(No Model.)

2 Sheets—Sheet 1.

F. J. PATTEN.

MULTIPLEX TELEGRAPHY.

No. 395,508.

Patented Jan. 1, 1889.

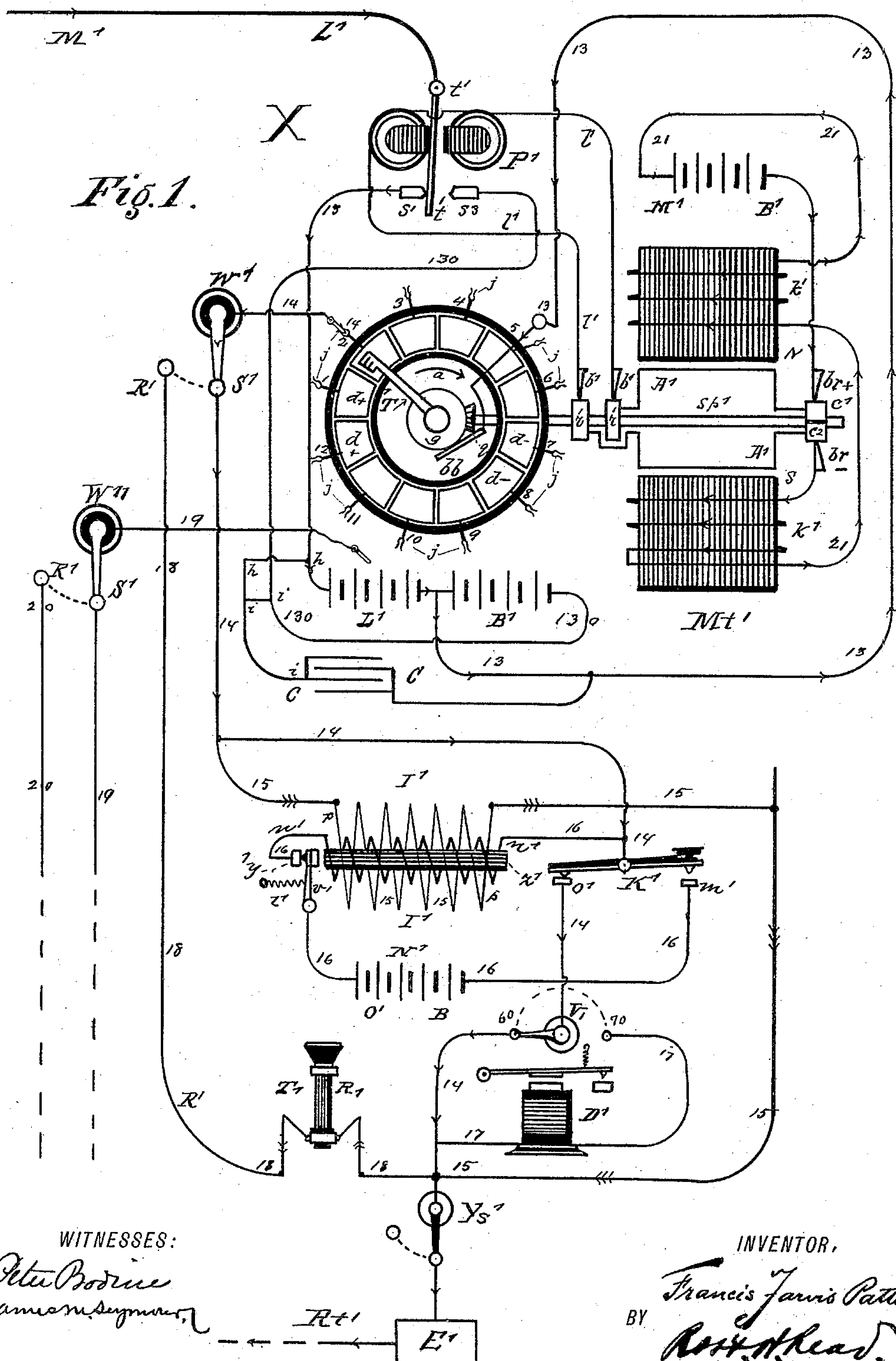

Fig. 1.

