(No Model.) 2 Sheets—Sheet 1.

P. B. DELANY.

MULTIPLEX TELEGRAPHY.

No. 440,768. Patented Nov. 18, 1890.

Fig. 1.

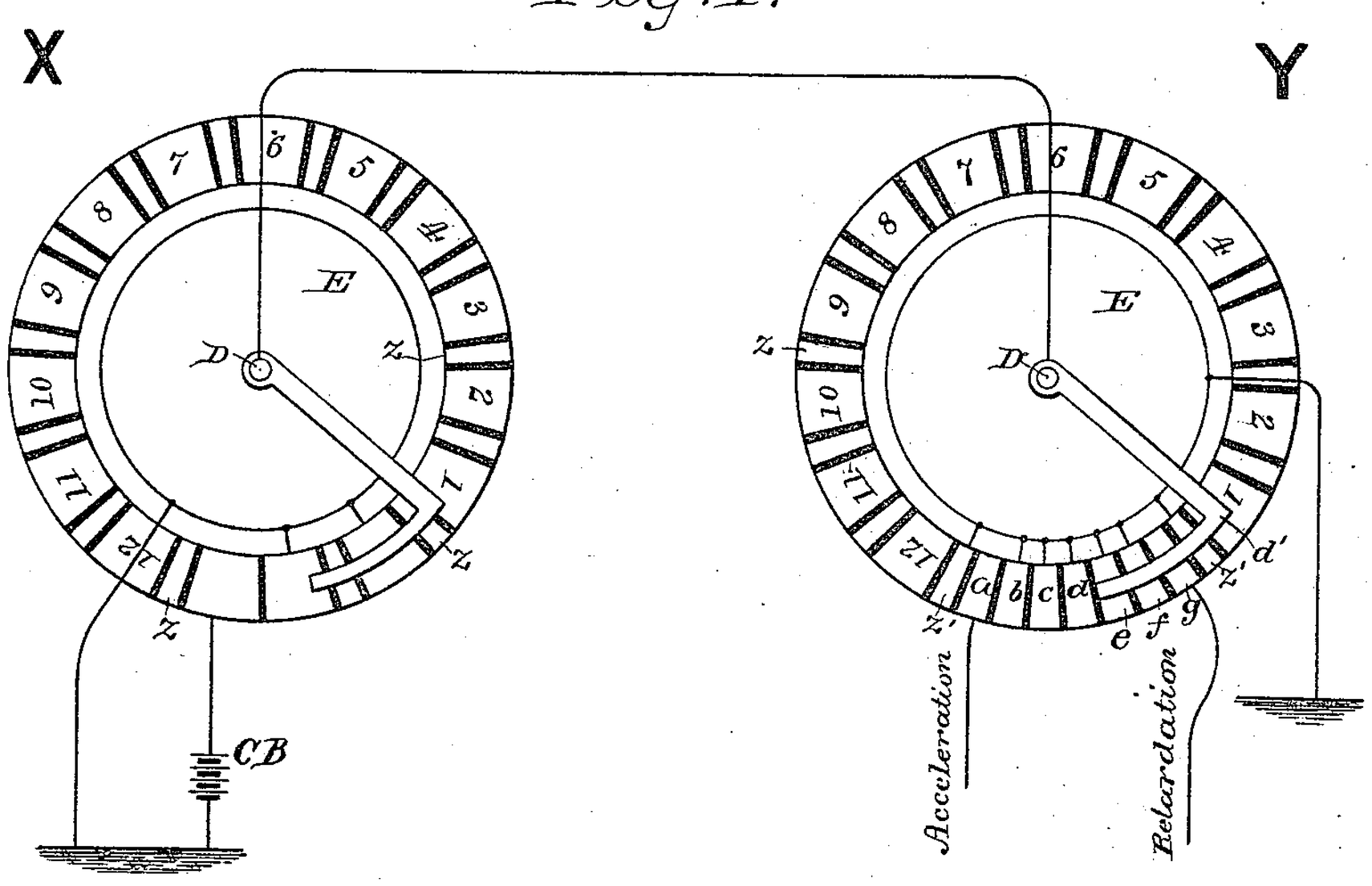
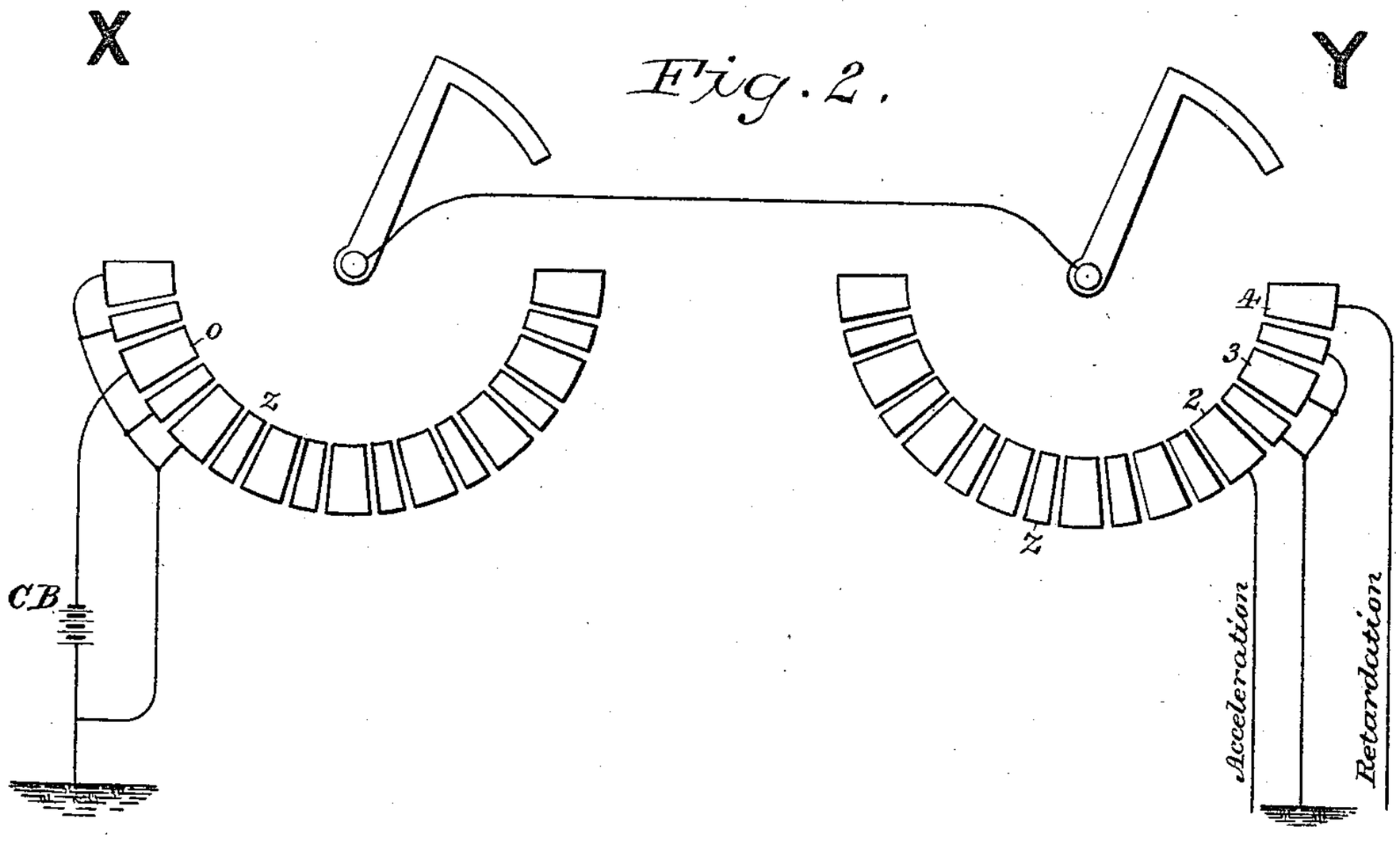


Fig. 2.



