(No Model.)

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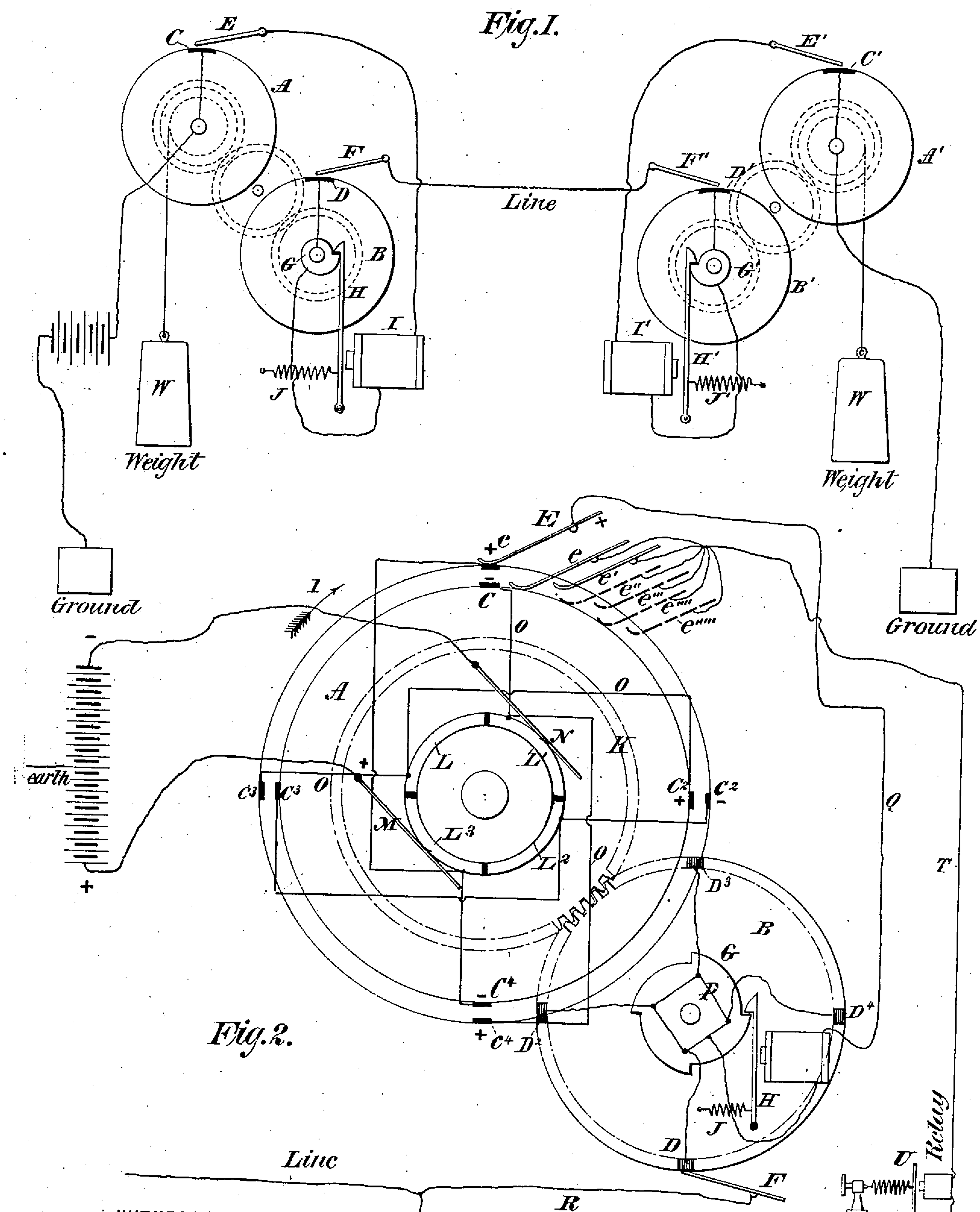
A. M. A. BEALE.

TELEGRAPHY.

No. 360,987.

Patented Apr. 12, 1887.



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4 Sheets—Sheet 2.

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Fig. 4.

