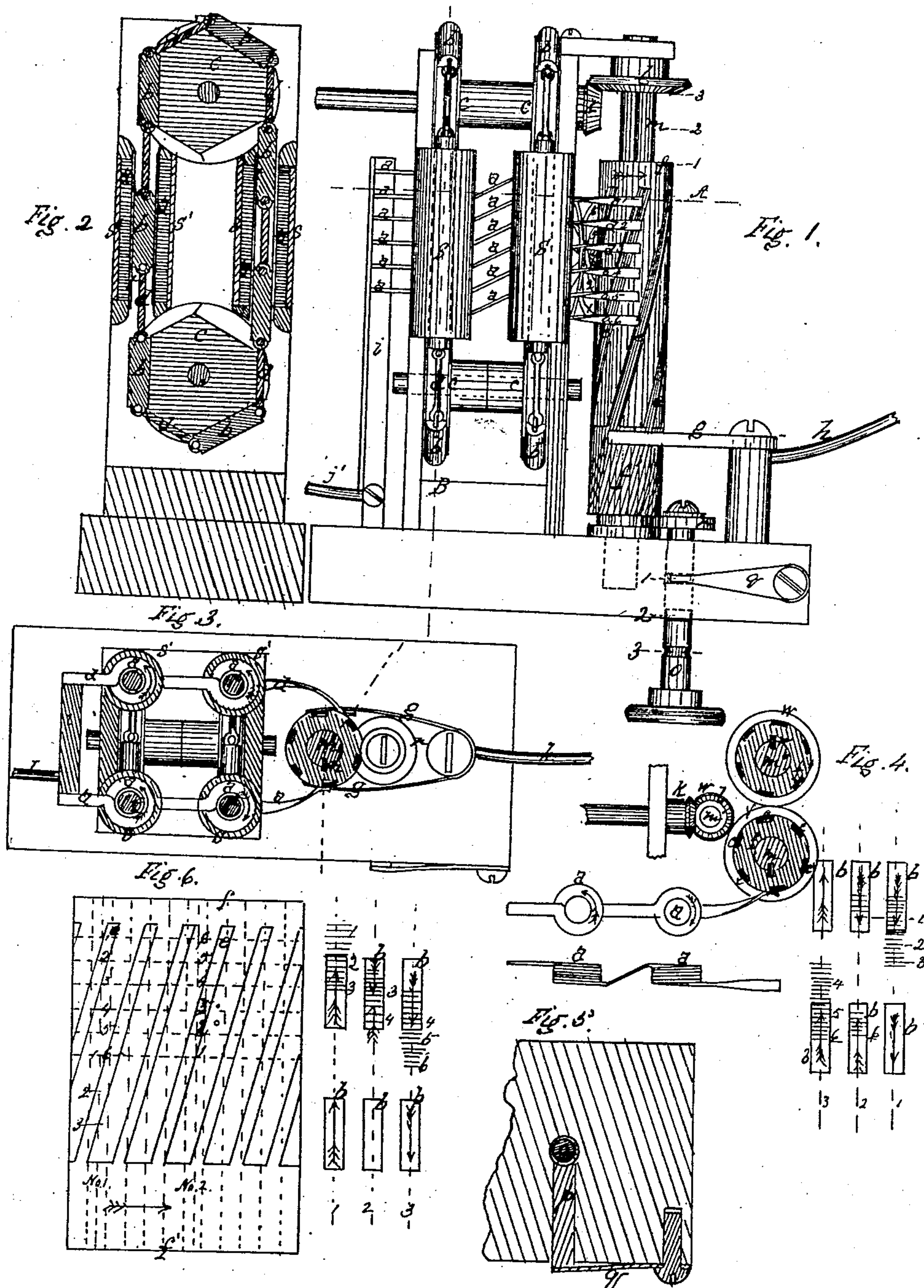


W. WICKERSHAM.
ELECTROMAGNETIC ENGINE.

No. 78,629.

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WILLIAM WICKERSHAM, OF BOSTON, MASSACHUSETTS.

Letters Patent No. 78,629, dated June 2, 1868.

