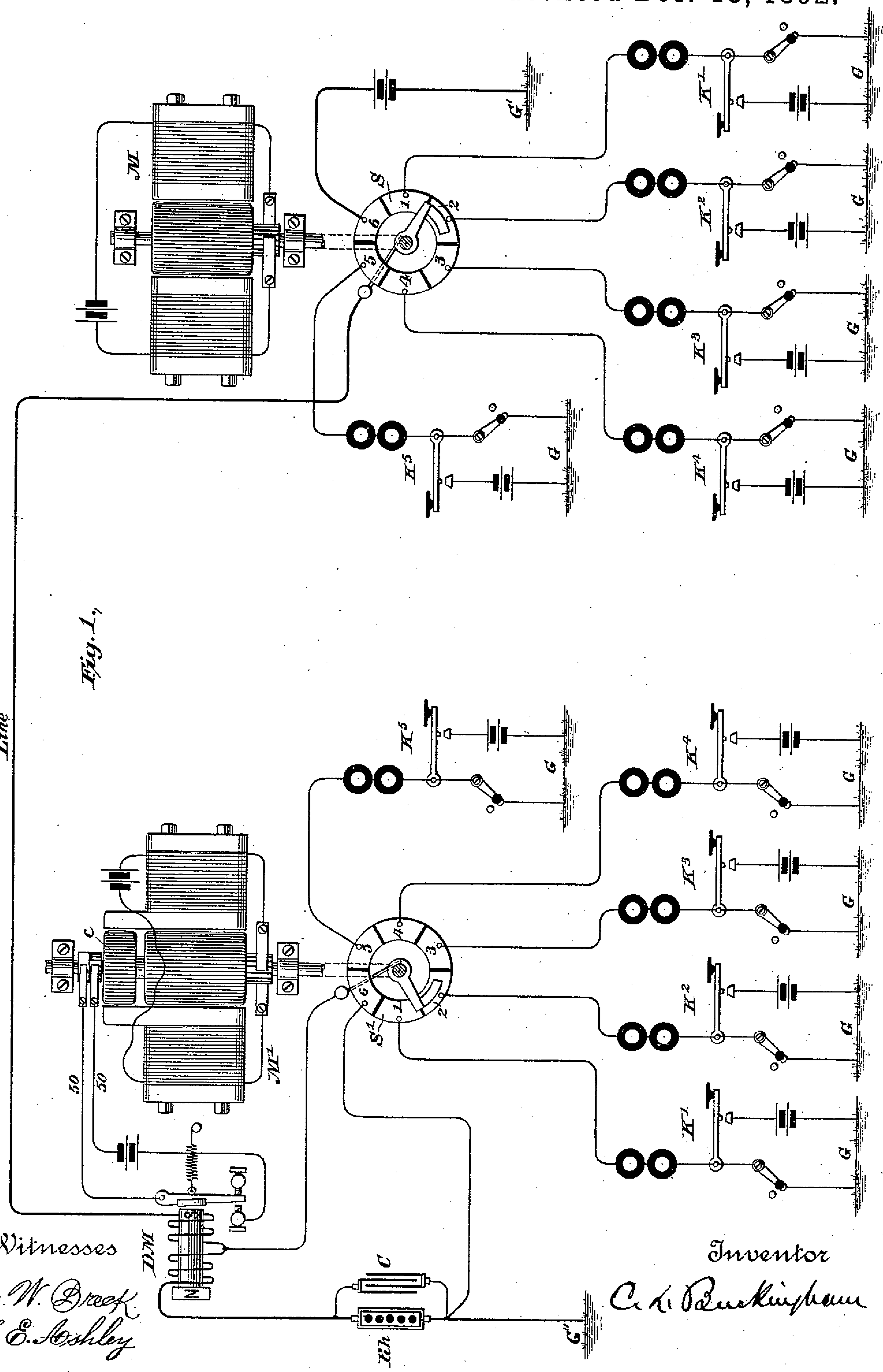
(No Model.)

2 Sheets—Sheet 1.

C. L. BUCKINGHAM.

SYNCHRONOUS MULTIPLE TELEGRAPH.

No. 487,984. Patented Dec. 13, 1892.



