(No Model.) 4 Sheets—Sheet 1.

E. GRAY.

ELECTRO MECHANICAL MOVEMENT.

No. 491,346. Patented Feb. 7, 1893.

Fig. 1.

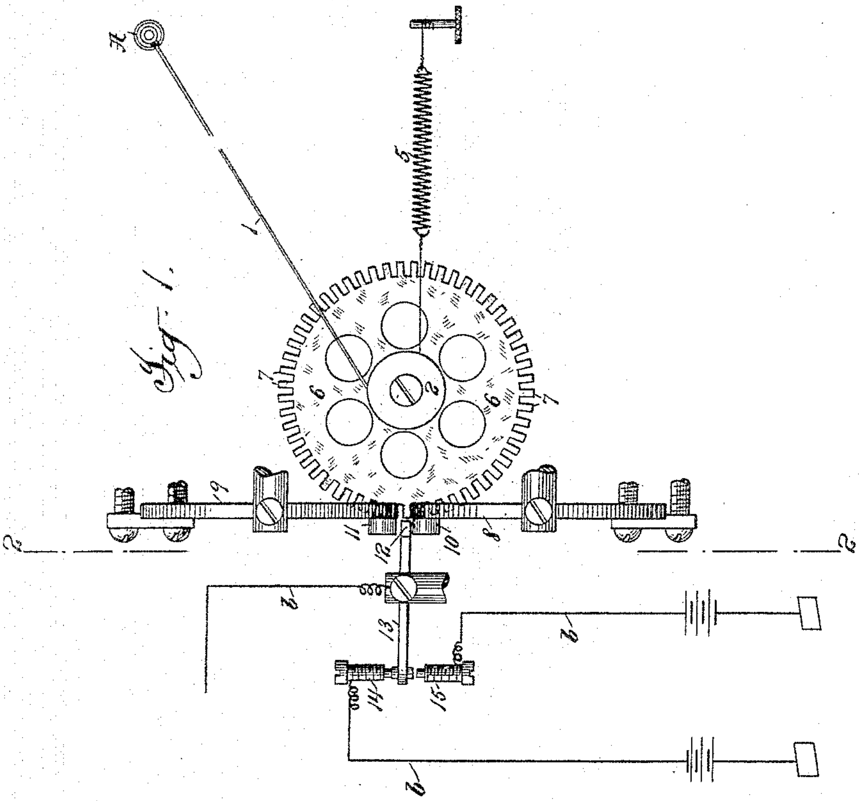
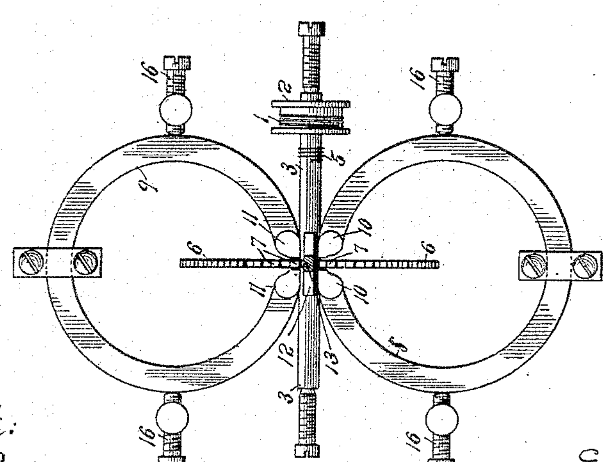


Fig. 2.



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ELECTRO MECHANICAL MOVEMENT.