IMPROVEMENT IN ELECTRO-MAGNETIC ENGINES.

The Schedule referred to in these Letters Patent and making part of the same.

TO ALL WHOM IT MAY CONCERN:

Be it known that I, WILLIAM WICKERSHAM, of Boston, in the county of Suffolk, and State of Massachusetts, have invented a new and improved Electro-Magnetic Engine; and I do hereby declare that the following is a full and exact description thereof, reference being had to the drawings, and to the figures and letters of reference marked thereon.

I use in my specification a few terms and phrases which may not have been used before in precisely the same sense in which I use them. I will, therefore, define them, to make my meaning more clear.

"Electro-magnetic chain," or, briefly, "magnetic chain," a chain composed of links, one half of which are non-magnetic, and the other half magnetic bars, either steel or iron. When made of iron, the links become electro-magnets by being surrounded by a coil, through which an electric current passes.

"Magnetic bar," the magnetic link in the electro-magnetic chain, either steel or iron, occupying the space between each two consecutive non-magnetic links in said chain, described in my specification.

The first feature of my invention relates to the arrangement of the magnetic bars, and consists in placing them in an endless chain, having non-magnetic links or connection-rods in the spaces between them, the magnets being intermittent and separate links in the chain.

The second feature of my invention relates to the disposition of said magnetic chains in the engine, and consists in the construction of two chain-gears on parallel shafts, of suitable form and distance apart to receive said chain, all arranged in such manner that the gears and chain can revolve together.

The third feature of my invention relates to the extension of my engine for the increase of power, and consists in the duplication to any number desirable of these said magnetic-chain gears on each shaft, with the corresponding number of electro-magnetic chains all working concurrently together and communicating their power to the same shafts.

The fourth feature of my invention relates to the manner of extending the helices to increase the power of the engine, and consists in so coiling or forming a thin ribbon-shaped strip of metal into two or more helices, with the width of the strip at right angles to the axis, the number corresponding to the number of electro-magnetic chains working on one shaft in said engine, and so arranging them in the engine that one of said chains (as they revolve) shall pass through each of said helices, formed of the same strip of metal.

The fifth feature of my invention relates to the device for closing and opening the electric currents or circuits which pass through the helices, and which give polarity to the magnetic bars, and consists in having the strips of metal, of which the helices are formed, extend at one end of the engine beyond the helices, on to one side of a revolving cylinder, which has strips of metal or conductors placed at intervals around it and even with its surface, which conductors are formed spirally, or have a twist, as they extend from one end of the cylinder to the other, and all so arranged with relation to the extended strips forming the helices, that, when they rest on the spiral conductors of the cylinder, the circuit is closed, and, when they rest on the spaces between these, the circuit is open, and so further arranged that the closing of the circuit successively in the different helices forming each column will advance from one end to the other at the same speed as the magnetic bar does while passing through them, which is done by means of the spiral form of the conductors on said cylinder.

The sixth feature of my invention consists in so arranging these spiral conductors in said cylinder that one of them will close and open the circuits for the passage of each of the magnetic bars, as it advances through its column of helices, said helices being connected with one pole of the battery, at the opposite end of the engine from said cylinder, and with the other pole through the spiral conductors on the cylinder.

The seventh feature of my invention relates to the device for stopping the machine or reversing the speed, and consists in so constructing the shaft through said circuit-cylinder and the cylinder, that it can be moved to any position on the shaft, and still revolve with it, and then by arranging all parts connected with the said circuit-cylinder in such manner that the cylinder can be moved to such a position on its shaft, that the closed circuit through the helices will always be in such position that the magnetic bars will have no power of motion in either

direction, and so that it can be moved one way or the other from this point, causing the electro-magnetic chains to move in either direction, at pleasure.

The eighth feature of my invention relates to the device for moving the circuit-cylinder to any desired position, and controlling it, which consists of a rod, fitted into the stand in a parallel position with the cylinder, and close to it, with spring-stops, and by having secured on the end of this rod a revolving washer, working in a groove in the cylinder, in such manner that, when the rod is raised or depressed, the cylinder will move with it and be held in any position where the rod is allowed to rest, so that, by moving the said rod (and consequently the cylinder) to one position, the engine will run with its greatest power in one direction, and by moving it to an opposite position the engine will run with its greatest power in the opposite direction, and by moving said rod to an intermediate position the engine will remain at rest.

