W. H. KELLER & S. D. SIBLEY.

RECIPROCATING MOTOR.

APPLICATION FILED JULY 8, 1908. RENEWED NOV. 14, 1911.

1,043,573.

Patented Nov. 5, 1912.

2 SHEETS—SHEET 1.

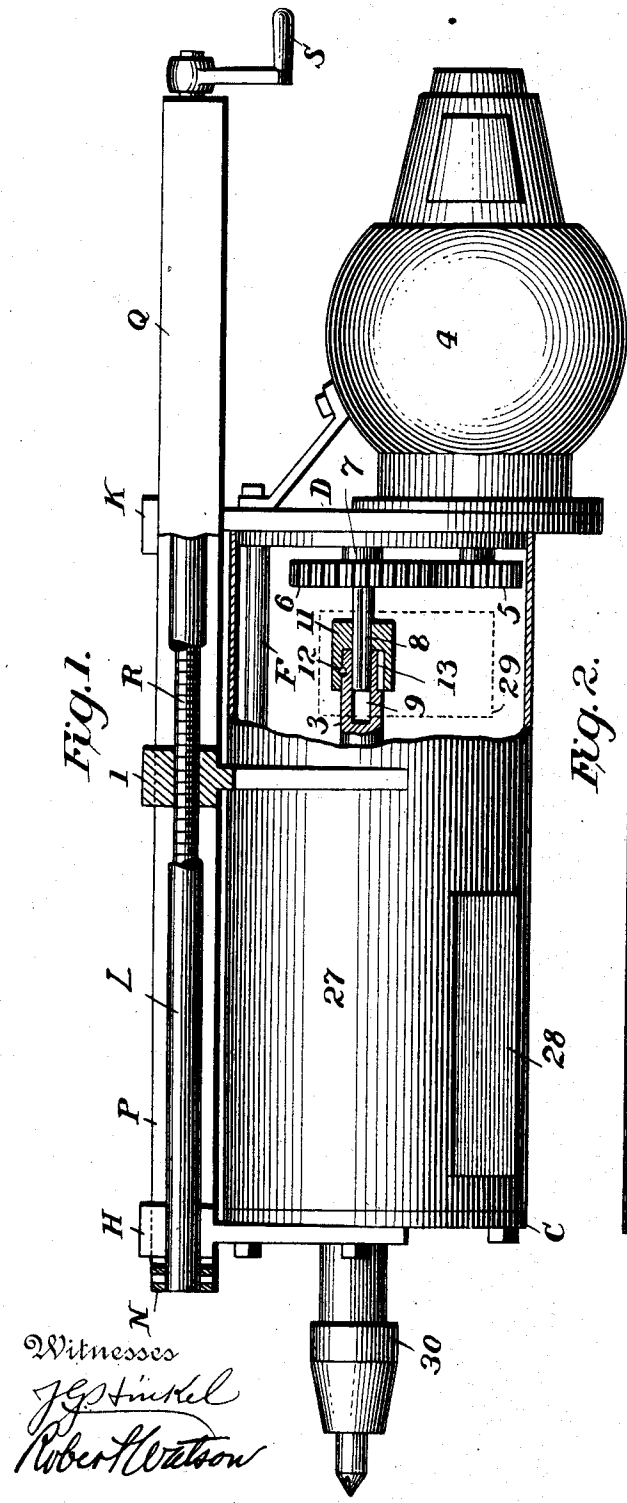

Fig. 1.