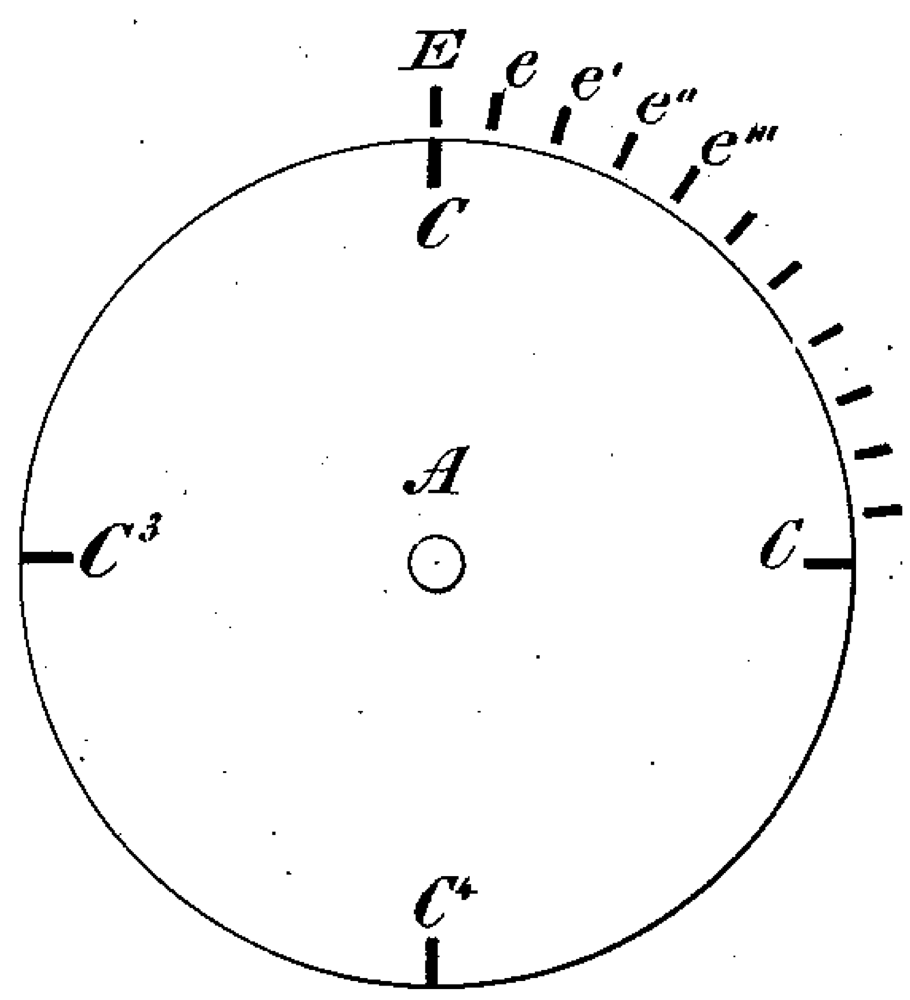

Fig. 5.

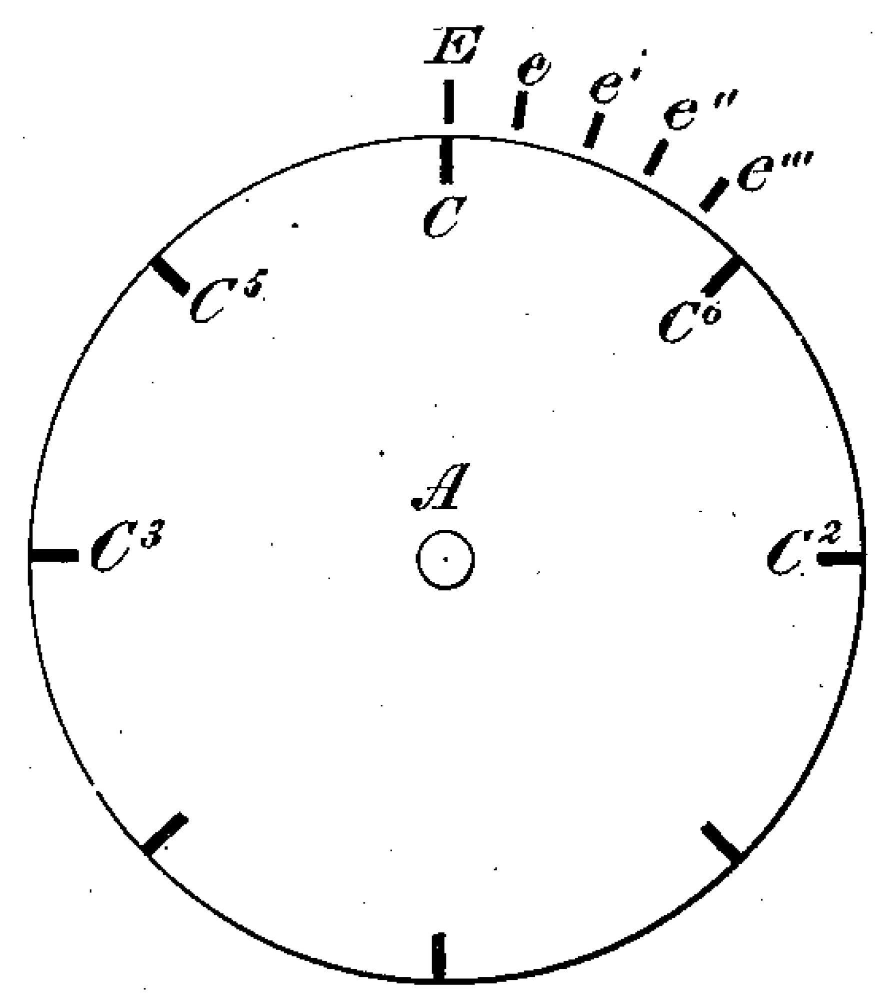

Fig. 3.

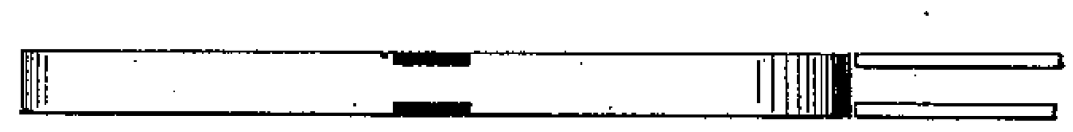

Fig. 8.