The ninth feature of my invention relates to the manner of forming and arranging the helices with regard to the direction of the electric currents around the magnetic bars, and consists in so forming each line of helices made of one strip of metal, that each one in the line shall coil around in a different direction, and shall conduct its electric current around its magnetic bar in a different direction from the one next preceding it, and the next one in advance of it, giving to the magnetic bars in them alternate reversed polarities, all the helices in each column conducting their currents in the same direction.

The tenth feature of my invention relates to the manner of arranging the two sides of the engine, and consists in coiling the two columns of helices reversely, which are on opposite sides of the machine, and through which the same electro-magnetic chain passes, so that, if the north polarity in one is upwards, in the other it will be downwards, and *vice versa*.

Referring to my drawings—

Figure 1 is a side elevation, showing the electro-magnetic chains and chain-gears and their shafts, showing also two of the cylinders or cases containing the columns of helices, also the conducting-bars or strips of metal forming the helices at each end of the engine, and their connection with each pole of the battery, also the circuit-cylinder and its connections.

Figure 2 is a perpendicular section in the red line, B, through one of the electro-magnetic chains and its chain-gears, and through the two columns of helices and their cases through which the magnetic bars of said chain pass.

Figure 3 is a horizontal section through the engine, in the red line A, near the upper part, showing the metallic plate at one end of the engine connected with the positive pole of the battery, and at the same time connected with one end of all the strips of metal forming the helices, also showing a top view of the four columns of helices as they stand in their cases, and also showing the extension of the strips forming the helices on to the circuit-cylinder, through which they are connected with the negative pole of the battery.

Figure 4 shows a side and a top view of the thin strip of metal formed into helices, as it is when ready for use in the engine; also it shows an arrangement by which two circuit-cylinders are used instead of one, as shown in figs. 1 and 3.

Figure 5 shows a section of the part of the stand through the rod which moves the circuit-cylinder, showing the arrangement of the spring-stop which holds it in position.

Figure 6 shows the surface-plan of the circuit-cylinder, also showing, at the left-hand side, the relation of the magnetic bars to the open circuits in the front part of the machine, in three different positions of the circuit-cylinder, and at the right-hand side is shown the same thing, with regard to the magnetic bars in the back part of the engine.

a a a, &c., are the helices; *b b b*, &c., are the magnetic bars; *c c*, &c., are the chain-gears; *d d d*, &c., are the links between the magnetic bars, connecting them together in a chain; *e e e* are strips of metallic conductors, six in number, placed at intervals around the circuit-cylinder, *f*, and in a spiral direction from one end to the other, and all terminating in a metallic base, *f'*, at the lower end, which base is in constant connection with the negative pole of the battery, through the conductor *g* and the wire *h*, while the plate *i*, through the wire *j*, is in constant connection with the positive pole of the battery.

k is a cam-gear on one of the shafts of the chain-gear. This gear *k* works in a gear, *l*, twice its size, on the shaft *m*. This shaft has a groove from one end to the other, into which a splino or tongue, *n*, projects from the cylinder *f*, in such manner that the cylinder can move up or down on the shaft, but must turn with it as it revolves.

o is a rod, with three small notches, marked by three red figures, 1, 2, and 3, into which the bar *p* is pressed by the spring *q*. This rod has secured to its upper end a revolving washer, *r*, which works in a groove in the base, *f'*, of the circuit-cylinder, all arranged in such manner that, when the bar *o* is moved upwards, so that the notch at figure 2 comes under the bar *p*, the upper end of the cylinder will move from the position 1 to that of 2, and when the notch in said rod at 3 is moved up to the bar *p*, then the upper end of the cylinder will be in the position 3.

s s are the two cylindric cases in the front part of the engine, enclosing the two columns of helices, and *s'* are the two cases in the back part of the machine, for the two other columns of helices.

t t t t are four small thin tubes inside of the helices, through which the magnetic bars pass.