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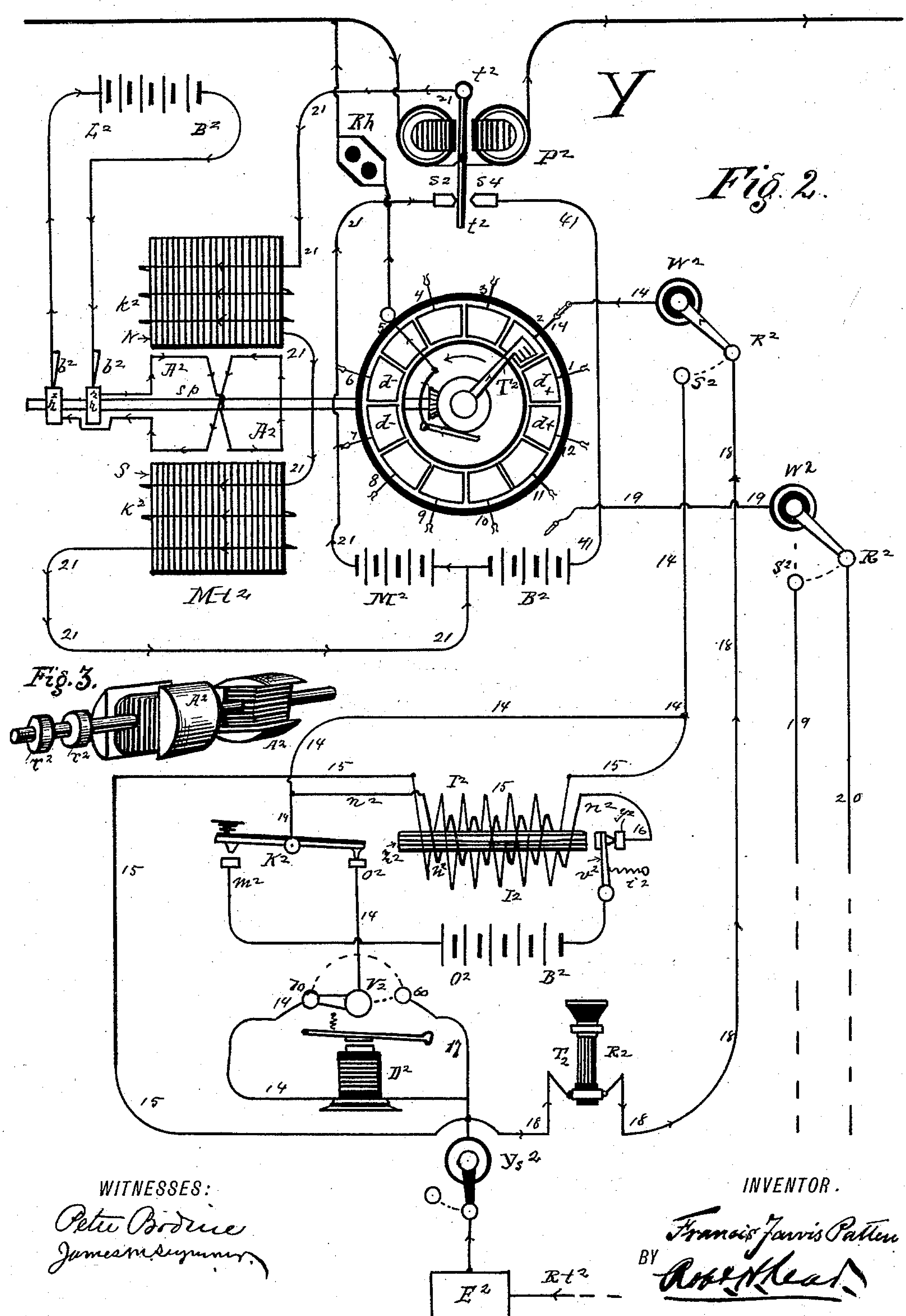

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MULTIPLEX TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 395,508, dated January 1, 1889.