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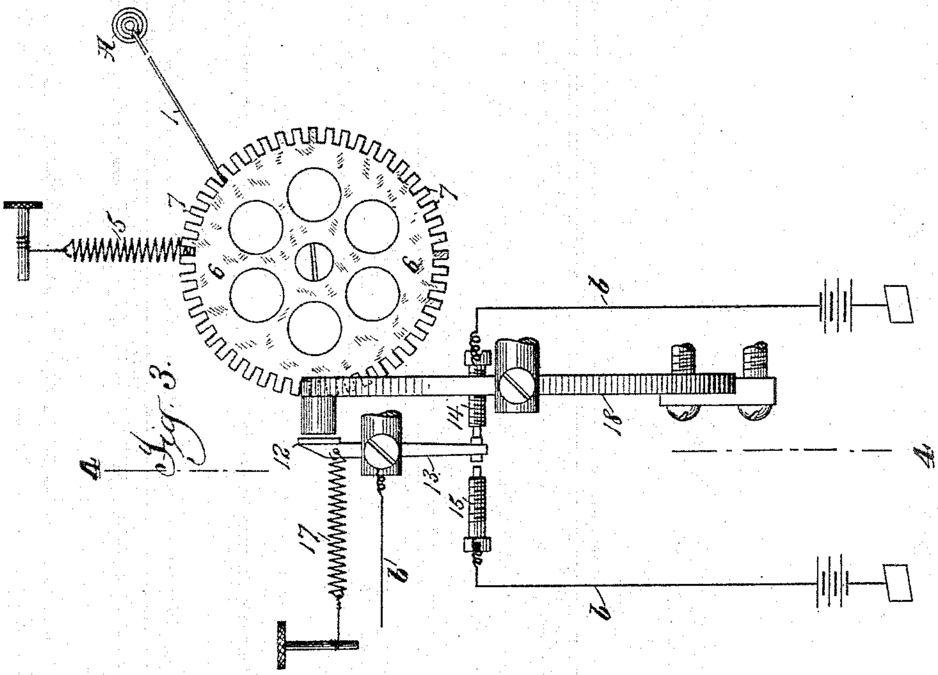

Fig. 3.

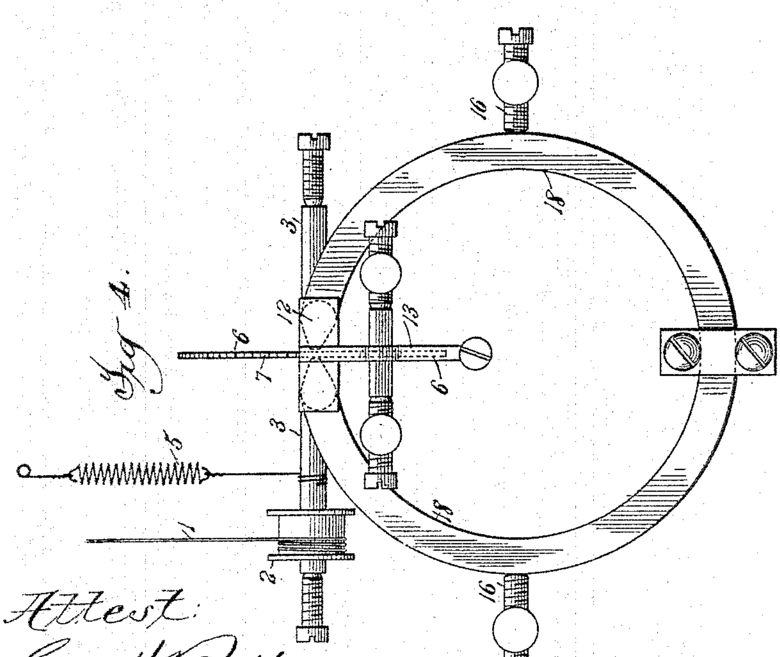

Fig. 4.

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

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4 Sheets—Sheet 3.

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Fig. 5.

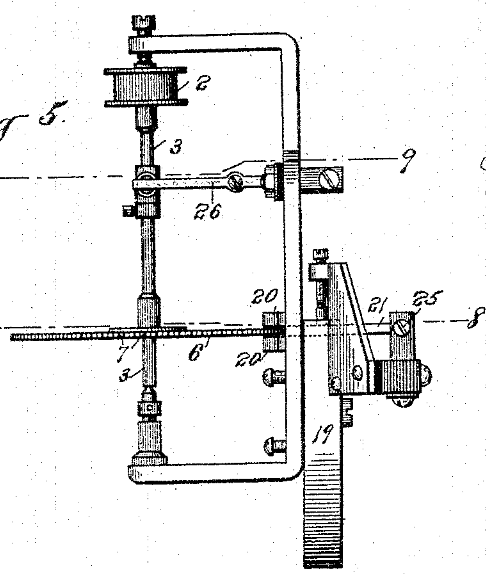

Fig. 6.