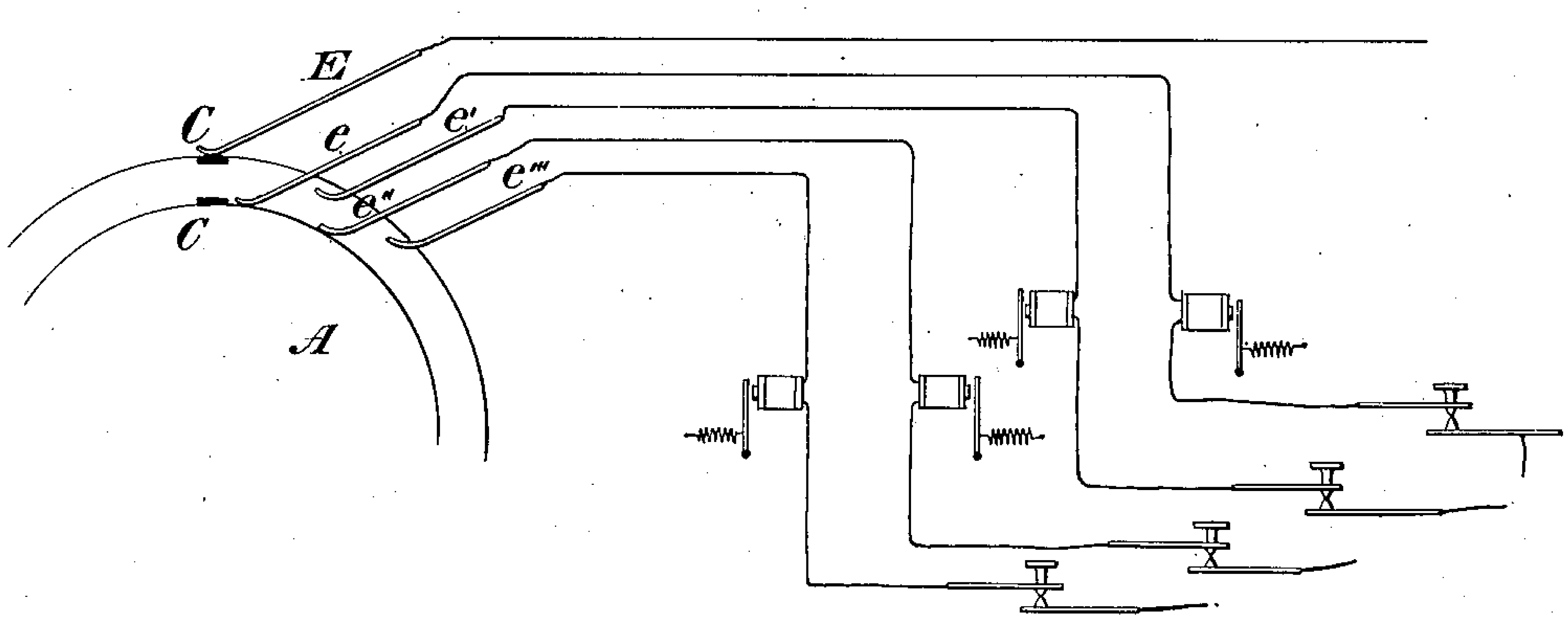

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Fig. 6.