WITNESSES

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Fig. 3.

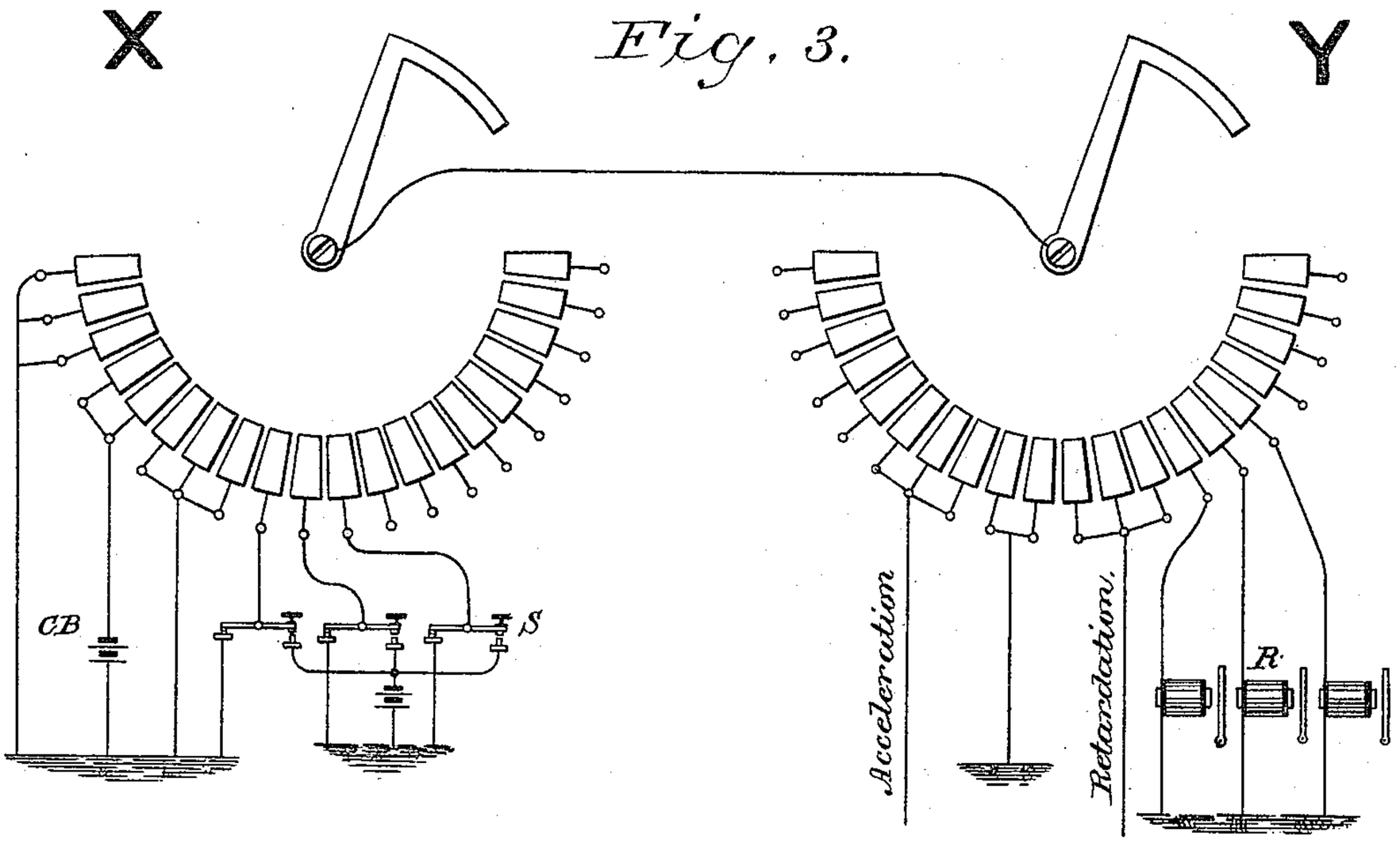
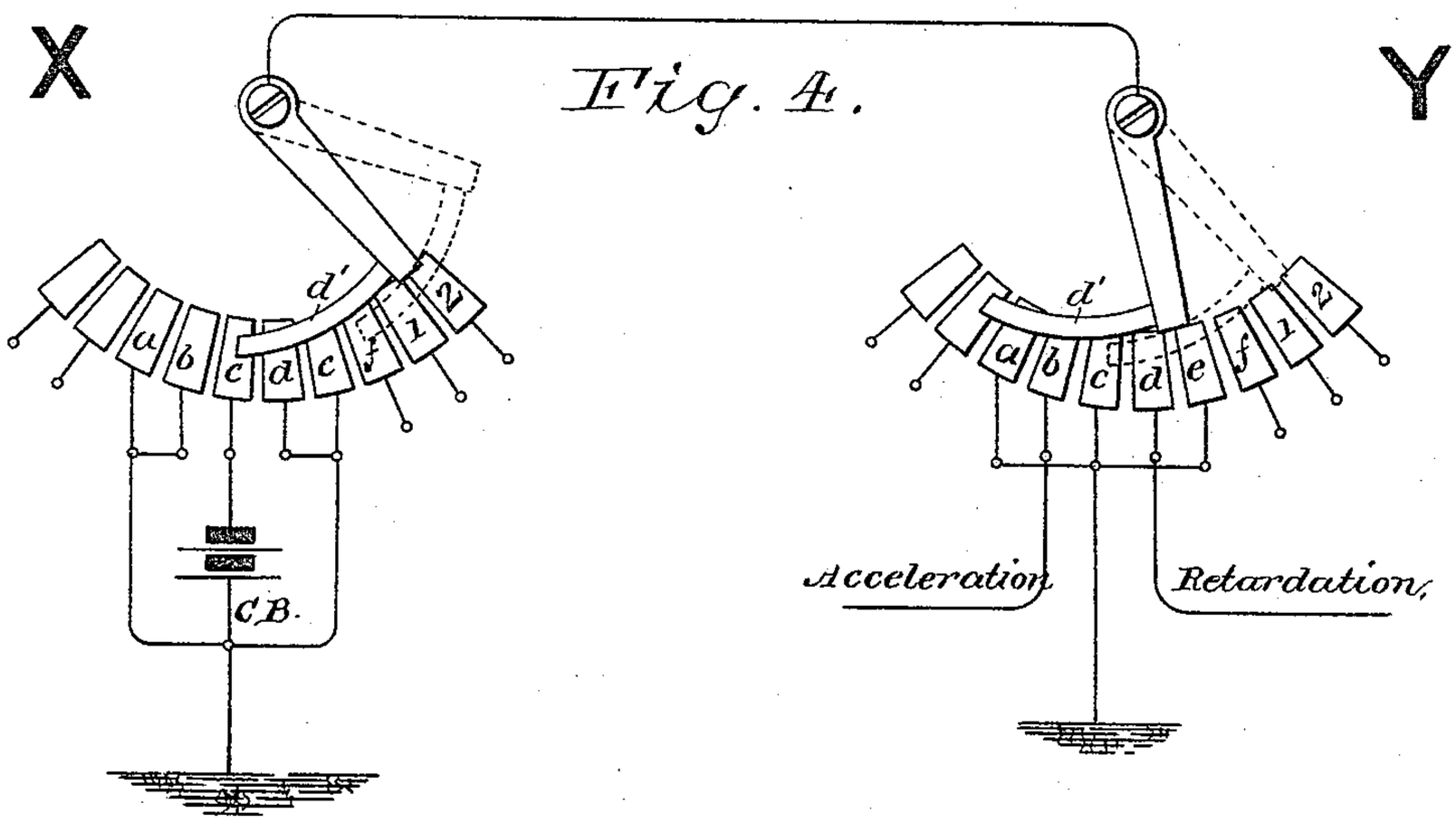