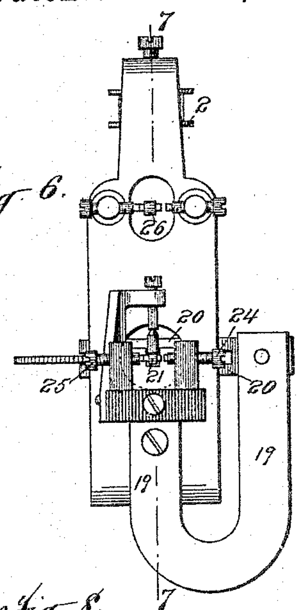

Fig. 7.

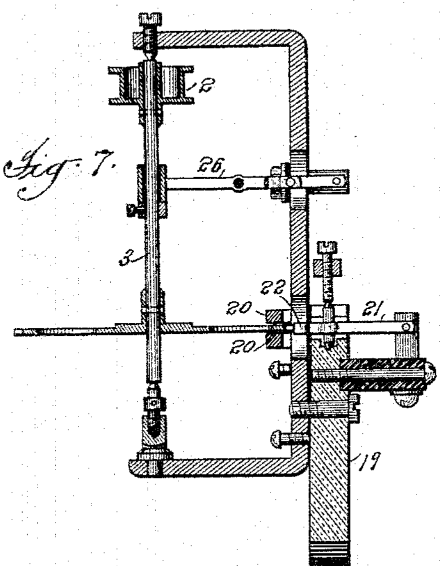

Fig. 8.

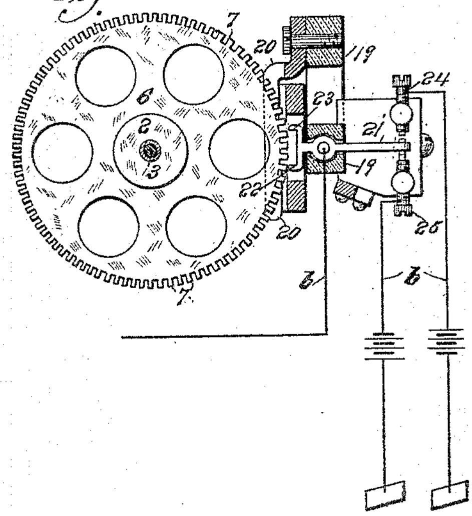

Fig. 9.

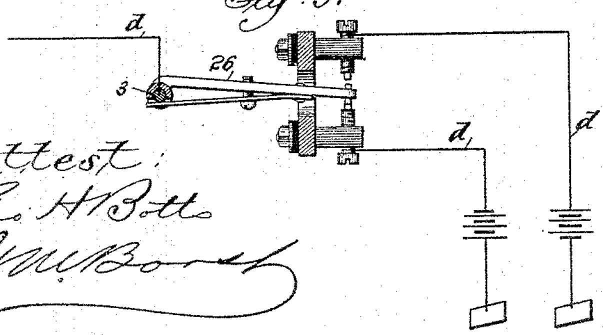

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Fig. 10.

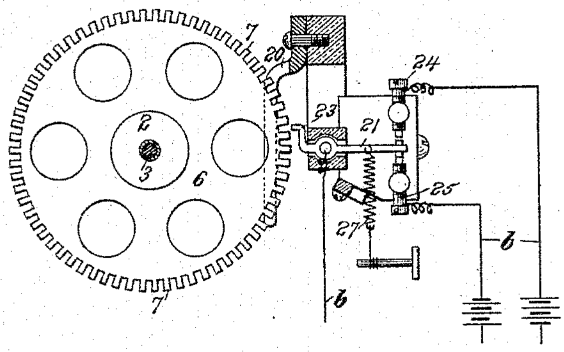


Fig. 12.

