2 Sheets—Sheet 1.

C. G. PAGE.

ELECTROMAGNETIC ENGINE.

No. 10,480. Patented Jan. 31, 1854.

Fig. 10.

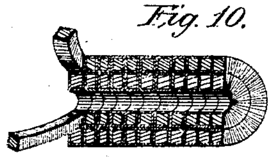


Fig. 3.

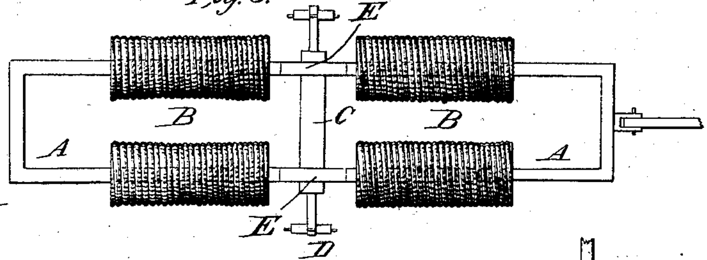


Fig. 9.

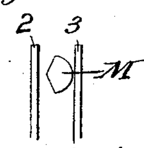


Fig. 1.

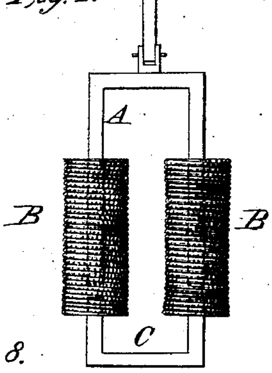


Fig. 4.

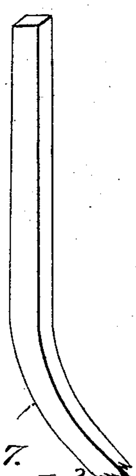


Fig. 2.

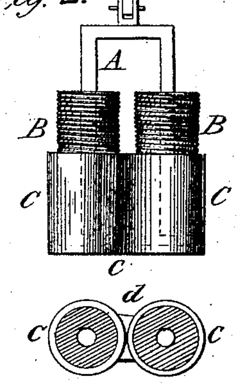


Fig. 8.

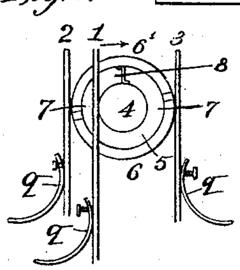
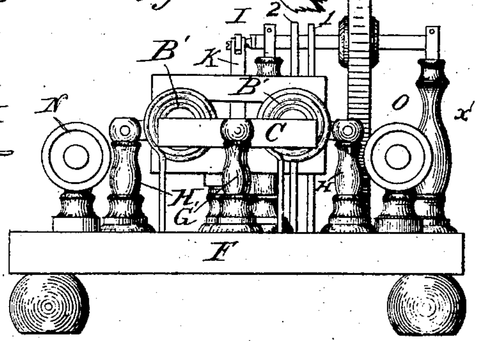


Fig. 7.



2 Sheets—Sheet 2.

C. G. PAGE.

ELECTROMAGNETIC ENGINE.

No. 10,480. Patented Jan. 31, 1854.

Fig. 5.