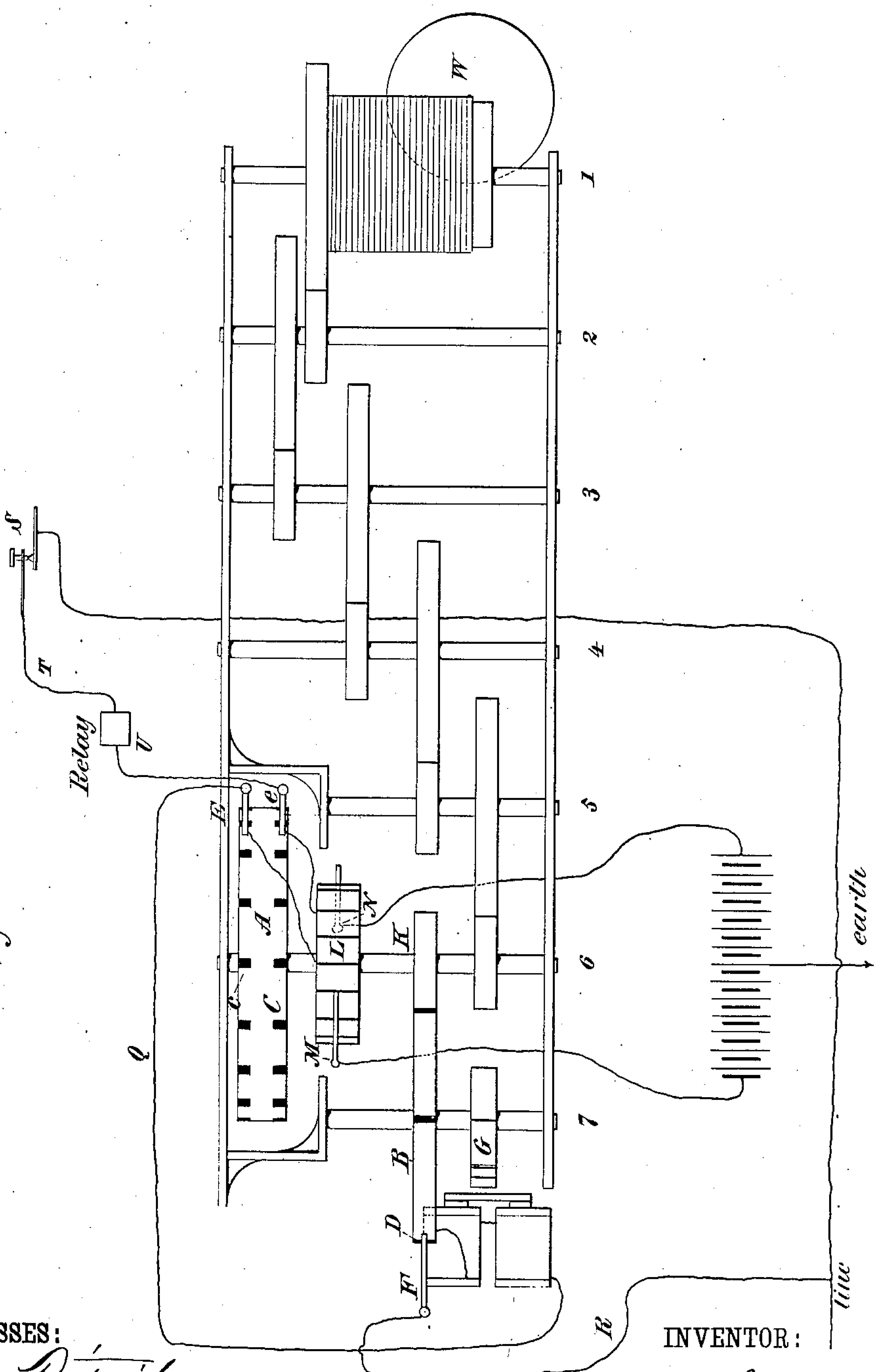

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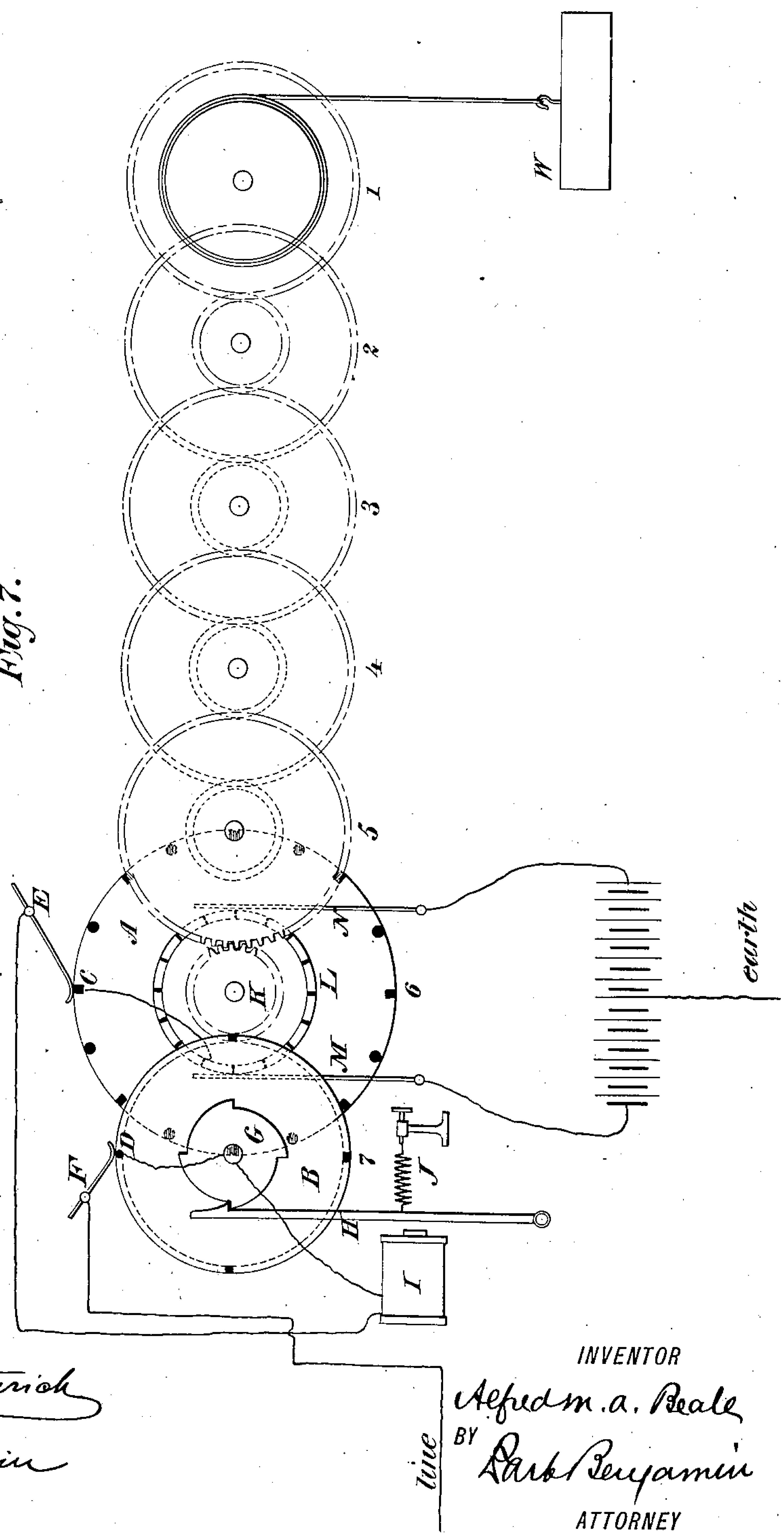
Fig. 7.