Application filed October 16, 1888. Serial No. 288,274. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS JARVIS PATTEN, a citizen of the United States, residing in the city, county, and State of New York, have invented a new and Improved System of Multiplex Telegraphy, (for which I have filed an application for Letters Patent in France, dated November 13, 1888,) of which the following is a specification.

This invention relates to telegraphy, and particularly to that class of telegraphic systems known as "multiplex," in which a number of messages may be simultaneously transmitted on the same line-wire. Among the many systems of this character now known to the public some—as the duplex and quadruplex—are operated by the use of different strengths and polarities of transmitting-current, and others contain at different stations distributing apparatus—as sunflowers—kept in synchronous rotation by electrically-controlled step-by-step devices, which give each of a series of local stations the use of a line-current for a portion of each increment of time during which the apparatus is in use. My invention generically belongs to the latter type, embodying a novel system of synchronism, by which distributing apparatus at different stations is kept in unison, and an independent system of signaling between the stations.

My invention consists in a system in which current-distributers or progressive circuit-closers are maintained in synchronism by electric motors having independent field-magnets and armature-circuits, one of which circuits in each motor is controlled by a line-current changed by reversal or interruption, or otherwise, at periods corresponding to the armature-revolutions, and the other of which circuits is excited by source of direct current.

My invention also consists in determining the rate of change in the controlling-current for synchronizing the motors by the revolutions of a controlling-motor, which sets the pace for the other motors of the system.

It also consists in a system of signaling over the same line-wire with a current of an electro-motive force which will not interfere with the synchronizing current and operation.

My invention embodies, also, other features, which will be hereinafter fully described in this specification, and definitely indicated in the appended claims.

In the accompanying drawings, which illustrate my invention, Figures 1 and 2 show diagrammatically two distant main stations from which radiate the connections with several local stations, the apparatus for one such local being shown.

As shown, Fig. 1 represents the apparatus in condition for sending, and Fig. 2 the apparatus in condition for receiving. The two station-equipments are nearly identical in arrangement, differing only in the connections of the synchronizing apparatus. Fig. 3 is a detail of the motor-armature at station Y.

The synchronizing apparatus consists of the following operative parts:

At the sending-station X is an ordinary direct-current electric motor, Mt', driven by an independent battery, M′ B′, provided with an armature of the ordinary Siemens H type, A′ A′. This armature is connected through the commutator c' c^2 and brushes $br+$ and $br-$ to the motor-battery M′ B′. The armature A′ A′, instead of being a simple closed coil, is broken at its middle point, and the two terminals thus formed are secured to the two insulated contact-rings r' and r', upon which the brushes b' and b' bear. To these brushes an external loop, l' l', including the coils of a polarized relay, P′, is connected. The armature-circuit A′ A′ is therefore closed through an independent external loop, l' l', forming an independent part of the armature-circuit.

From the operation of such machines it follows that an alternating current reversed at each half-revolution of the armature circulates in the loop l' l' as a result of the action of the two-part commutator c' c^2. These alternating currents cause the tongue or armature t' of the polarized relay P′ to vibrate between the contact-stops s' and s^3 at each reversal of current in the motor-armature A′ A′ and loop l' l'. The fixed end of this armature t' is attached to the main line L′ M′, extending from the station X to the station Y. The contact-stops s' and s^3, against which the vibrating tongue t' strikes at each reversal of current, are connected to the opposite poles of the line-battery L′ B′, Fig. 1, where it is connected to earth at E′ through the wire 13, the trailing brush T′, and other connections.