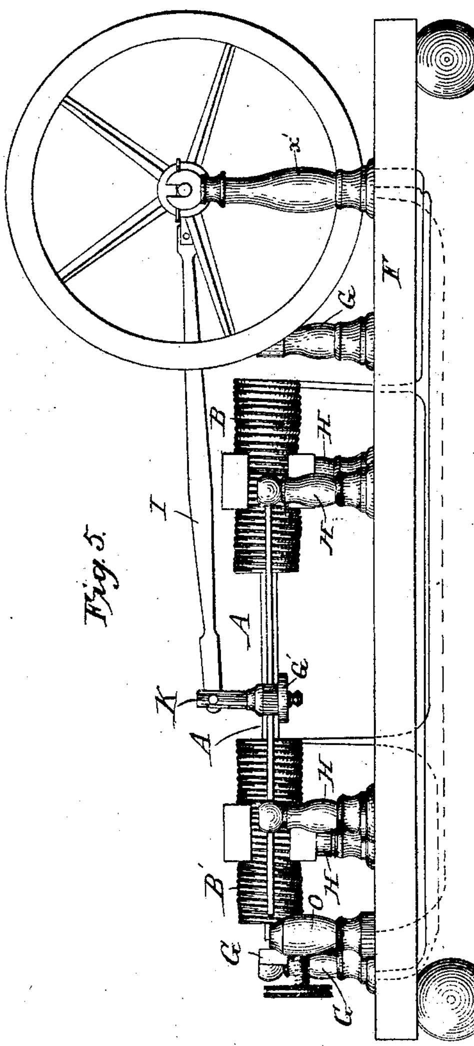
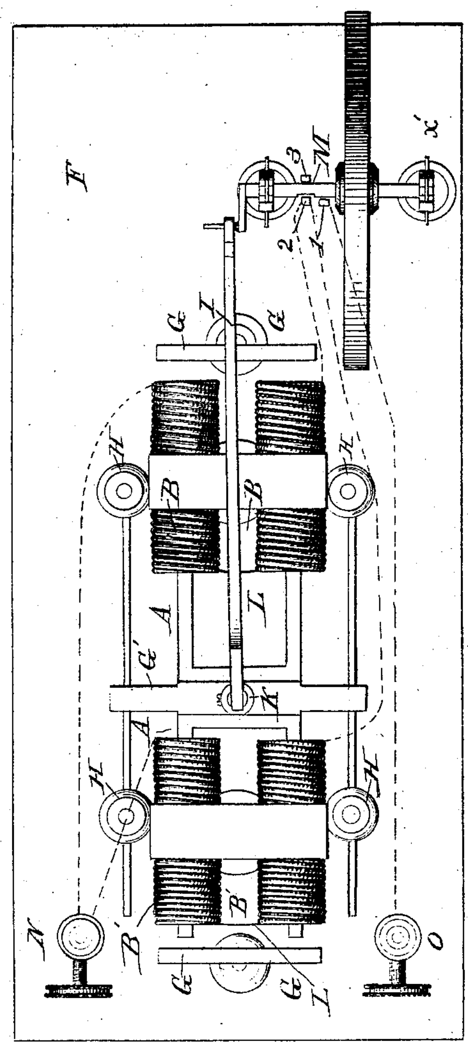


Fig. 6.



UNITED STATES PATENT OFFICE.

CHARLES G. PAGE, M. D., OF WASHINGTON, DISTRICT OF COLUMBIA.

IMPROVEMENT IN ELECTRO-MAGNETIC ENGINES.

Specification forming part of Letters Patent No. **10,480**, dated January 31, 1854.

To all whom it may concern:

Be it known that I, CHARLES GRAFTON PAGE, of Washington, in the county of Washington and District of Columbia, have invented certain Improvements in the Application of Electricity as a Motive Power; and I do hereby declare that the following is a full, clear, and exact description of the principle or character which distinguishes them from all other things before known, and of the usual manner of making, modifying, and using the same.

My invention consists in a peculiar mode of applying the galvanic current for the purpose of obtaining a motive power, to be described as follows:

The species of electro-motion which I employ is that which is exhibited in the well-known apparatus of De La Rive's ring used for philosophical illustrations, in which, by the agency of electricity, a coil of wire is drawn over a magnetic bar from one end to its center, or vice versa, the bar is drawn within the coil when it is conveying an electric current. This species of motion I have termed the "axial motion," and having discovered that it possesses considerable and peculiar advantages in its practical application, I have called the engines constructed upon this principle of action "axial engines," by way of distinction from electro-magnetic engines. With a given electric current, conducting-coil, and magnetic or axial bar it is true that the axial force is much less than that force exhibited between the poles of this axial bar and a piece of soft iron when the two are in very close proximity or in contact. In the axial action it is a force exerted between a coil of copper wire conveying an electric current and a magnet, and in the electro-magnetic action it is the force exerted between two magnets. Every attempt hitherto to enlarge electro-magnetic engines with a view to increase proportionally their power has been attended with considerable loss of power; and having investigated and discovered the true causes of such loss, I have invented the remedy to a great extent in the peculiar application of the axial force to engines under several modifications of form, and have found in practice that although the actual force exerted upon the axial bar is apparently and comparatively small, yet the available mechanical force realized in this way is greater from the same electric current than when electro-magnets are employed in the known ways. The very short distance through which magnets act with power, and the rapid diminution of power as the magnets recede from each other present serious practical difficulties in electro-magnetic engines whether in the reciprocating or rotary form. In the axial engine we can exhibit the magnetic power acting almost with uniformity through a considerable distance, and also acting with considerable power through a great distance, some portion of the magnetic bar being always in close proximity to the helix. The axial forces are peculiarly well adapted to reciprocating forms of engines, and thus admit of the entire concentration of electric power upon one or two magnets. In electro-magnetic engines it has been found that the retention of magnetism by the electro-magnets operates greatly as a retarding force. In the axial engines the retained magnetism of the iron bar is so much saved, provided the retention be not indicative of a bad quality of iron or one that would resist the development of magnetism. In the axial engine the action is between copper and iron, the former not susceptible of magnetism, and therefore exerting no force upon the magnet after the current is withdrawn; but I have found it advantageous sometimes to employ the co-operation of the electro-magnet in the axial engines in various ways where the axial bar moves in only one helix—that is, where the bar does not pass through one helix to be operated by another in succession. The pole or poles of the bar in this case are not allowed to come into very close proximity with the electro-magnet, and as what retarding force is felt in this case is at the end of the stroke, where the motion is slow, and it is convenient to cut off the electric current for a considerable interval, the loss is small in comparison with the loss from retention of magnetism in electro-magnetic engines proper.