Witnesses

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

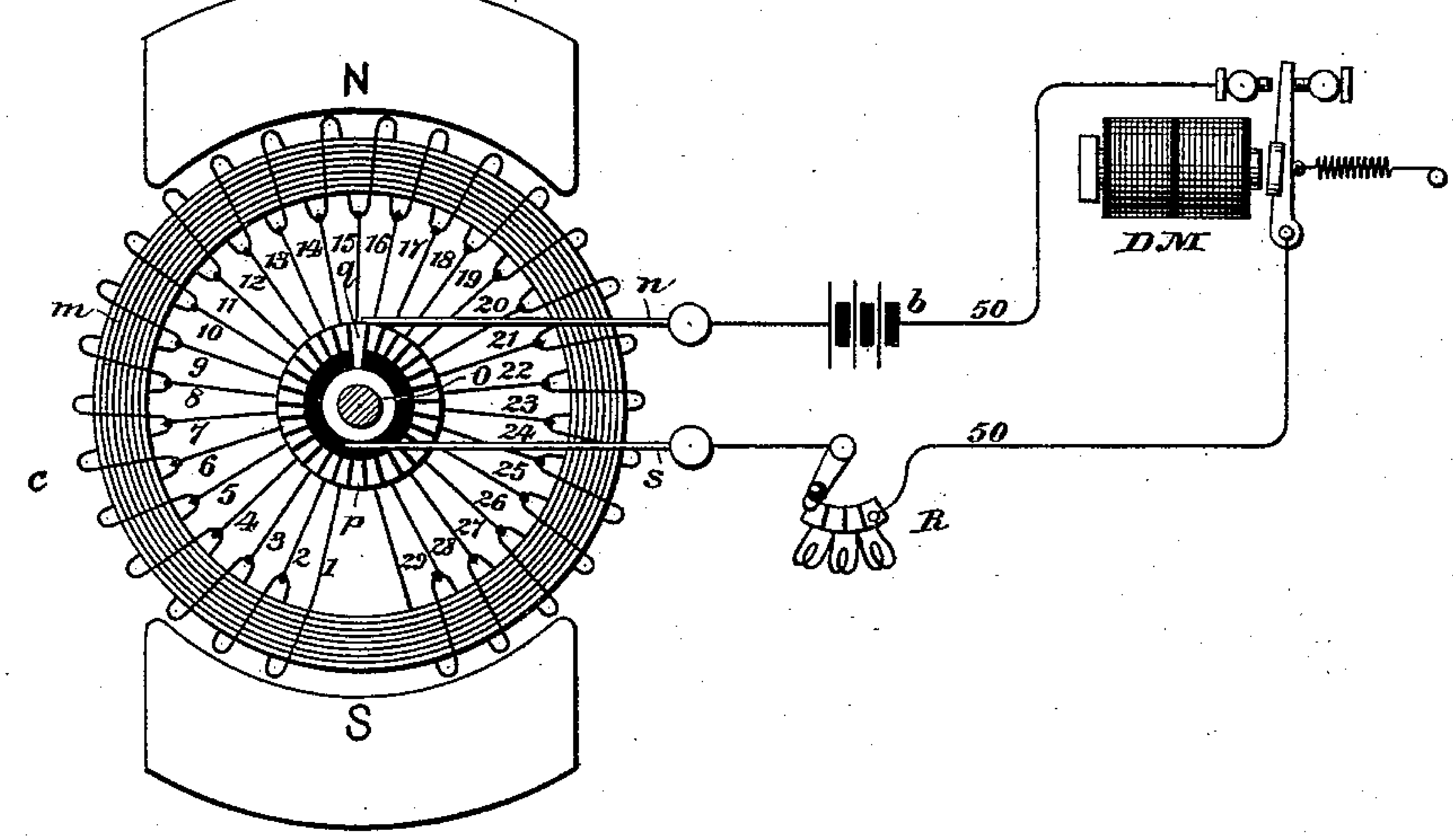
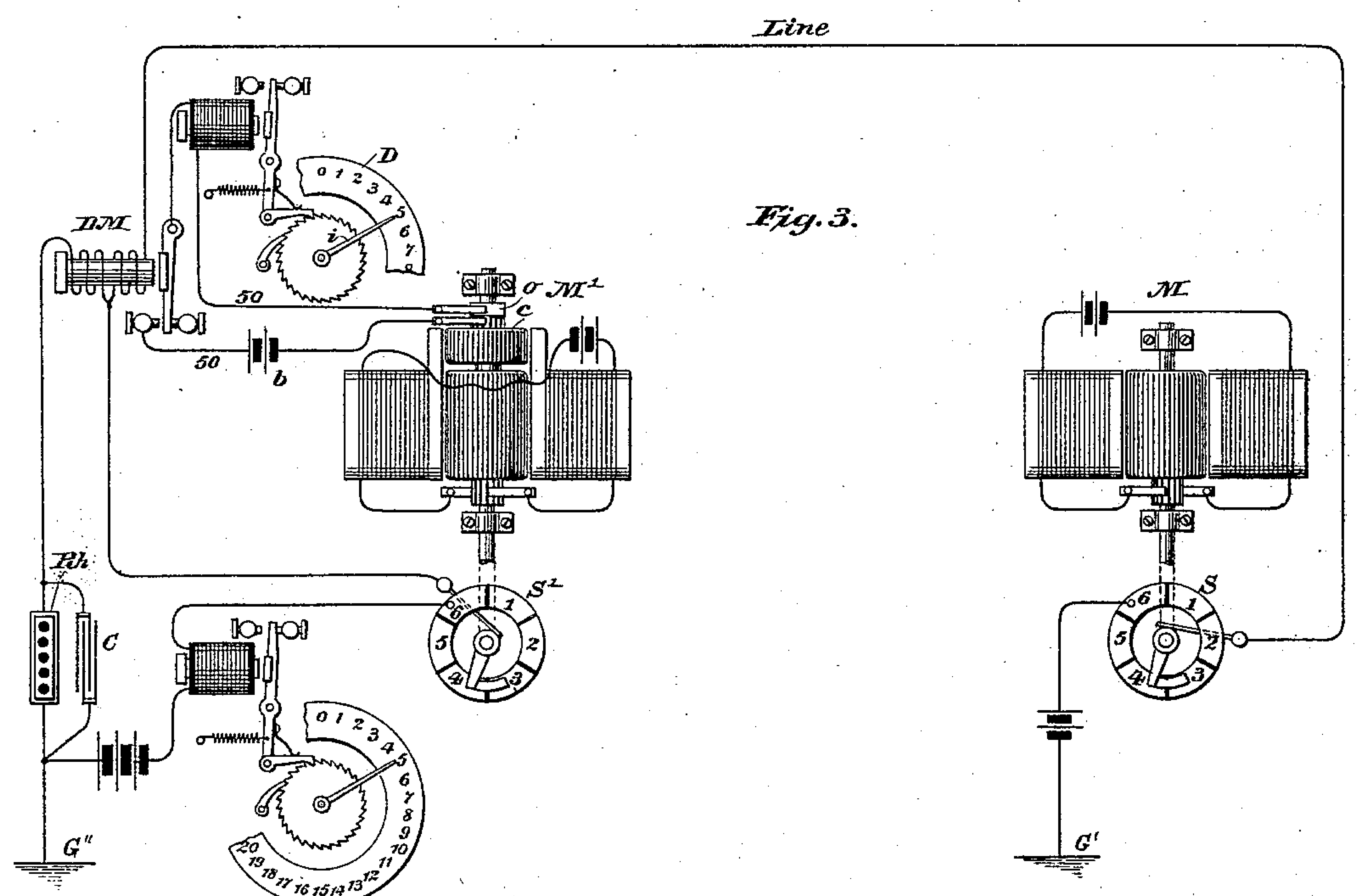