It follows from what has so far been described that as the motor-armature A′ A′, Fig. 1, revolves, the vibrating armature t' of the polarized relay P′ will move rapidly back and forth, beating the half-revolutions of the armature A′ A′, and at each half-revolution this vibrator will send a pulsation of current alternately positive and negative over the main line M′ L′ M^2 L^2 to the distant station from the line-battery L′ B′, to which it is connected through the contact-stops s' s^3. At the distant station Y or any terminal or way station the main line M^2 L^2 passes through or includes in circuit the coils of another polarized relay, P^2, Fig. 2, and the armature of this polarized relay will vibrate in unison with and respond to the vibrations of the relay at station X as the alternating pulsations of current are transmitted by the latter over the line from the battery L′ B′, and the relay P^2 at Y will therefore beat the half-revolutions of the armature of the motor Mt' at station X. Now the relay at the distant station Y has the fixed end of its vibrating tongue t^2 connected in the field-circuits k^2 k^2 by wire 21 of the motor Mt^2 at Y, the other terminal of the field-coils being connected to the middle point of the split battery M^2 B^2, the terminal poles of which are connected through the wires 21 and 41 to the contact-stops of the relay P^2. From these connections it follows that as the tongue t^2 of the relay P^2 at the station Y vibrates to and fro it will send alternate currents through the field-coils k^2 k^2 of the motor Mt^2 at station Y, and its field-magnetism will be reversed at each vibration of the tongue of the polarized relay P^2. Now the armature A^2 A^2 of this motor Mt^2 is supplied with a continuous direct current from the independent battery L^2 B^2 through the insulated contact-rings r^2 r^2, to which the armature-terminals are connected. Having thus a direct current in the armature and an alternating field, this motor will revolve and its armature will turn precisely one-half a revolution at each reversal of the field-current and magnetism of the field; but as this current and the induced magnetism are reversed by the polarized relay P^2 while moving in unison with the relay at station X, which latter beats the half-revolutions of the armature A′ A′ of the motor at that station, it follows that the two machines Mt' at X and Mt^2 at Y must revolve in unison with each other, the half-revolutions of the armature in one machine corresponding precisely to the half-revolutions of those in the other.

It will thus be seen that one of the motors sets the pace for all of the others and becomes a controlling agency by which the speed of all the others is regulated, any variation in the speed of one being instantly accompanied by a similar and equal change in the speed of all the others.

In order to make the controlled motors instantly and unerringly responsive in time and direction of movement to the controlling line-current, I provide its armature with two coils, A^2 A^2, at different lateral positions on the armature-spindle, but in the same magnetic field, the poles of these coils being set at right angles to each other, so that one pair of poles will always be under the influence of the magnetic field. Such in brief is the synchronizing device used in this system, and it is self-corrective in its tendencies, the machine exerting a positive effort to get into synchronism instead of getting out.

At each station the spindles of the motors either carry or are geared to an auxiliary spindle which carries a revolving trailing brush thus caused to sweep over a table of circular contacts or segments, $d+$ $d-$, and in both machines the gearing between the armature-spindle and the trailer is such that the trailer shall have a rate of speed suitable for a synchronous multiplex system of telegraphy. A single segment or any convenient portion of the entire circumference of the disk may be made to correspond to a single transmitted impulse of positive or negative current over the line from the local battery L′ B′. We may therefore designate the segments + and − in opposite halves of the ring, and it follows that a corresponding positive or negative current will be transmitted over the main line and through all the apparatus at each passage of the trailing brushes over that portion of the table of contacts according to which one of the two contact-stops s' or s^3 is in bearing with the tongue t'.

Having thus described the essential features of the synchronizing apparatus, the systems of circuits and connections for telegraphic transmission will be explained.

The fixed part of the segmental distributer $d+$ $d+$ $d-$ $d-$ is divided into a number of separate insulated segments equal to the number of branch circuits it is desired to connect to a single main line or some multiple thereof.

By the term "distributer" I mean a series of contacts or segments progressively engaged by contact device or brush, so that when the distributer is operated successive engagements of the contacts will be made with the brushes, and local branch circuits connected to the contacts will be successively connected to line.

A distributer is shown in the drawings of twelve branches, the necessary circuits for sending and receiving being drawn in detail for one of them only, the rest being simply a repetition of the one shown in detail. The local branches are connected to the distributer-segments, as shown at 1 2 3, &c., to 12. Each branch leaving the segment goes to a switch-center, W^2 W^{11}, &c., where an ordinary switch connects the branch to a sending or to a receiving wire, as desired. The circuits complete are shown for the branch or leg No. 2 at each station. In the following description it will be supposed that the trailing brushes T′ and T^2 at the two stations are revolving synchronously in the direction indicated by the curved arrows, and that they are, therefore, at any instant of time in contact with corresponding segments, and therefore connecting for the time being the circuits radiating from segments No. 2 at each station with each other through the main wire, the transmitting and receiving apparatus for that particular local branch, and the earth-return Rt′ and Rt^2. Each local branch therefore becomes a return branch for the current passing over line, by which it may again reach the transmitting-station. These return branches may be connected to a metallic return-circuit or may be grounded, as shown in the present embodiment of my invention.