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UNITED STATES PATENT OFFICE.

ALFRED M. A. BEALE, OF NEW YORK, N. Y.

TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 360,987, dated April 12, 1887.

Application filed March 27, 1886. Serial No. 196,833. (No model.)

To all whom it may concern:

Be it known that I, ALFRED MEYER ALBERT BEALE, of the city, county, and State of New York, have invented a new and useful Improvement in Electrical Synchronous Mechanism, of which the following is a specification, reference being had to the accompanying drawings, forming part hereof.

My invention relates to means whereby two electrically-connected mechanisms, for example, are caused to move in exact time, the one with the other; and it consists more particularly in the apparatus, hereinafter shown and described, whereby said mechanisms are actuated by gravity, whereby, one mechanism moving out of time with and in advance of the other is automatically arrested until the latter overtakes it, when both begin a new movement or partial movement simultaneously, and whereby the synchronizing of said mechanisms is caused to take place frequently in very brief intervals of time, and in the construction and arrangement of said mechanism.

In the accompanying drawings, Figure 1 is a diagram showing the general disposition of my new electrical synchronous mechanism. Fig. 2 is also a diagram showing the said mechanism as arranged at one end of a line conductor, and also in combination therewith a telegraphic apparatus for signaling. Fig. 3 is a side view of the disk A of Fig. 2. Fig. 4 is a diagram of a rotary disk with four contact-plates and eleven fixed fingers. Fig. 5 is a diagram of a rotary disk with eight contact-plates and five fingers. Fig. 6 is a diagram showing the same with a greater number of contact-plates on the rotary disk, and also the general disposition of the actuating weight and gearing, the several devices being shown in side elevation. Fig. 7 is a diagram showing the same thing as Fig. 6, but in plan. Fig. 8 shows each finger *e e′ e″*, &c., connected in branch circuit, with a key in each branch.

Similar letters of reference indicate like parts.

In another application for Letters Patent filed simultaneously herewith, Serial No. 196,750, I have fully described and claimed the telegraphic signaling apparatus and mechanism herein shown combined with my synchronizing mechanism. The said telegraphic apparatus as claimed in my said other application I herein disclaim.

The general principle of my synchronic system will be best understood from Fig. 1, which is a skeleton diagram of the circuits and apparatus, not in anywise preserving relative proportions, but simply illustrative. At each end of the line are the wheels A and A′. These wheels are rotated by the action of descending weights. The problem is to make the wheel A rotate in exactly the same period of time as the wheel A′—that is, synchronously. I propose to use descending weights as the source of motive power, because, other things being equal, they will fall by attraction of gravitation in equal times, in accordance with known laws. I do not actuate my mechanism by electromotors, nor by any action of electricity, because, no matter how generated, the electric current is never uniform in strength, and therefore it is itself a disturbing element in any apparatus depending upon it for uniform mechanical motion.

The synchronizing mechanism is the same at each end of the line. The disk A is supposed to be rotated by the descending weight W through any suitable mechanism. From the disk A is actuated the disk B, and for present purposes of explanation it is assumed that the disk B is so connected to disk A by positive gearing as that both disks necessarily rotate in the same period of time. On the disk A is a contact-plate, C, and on the disk B a contact-plate, D. Bearing against the periphery of disk A is a contact-finger, E, and bearing against the periphery of disk B is a contact-finger, F. Inasmuch as the disks A and B have the same period of revolution, it follows that when the finger E meets the plate C on disk A the finger F will meet the plate D on disk B.

On the shaft of disk B is an escapement-pinion, G. Adapted to engage with this by the action of a coiled spring, J, is a catch, H, which forms the armature of an electro-magnet, I. The current from the battery proceeds to the shaft of disk A by brushes or other convenient means, (not shown in Fig. 1,) and thence is conducted radially on said disk to the contact-plate C. When the finger E meets this plate, the current proceeds to said finger and thence to the electro-magnet I. From the magnet the current goes to the shaft of disk B, thence radially on said disk to contact-plate D to finger F, and thence to the line. At the other end of the line the current traverses the similar apparatus in the reverse way—that is, it first goes to finger F′, to contact-plate C′, disk B′, magnet I′, finger E′, disk A′, and so to ground. Now, it will be evident that here are four contact-points, two at each end of the line, all of which must be closed before the current can flow—that is, the finger E must be on plate C, the finger F on plate D at one end of the line, and the finger E′ on the plate C′ and the finger F′ on the plate D′ at the other end of the line; but in order that this may happen the contact-plates on all four disks, A A′ B B′, must come opposite their respective contact-fingers at the same moment; or, in other words, each disk must complete its revolution between the intervals of contact of fingers and plates in precisely the same period of time.