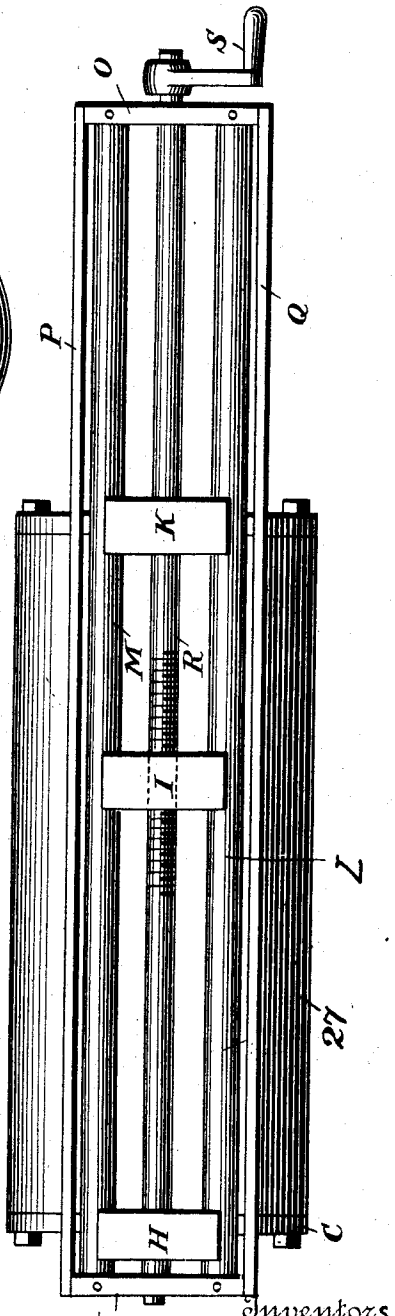

Fig. 2.

Witnesses

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2 SHEETS—SHEET 2.

Fig. 3.

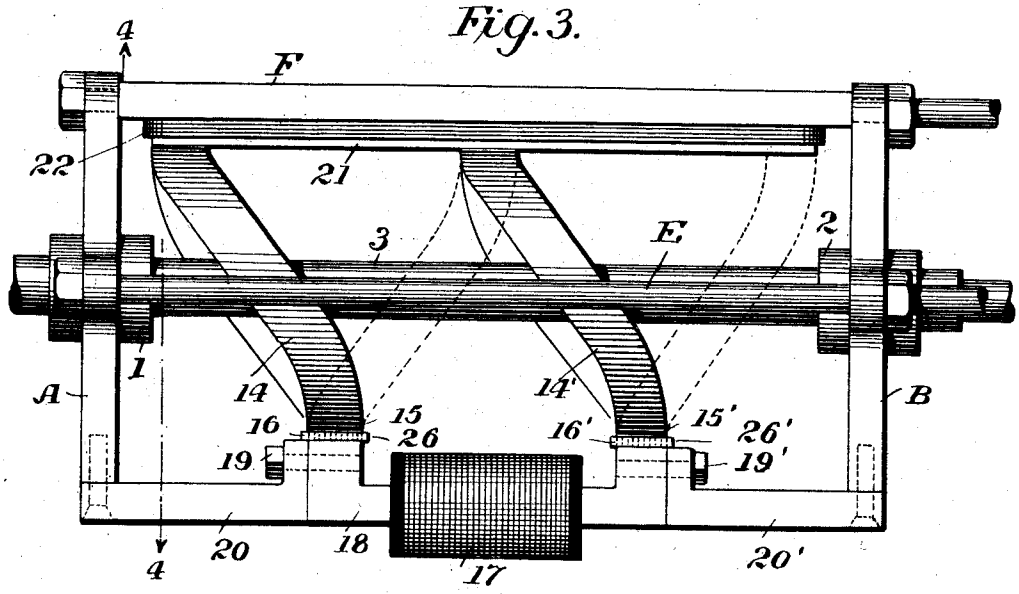


Fig. 4.

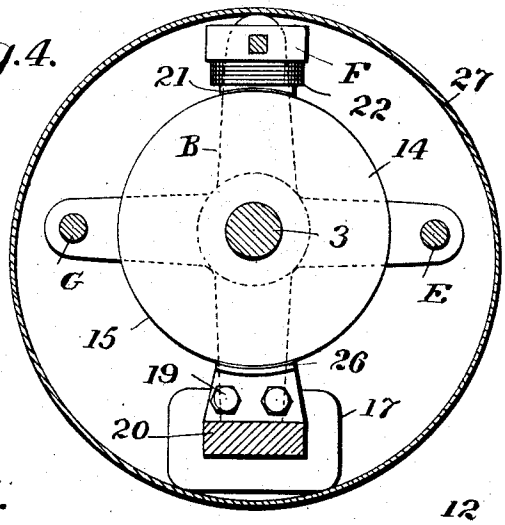


Fig. 5.