In fig. 4 is shown a somewhat modified plan for opening and closing the circuits through the helices. In this the gear *k* works in the gear *l'*, of the same size, on the upright shaft *m'*, which has a spur-gear on the lower end, which works in the gear *v* on the shaft *m*, and this, again, turns the gear *w*, of the same size, on the shaft *m''*. These three last-named gears are indicated by red circular lines. These shafts *m* and *m''*, fig. 4, operate the circuit-cylinders *f* and *f''* in the same manner that the shaft *m* operates the cylinder *f*, fig. 1, before described, and the circuit-cylinder and its conducting-bars *e e e* are formed and arranged as in the cylinder *f*, fig. 1, and

detailed in fig. 6, except that its motion is in the reverse direction, thereby causing the successive closing and opening of the circuits through the helices of the back part of the engine, to proceed upwards, suiting the upward movement of the magnetic bars on that side, instead of the plan, as shown in fig. 1, of having the parts of the strips forming the helices in the back part of the machine, which rest on the cylinder *f*, reversed, that is, No. 1 bent down to the position 6, and No. 2 to the position 5, and so on through the series.

Having described the parts, I will proceed to describe the operation of my engine.

Assuming all parts of the engine to be in the positions shown in the drawings, and the wire *j* in connection with the positive pole of the battery, thereby bringing all the helices on both sides of the engine in the same connection, and the wire *h* to be in connection with the negative pole, and allowing the red line in front of the cylinder *f*, marked in red, No. 1, to be the line of contact between the bars *a a a* and said cylinder, it will be seen that the three upper helices, as extended to the cylinder *f*, marked as 1, 2, 3, fig. 1, are in connection with one of the conductors *e*, and consequently the circuit is closed through them, and the relation of the two magnetic bars just entering them from above is shown at the upper magnet in the red line marked 1, on the left hand in fig. 6, where the small red lines, made across said magnet at the lower end, and below it, represent the position of the closed circuits through the three upper helices, and it is clear that this magnetic bar, thus situated, will be impelled downwards, as the arrow-point indicates, and if this magnetic bar is allowed to move in the direction thus impelled, the impelling force will continue in the same direction, so long as the same relation exists between the magnetic bars and the closed circuits, if the column of helices through which it passes is ever so long; and this is what is actually done by the circuit-cylinder *f*, for it will be observed that, as soon as these magnetic bars in the front part of the engine, or the one, *b'*, fig. 6, just referred to, which represents them, begins to move downwards, the cylinder *f* begins to turn, as indicated by the arrow-point at its upper end, and by moving but a little way the conductor *e*, leaves its connection with the upper helices, marked 1, and the conductor, by a little movement of said cylinder, will come into connection with the fourth series of helices, closing the circuit in the second, third, and fourth helices, the first, fifth, and sixth being open, and, by a still further movement, the third, fourth, and fifth helices have closed circuits, and so on, the form and motion of the conductor *e* being such as always to close and open the circuits successively downwards, in such manner that the relation of the closed circuits through the helices will remain the same, as nearly as may be, to the position of the magnetic bars as they advance downwards, and by the time the next magnetic bars approach the columns of helices, the next conductor *e* will close the circuit, first, of the first helix, then the second, third, fourth, and so on, always closing the circuits far enough in advance of the moving magnets (when the machine is properly adjusted) as to impel them with their greatest force.

We will assume the machine again to be in its first position. When the cylinder is moved upwards from its first to its second position, the first and sixth helices will have closed circuits, and, as shown in the magnetic bars on the second red line on the left, in fig. 6, the lower one will be impelled upwards, and the upper one downwards, as the arrow-points indicate, and the engine will rest, and when said cylinder *f* is moved to its upper position, the circuits will be closed in the fourth, fifth, and sixth helices, as shown in the magnetic bars on the third red line on the left of fig. 6, and the lower magnet will be impelled upwards, and the engine will run in a reverse direction from that first described.