I have already stated that the disks A and B at one end of the line will rotate exactly together, and necessarily so, because of positive gearing between them. So also of the disks A′ and B′, similarly arranged at the other end of the line. Suppose, now, that while the fingers E and F are off the plates C and D a current goes to line by other means, not shown in Fig. 1, but which will be described farther on, and as the shoulder of the escapement-wheel G is then clear of the catch H, the disk B and the disk A geared to it will be free to turn. Suppose, further, that when the contact-plates C and D come under the fingers E F, this other means goes out of operation, so that the only current that can go on the line at that time must go through the fingers E F and contact-plates C D, and thence, as already described, through the magnet I, and so to fingers F′ E′ and plates D′ C′ to ground. Finally, assume that when the contact-plates C and D come under the fingers E F, the contact-plates at the other end of the line have not got to their corresponding fingers, because the disks A′ B′ have from some cause been retarded, and hence are not moving synchronously with the disks A and B. Clearly, then, there can be no current to the line, the magnet I will be de-energized, and the catch H will drop into the notch or against the shoulder of the escapement-wheel G and stop the revolutions of the disk B, and consequently of the disk A^2. Meanwhile the weight at the opposite end of the line is rotating the disks there. The moment the plates D′ and C′ come under their fingers the circuit is completed through the magnet I, which removes the catch H from the escapement-wheel G and all four disks, A B A′ B′, begin their new revolution simultaneously. In brief terms, then, the principle of arrangement is this: Two rotating disks, both actuated by gravity, are at electrically-connnected stations. If one disk runs ahead of the other it waits for the other to catch up, and then both start even again. In the illustrative diagram, Fig. 1, I have shown this to occur once only during each revolution of the disks A A′ for the sake of simplicity; but it is not at all necessary that the wheels should make an entire revolution before this automatic regulation of one by the other occurs, nor is it desirable, because the synchronizing should occur in practice much oftener. Therefore, in practice, I make it take place several times during each revolution. Inasmuch as the speed with which the disks are revolved has nothing at all to do with the making of this synchronizing apparatus, it will be at once apparent that even if my disks rotate at the comparatively slow speed of once per second, I can correct the position of one by the other if need be thirty or forty times in that interval, and hence it becomes simply a question of the most desirable number of times that the synchronizing shall take place in a given period of time to render not only the whole period of revolution of the two disks exactly alike, but to cause the said disks to move throughout that period at precisely the same rate. Of course it is not necessary to fix upon any definite number of synchronizing adjustments here, because this will depend necessarily greatly upon the particular construction, accuracy, and uses of the instruments employed; but the point that I desire especially to emphasize is that I cause the two wheel-disks at opposite ends of the line to adjust themselves each by the other at certain increments of their period of revolution, and that obviovsly by increasing the number of these increments I can cause more adjustments per revolution, and hence render the movement of the disks nearer and nearer to absolute unison.

Fig. 2 represents the apparatus arranged at one end of the line, as before, by diagram, but with more detail, and also shows the arrangement of the signaling as well as the synchronizing circuit. Here, as in Fig. 1, are shown the disk A and the disk B, the latter, however, being geared from the shaft of disk A, so as to revolve in the same period of time as does wheel A. On the periphery of the disk A are equidistantly spaced four pairs of contact-plates, C *c*, C^2 c^2, C^3 c^3, C^4 c^4. The plates of each pair are disposed at opposite edges of the periphery, as shown in Fig. 3. On the periphery of disk B are four contact-plates, D D^2 D^3 D^4. In Fig. 1 the outer circle of the disk A represents the lower edge of the periphery and the inner circle the upper edge when the disk is placed, for example, in a horizontal position.

Rigidly secured in proximity to the disk A are two spring contact-fingers, E and *e*. The finger E is set slightly in advance of the finger *e*, so that when the disk A is revolved in the direction of the arrow *l* the finger E will meet the contact-plate C, for instance, before the finger *e* meets the contact-plate C, and so for each of the four pairs of contact-plates.

Near the periphery of disk B is secured a spring-finger, F, which, as this disk rotates, makes contact with each contact-plate D in succession. On the shaft of disk B is fastened the escapement-wheel G, here having four shoulders or indentations.

I is an electro-magnet; H, its armature provided with hook or latch to engage with the escapement-wheel G by the action of the coiled spring J when released by the magnet.

On the shaft K of disk A is arranged a commutator having four contact-plates, L L′ L^2 L^3. In proximity to opposite sides of said shaft are secured brushes or spring contact plates M and N. One of these plates connects with the positive and the other with the negative pole of the split battery by suitable wires.

Each commutator-plate is connected by wires O to two of the contact-plates on the rim of the disk A. Thus the plate L′ connects with the plate C and the plate c^4, the plate L^2 with the plate C^3 and the plate c^2, the plate L^3 with the plate C^4 and the plate c, and the plate L with the plate C^2 and the plate c^3.