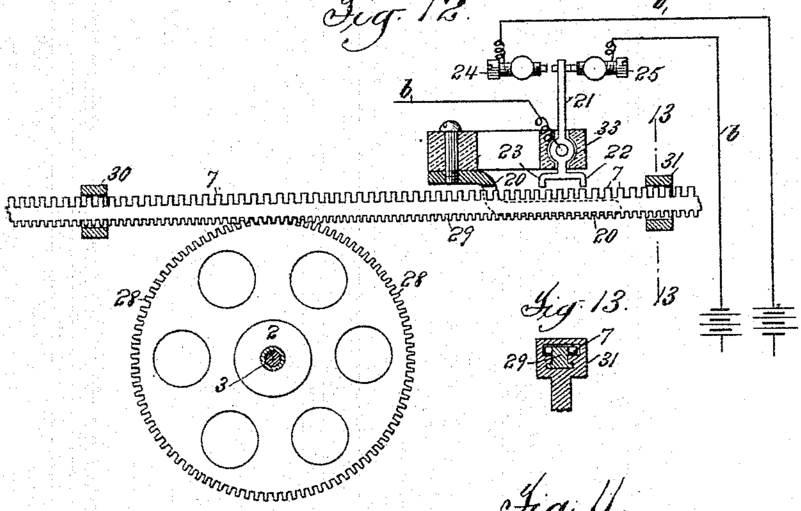
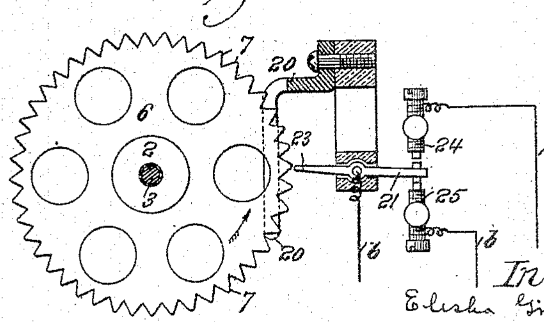


Fig. 13.

Fig. 11.



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UNITED STATES PATENT OFFICE.

ELISHA GRAY, OF HIGHLAND PARK, ILLINOIS.

ELECTRO-MECHANICAL MOVEMENT.

SPECIFICATION forming part of Letters Patent No. 491,346, dated February 7, 1893.

Application filed January 8, 1892. Serial No. 417,365. (No model.)

To all whom it may concern:

Be it known that I, ELISHA GRAY, a citizen of the United States, residing at Highland Park, county of Lake, and State of Illinois, have invented certain new and useful Improvements in Electro-Mechanical Movements, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

My invention consists of a magneto-mechanical movement which may be applied to various uses, the principal application now in view relating to mechanism for sending telautographic messages, of which various forms are set forth in my Letters Patent Serial Nos. 386,814, 386,815, 461,470, 461,471, 461,472, 461,473, and 461,474, the special object attained in that connection being an improvement in the transmitters whereby the pulsations through which the receiving pen is operated or controlled are sent to line. It is important in a transmitter to secure certainty of contact in the circuit making and breaking device, rapidity of movement, and small liability to deterioration through friction of parts. These advantages I secure in my present invention by employing a vibrating circuit maker and breaker operated magnetically through the making and breaking of a magnetic circuit or circuits, in turn controlled by the movements of the transmitting pen.

In the drawings annexed hereto, in which are shown various forms of mechanism embodying my invention, Figures 1 and 2 are respectively plan and side views of such a mechanism, Fig. 2 being a sectional elevation on the line 2—2 of Fig. 1. Figs. 3 and 4 are similar views of a modified form, Fig. 4 being a sectional elevation on the line 4—4 of Fig. 3. Figs. 5, 6, 7, 8, and 9 represent a preferred form of such a mechanism, Fig. 5 being a side and Fig. 6 a rear elevation, Fig. 7 a sectional elevation on the line 7—7 of Fig. 6, Fig. 8 a plan partly in section on the line 8—8 of Fig. 5, and Fig. 9 a section on the line 9—9 of Fig. 5, of the same. Figs. 10, 11 and 12 show modifications Fig. 13 being a section on line 13—13 Fig. 12.