It will be observed that there are two red lines drawn from top to bottom on the surface view of the cylinder *f*, fig. 6. The first of these, No. 1, shows the line of connection of the helices on the front side of the engine with said cylinder, and the other line, No. 2, shows the line of connection of the helices at the back of the engine, and the horizontal dotted lines across this view show the lines of connection of each helix around the cylinder when the cylinder is in its first position.

It will be further seen, also, that the red numbers on these lines, which indicate the helices in their columns, are reversed, that is, those on the first line commence at the top, and those on the second commence at the bottom. This change is made because the upper helices at the back of the machine must have their connection with the cylinder on the lowest position or dotted line, and the second helix from the top on the second line from the bottom, and so on, all reversed, as shown in fig. 1, behind the front connections. This is necessary, because the magnetic bars in the rear part of the engine move upwards, when those in front move downwards, and always in the reverse direction.

By this arrangement the same relation is preserved between the moving magnetic bars and the closed circuits in the back and front of the engine, though the magnets move in reverse directions, and the elevation of the cylinder *f* to the second and third position, has the same effect to stop the machine and reverse its speed, as in the front part, as shown in the magnetic bars in the three red lines at the right-hand side of fig. 6, where, in line 1, the open circuits are shown as in the first position of the cylinder, and in line 2 the second position, and in line 3 the third position of the cylinder, where the speed is reversed, and the magnets in the rear part of the engine move downwards.

By having two circuit-cylinders running in reverse directions, as shown at *f* and *f'*, fig. 4, the helices may have their connection with the cylinders in their natural order, as shown in the front part of the machine in fig. 1.

The chain-gears, *c c*, I construct by cutting into the periphery spaces for the magnetic bars, and between those, spaces for the links *d*, smaller than the others, so that there will be bearings, in the wheel or gear, for the ends of the magnetic bars to rest against, so that they cannot change their position in the gear.

Two of these gears, *c c*, placed on two parallel shafts suitably distant to receive one electro-magnetic chain, *b d*, *b d*, with two columns of helices, *a a*, one at the back and one at the front of the machine, the plate *i* and its connection with the positive pole of the battery, and the cylinder *f* and its connection with the negative pole, would constitute a complete engine; but I have taken great pains in arranging and contriving this machine, so that, for the increase of power, it can, in a very simple manner, be extended. Merely by increasing the length

of the shafts, and placing on them any desirable number of chain-gears and chains, and by increasing the number of helices in each strip, the engine may be extended to any desirable amount of power, still preserving a very desirable compactness.

To show the manner in which this is accomplished, I have arranged my engine with two chain-gears on each shaft, and two chains, as shown at *c c*, *b d*, *b d*, &c., figs. 1 and 3, and I have constructed two helices on each metallic strip, as shown at *a a*, &c., figs. 3 and 4.

On the top view of these helices, I have placed small arrow-points, which indicate the direction in which the electro-current flows around the magnetic bar when passing through the helix.

These views show also the manner and direction in which these thin metallic strips are coiled into helices, and it will be observed that in the first helix, from the plate, *i*, on the front side of the engine, fig. 3, the current flows in a left-hand direction around the magnetic bar, and in the second helix, on the same strip, the current flows in a right-hand direction.

By this arrangement the helices may be very near together, and they will mutually assist each other in charging the magnetic bars and giving them power, and indeed, if three helices are placed in a line near to each other, as they can be, and an electro-magnet is placed in the middle one, and we allow an electric current to pass through only the outside ones, the magnet thus situated will receive a charge of magnetic polarity of considerable power, which would be added to the power it would receive from its own helix if the current passed through all three. But suppose, on the contrary, the current was made to flow the same way, around through the middle helix, as through the end ones, then the force of the outside helices would serve to neutralize that of the middle one, and their power must be subtracted from that of the middle helix to get the resultant force of the magnetic bar; hence the value of my arrangement.

It will be noticed, by examining the four helices in fig. 3, that those on the opposite sides of the machine, through which the same chain passes, have their currents flow in reverse directions. The object of this is, that the same polarity may be preserved in the magnetic bars while passing down through one column of helices, and up through the other on the opposite side of the engine.