Fig. 4.



WITNESSES

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UNITED STATES PATENT OFFICE.

PATRICK BERNARD DELANY, OF NEW YORK, N. Y.

MULTIPLEX TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 440,768, dated November 18, 1890.

Original application filed July 30, 1886, Serial No. 209,557. Divided and this application filed December 9, 1887, Serial No. 257,440. (No model.)

To all whom it may concern:

Be it known that I, PATRICK BERNARD DELANY, a citizen of the United States, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in the art of Multiplex Telegraphy, of which the following is a specification.

This application is a division of my pending case, Serial No. 209,557, filed July 30, 1886, and I disclaim herein any subject-matter claimed in said case.

In various Letters Patent of the United States heretofore granted to me I have shown systems of synchronous telegraphy based upon the idea of splitting up or subdividing a main line into a number of independent circuits by means of synchronously-moving circuit-completers traversing over a circle of insulated segments at each end of the main line in such manner that all the sub-circuits can be simultaneously operated in either direction. In working such synchronous systems it has been considered necessary that the traveling circuit-completers rest at the same time upon corresponding segments—in other words, that the circuit-completers must at the same time rest on segments connected in the same sub-circuit, and the line must be such that a current sent into it at one end can reach and manifest itself at the other end during the time the circuit-completers remain in contact with said segments. Such an operation is suitable for short lines, and has the advantage that the pairs of operators on any sub-circuit can communicate in either direction at all times. But the system cannot be practically operated under the conditions above recited where the line is of such length, or where by reason of cables, underground wires, or other causes of increased resistance of the main line, the "time" or retardation of the line is such that with segments of reasonable practicable size—such as I have heretofore generally used—an impulse sent into one segment at one end of the line cannot reach and manifest itself on the segment belonging to the same sub-circuit at the other end of the line during the time that the circuit-completers are upon said pair of segments. This difficulty might be overcome by increasing the widths of the segments proportionately to the time of the line, but that would greatly decrease the transmitting or message capacity of the line and be objectionable for other reasons. Or other ways might be devised—for instance, in a pending application filed by me I have shown an organization for the purpose in which the feature of reciprocal communication over each sub-current is retained.

In operating the synchronous systems to which I refer, it has therefore always been a necessary condition that the circuit-completers rest simultaneously upon contacts with which the terminal instruments of a given sub-line are connected. The rotating circuit-completers must, therefore, be synchronous as regards their contact with the segments with which any given sub-circuit is connected, though they need not necessarily be synchronous as regards actual correspondence of position relatively to the points of the compass on the circles of segments.

My present invention is in part based upon the idea of transmitting impulses or messages over the line and sub-circuits in one direction only, and of receiving the impulses in their proper successive order upon segments which allow for the time of the line irrespective of the position or synchronism of the circuit-completers. In other words, provided the circuit-completers run isochronously, or make given revolutions in the same period of time, it is immaterial whether the circuit-completers are synchronous in either the sense of always occupying exactly corresponding positions with reference to the circle of segments, or synchronous in the sense of resting at the same moment upon segments connected in the same sub-circuit. For instance, in my present method of working, herein described, if the circuit-completers are run synchronously in either of the senses above mentioned, the operation would be as follows: If both circuit-completers rested at the same moment upon segments each numbered 1 and occupying exactly corresponding positions, a transmitted impulse sent into the line would not be

received upon the other segment No. 1, but would be caught upon that segment which was properly located according to the time of the line. Thus, if the time of the line were equal to one segment the impulse would be manifested on segment No. 2; and if the time were equal to two segments the impulse would be received on segment No. 3. Again, if the circuit-completers are not synchronous as regards correspondence of position—that is, if, for instance, at the transmitting end the circuit-completer rests on No. 1 segment at the moment the receiving-circuit completer rests on No. 4 segment—the transmitted impulse would in like manner be received upon that segment located beyond No. 4 in such position according to the time of the line, as to properly catch the impulse.

From what has already been said it will doubtless have been perceived that an impulse sent into the line through a segment having a given number may be received upon the segment having a like number, one circuit-completer being run ahead of the other. To restate the matter briefly, the transmitting-operators may all be working and a succession of impulses be sent into the line at one end as the circuit-completer traverses the segments, and at the receiving end of the line such successive impulses will in exact and proper rotation be received upon segments located so as to allow for the time of the particular line and irrespective of the numbers they bear.