Fig. 3.



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UNITED STATES PATENT OFFICE.

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SYNCHRONOUS MULTIPLE TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 487,984, dated December 13, 1892.

Application filed April 30, 1890. Serial No. 350,006. (No model.)

To all whom it may concern:

Be it known that I, CHARLES L. BUCKINGHAM, a citizen of the United States of America, residing in the city, county, and State of New York, have made a new and useful Improvement in Synchronous Multiple Telegraphs, of which the following is a specification.

Heretofore synchronism has been established between rotating arms at the two ends of a line either by employing some of many transmissions for unison and the remainder for the sending of messages, as in the Delany system, or by using a continuous series of pulses to preserve unison and other values of current, either greater or less, for telegraphing. Patten employs a continuous series of weak pulses of alternating polarity for synchronism, while telegraph-signals are simultaneously transmitted by increasing the current strength. By my improvement the arms at the two stations are synchronized by periodically transmitting from the receiving end of the line a pulse to the transmitting end, which there operates upon a relay controlling an adjusting mechanism, and it is by this means that a correcting-motor, which is geared with one of the trailing arms, is made once during each rotation of the other arm to exercise either an accelerating or a retarding influence. The correcting-motor is so constructed that when its armature occupies a certain position, it then requiring no adjustment, the closing of the local circuit by the synchronizing-relay produces no effect upon the motor. If, however, the armature is moving too fast, there will be a path through the motor, by which the latter becomes an active agent to retard the speed of rotation, and in the same manner if the armature be moving too slow there will be another path through the motor, such as to cause it to rotate more rapidly. As will be hereinafter seen, the synchronizing-relay cannot be placed at the receiving-station, either in the main line or in one of the branches. If the relay were placed in the main line, it would constantly respond to telegraph-pulses, thus closing the local circuit of the synchronizing-motor out of time and deranging its action. Likewise if the relay were placed in a branch from one of the contacts of the circular series of segments and a corresponding branch at the transmitter were provided with battery, the arrangement would be inoperative, for in this case the relay would not close its contact when the arms were running out of unison. It would only operate when the arms at the two stations were in synchronism or when correcting effects were not at all needed.

My invention also relates to improved means for determining whether or not the trailing arms at the two stations are rotating at equal speeds.

I will now describe my invention by reference to the accompanying drawings.

Figure 1 is a diagram showing a multiple synchronous-telegraph system with an independently-actuated motor at each station for rotating the trailing arms. Fig. 2 represents a correcting-motor appended to a driving-motor to cause the latter to rotate more slowly or rapidly and to thus keep time with the trailer at the receiving-station. Fig. 3 is a diagram of apparatus employed at the two stations to show the relative rates of the rotating arms.

In Fig. 1 I have shown six segments in the circular series of contacts over which the trailing-arms rotate, and to five of these segments are connected conductors in which are placed keys K′ to K^5, and relays making in such case a set of operator's instruments. At the transmitting-station segment 6 is connected to earth G^2, while at the receiving-station segment 6 is connected to the battery branch extending to earth G′. At the transmitting-station the trailer is geared with the shaft of an electro-magnetic motor M′, the latter being continuously actuated by a local battery, while an independently-actuated motor M is also employed at the receiving-station, it having as nearly as possible a speed of rotation equal to that of M′. To keep the two motors in unison, however, I place upon the shaft of M′ the armature *c* of a correcting-motor, whose field-poles, as here shown, are extensions from the field-magnets of M′. This auxiliary motor is so designed that when in a certain position—a position of adjustment—if the local circuit 50 be closed, no current will find a path through its armature. In most positions, however, whether at one side or the other of this point there will be a current formed through some of its coils.

