

It is obvious that the receiving arrangement shown in Fig. 3 is only applicable to the arrangement in which vibratory or wave currents are sent into line while the key is at rest, the closing of the key acting to shut off the vibrations or waves, so that the retractor of S² can connect the local points, and thereby close the circuit of sounder S³.

It is evident that electro-magnet S⁴, connected as shown in Fig. 3, is a suitable arrangement to obviate the static difficulties caused by the charging and discharging of the main line in multiplex telegraphs.

It will be understood that the secondary circuit of the vibrator K, (shown in Fig. 1,) which serves as an equating device for the outgoing vibratory or wave currents, might be dispensed with and the ordinary equating-circuit to earth be extended so as to include an equating-coil upon the induction-coil I, so that the outgoing waves or pulsations produced by the vibrator would produce no effect on the wave-signal-receiving apparatus at the same station. Other equating devices might be employed without departing from the spirit of my invention. My invention is not limited to any particular method of producing the vibratory or wave currents, the gist of the invention consisting in the arrangement of the wave-current receivers in the the secondary circuit of an induction-coil whose primary is in the line-circuit, so that ordinary signals by an ordinary duplex or quadruplex telegraph or similar system of telegraphy in which there is a constantly-closed circuit may be sent over the same wire simultaneously with the vibratory-current signals without disturbing the receivers for the latter.

What I claim as my invention is—

1. The combination, upon the same telegraph-line, of continuity-preserving transmitters interposed in the main line, and wave or vibratory signal apparatus the receivers of which are placed in the local secondary circuit of an induction-coil whose primary is in the main-line circuit, substantially as and for the purpose described.

2. The combination, upon the same telegraph-line, of a Morse transmitter interposed in the main line and provided with continuity-preserving points, suitable receiving apparatus therefor, an induction-coil whose primary forms a portion of the main line, a vibratory receiver in the secondary of said coil, and devices for producing in the main line vibratory currents, said devices being in a circuit independent of the secondary of said coil and controlled by a suitable transmitting-key.

3. The combination, with a main telegraph-line used for signaling by apparatus working without rupture of the main-line circuit, of vibratory or wave signal receiving apparatus whose electro-magnet is included in the local secondary circuit of an induction-coil, the primary coil of which latter is included in the

main-line circuit, a local battery controlled by the vibrating armature of the receiver, and an electro-magnet or sounder in the local-battery circuit.

4. The combination, with the main line of a duplex telegraph, as described, of an induction-coil the primary of which is in the main-line circuit, an electro-magnet having a vibratory armature connected in the local secondary circuit of said induction-coil, back and front contact-stops for the armature or other vibrating part of the electro-magnet, and a local battery and electro-magnet whose circuit is through said stops.

5. The combination of main line L, induction-coil I, coils E F, electro-magnet H, and armature therefor, local battery connected to the armature-lever and to a receiving electro-magnet, and back and front contact-stops for the armature electrically connected to one another.

6. The combination, upon the same main line of duplex or quadruplex telegraph apparatus, of an automatic vibrator in a short circuit for a section of the main-line battery, an induction-coil in the main-line circuit, and a vibratory receiving apparatus in a local secondary circuit of said induction-coil.

7. The combination, upon the same telegraph-line, of duplex telegraph apparatus at each end thereof, controlling a section, M B′, of a main-line battery, automatic vibrators in a short circuit for the section M B of battery at each end, and operating at the same rate of speed, and vibratory-current-receiving apparatus at each end of the line connected to the local secondary circuit of a line induction-coil.

8. The combination, substantially as described, of main batteries M B, M B′ at both ends of a telegraph-line, duplex telegraph-transmitters controlling one section of said batteries, an automatic vibrator controlling the other section, and induction-coils I at each end provided each with a local-receiver secondary, a line primary, and a local equating primary coil.

9. The combination, with an induction-coil having a local-receiver secondary, a line primary, and a local equating primary coil, of an automatic vibrator and a second induction-coil whose primary is in circuit with the vibrator, and whose secondary is connected to the equating-primary of the first-named coil.

10. The combination, with a line primary coil, of a receiver secondary local coil, an electro-magnet in circuit with the latter, a vibratory armature, and front and back stops for the latter electrically connected and in circuit with a local battery.

11. The combination of duplex transmitters T, normally disconnected from sections M B′ of battery, transmitters T′, normally connected with the contacts of an automatic vibrator in a short circuit for section M B of battery, suitable duplex telegraph-receivers, C, and vibratory receiver-magnets in the local secondary circuits of induction-coils whose primaries form portions of the main-line circuit.

12. The combination of induction-coil I, wound and connected as described, induction-coil I′, and automatic vibrator K, actuated thereby and in circuit with the primary of said coil, as and for the purpose described.

13. The combination, substantially as described, of a vibratory-current receiver, a local circuit controlled thereby and containing a receiving electro-magnet, and an electro-magnet placed in a derived circuit to the receiver electro-magnet, so as to prevent by its discharge a false signal by the momentary action of armature for the vibratory-current receiver.

Signed at Buffalo, in the county of Erie and State of New York, this 11th day of July, A. D. 1882.

BENJAMIN THOMPSON.

Witnesses:

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OLIVER S. BRUCE.