In the accompanying drawings, Figure 1 is a diagram view illustrating circles of segments, trailers, or circuit-completers and an arrangement for maintaining the proper movement of the circuit-completers. Figs. 2, 3, and 4 are similar views showing portions of circles of segments and modified arrangements.

The trailers may be driven in the manner disclosed in my prior patents and geared up for higher speed, if desired, as described in my original case, Serial No. 209,557, filed July 30, 1886, of which this case is a division, or in any other suitable manner.

The message-segments are numbered from 1 to 12, and as viewed in the drawings those numbered alike occupy corresponding positions in the two circles.

The intermediate segments *z* are used for separating the message-segments, and also, when desired, for grounding the line. They are separate and independent of each other and of the other segments, and may individually be connected in any desired way to ground or otherwise.

Any suitable means for correcting the trailers may be used—for instance, the various methods shown in my prior patents or that shown in the original case, of which this is a division.

The correcting-impulses are all sent from one end of the line from X to Y, as illustrated in the figure, and may be either accelerating or retarding impulses, according to the position of the circuit-completer at the receiving-station. One correcting-impulse for each revolution of the circuit-completers will be ample. At station X three large segments similar to the message-segments are shown as devoted to the correction of the speed of the apparatus. The correcting-battery CB is shown as connected with the first one of these segments, and the other two may be grounded. At station Y the space corresponding to that occupied by the three correcting-segments at station X is occupied by a number of smaller segments—say seven, marked *a b c d e f g*—which may be the same size and preferably have segments *z' z'* arranged at each side of the group.

In the arrangement shown in Figs. 1, 2, and 3 provision is made for the time or retardation of the line, and the correction-receiving segments are displaced relatively to the battery-connected correction-sending segment at station X. The middle one *d* of the smaller segments is shown as grounded. Such segment is displaced according to the amount of retardation of the line—that is, if the circuit-completers are running in the same relation to the corresponding segments the current sent in at the battery-segment at station X will be delivered into the segment *d* at station Y. If the circuit-completer at Y, however, is tardy and rests upon the segment *a* at the moment the current manifests itself, a correcting-impulse of acceleration will be imparted to the circuit-completer-driving apparatus at station Y, and if the circuit-completer rests upon the segment *g* a correcting-impulse of retardation will be given the circuit-completer-driving apparatus at Y, as presently described.

The segments *z' z'* are preferably normally grounded, so as to keep the line free from any current as the circuit-completer comes upon the correcting-segments, and as the circuit-completer leaves such contacts to come upon the first message-segment, the other smaller segments may also be grounded, as shown, if desired to discharge the correcting-battery current from the line when the apparatus is running properly, and other segments than those mentioned may be connected for correction, according to the retardation of the line.

From what has been said it will have been perceived that it is entirely immaterial what point in the circle is selected for the location of the correcting-segments. In other words, as it is entirely immaterial whether the circuit-completers run synchronously as regards actual position or synchronously as regards resting upon exactly corresponding segments at the same time, the correction-receiving segments may be selected at any point in the circle. When both circuit-completers are running properly, the current sent in from the correcting-battery CB at the distant station will be delivered into the ground located be-

tween the accelerating and retarding segments. If the receiving-circuit completer is running out of time, then when the transmitted correcting-impulse has reached the circuit-completer and the circuit-completer touches the accelerating or retarding contact the speed of the receiving apparatus will be increased or diminished.

In Fig. 2 I have shown two connected stations, with a portion of a circle of segments at each station. In these circles the segments are the same size, whether they be for correction or messages, while the interposed ground-segments *z* are somewhat smaller. I might, however, make all the segments the same size and connect them for use in any manner desired.