Referring to Fig. 2, I have shown a modified Gramme-armature motor consisting of two field-poles, an annular iron armature, and a continuous winding broken at one point. This armature is provided with an ordinary sectional commutator p, the segments, all but one, being connected to the armature-coils by wires numbered from 1 to 29. The segment q, connected with wire 15, however, is prolonged and is in metallic connection with a ring o, against which bears the spring s, the latter also being in electrical connection with the pivotal bearing of the armature-lever of relay D M. Spring n bears upon commutator p and is connected to one pole of the battery b and to the front contact of relay D M. It is now seen that if the relay-armature were attracted when the motor-armature is in the position shown in Fig. 2 the current from battery b would not find a path through any of the coils of the motor-armature, the circuit from brush n to s in this case being formed through segment q and ring o. If, however, the motor armature were rotated to the left there would be a circuit through the coils to the right of wire 15 and through as many of them as are represented by the displacement which the armature has undergone. A circuit would likewise be formed through coils at the left of wire 15 if the armature were thrown to the right. It now being remembered that the shaft of the motor-armature is rigidly fixed to the trailing arm at the transmitting-station, it is seen that if the arms at the two stations are rotating in synchronism segment q will be in contact with brush n while said arms are in contact with segments 6. It is obvious that current will not under this condition flow through any of the coils of the auxiliary motor-armature. If, however, the trailer at the correcting-station were rotating too rapidly from right to left current would flow through some of the motor-coils at the right of wire 15. If the trailer were rotating too slowly, current would flow through some of the coils to the left of wire 15, and there would be a circuit through more or less coils, according as the trailer was far or only a little way out of adjustment. If the trailer were out of adjustment one-quarter of a rotation, of course current would flow through coils covering one-quarter of the armature-annulus, and, indeed, a circuit might be formed through the entire number of coils either at the right or the left of wire 15. With this arrangement it is obvious that when the trailer and correcting-armature are far out of adjustment a large number of coils are brought into circuit, thus producing a very strong correcting effect, and that the number of coils brought into action diminishes with the necessity for adjustment. Owing to this fact the armature of the correcting-motor is gradually worked into a position of adjustment, the adjusting effects being of a diminishing amount, and, as a consequence, a corrective force tending to throw the armature over the line of adjustment from too fast to too slow or from too slow to too fast is avoided.

As has already been stated, a battery branch from segment 6 is joined to earth at the receiving-station, while at the transmitting-station is a corresponding branch which is unprovided with battery. Relay D M and the correcting-motor, as already stated, are placed at the transmitting-station rather than at the receiving-station, because if they were placed at the latter the telegraphic pulses would derange adjustment; but in order that the relay may not be actuated by pulses at the transmitting-station it must be given a duplex character. This I have done by making it of the differential form, connecting one of its coils with an artificial line having a resistance Rh and a condenser C, as is ordinarily done in duplex telegraphy. Any of the many well-known forms of duplex relay may be used.

The system thus far described contemplates the transmission of messages in one direction only and a series of transmitting-instruments K′ to K^5 at one station and a corresponding series of receiving-instruments at the other end of the line; but messages may also be sent in the opposite direction if the currents employed be of such a character as not to operate the synchronizing relay, thereby causing the correcting-motor to operate out of time. This difficulty is obviated by polarizing the synchronizing relay D M, and by employing a battery in the branch leading from segment 6 of a polarity opposite to that of the batteries used for telegraphing from the same station. If, for example, relay D M is so polarized that it will respond to positive and not to negative currents, only negative currents can be used to telegraph toward the station at which the relay is placed. In this manner messages may be sent from both stations simultaneously, or all from the right to the left station. As shown at the right station, the branch leading from segment 6 presents positive polarity to line to work the synchronizing relay. The transmitting-batteries brought into action by keys K′ to K^5, therefore, must be of negative polarity in order that they may have no influence upon the synchronizing relay.

In Fig. 2 I have shown a hand-switch by which more or less resistance can be brought into circuit 50 to regulate the effect of battery b upon the correcting-motor.

In Fig. 3 I have shown means by which it may be determined visually whether the trailing arms at the two stations are rotating at the same speed. In the local circuit 50 I place an electro-magnet whose armature-lever carries a driving-pawl at one end which acts upon the teeth of a ratchet-wheel to rotate an indicator-arm i over a dial. A similar arrangement is operated by the branch circuit leading from segment 6 to earth G^2; but in this case the branch must be provided with a battery. It is obvious that the ratchet controlled by circuit 50 is moved step by step with each rotation of the trailer at the distant station, and thus it is seen that as arm *i* passes over the figures of dial D we are able to determine at what speed the trailing-arm at the distant station is being moved. The indicator controlled by the branch leading from segment 6 at the home station also indicates the speed at which the trailing-arm at the home station is rotating, and by comparing the movement of the two indicators we may determine approximately whether the two trailing-arms are running at the same speed. If one is running more rapidly than the other, adjustment may be principally effected by adjusting the hand-switch shown in Fig. 2, and their rates having been brought to almost equal each other they may then be left to the automatic correcting devices to further equalize their speeds and to keep them in synchronism.