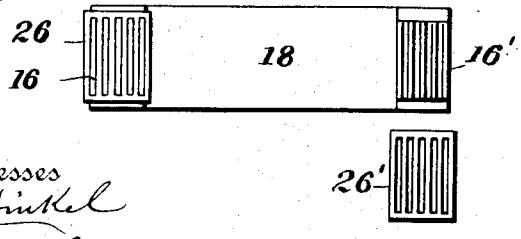
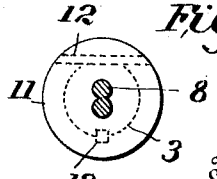


Fig. 6.



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UNITED STATES PATENT OFFICE.

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RECIPROCATING MOTOR.

1,043,573. Specification of Letters Patent. Patented Nov. 5, 1912.

Application filed July 8, 1908, Serial No. 442,468. Renewed November 14, 1911. Serial No. 660,308.

To all whom it may concern:

Be it known that we, WILLIAM HENRY KELLER and SAMUEL DUNHAM SIBLEY, citizens of the United States, both residing at Eccles, in the county of Raleigh and State of West Virginia, have invented certain new and useful Improvements in Reciprocating Motors, of which the following is a specification.

This invention relates to reciprocating motors and is especially adapted for use in connection with drills, punches, hammers or the like and particularly where such devices are used for drilling or punching in rock or coal or any similar uses.

In our application Serial No. 438,992, filed June 17th, 1908, is disclosed a reciprocating motor of the character above referred to. By the present invention certain improvements upon the apparatus of our former application are provided.

One object of the invention is to improve the construction of the magnetic circuit of magnetism producing the pull which coöperates with the rotary motion to produce axial motion.

Another object of the invention is to provide means for counterbalancing the transverse pull upon the shaft of the magnetic means for converting rotary into reciprocating motion.

Other objects of the invention will appear hereinafter.

In the acompanying drawings which illustrate the invention, Figure 1 is a side elevation of apparatus embodying the invention, partly broken away and partly in section; Fig. 2 is a top plan view of the apparatus shown in Fig. 1; Fig. 3 is an enlarged side elevation, with the casing removed, of that portion of the apparatus whereby the rotary motion of the shaft is converted into axial movement thereof; Fig. 4 is a section on the line 4—4 of Fig. 3 looking to the right, this figure being on the same scale as Fig. 3; the casing being applied; Fig. 5 is a top plan view of the electromagnet for reciprocating the shaft, the coil being removed and one of the grids being shown at one side of the pole face to which it belongs, the other pole face having its grid in place; Fig. 6 is an end view of a collar as will be referred to hereinafter.

Referring to the drawings, a frame, comprising the spiders A and B and the heads C and D, which are secured and spaced by the longitudinal rods E, F and G, is sustained by means of the brackets H, I and K which are adapted to slide upon longitudinal rods L and M which are parts of a support, which support is shown as comprising the end pieces N and O and the longitudinal pieces P and Q. The frame is thus movable with relation to the support and to effect this movement a screw R is rotatably mounted in the support and its screw threads engage with screw threads provided in the bracket I so that as the screw is turned by any suitable means as a crank S, the frame is moved along the support. This support may be mounted in any suitable manner for the purposes in view and when it is desired to frequently move the apparatus to various locations, the support may be mounted upon a wheeled vehicle.