Referring to Fig. 2, if I select segment marked O at station X for connection to the correcting-battery CB, I may select at the other station Y any segments desired. For instance, I may select Nos. 2 and 4 for connection to the accelerating and retarding apparatus, as indicated. In that event I would ground at the receiving-station segment No. 3, and also, preferably, the separating or ground segment on each side of it. This would give a ground-contact between the accelerating and retarding segments of considerably greater area than that of the segment O from which the correcting-impulse was sent into the line. A similar arrangement is exhibited in Fig. 1. This is a desirable feature, because the current will discharge at Y more slowly than it comes in at X, and by providing this enlarged area of ground-contact the line will be properly discharged between the correcting-segments 2 4 and not affect the retarding apparatus when the circuit-completer runs upon segment 4. I might connect a segment on the outside of the accelerating or retarding segment to the accelerating or retarding devices to catch all the correcting-current, if desired, thus providing an area of contact for the delivery of a correcting-impulse to the correcting devices larger than the segment from which the impulse was sent into the line; or I might connect the correcting-battery with two segments and the retarding or accelerating devices each with three segments, as shown in Fig. 3. In this figure the segments are all the same size. They may be connected as desired.

At station X, Fig. 2, I might, as shown, ground the separating or ground segment and the adjoining main segment on each side of the segment O, with which the correcting-battery CB is connected. This, however, is not necessary, and under some conditions by leaving these segments open a more marked effect will be produced at Y by the transmitted impulse.

Now in regard to the transmission of messages, such transmission should, in order to utilize the full capacity of the line, be in the same direction that the correcting-impulses are sent over the line—in other words, transmission should be from X to Y, as shown in the drawings. Operator's sending-instruments S may therefore be connected with each of the message-segments at X, and receiving-instruments R may be connected with each of the receiving-message segments at Y. If the time of the line is equal to the space between two message-segments, then a message sent on segment 6, for instance, would be received at Y on segment 7. If the time of the line is equal to two message-segments, then it would be received on segment 8. It will therefore be readily perceived that if all the operators connected with the message-segments at X should transmit simultaneously the transmitted impulses would be successively sent into the line, and the receiving-segments at Y being properly selected according to the time of the line such message-impulses would in proper and accurate succession be delivered through the proper segments to the receivers, and this irrespective of the position of the circuit-completers, provided they make a revolution in the same period of time.

In Fig. 3 I have shown the message-segments all the same size, and in both Figs. 2 and 3 have illustrated the use of several segments connected together so as to electrically constitute one segment; but obviously, so far as this part of my invention is concerned, the condition and operation will be precisely the same if the segments were made very much smaller and a suitable number connected together to give the required area of contact.

In the figures thus far described the trailers are shown as running together—*i. e*, in the same relation to the correspondingly marked or numbered segments. An objection to working according to this plan is that one or more of the message-segments to the left of the correcting-segments as viewed in the drawing must be idle, because if a message-current were sent into such a segment it would be delivered into some one or more of the correcting-segments at the receiving end of the line, and thus prevent the proper running of the apparatus.

At the beginning of this specification it is stated that one circuit-completer may be run ahead of the other. Such an arrangement is shown in Fig. 4 and has certain advantages over those above described. In that figure the segments are shown as of same size. They may of course be made of any desired size and connected to accomplish the desired results, as fully stated above in connection with the other figures. As before, two stations X and Y are shown. The correcting-segments at both stations are marked *a b c d e f*. At the correction-sending station X a segment *c* is connected with the correcting-battery, the segments *a b* on the left and *d e* on the right being grounded. At station Y segment *c* is grounded, *b* connected with acceleration devices, *d* with retardation devices, and *a* and *e*