I have also made an important improvement in the construction of helices for electro-magnetic purposes by the employment of square instead of round wire. When a helix is made of round wire wound from end to end of the helix back and forth upon itself, there is a great deal of vacant space between the individual turns of wire and between the successive layers. This space is so much loss in the economy of the electric power, and this I remedy by the use of the square wire. The helix of square wire is shown in section in Fig. 10. Other rectangular forms of wire may be employed with similar advantage in this respect; but the square is not only the most perfect form for this purpose, but is the form which presents the least surface to be insulated, which is an important point. Another advantage of the square wire is its facility of insulation. Round wire must be wrapped entirely with insulating material, and this operation, whether done by hand or machinery, is expensive, whereas the square wire need only be covered upon one of its sides with paper, cloth, or other insulating material, which may be fastened to it with glue. I have usually preferred for this purpose strips of cheap cotton fabric. After the first layer of the helix is completed then a strip of cloth is wound spirally around it, which makes the insulating-coat between this and the next layer.

I am aware that flat strips or ribbons of copper were used in the construction of spirals for electro-magnetic purposes prior to my invention of the square-wire helix. There is, however, a characteristic as well as a practical difference between the spiral and the helix. The spiral is made by winding the ribbon or wire upon itself, after the manner of a roll of tape or ribbon, while the helix is like a continuous screw-thread. The spiral is a continuous winding at right angles to the axis of the mandrel upon which it is wound, while the helix is a continuous winding in a direction oblique to such axis. I am not aware that helices were ever made prior to my invention of square or any rectangular shape of wire wound back and forth upon itself.

It is possible to imitate the helix to some extent by joining a number of spirals; but practically it is awkward and disadvantageous. In the construction of a helix of rectangular wires the further we depart from the square form the greater the difficulty of construction and the greater the loss of power, not only from increased obliquity of the wire to the axis of the helix and the inclosed magnet, but from the fact that its surface increases as we depart from the square form, and therefore requires more room for insulating material.

Fig. 4 represents the square wire.

Fig. 1 exhibits the most simple form for the axial engine. A is the axial bar or bars, (shown with a connecting-rod attached to it;) B B, the helices, and C the electro-magnet. The axial bar may be guided in its motions in any of the usual ways of guiding reciprocating rods or pistons. The electro-magnet C is fixed, and so that its poles shall not come very near those of the axial bars. It may be made adjustable, if necessary.

Fig. 2 exhibits another mode of employing the electro-magnet in connection with the axial bar. A is the axial bar; B B, the helices, and C the electro-magnet. This magnet consists of two hollow cylinders of wrought-iron, *c c*, united by a wrought-iron strap, *d*. These cylinders envelop the helices for about one-half to two-thirds their length.

Fig. 3 exhibits another form for the axial engine. A A are the axial bars; B B, the helices; and C is the electro-magnet or armature, which, in this case, is a soft-iron roller mounted upon suitable bearings D D. This roller-magnet serves also the purpose of a friction-roller and support for the frame of axial bars, which, in this case, are united by bars or rods of brass E E or of other non-magnetic material.

Figs. 5, 6, and 7 are different views of an entire working-engine, in which the arrangement of the axial bars is still different from the preceding. A A are the axial bars; B B′, the helices; and C C the electro-magnets or armatures. In these figures and Fig. 3 the soft-iron bars C C are represented as armatures or induced magnets; but they may be used as such or as electro-magnets at pleasure. When used as electro-magnets they are to be enveloped with helices, which are to be connected with the main battery or a separate battery for this special purpose. When used as electro-magnets their power must be interrupted by means of a cut-off, and at the same time or before the electric current is cut off from the helices. With the elements above it will be competent for a skillful mechanic to construct an engine, especially one who is acquainted with the various modes of mounting, constructing, and working steam and other reciprocating engines.