Referring now to Figs. 1 and 2, A is the usual transmitting pen, which may be a pen, pencil, stylus or other device suitable for making or recording a character, or a simple handle of convenient form, all of which are for convenience of reference included under the term "transmitting pen," as used herein. The pen is properly connected, as by a flexible cord 1, to the pen drum 2 on the shaft 3, the shaft being mounted so as to rotate freely and provided with the usual retractile 5. Upon shaft 3 is mounted a wheel 6 having teeth 7 of magnetizable material, as soft iron. 8 and 9 are two magnets each provided with pole pieces 10, 11, the pole pieces of each magnet being placed in proximity to each other with sufficient space left between them to permit the passage of the teeth 7 and being reduced or tapered so as to present to the wheel a surface approximately equal to the width of one tooth. The magnets are placed in proximity to each other in a plane perpendicular to the plane of the wheel. Between the two magnets is an armature 12 of magnetizable material, as soft iron, attached to the end of a lever 13 pivoted near its center which acts as a circuit maker and breaker between stops 14 and 15 through which lever and stops line circuit *b* passes. The set screws 16 permit ready adjustment of the magnet pole pieces to each other.

The operation is as follows:—The pen A (being connected as in the mechanism of the above-mentioned patents to two devices such as have just been described, one for each of two cross-wise directions of movement, one only of which devices is shown in the drawings), as it moves, in forming the letters, figures or other characters or forms to be transmitted, to and from the pen drum 2, gives a rotary motion to the wheel 6, in one direction or the other. When a tooth 7 comes between the pole pieces 11 of magnet 9, the magnetic circuit of that magnet is closed through that tooth. The two magnets are so placed with reference to each other that at this moment there is no tooth between the pole pieces of magnet 8. The magnetic circuit of the latter magnet is therefore then broken and it attracts the armature 12, causing the latter to make contact with the stop 14. As the wheel advances a tooth comes between the pole pieces 10 and the tooth theretofore between the pole pieces 11 is withdrawn from between the latter pole pieces. The magnetic circuit of the magnet 8 is thus completed through the tooth between its poles and the magnetic circuit of the magnet 9 is broken. The armature 12 is therefore released from magnet 8, and attracted to magnet 9, causing the lever 13 to break contact with stop 14, and make contact with stop 15. As the movement of the wheel continues this vibratory movement of the lever is correspondingly reproduced and pulsations caused to traverse the circuit *b*.

In the form of the mechanism shown in Figs. 3 and 4 one of the magnets 8, 9 is omitted and its place supplied by a retractile spring 17 which acts to move the lever 13 in one direction while it is moved in the other direction by the pull of the magnet 18 against the tension of the spring. The operation of this mechanism is otherwise the same as of that above described and the spring is to be regarded as the equivalent of the omitted magnet.

I will now describe the form of this mechanism shown in Figs. 5 to 9, and which is the form which I prefer to employ. In this form a single magnet is employed, but the arrangement is such as to provide two partially independent magnetic circuits. The magnet 19 is provided with an extension 20 of magnetizable material, such as soft iron, attached to one of its poles, which is placed in proximity to the teeth of the wheel 6, the preferred form of the extension 20 being a fork through the slot of which the teeth of the wheel 6 move. Upon the other pole of the magnet 19 is pivoted a lever 21 bifurcated at one end into the two points, 22, 23. The bifurcated portion of this lever and its body as far as the pivot are of magnetizable material, as soft iron, and it is placed in proximity with the path of the teeth 7 of the wheel 6 so that the magnetic circuit of the magnet 19 may be completed through the extension 20, the teeth 7 of the wheel 6, one or the other of the points 22, 23, and the lever 21. The lever 21 acts as a circuit maker and breaker between stops 24, 25 through which lever and stops the circuit *b* passes. The points 22, 23 of lever 21 are placed at such a distance apart that when one of them is opposite a tooth of the wheel 6 the other will have a position between two of these teeth. They are so placed with reference to the wheel 6 that when the lever 21 is in one of its contact positions, as against the stop 25, one of the points, as 22, will be in close proximity to the path of the teeth 7, completing the magnetic circuit of the magnet 19 through the point 22, the tooth with which it is in juxtaposition and the extension 20, while at the same time the other point 23 of the lever 21 is relatively removed from the path of the teeth 7 and the magnetic circuit through that arm or point of the bifurcated lever is broken. In the other position of the lever 21, against the contact stop 24, the point 23 is in close proximity to the path of the teeth 7, while the point 22 is relatively removed from that path, thus causing the magnetic circuit through point 23 to be closed and that through point 22 to be broken. It results from this construction that as the teeth of the wheel come successively in proximity with the point 22, the lever 21 will be caused to assume that position in which the magnetic circuit is completed through the point 22 and broken through the point 23, and as the teeth pass in succession in proximity to the point 23 the lever 21 will assume that position in which the magnetic circuit is completed through point 23 and broken through point 22, these positions alternating successively with each other, and in consequence the line circuit *b* being continuously and uniformly interrupted, causing electric pulsations to traverse it to the receiving station.