are grounded. Segment *f* may be left in the air or grounded, or if it is desired to have two segments connected to the correcting-battery and two to the corresponding ground at Y the segment *f* may be utilized. As shown, the trailer at X is running ahead of that at Y, the difference between them depending on the time of the line. Thus assuming the time of the line to be three segments, while the trailer at X is on correcting-battery segment *c*, trailer at Y is on the segment ahead of *a;* but by the time the latter trailer reaches *c* the current from the correcting-battery has arrived and is discharged into the ground. The relative positions are clearly shown by the full and dotted lines. If trailer at Y is tardy, the current from CB will be delivered into the accelerating devices connected with *b*, and if too fast into the retarding devices connected with *d*. Of course the message-currents are transmitted in the same way—that is to say, an impulse sent into the line at X through any message-segment would arrive at Y by the time the trailer there had reached the corresponding segment and would be delivered through said segment to the receiving-instrument corresponding with the transmitter from which the impulse was sent. With this plan there is no idle space in the circles, because the received current, either for messages or correction, is delivered into segments corresponding with those from which the current is sent out. It will also be noted that the trailers automatically adjust themselves to the time of the line, for when they are started to rotating the trailer at Y will be accelerated or retarded until it finds its true relation to the trailer at X and delivers the current from CB into the ground through segment *c*.

Changes in the condition of the circuit affecting its time arising from atmospheric or other causes are automatically compensated, because if a change tending to reduce the time of the line occurs the current from CB will reach the trailer at Y while it is still upon segment *b*, and the trailer will be accelerated and the distance between the two trailers correspondingly reduced. A corresponding retarding effect is produced by the retarding devices if the time of the line should increase. The instruments, therefore, are adapted to any lines, and no special adaptation or change is required to work them on any circuit.

In starting the apparatus both trailers are caused to rotate at what is approximately the same speed, and if necessary, the speed of trailer at Y may be slightly adjusted until the correcting-impulses are delivered into the ground through segment *c*.

The advantages of my improved method of working, besides those above mentioned, are that a great number of circuits may be worked over any given line and the received impulses will be strong and effective, because all the current arriving at the receiving-station is delivered into the receiving-segment, and not partly into adjoining ground-segments, as is the case when operating in both directions under my patented system.

The special apparatus above described is not essential to the practice of my improved method of working, though I deem it specially well adapted for the purpose.

The apparatus shown in my prior patents might with little, if any, change be worked according to my present plan, though there would be certain objections to it. Two main lines could be used advantageously—one for sending, the other for receiving—and the operators' instruments arranged in relation to each other, similar to the common disposition of quadruplex lines, so that the operator receiving on No. 1 circuit of one wire may break the operator on No. 1 circuit of the other wire. This is a common arrangement in quadruplex telegraphy and needs no illustration.

No claim is made herein to the broad idea of sending an impulse from one segment and receiving it on another so displaced relatively to the sending-segment as to allow for the time of retardation of the line, as such subject-matter is claimed in another pending application filed by me.

I claim—

1. As an improvement on that system of multiplex telegraphy in which moving circuit-completers traverse over series of insulated contacts at each end of the line, whereby the line is split up into separate circuits, the method, substantially as set forth, of operating on long lines, which consists in sending impulses of electricity into the line in succession in one direction only and irrespective of whether each preceding impulse has reached or been delivered at the receiving-station, and receiving such impulses as they arrive at the distant end of the line in their proper succession, according to the time of the line.

2. The herein-described improvement in that system of multiplex telegraphy in which circuit-completers traverse series of insulated segments at each end of the line, whereby the line is split up into separate circuits, which improvement consists in running the circuit-completer at the transmitting end ahead of that at the receiving end a distance proportional to the time or retardation of the line, sending electrical impulses into the line at the transmitting end as the circuit-completer crosses the segments, and receiving such impulses by the time they reach the receiving end of the line upon corresponding segments.

3. The herein-described improvement in that system of multiplex telegraphy in which circuit-completers traverse series of insulated segments at each end of the line, whereby the line is split up into separate circuits, which improvement consists in running the circuit-completer at the transmitting end ahead of

that at the receiving end a distance proportional to the time or retardation of the line, automatically correcting the relation of the circuit-completers to each other to compensate for changes in the time of the line, sending electrical impulses into the line at the transmitting end as the circuit-completer crosses the segments, and receiving such impulses by the time they reach the receiving end of the line upon corresponding segments.

In testimony whereof I have hereunto subscribed my name.

PATRICK BERNARD DELANY.

Witnesses:

EDWARD C. DAVIDSON,

FRANCES M. GIBBS.