On the disk B are wires P, whereby the contact-plates D D^2 D^3 D^4 are electrically connected together and to the electro-magnet I. Said magnet is also connected by a wire, Q, to the finger E. The finger F is connected by a wire, R, to line, and the line connects with the key S and thence by the wire T to a relay, U, and so to the finger e. The battery is also, as shown, split and connected to earth.

Supposing the parts to be in the positions represented, it will be evident that the negative current from the battery is led to the commutator-plate L′, and thence to the plates C and c^4; but as no circuit is established with these plates the current cannot flow. The positive current, however, passes to the commutator-plate L^3, with which the brush M is in contact, and thence goes to the plates C^4 and c. With the plate c the finger E is in contact, and hence the current can proceed to the wire Q, magnet I, and wire P upon the disk B. From the disk B the current can pass by way of the contact-plate D, which has met the finger F, upon said finger, and so to line. Now, as has been explained with reference to Fig. 1, if the corresponding mechanism at the other end of the line is in precisely the same position, then the current will be established. The magnet I will attract its armature H, which is shown in engagement with the escapement-wheel G. The wheel G being released, the weight W of Fig. 1 will be free to turn the disks A B, and the disk A will begin its revolution in the direction of the arrow l. As it does so the contact-plate c will move out of contact with the finger E, and the contact-plate C will move into contact with the finger e. Circuit will thus be broken from the positive pole of the battery, but made from the negative pole, because it can now pass from brush N to commutator-plate L′, thence to plate C, and so to the finger e. From the finger e the current passes by the wire T to the relay U, and thence to the operating-key S, and so to line, and if the key is worked while this state of affairs continues, then signals will be transmitted. Every time a pair of contact-plates comes round to the fingers E and e this same thing happens—that is, through the circuit made by finger E the synchronizing action takes place, as described, and through the circuit subsequently made through finger e signals are sent. Consequently, with a disk, A, arranged as shown in Fig. 1, the synchronizing adjustment occurs four times at every revolution, and also four times during every revolution a signaling-circuit is established. As has already been stated, when the fingers E and e successively close circuit on the plates c and C, first a plus and then a minus current goes to line. Supposing, now, the disk to have rotated one-quarter revolution in the direction of the arrow l, then the plate c^3 will meet the finger E; but the current to plate c^3 is negative, and as the last closing of the circuit through plate C and finger e sent a negative current to line, here would be two negative currents following each other, which of course is undesirable, as for rapid working the current should reverse at each succeeding contact. I can avoid this difficulty by adding another contact-finger, as e', placed in rear of finger E. Now, the succession of contacts from the position shown in the drawings, Fig. 1, and the direction of the respective currents is as follows: Finger E is on contact-plate c and receives a plus current; then finger e meets plate C and receives a minus current; then finger e' is met by plate c and receives therefrom a positive current. The last current going to line from this pair of plates C c is therefore positive. Supposing the disk turned forward in the direction of arrow l one-quarter of a revolution, finger E meets plate c^3, but to this plate a negative current is passing; then finger e meets plate C^3, which receives a positive current, and finger e' in turn meets plate c^3, which is negative, so that, in brief terms, I use an odd number of contact-fingers, E e e', and as the current alternates in direction it begins, for example, plus to E, minus to e, plus to e', and then minus to E, plus to e, minus to e', and so on. One of these contact-fingers, E, controls the synchronizing-circuit, the others the signaling-circuit. It will be apparent that the number of fingers e e', &c., is immaterial: I can use as many as I can find place for in the space included between two successive pairs of contact-plates on the disk; but there should be an odd number of these fingers—that is, an even number of fingers for the signaling-circuit and one finger for the synchronizing-circuit. Thus a succession of additional fingers, e' e'' e''', &c., for the signaling-circuit is represented in Fig. 2 by dotted lines. I have shown all of the signaling-circuit fingers connected to the same wire in Fig. 2. In practice, however, each finger e, e', &c., might be connected to its own wire, relay, and key, as in Fig. 8, so that as many operators could send as there were fingers, the signals for each key passing to line whenever the finger e belonging to that key made contact. The gearing of disk A to wheel B is such that, for example, when the plate c comes to the finger E the plate D on disk B comes to the finger F, and a shoulder on the escapement-wheel arrives in a position to meet the latch-armature H if the latter be not attached by its magnet I.

The number of contact-plates on the disk A and of signaling-fingers will depend on the following considerations:

First. Where it is desired to allow a large number of operators to work simultaneously, then there must be, as stated, a corresponding number of signaling-fingers e. As all of these fingers must be placed between two successive pairs of contact-plates on disk A, it follows that in order to afford space for the fingers the pairs of contact-plates must be sufficiently separated. Thus in Fig. 3, if it is desired, for example, to employ ten operators, it may be necessary to use but four pairs of contact-plates, C to C^4, on the disk A, because space equal to the length of a whole quadrant of the circumference is necessary to accommodate the fingers. In such case it might be necessary to drive the wheel at very high speed, so as to insure a sufficient frequency of circuit-closing for each finger e e', &c.

Second. If, however, a smaller number of operators will suffice—say four—then on a disk of equal size a space equal to one-eighth of the circumference will be ample for the accommodation of all the fingers; hence, as in Fig. 4, eight pairs of contact-plates, C to C^8, may be employed. The speed of the revolutions of the disk may be but half as great to obtain the same number of circuit-closings on each finger, and as at each passage of each pair of plates under the synchronizing-finger the synchronizing adjustment is effected, it will be apparent that with such a wheel the synchronic regulation occurs at every eighth part of a revolution, instead of but four times per revolution.