In Fig. 9 is shown in plan a diagram of the connections of the reversing circuit *d*, 26 being the reversing lever frictionally mounted upon the shaft 3, which causes the polarity of the current in the reversing circuit *d* to be reversed upon each reversal in direction of movement of the transmitting pen, whereby the movements of the receiving pen are correspondingly reversed in direction. In this type of construction, as in the one first described, one of the magnetic circuits or paths may be dispensed with and its place supplied by its equivalent, a spring. Such a mechanism is illustrated in Fig. 10. One of the arms of the bifurcated lever 21 is omitted and the retractile spring 27 is substituted for it. The strength of this spring is so adjusted that when the point 23 is in juxtaposition with a space between the teeth 7, and the magnetic circuit is, therefore, substantially broken, the spring will draw the lever against the stop 25; but when the point 23 is in juxtaposition with one of the teeth 7, the attractive force of the completed magnetic circuit will be such as to overcome the spring and cause the lever 21 to vibrate to the position in which it rests against the stop 24. Similar results are, therefore, obtained as when the bifurcated lever 21 is employed.

In Fig. 11 a further modification is shown in which, again, the lever 21 has but a single point. In this case as the disk 6 revolves in the direction of the arrow one of the teeth 7 coming in juxtaposition with the point 23 will complete the magnetic circuit, and the point 23 will follow the tooth, maintaining its juxtaposition thereto, until it rests against the contact stop 25. The continued movement of the tooth now substantially breaks the magnetic circuit through it; but instantly the next following tooth 7 comes near enough to the point of the lever to establish the magnetic circuit through it. The lever now swings to meet the advancing tooth until it makes contact with the stop 24. The continued forward movement of the last mentioned tooth will carry the point 23 with it, breaking its contact with the stop 24, until the lever again rests upon stop 25. In this form of device the teeth 7 would preferably be made pointed, and would be placed twice as far apart for the same rapidity of vibration of the lever 21 as in the form shown in Figs. 5 to 9. It would be an inferior construction, but would be operative, and in it, as in the other cases, the vibration of the lever would be effected by the making and breaking of the magnetic circuit.

In the devices thus far illustrated and described, the movement of the series of teeth is rotary. It may, however, be a reciprocatory motion in a straight line, and substantially the same results may be thus accomplished in any of the forms of mechanism which have been mentioned. Such an arrangement is illustrated in Fig. 12. The drum shaft 3 is provided with a pinion 28 meshing with a rack 29 adapted to reciprocate longitudinally in guides, as 30, 31. This rack carries the magnetizable teeth 7 and its body is in whole or in part of magnetizable material. The lever 21 is pivoted upon one pole 33 of this magnet and the forked extension 20 from the other pole straddles the rack and teeth 7. As the pen drum is caused to rotate in accordance with the movements of the transmitting pen, the rack 29 is given a reciprocatory motion and causes vibration of the lever 21, as in the forms of mechanism above described. It is, therefore, to be understood that in all cases I have in contemplation a reciprocatory as well as a rotary motion of the series of teeth 7.