It has been found difficult, if not impossible, to procure iron free from carbon, and just in proportion as the magnetic bar contains carbon, its tendency is to become a fixed magnet when placed in a helix with a closed circuit, and it requires as much electric force to change a fixed magnet into a neutral state, as to change it from a neutral state to a magnet, hence the waste of force in all electro-magnetic engines requiring a change of polarity in the magnetic bars, and hence the value of the arrangement just described, for preserving the same polarity in the magnetic bars, as carbon in the iron does not interfere with the working of the engine; indeed, fixed steel magnets may be used successfully in place of the iron electro-magnets.

In constructing my engine, the magnetic bars should be made of the best of iron, or of the best of steel in case steel magnets are used. The helices should be formed of the purest copper, and insulated by wrapping in the manner well known for preparing wire for helices, or by varnishing it with shellac or other non-conducting varnish.

The spiral conductors, *e e e*, should be made of silver, or of silver-plated copper, and the base, *f'*, of the same material.

The base, *f'*, should be insulated by having the stand made of a non-conductor, or by having a block of ivory set into the stand for the bearings of the cylinder and the rod *o*, or in any other way known to electricians; also the plate *i* should be insulated.

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

1. In electro-magnetic engines, I claim the arrangement of the magnetic bars in an endless chain, having alternate magnetic bars and links of non-magnetic metal, the chain being so arranged in the engine that all the magnetic bars can pass successively through the same helix or column of helices, substantially as described, and for the purpose set forth.

2. In electro-magnetic engines, I claim the construction of two chain-gears on parallel shafts, of suitable form and distance apart to receive the electro-magnetic chain, all arranged in such manner that the gears and chain can revolve together, substantially as described.

3. In electro-magnetic engines, I claim the arrangement of two or any desirable number of chain-gears on the same shaft, with the corresponding number of electro-magnetic chains, all working concurrently together and communicating their power to the same shafts, substantially as described, and for the purpose set forth.

4. In electro-magnetic engines, out of a thin ribbon-shaped strip of metal, I claim the formation of two or more helices, as described, and so arranging them in the engine, in columns or otherwise, that each shall receive a different series of magnetic bars through it, and so further arranging them that when the circuit is closed through one helix, it shall be closed through all of the series thus formed of said strip, substantially as described.

5. I claim the circuit-cylinder, with its spiral conductors so formed and in such connection with the helices, that it shall continue the same relation between the closed circuits and the position of the magnetic bar, or as near as may be, as it advances through the column of helices.

6. I claim such disposition of these spiral conductors around said circuit-cylinder, that one of them will perform the same function for each magnetic bar as it enters a column of helices, or for all the magnetic bars of a series which enter a series of said columns at the same time, substantially as described and for the purpose set forth.

7. I claim such an arrangement of the spiral conductors *e e e*, on the sides of the cylinder, in combination with its movable arrangement on its shaft, as will close the circuits in such manner in its middle position that there will be no tendency of the magnetic bars to move in either direction, and as will open the circuits in such manner in its upper and lower positions as will give motion to the magnetic bars, but in diverse directions. the

upper position in one direction, and the lower position in the opposite direction, substantially as described and for the purpose set forth.

8. I claim, in combination with the cylinder, the device, consisting of the sliding bar *o* and the spring *q*, for moving the circuit-cylinder to and holding it in any position needful to stop the engine or running it in either direction, as described.

9. I claim making each alternate helix, of those formed of the same strip of metal, coil around in a diverse direction from the others, in such manner that when an electric current passing through a line of helices, so formed of the same strip of metal, produces a north polarity in one end of a magnetic bar, placed in any one of said helices, a south polarity will be produced in the same end of a magnetic bar placed in either of the adjoining helices of the same line, the electric current flowing in the same direction through all the helices in the same column, substantially as and for the purpose described.

10. I also claim such an arrangement of the columns of helices on the opposite sides of the engine that through any two columns, one on the back and the other on the front of the engine, through which the same electro-magnetic chain passes, the electric current shall flow in diverse directions, giving north polarity to the upper end of a magnetic bar in one, while it gives south polarity to the upper end of the magnetic bars in the other, and *vice versa*, all substantially as described and for the purpose set forth.

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