In Figs. 5, 6, and 7 F is the base-board; G, the pillars supporting the armatures; H H, the pillars sustaining the guide-rods, which play back and forth through ways or holes in the top of the pillars. These rods are fixed firmly to the cross-head G′, to which are attached the axial bars A A. The connecting-rod I from the crank of the fly-wheel takes hold of the stud K on the cross-head. The helices are mounted on suitable supports, and the two helices of each pair are connected by the wires L. These pairs of helices are each connected by wires with the conducting-springs 2 3 (bearing each alternately against the cut-off M upon the fly-wheel shaft) by means of wires passing down, through, under, and again up through the base-board, as shown by the dotted lines. The helices are also connected with the binding screw-cup N, as shown by dotted lines, and the dotted lines also show the connection of the binding screw-cup O with the conducting-spring 1 of the cut-off. The cut-off embraces the segmental portion M of the shaft and springs 2 3 acting with it. (See Fig. 9.) The cut-off is shown upon a larger and more perfect scale in Fig. 8, though identical in principle and action with that shown in Fig. 6. It consists of two semi-cylindrical metallic segments, 6 6′, insulated from each other and secured to a cylinder of wood upon the fly-wheel shaft 4.

The insulation is shown at 7 7, and consists of a piece of ivory or box-wood. An entire metallic ring, 5, is fixed upon a part of the wooden cylinder of less diameter than that to which the insulated-segments are attached. This ring is connected by a strip of metal, 8, with one of the metallic segments, 6′. The conducting-springs 1 2 3 are shown in position. Conducting-spring 1 may be dispensed with, and the current conducted upon the shaft through pillar *x*′. Let us suppose that spring 1 is connected through screw-cup O with the positive pole of a galvanic battery. The current will pass through the metallic connections to spring 2. This spring 2 is connected, as before shown, with one termination of the helices B′, their other termination being connected with the binding screw-cup N, which is connected with the negative pole of the battery. The helices B′ are, therefore, in action, and the cut-off being supposed to revolve in the direction of the arrow, they appear to have nearly completed the stroke of the engine or the motion of the axial bars, which are seen with their poles passed entirely through the helices and within the influence of the armatures or electro-magnets C C. The instant or before the dead-point is reached the helices B must be charged to propel the frame of axial bars in the opposite direction. This is effected by the revolution of the cut-off in the direction of the arrow, the segment 6′ being brought into contact with spring 3, as will be seen by tracing the wire-connections in dotted lines. The segment 6 has no other office than to preserve the cylindrical form of the cut-off. The pressure of the springs may be regulated by various means, and, for instance, the set-screws 9 9 9 are shown as one of the most simple.

Prior to my invention experiments for the sake merely of philosophical illustration were made with rings or helices and permanent magnets; but I found that soft-iron bars were much better than steel bars or magnets for obtaining power. I have tried steel of the best quality in comparison with soft iron and found it inferior in dynamic or mechanical value, although the purer kinds of steel may sometimes be used. In addition to the axial engine for motive power, I contemplate using this mode of applying the galvanic current under other forms for several purposes to which it seems to be peculiarly adapted—to stamping, crushing, pressing, compressing, printing, beating gold-leaf, pile-driving, pumping, punching, and trip-hammers, to all of which and similar operations it is appropriate and applicable in the manner of direct-action engines—that is, the power may be applied to these various operations directly without the interposition of a crank and fly-wheel, although in some of these operations the fly-wheel may be of advantage.

The simplicity and great facility of application to a variety of mechanical operations are distinguishing-features of the axial action.

It is obvious that the bars and helices may be multiplied or that a single bar may be used in place of the frame of bars represented.

Having thus described my invention, what I claim is—

1. The employment of the axial action or force of the electric current as a mechanical agent or motive power for the various purposes herein named, the power being produced by the combination or united operation of a helix or helices, an axial bar or bars of iron, and a cut-off, or its equivalent, for regulating the motion of the axial bar or bars under a general arrangement in principle, substantially as herein set forth.

2. The employment of co-operating electro-magnets or armatures, in combination with axial bars, helices, and cut-off, or its equivalent, substantially as herein set forth.

3. The employment of square wires in the construction of helices for electro-magnetic purposes, substantially as set forth.

CHAS. G. PAGE.

Witnesses:

WM. GREENOUGH,

TOLMIE CAMPBELL.