While I have spoken in this description of the magnetic circuits as being made and broken for the purpose of giving movement to the vibrating lever carrying the armature, it is to be noted that these terms are not, when the ultimate characters of the phenomena under consideration is considered, strictly accurate. Theoretically in none of the forms of mechanism above shown is the magnetic circuit absolutely broken, but rather the substantial portion of the magnetic lines of force are diverted or shifted from that magnetic circuit which is relatively open to that which is relatively closed, a minute portion of the lines of force however in theory still traversing the relatively open path. In fact, however, and as regards the practical operation of the mechanism, this weakening of the lines of force in one path of the circuit and strengthening them in the other, amounts to an interruption or break of the relatively open circuit and a making of the relatively closed circuit.

It is for convenience of description that the terms "make and break" are employed, as they are to be understood as indicating such a substantial change of condition in the magnetic circuit as will cause the vibrating lever to be operated. Even were a construction of mechanism for this purpose employed such that the operation of the vibrating lever were effected by successive absolute breaks in a magnetic circuit, such a mechanism would be substantially the same mechanism as that herein shown since the changes of magnetic strength herein referred to produce substantially the same practical effects as would be attained from absolute magnetic makes and breaks.

In using the term "teeth" I intend to include thereunder not only what are technically termed "teeth" in mechanics, that is, separate pieces of material projecting from a body or surface, but also pieces or strips of magnetizable material of whatever form provided that they are separated from each other so that as they successively move in the presence of the magnetic circuit they will cause a succession of magnetic makes and breaks or shiftings of the magnetic circuit. It is not necessary, of course, that the spaces between the teeth should be open, as in the devices illustrated. If preferred these spaces may be occupied by non-magnetic or relatively non-magnetic material.

I do not confine myself to the use of the mechanism shown solely for operating a lever used to make and break an electric circuit, but intend to protect its use for causing the vibration of the lever for other purposes as well.

It is to be remembered that in the art the juxtaposition of two poles of different polarity, each pole belonging to a separate magnet, is the substantial equivalent of a single magnet for accomplishing many purposes. This would be the case in the mechanism above described. Thus if two bar magnets were substituted for the single magnet shown in Figs. 5 to 8, and the opposite poles of these magnets were brought into juxtaposition, the lever 21 being pivoted upon one pole and the teeth 7 moving in magnetic contact with the other pole, similar results would be obtained, though with the expenditure of somewhat more energy.

Under the term "magnet" I intend to include every suitable source of magnetic energy.

Many other modifications besides those to which I have specifically referred might be made in the construction of the apparatus, and still it would contain my invention.

What I claim is:—

1. The combination of a magnet, a movable series of teeth, and a lever mounted so that it may vibrate and placed within the range of magnetic influence of the magnet, the movement of the teeth operating to make and break the magnetic circuit and thereby give a vibratory movement to the lever, and an electric circuit controlled through the movement of the lever, substantially as set forth.

2. The combination of a magnet, a movable series of teeth forming, when in proper position, a part of the magnetic circuit of the magnet, and a vibrating electric circuit breaker, the movement of the teeth operating to make and break the magnetic circuit and thereby give a vibratory movement to the electric circuit breaker, substantially as set forth.

3. The combination of a magnet, a toothed

wheel, the teeth thereof forming, when in proper position, a part of the magnetic circuit of the magnet and a vibrating electric circuit breaker, the revolution of the wheel operating to make and break the magnetic circuit and thereby give a vibratory movement to the electric circuit breaker, substantially as set forth.

4. The combination of a magnet or magnets constituting two partially or wholly independent magnetic circuits, a movable series of teeth, and a vibrating electric circuit breaker, the movement of the teeth operating to alternately make and break said magnetic circuits and thereby vibrate the electric circuit breaker, substantially as set forth.

5. The combination with a lever mounted so that it may vibrate and provided with a bifurcated magnetizable portion, of a series of teeth adapted to attract the magnetizable portion of the lever and movable with reference thereto, said teeth being so arranged with reference to the lever that as they are moved in proximity to it the lever is caused to vibrate, substantially as set forth.

6. A magnet in which one pole piece is provided with a lever mounted so that it may vibrate, and the other pole piece is movable and provided with a number of teeth of magnetic material so arranged with reference to the lever that as they are moved in proximity to it the lever is caused to vibrate, substantially as set forth.