Station X is represented as sending and station Y as receiving over the line and connections of branch No. 2, the switch W′ in Fig. 1 being turned to S′, through which the transmitting apparatus is connected in circuit, and the corresponding switch, W^2, in Fig. 2 being turned to R^2, through which the receiving apparatus is put in circuit with the main line. The sending apparatus at X, Fig. 1, consists, first, of the direct wire 14 14, which makes connection through the key K′, switch V′, and Ys′ direct with the earth at E′. The synchronizing-current has a low-resistance path through these connections and key K′ when the latter is on its back contact, said synchronizing-current being grounded at the station X by way of middle point of split battery L′ B′, wire 13, brush *b b*, trailer T′, local branches through the switch W′, wire 14, by way of key K′, switch V′, and earth, and through the shunt 15 15, which is placed in series with 14 and made the path for both the synchronizing and transmitting currents when the key is depressed, and the circuit 16 16 is closed through the front contact, *m′*, and battery N′.

I′ I′ is a generator of high-tension current. (Shown in the drawings as an ordinary induction-coil.) Its low-resistance coil—here made the primary—is connected in the circuit 16 16, including the battery N′, the circuit being completed through the vibrator *v′* and back contact, *y′*, thereof. Whenever the key K′ is depressed a pulsatory current is sent through the primary of the induction-coil by the make-and-break action of the vibrator *v′*, acted upon by the core Z′ of the induction-coil. The inductive action thus brought about sets up pulsatory currents of high electro-motive force in the secondary *p p* of the induction-coil, and this circuit, it will be observed, is always closed through the line-connections whenever the key K′ is depressed, the low-resistance circuit through the back contact and 14 to earth being first broken. As long as the key K′ is depressed, therefore, a series of rapid vibratory impulses of high electro-motive force is transmitted over the line as long as the trailer is on the segment No. 2. If, now, the trailer is given a speed of fifteen revolutions or contacts with the branch No. 2 per second, these series of vibratory impulses will be repeated in such rapid succession that the break in any sound thus produced could not be detected by the ear, and as long as the key remains depressed a buzzing sound would be produced by these impulses in a telephone-receiver.

The receiving apparatus connected in circuit at station Y is shown as an ordinary telephone, T^2 R^2, at station Y and T′ R′ at station X, though any instrument that would respond to high-tension currents might be used. Whenever a key in any local branch is depressed, a continuous "buzz" is heard in the telephone-receiver, which may be broken into Morse signals by the usual manipulations of the sending-key.

The sounders D′ and D^2 at the two stations are used for calling the sending-operator or "breaking." The pulsatory currents transmitted by the induction-coil when either key is depressed are so rapid and of such high electro-motive force that the sounder, or relay used to actuate the sounder, will not respond.

It will be observed, however, that at each successive contact of the trailer with a local-station segment a momentary synchronizing-current is sent to the line from the battery L′ B′, Fig. 1, and the relay will respond to these currents, and when switched into the low-resistance circuit, as shown at D^2, Fig. 2, this relay or sounder will attract its armature with each successive contact of trailer and segment, and will "chatter" as the synchronizing-current passes in rapid pulsations over the line, and may thus be used to call the attention of the operator, for if the switch V′ at X be momentarily removed from the contact 60 and the operator at Y have his switch W^2 on the sending-contact S^2 the relay or sounder D^2 will cease vibrating, and thus attract the attention of the operator at station Y.

It is evident from an examination of the system that it consists in the use of a comparatively low-tension battery-current sent alternately from opposite poles of the battery as a synchronizing-current, which is constantly maintained, the line being charged first with a series of plus waves of current and then discharged by a corresponding succession of minus waves.