Rotatably mounted in suitable bearings 1 and 2 in the spiders A and B, is a shaft 3. This shaft is rotated by an electric motor 4 which is mounted on the head D and is therefore carried with the frame as it is fed in one direction or the other by the turning of the screw R. Upon the motor shaft is fixed a gear 5 which meshes with a gear 6. The gear 6 is fixed upon a shaft 7 which at one end enters a bearing 8 in the frame. The other end of the shaft 7 is **8**-shaped in section and enters within a cavity 9, bored into the end of the shaft 3, through a hole 10, **8**-shaped in section, in the collar 11 which is fixed upon the shaft 3 in any suitable manner as by a transverse key 12. A longitudinal key 13 may also be employed if thought advisable. This connection between the shafts 7 and 3 permits them to have relative axial movement but prevents them from having rotary movement with relation to each other. It will be seen that the gear 6 is larger than the gear 5 and that therefore the shafts 7 and 3 revolve at a slower speed than the shaft of the motor. It is desirable that a reducing gear be employed as it permits of the use of a small high speed motor without producing undue speed in the shaft 3.

To give an axial movement to shaft 3, two similarly inclined iron disks 14 and 14′ are fixed upon the shaft. The peripheries 15 and 15′ of these disks are concentric with the shaft and facing these peripheries are the opposite pole faces 16 and 16′ of a mag-

net which is secured to the frame hereinbefore referred to. This magnet is an electromagnet comprising the coil 17 which encircles the core 18 upon which the pole faces just referred to are formed. It will be noted that the ends of this core are bent at right angles to the axis of the coil so that a magnet of the horseshoe type is formed, having the pole faces 16 and 16′ at its extremities. The core is secured between the bottom ends of the lowest arms of the spiders A and B by means of the members 20 and 20′, the member 20 being secured at one end to the spider A and at the other end to the core 18 by means of bolts or screws 19, while the member 20′ is secured at one end to the spider B and at the other end to the core 18 by means of bolts or screws 19′. When electric current is supplied to the coil 17 or, in other words, it is energized, a magnetic flux will pass through the core 18 and, emanating from the pole face 16 or 16′ according to its direction will pass to the periphery of one of the inclined disks through the disk to the shaft 3, and through the other disk to the other extremity of the core when the magnetic circuit will be completed.

In order that the magnetic flux may not be shunted off through the frame from the disks 14 and 14′, the members 20 and 20′ are preferably of non-magnetic material such as brass.

In order to fix the magnetic flux between each of the pole faces 16 and 16′ and the periphery of its corresponding disk, in position, windings 26 and 26′ are provided in the pole faces each of which windings is shown as consisting of a grid of copper let into slots in the pole face. This operates in a well-known manner to oppose any shifting of the field and thus prevents cross pulling of the magnet, side sliding or lagging. The pull of the magnet above referred to upon the disks tends to draw the shaft 3 forcibly against the sides of its bearings, so that undue wear of the bearings might be caused. Under some circumstances the shaft 3 might even be sprung. To avoid the effect of this transverse pulling of the shaft by the magnet, means is provided for compensating it. In the apparatus shown, this means consists of a compensating magnet arranged opposite the magnet comprising the coil 17 and core 18. This magnet comprises a core 21 upon which is mounted a coil 22. This core is secured to and may be formed integral with the frame rod F which may be broadened out and formed of a suitable cross section for the purposes in view, as shown clearly in Fig. 4. The rod F may be made square in section where it passes through the spider A so as to prevent it from turning. The core 21 has a pole face opposite the peripheries of the disks and extends continuously from end to end, being at the same distance from the shaft 3 at all points. Also the pole face is of such extent that both of the disks 14 and 14′ are beneath it at all times during the operation of the machine. With the construction just referred to it will be apparent that as the peripheries of the disks move back and forth in front of the pole face of the core 21, the amount of magnetic flux passing through the disks from the core 21 will not change and, therefore, the compensating magnet will exert no material force tending to prevent reciprocation of the shaft 3. The disks will, however, be attracted along lines transverse to the shaft 3 and in a direction opposite to the pull exerted by the magnet comprising the coil 17 and core 18. By suitably adjusting the pole of the compensating magnet the transverse pull of the other magnet can be nicely balanced. It will be apparent that the magnetic circuit of the compensating magnet will be from the core 21 through the disks 14 and 14′, the shaft 3, the spiders A and B, (which should be of iron) to the frame rod F and thence to the core 21 when the magnetic circuit is complete.