7. A magnet in which one pole piece is provided with a bifurcated lever mounted so that it may vibrate, and the other pole piece is movable and provided with a number of teeth of magnetic material so arranged with reference to the lever that as they are moved in proximity to it the lever is caused to vibrate, substantially as set forth.

8. The combination with a lever mounted so that it may vibrate and provided with a magnetizable portion, of a rotatory disk provided with a number of teeth adapted to attract the magnetizable portion of the lever, said teeth being so arranged with reference to the lever that as the disk is rotated the lever is caused to vibrate, substantially as set forth.

9. The combination with a lever mounted so that it may vibrate and provided with a bifurcated magnetizable portion of a rotatory disk provided with a series of teeth adapted to attract the magnetizable portion of the lever, said teeth being so arranged with reference to the lever that as the disk is rotated the lever is caused to vibrate, substantially as set forth.

10. A magnet in which one pole piece is provided with a lever mounted so that it may vibrate, and the other pole piece is provided with a number of teeth attached to a rotatory disk and so arranged with reference to the lever that as the disk is rotated the lever is caused to vibrate, substantially as set forth.

11. A magnet in which one pole piece is provided with a lever mounted so as to vibrate and acting as a circuit maker and breaker, and the other pole piece is movable and provided with a number of teeth so arranged with reference to the lever that as they are moved in proximity to it the lever is caused to vibrate, substantially as set forth.

12. A magnet in which one pole piece is provided with a lever mounted so that it may vibrate and acting as a circuit maker and breaker, and the other pole piece is provided with a number of teeth attached to a rotatory disk, and so arranged with reference to the lever that as the disk is rotated the lever is caused to vibrate, substantially as set forth.

13. The combination of a telautographic transmitting pen, an electric circuit, a vibrating electric circuit maker and breaker for sending pulsations to line, and a source of magnetic energy and a circuit or circuits therefor serving to transmute the movements of the transmitting pen into vibrations of the circuit maker and breaker, substantially as set forth.

14. The combination of a telautographic transmitting pen, an electric circuit, a circuit making and breaking lever for producing pulsations in said circuit, a source of magnetic energy and a circuit or circuits therefor, a series of teeth connected with the transmitting pen so as to move therewith, the movement of the teeth operating to change said magnetic circuit or circuits and thereby cause the circuit making and breaking lever to vibrate, substantially as set forth.

15. The combination of a telautographic transmitting pen, an electric circuit, a circuit making and breaking lever for producing pulsations in said circuit, said lever being provided with a bifurcated magnetizable portion, a series of teeth adapted to attract the magnetizable portion of the lever and connected with the transmitting pen so as to move therewith, said teeth being so arranged with reference to the magnetizable portion of the lever that as they are moved in proximity to it the lever is operated, substantially as set forth.

16. The combination of a telautographic transmitting pen, an electric circuit, a circuit making and breaking lever for producing pulsations in said circuit, and a magnet of which the lever or a part thereof constitutes one pole piece and the other pole piece whereof is provided with a series of teeth connected with the transmitting pen so as to move therewith, said teeth being so arranged with reference to the lever that as they are moved in proximity to it the lever is operated to produce pulsations in the circuit, substantially as set forth.

17. The combination of a telautographic transmitting pen, an electric circuit, a circuit making and breaking lever for producing pulsations in said circuit, said lever being provided with a magnetizable portion, a rotatory disk provided with a number of teeth adapted to attract the magnetizable portion of the le-

ver and connected with the transmitting pen so as to be rotated as the pen moves, said teeth being so arranged with reference to the magnetizable portion of the lever that as they are moved in proximity to it the lever is operated, substantially as set forth.

18. The combination of a magnet, a movable tooth or series of teeth, and a lever mounted so that it may vibrate, the movement of the teeth operating to make and break the magnetic circuit and thereby give a vibratory movement to the lever, and an electric circuit controlled through the movement of the lever, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

ELISHA GRAY.

Witnesses:
WM. M. GOODRIDGE,
THOS. S. WHEELWRIGHT.