The manipulation of any key in the system operates to superpose upon the existing waves of synchronizing-current a rapid pulsatory current of high electro-motive force which will traverse the wire independently of the synchronizing-current and without interfering with it, the effect of the latter being simply to produce a buzzing sound in the telephone-receiver as the diaphragm is alternately attracted and released by the rapid make and break of the pulsatory current sent from the secondary of the induction-coil to line.

Each distributer is provided with connections by which any desired local stations may be connected—that is to say, the connecting-wires for any pair of locals may be electrically attached to corresponding segments of the distributers. This may be done by an ordinary plug and flexible connection to connect with a segment, the plug being inserted in a holder, as shown at *j*, Fig. 1.

In Fig. 2 is shown a rheostat at R*h*, which is inserted between the main line and the branch to earth in order to balance the line with respect to the branch placed to earth at Y, so that this path to earth may be made equal to that at any other point along the main line where another distributer might be inserted.

It is evident that with a single-wire main-line circuit, as shown, the pulsatory currents must traverse all the resistances in the circuit, including that portion of the battery L′ B′ at the time furnishing the synchronizing-current. To avoid this a condenser, C, Fig. 1, is placed in a shunt around both halves of this battery. The pulsatory currents will readily traverse this resistance, while the synchronizing-current will take the path through the battery.

In a system such as I have described the synchronizing apparatus is entirely independent of the signaling system. The trailing brush is driven by or geared to the moving part of the motor, so as to give each operator the use of the line practically all of the time, and it is only necessary to secure certainty of action that a vibrator for the induction-coil be used having a proper rate of vibration to insure the signaling-current passing to line when the brush bears on any particular segment.

Another application filed by me, No. 289,025, October 24, 1888, contains a description of a system of multiplex telegraphy in which the circuit-breaking apparatus for the induction-coil, which in the present embodiment of my invention is a vibrating rheotome, is actuated by the trailing arm. In the other application is also described means for providing the synchronizing-current for a large portion of the time with a low-resistance path to ground at the station, so that the effect of said current will not be weakened by the resistance of the receiving apparatus.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a telegraph system, the combination of a line-circuit connecting different stations, synchronously-moving electric motors located at said stations, current-distributers driven by said motors, local branches successively connected to line by the distributer, a practically-continuous source of current for establishing synchronism, a source of current of different electro-motive force for signaling, and electric connections between said signaling source and the local distributer-segment, a controlling-key, and receiving-instruments to respond to said signaling-current, whereby the signaling-impulses are thrown upon the line during the continuance of the synchronizing-current.

2. In a telegraph system, the combination of a series of synchronously-moving motors located at different stations, a line-circuit connecting the stations carrying a practically-continuous low-tension current for controlling the motors, a series of current-distributers driven by the motors, local branch circuits successively connected to line by the distributers, an induction-generator for throwing high-tension currents on line, and electric connections between the induced circuit of said generator and the local distributer-segment, a controlling-key, and receiving-instruments at the several stations to respond to the high-tension currents.

3. In a telegraph system, the combination of a line-circuit connecting different stations, synchronously-moving electric motors located at said stations, controlled by a low-tension current on said circuit, distributers driven by said motors, local branches successively connected to line by the distributers, a switch for connecting each branch through a low-tension or a high-tension receiving-instrument, being normally on the low-tension branch, and a transmitting-instrument at each station for throwing high-tension current through the distributer and line into a desired local branch, whereby any desired local may be first called and then communicated with.

4. In a telegraph system, the combination of a line-circuit connecting different stations, synchronously-moving electric motors located at said stations, current-distributers driven by said motors, local branches successively connected to line by the distributers, a practically-continuous source of low-tension current for establishing synchronism, a calling-instrument in normally-closed relation to each branch, an induction-generator, electric connections between said generator and the local distributer-segment, a controlling-key, and a receiving-instrument at each station to respond to said high-tension current.