It will be understood that the magnet coils 17 and 22 are each suitably connected with a source of electric current and that suitable switches are provided for making and breaking the circuit of either so that it may be energized or deënergized at will. The electric motor 4 may be of any suitable and well-known construction and it will be understood that it is suitably connected with a source of current and that suitable means for starting or stopping or otherwise controlling it are provided.

Upon the frame may be placed a suitable inclosing casing 27 for protecting the mechanism and in this casing may be provided suitable doors as 28 and 29 whereby hand holes are provided through which the mechanism may be reached for attending to lubrication or for other purposes.

At one end of the shaft 3 (see Fig. 1) may be mounted a chuck 30 for holding a drill or other tool.

The parts being in the position indicated in full lines in Fig. 3, the shaft 3 will be at the extreme left hand limit of its movement. It being understood that the magnet coil 17 is supplied with current and that, therefore, the magnet having the core 18 is energized, as the shaft 3 is revolved by the motor 4 through the gears, the peripheries of the disks 14 and 14′ will be attracted to the pole faces 16 and 16′ and by reason of the fact that the successive portions of each periphery which is presented to a pole face are axially disposed along the shaft, the rotary movement of the shaft will be converted into axial movement thereof. When the shaft 3 and the disks thereon have re-

volved through 180 degrees from the position just referred to, the disks will occupy positions as indicated by dotted lines in Fig. 3, when the shaft 3 will have been moved axially into its farthermost right hand position. As the rotation of the shaft is continued it will be axially moved back toward the left hand position, when a complete revolution has been made, the disks will occupy their original positions, as shown in full lines and the shaft will have been reciprocated axially from its extreme left to its extreme right hand position and back again. The rotation of the shaft 3 being continued, the cycle of operations just referred to will be repeated and it will be obvious that during the continuous rotation of the shaft a series of axial movements thereof will be caused and the drill or other tool will be alternately driven forward and retracted so long as the shaft 3 continues to rotate and the magnet 18 is sufficiently energized.

It has been pointed out in our prior application, above referred to, that the operation of the inclined disk and magnet upon the shaft 3 is somewhat analogous to that of a cam. In the apparatus shown herein, the operation is similar, each of the two inclined disks acting in this cam-like manner.

It will be observed that in the apparatus of the present application the magnetic circuit passing through the core 18 is completed through the inclined disks whereas in the apparatus of our former application either the frame or an auxiliary brush or arm was employed to complete the similar magnetic circuit.

While the invention has been shown in what is considered its best embodiment, it may be embodied in other structures without departing from its spirit and is not, therefore, limited to the structure shown.

What we claim is:—

1. In a reciprocating motor, the combination with a rotatable shaft, of means for rotating said shaft, a plurality of inclined disks upon said shaft and a magnet having its poles presented to the peripheries of said disks and adapted to attract said peripheries to move said shaft axially as it is rotated.

2. In a reciprocating motor, the combination with a rotatable shaft, of means for rotating said shaft, means disposed laterally of and exerting a pull, having a transverse component, upon said shaft, for axially moving said shaft, and means for counterbalancing the transverse pull of said means for axially moving said shaft.

3. In a reciprocating motor, the combination with a rotatable shaft, of means for rotating said shaft, magnetic means disposed laterally of and exerting a pull, having a transverse component, upon said shaft, for axially moving said shaft and means for counterbalancing the transverse pull of said magnetic means.

4. In a reciprocating motor, the combination with a rotatable shaft, of means for rotating said shaft, magnetic means disposed laterally of and exerting a pull, having a transverse component, upon said shaft, for axially moving said shaft and magnetic means for counterbalancing the transverse pull of the aforesaid magnetic means.