I do not limit myself to the use of the particular kind of motor hereinbefore described as included in the correcting-circuit for effecting the synchronism, inasmuch as any other means suitable for the purpose might be employed in the local correcting-circuit controlled by the relay for effecting synchronism, my invention, so far as this part thereof is concerned, consisting, broadly, in the combination, with the synchronously-operating transmitter and receiver, of a duplex relay at the transmitting-station, an actuating-motor for the transmitter, a local correcting-circuit at such station, a duplex relay for controlling said local circuit, and a synchronizing-battery branch at the receiving-station intermittently closed by the operation of a motor thereat.

What I claim, and desire to secure by Letters Patent, is—

1. In a synchronous multiple telegraph, a synchronizing arrangement consisting of a battery at the receiving-station, a duplex relay at the transmitting-station, a local circuit, and a unison-motor controlled thereby, substantially as described.

2. In a synchronous telegraph, a synchronizing arrangement consisting of a battery in a branch at one station, a duplex relay at the other station, a local circuit, and a unison-motor controlled thereby, substantially as described.

3. In a synchronous telegraph, an independently-actuated motor at each station, a correcting-motor and a duplex relay for controlling the speed of one of said motors, and a synchronizing-battery at a distant station, substantially as described.

4. In a synchronous telegraph, an independently-actuated motor for driving a rotating arm at each station, a synchronizing-relay and a correcting-motor at one station, the armature of the correcting-motor being so constructed that a circuit will be found through certain coils when it is rotating either too fast or too slow, but not otherwise.

5. In a synchronous-telegraph system, an independently-actuated motor M′, geared with a trailing arm, a correcting-motor having an armature *c*, provided with a broken Gramme winding, a sectional commutator *p*, a ring *o*, electrically connected with segment *q*, brushes *s n*, relay D M, and a battery at the distant station for operating the same, substantially as described.

6. In a synchronous telegraph, the combination of a trailing arm at one station, adapted to rotate over a circular series of electrical contacts, an actuating-motor M′, geared with said arms, a correcting-motor whose armature *c* is provided with a broken winding and is mounted upon the same shaft, a sectional commutator, and a ring with which one of the segments of the sectional commutator is electrically connected, and contact-brushes *s n*, substantially as described.

7. In an electro-magnetic motor, the combination of a ring-armature which is provided with a broken winding, a sectional commutator *p*, a ring *o*, a prolonged segment *q*, and brushes *n s*.

8. In an electro-magnetic motor, the combination of an armature provided with a broken series of actuating-coils, a sectional commutator *p*, ring *o*, brushes *n s*, and a local circuit for actuating said motor, whereby the actuating-current will find a path through certain coils and in such manner as to give it a tendency to rotation either in one direction or the other, substantially as described.

9. In a synchronous-telegraph system, two indicators at one station controlled, respectively, by the rotating arms of the synchronous telegraph, one at each end of the line, whereby it may be determined whether the telegraph apparatus at opposite ends of the line are rotating at equal speeds, or approximately so.

10. In a synchronous multiple telegraph, two independent step-by-step indicators operated, respectively, by pulses transmitted over the telegraphic circuit from the distant station and by pulses which are called into action by a device moving synchronously with the telegraph apparatus at the same station.

11. In a synchronous multiple telegraph, a sunflower or its equivalent at each station, a synchronizing device insensible to telegraphic current transmitted from the same station as well as to telegraphic currents from the opposite station, and means for transmitting synchronizing-pulses from such opposite station independently of the telegraphic currents.

12. The combination, with the synchronously-operated transmitter and receiver, of a duplex relay at the transmitting-station, an actuating-motor for the transmitter, a local correcting-circuit at such station, a duplex

relay for controlling said local circuit, and a synchronizing-battery branch at the receiving-station intermittently closed by the operation of a motor thereat.

13. In a synchronous telegraph, a synchronizing arrangement comprising a generator in a branch at one station and a duplex relay at the other station controlling a local circuit for correcting devices at the same station with said relay, as and for the purpose described.

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Witnesses:
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