Third. Carrying out this idea still further, I find that probably in practice a length of one-eighth inch on the periphery of the disk A will measure that of each contact-plate C c. Assuming this to be correct, for purposes of illustration, then I may place in a space of one and one-eighth inch eight signaling-fingers and one synchronizing-finger. Therefore on a disk measuring nine inches in circumference I may have eight pairs of contact plates, or on a disk measuring eighteen inches in circumference I may have sixteen pairs of contact-plates. At every revolution of this last-mentioned disk it would be synchronized sixteen times, and with each one of the eight signaling-fingers sixteen closings of the circuit would be made. It simply remains then to drive this disk with great velocity, which is easily done by gearing, substantially as illustrated in Figs. 6 and 7, which are also a diagram. In Fig. 7 the fingers e are not shown. Here the cord of the weight W winds on the barrel 1, and on the shaft of this barrel is a cut gear which rotates arbor 2, arbor 2 rotates arbor 3, and so on to arbor 7. The gearing between arbors 1 and 2 is such, for example, that arbor 2 rotates four times as fast as arbor 1, and each succeeding arbor in like proportion revolves more rapidly than the one preceding it. Now, suppose that arbor 1 is turned by the descending weight at the very slow rate of one revolution in thirty seconds, then in the same period arbor 2 would make four turns, arbor 3 sixteen turns, arbor 4 sixty-four turns, arbor 5 two hundred and fifty-six turns, and arbor 6 a thousand and twenty-four turns; but arbor 6 carries the disk A, so that this wheel would therefore rotate at the rate of thirty-four revolutions per second. At each revolution, as I have said, there are sixteen contacts, so that the total number of closings of circuits for each signaling-finger would be six hundred and fifty-four per second, and the synchronizing current would pass as many times in the same interval.

Of course in multiplying the pairs of contact-plates on the disk A, it is also necessary to multiply the commutator-plates L on the shaft of said disk, so as to effect the reversal of the currents, as already described. So, also, it is necessary to multiply the contact-points on disk B and the shoulders or notches on the escapement-wheel G. This, however, is merely a matter of mechanical detail.

I claim—

1. The combination, at each of two electrically-connected stations, of two rotating disks, means of actuating the same, and circuit-closing devices whereby each disk is caused to close circuit through its associate disk, a line, and the opposite pair of disks, when corresponding points on the periphery of each of said four disks reach at the same moment given fixed points, the said fixed points being correspondingly located with reference to each disk, substantially as described.

2. The combination, at electrically-connected stations, of two independent rotary disks, means of actuating the same, means for arresting the motion of said disks, circuit-closing devices whereby each disk is caused to close circuit through a main line and through the opposite disk at like periods or points of the revolutions of both disks, and an electro-magnet, the said magnet operating to neutralize the action of the means for arresting the motion of said disks when energized by the passage of the current, substantially as described.

3. The combination, substantially as set forth, in an electrical synchronous mechanism, of a rotating disk having a circuit-closing plate on its periphery, a fixed finger adapted to make electrical contact with said plate, a second rotating disk positively actuated by said first disk, a circuit-closing plate on its periphery, a fixed finger adapted to make electrical contact with said plate, and a means for arresting simultaneously the motion of both of said disks

at one or more points, substantially as described.

4. The combination of a source of electricity, a rotating disk, a contact-plate carried by said disk, a fixed finger adapted to make electrical contact with said plate, a second rotating disk, a contact-plate carried by said disk, a fixed finger adapted to make electrical contact with said plate, a means of actuating said disks conjointly, a mechanism for arresting the motion of said disks, containing an electro-magnet and an armature adapted to engage with a toothed wheel on said second disk, and circuit-connections, substantially as described.

5. The combination of a source of electricity, a rotating disk, A, having on its periphery a contact-plate, C, a rotating disk, B, having on its periphery a contact-plate, D, fixed fingers E and F, escapement-wheel G, electro-magnet I, latch-armature H, a means (such as a coiled spring) for retracting said armature, circuit-connections, and a means (such as a descending weight) for rotating said disks A and B conjointly, substantially as described.

6. The combination, with a line-conductor joining two stations and a source of electricity, of a rotating disk, A, a contact-plate, C, on the periphery of said disk, a rotating disk, B, a contact-plate, D, on the periphery of said disk, fixed fingers E and F, escapement-wheel G, electro-magnet I, latch-armature H, a spring for retracting said armature, circuit-connections, and a means of rotating said disks A and B conjointly, the said parts being substantially as described and located at one of said stations, and at the other of said stations, and substantially as described, a rotary disk, A′, a contact-plate, C′, on the periphery of said disk, a rotating disk, B′, a contact-plate, D′, on the periphery of said disk, fixed fingers E′ and F′, escapement-wheel G′, electro-magnet I′, latch-armature H′, a spring for retracting said armature, circuit-connections, and a means of rotating said disks A′ and B′ conjointly, the said line-conductor being in electrical connection with the finger F at one station and the finger F′ at the other station.

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