5. In a reciprocating motor, the combination with a rotatable shaft, of an inclined disk thereon, a magnet adapted to attract said disk to move the shaft axially as it is rotated, said magnet being disposed laterally of said disk and exerting a pull thereon having a transverse component, and a compensating magnet adapted to attract said disk to counterbalance the transverse pull of the aforesaid magnet.

6. In a reciprocating motor, the combination with a rotatable shaft, of a plurality of inclined disks thereon, a magnet adapted to attract said disks to move the shaft axially as it is rotated, said magnet being disposed laterally of said disks and exerting a pull thereon having a transverse component and a compensating magnet adapted to attract said disks to counterbalance the transverse pull of the aforesaid magnet.

7. In a reciprocating motor, the combination with a rotatable shaft, of means for rotating said shaft, enlargements carried by said shaft and having peripheries surrounding said shaft, said peripheries being separated, displaced axially from each other and each of said peripheries extending axially as well as circumferentially of said shaft, and a magnet having its opposite poles presented to said enlargements respectively, said magnet and shaft being relatively movable axially, and said magnet and enlargements exercising a mutual attraction to cause relative axial movement between said shaft and said magnet as said shaft is rotated.

8. In a reciprocating motor, the combination with a rotatable shaft, of means for rotating said shaft, a plurality of disks upon said shaft and inclined to the axis thereof, and a magnet having its poles presented to the said disks, said magnet and disks adapted to be mutually attractive to cause relative axial movement of said shaft and said magnet as said shaft is rotated.

9. The combination with a rotatable shaft, of means for rotating said shaft, a plurality of disks upon said shaft and inclined to the axis thereof, an impact tool-chuck or holder, and a magnet having its poles presented to said disks and adapted to attract said disks to reciprocate said chuck or holder axially as said shaft is rotated.

10. In a reciprocating motor, the combination with a rotatable shaft, of means for

rotating said shaft, a plurality of disks upon said shaft and inclined to the axis thereof, a member of magnetic material extending adjacent to said disks, said member and shaft being relatively axially movable, and an electric coil adapted to establish magnetism through said disks and member so that the mutual attraction of said disks and member will cause relative axial movement of said shaft and member.

11. The combination with a rotatable shaft, of means for rotating said shaft, a plurality of disks upon said shaft and inclined to the axis thereof, a member of magnetic material extending adjacent to said disks, an impact tool-holder or chuck, and an electric coil adapted to establish magnetism through said disks and member so that the mutual attraction of said disks and member will cause reciprocation of said tool-holder or chuck.

12. In an impact device, the combination with a fixed coil, of a magnetic circuit for said coil comprising a part movable with relation to said coil, said part comprising a plurality of enlargements of magnetic material presented to the poles of said coil and mechanically connected by an element of such magnetic conductivity as to cause the magnetism from said coils to pass through said enlargements, means for reciprocating said movable part of the magnetic circuit of said coil with relation to said coil and an impact tool reciprocating with said movable part of said magnetic circuit.

13. In an impact device, the combination with an electric coil, of a magnetic circuit for said coil comprising a section movable axially with relation to said coil and having a plurality of masses of magnetic material mechanically connected together and corresponding to the poles of said coil, means for reciprocating said section axially of said coil and an impact tool reciprocated by said section.

14. In an impact device, the combination with an electric coil of a magnetic circuit for said coil comprising a part movable axially with relation to said coil, said part comprising a plurality of enlargements of magnetic material presented to the poles of said coil and mechanically connected by an element of magnetic material, said element being of such magnetic conductivity as to cause the magnetism from said coil to pass through said enlargements, means for reciprocating said movable part of the magnetic circuit of said coil with relation to said coil and an impact tool reciprocated by said movable part of the magnetic circuit.

In testimony whereof we have affixed our signatures in the presence of two witnesses.

WILLIAM H. KELLER.
SAMUEL D. SIBLEY.

Witnesses as to the signature of William H. Keller:

E. O. MORRIS,
W. M. TAYLOR.

Witnesses as to the signature of Samuel D. Sibley:

W. F. RUSSELL,
R. G. RUSSELL.