5. In a telegraph system, the combination of a line-circuit connecting different stations, synchronously-moving distributing apparatus at each station, a source of low-tension current for controlling the same, local branches successively connected to line by said distributing apparatus, an induction-coil at each station having its fine wire in shunt relation to the local branch, a receiving-instrument in each branch adapted to respond to the induced current, and a key for throwing current through the primary of the induction-coil and simultaneously rupturing the low-resistance branch of the shunt.

6. In a telegraph system, the combination of a line-circuit connecting different stations, synchronously-moving distributing apparatus at each station, a source of low-tension current for controlling the same, local branches successively connected to line by said distrib-

uting apparatus, an induction-coil at each station having its high-tension coil in shunt relation to the local branch, a vibrator for said induction-coil, a key for throwing current through the low-resistance coil of the induction-coil and to line, and a receiving-instrument in each branch adapted to respond to the induced currents.

7. A synchronizing system for multiplex telegraphy, consisting of a line-circuit connecting different stations, a current-changer in said line, controlled electric motors at the different stations having independent field-magnet and armature circuits, the polarity of one being constant and that of the other being reversed in accordance with the changes in the line-current, and a current-distributer driven by the moving part of each motor.

8. A synchronizing system for multiplex telegraphy, consisting of a line-circuit connecting different stations, a current-changer for reversing current in said line, a relay at each station actuated by the line-current, a local circuit periodically reversed by the armature of said relay, an electric motor having independent field-magnet and armature circuits, one of which is included in the circuit reversed by the armature of the relay, the other of which is excited by a current of one direction, and a current-distributer driven by the moving part of said motor.

9. A synchronizing system for multiplex telegraphy, consisting of a line-circuit connecting different stations, a controlling electric motor at one station, a series of controlled electric motors at the other stations, a pole-changer for the line-current operated by the controlling-motor, a relay at each station actuated by the reversals of the line-current, a local circuit periodically reversed by the armature of said relay, an electric motor having independent field-magnet and armature circuits, the field-magnet coils being included in the circuit reversed by the relay-armature, the armature-coils being excited by a current of one direction, and a current-distributer driven by said motor.

10. A synchronizing system for multiplex telegraphy, consisting of a line-circuit including polarized relays at different stations, a pole-changer for reversing current in the line, the armature of each relay playing between contact-points, a split battery having its two poles connected to the said contact-points, a motor having independent field-magnet and armature circuits, one of which circuits is connected to the relay-armature and the middle point of the battery, the other of which circuits is excited by a direct current, and a current-distributer driven by said motor.

11. A telegraph system comprising a main line connecting different stations, a current-controller for the line-currents periodically changing said currents, an electric motor at each station having independent field-magnet and armature circuits, a current-reverser operated by the line-currents for reversing current in one of said independent circuits, the other independent circuit being excited by a direct current, current-distributers at the several stations driven by the motors in a branch between the main line and return, and telegraphic transmitting and receiving instruments in each branch.

12. A system of multiplex telegraphy comprising synchronously-moving electric motors at different main stations, a line connecting said main stations and controlling the motors, a segmental distributer connected to line at each station driven by the motor, a series of return branches from the segments of the distributer passing through the several local stations, an inducing-generator for each branch having its induced circuit electrically connected with a local segment, and a key controlling the induced circuit, and a receiving-instrument at each local adapted to respond to the high-tension current.

13. A system of multiplex telegraphy comprising a main line connecting different stations, electric motors at the stations synchronously controlled by the main-line current, return branches at the stations including distributers driven by the motor, a low-tension receiver normally in the branch, an induction-generator and transmitting-key for throwing high-tension currents into the distributer and line, a high-tension receiver at each station adapted to respond to said high-tension current, and a rheostat in each branch.

14. A synchronizing system for multiplex telegraphy, consisting of a line-circuit connecting the different stations, electric motors at the different stations having independent field-magnet and armature circuits, the polarity of one being constant and having its poles ninety degrees apart, a current-changer in the line-circuit for reversing the polarity of the other independent circuit, and a current-distributer driven by the moving part of the motor.

In testimony whereof I affix my signature in the presence of two witnesses.

FRANCIS JARVIS PATTEN.

Witnesses:
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