W. A. STEDMAN.

ELECTRIC RECIPROCATING ENGINE.

APPLICATION FILED APR. 25, 1910.

991,384.

Patented May 2, 1911.

3 SHEETS—SHEET 1.

Fig. 1.

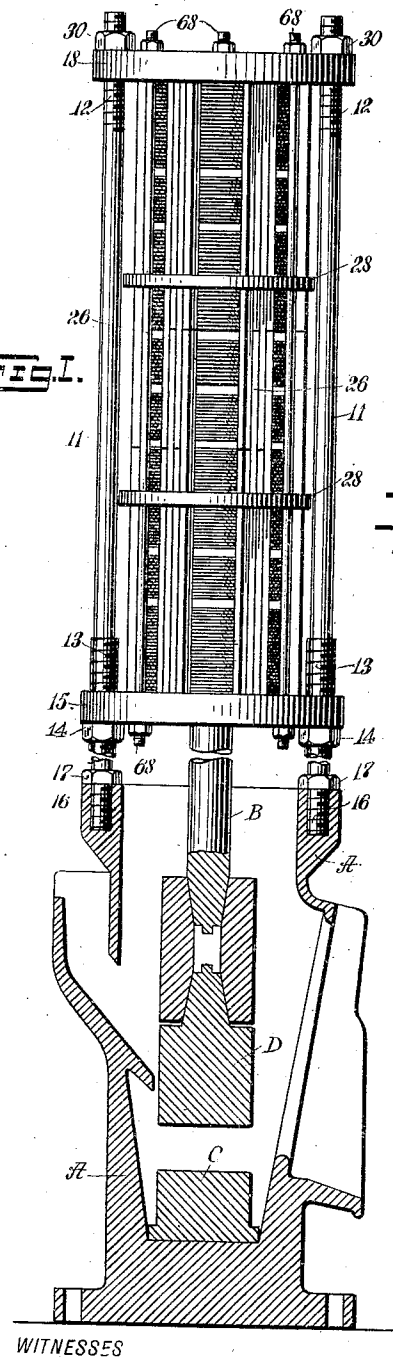
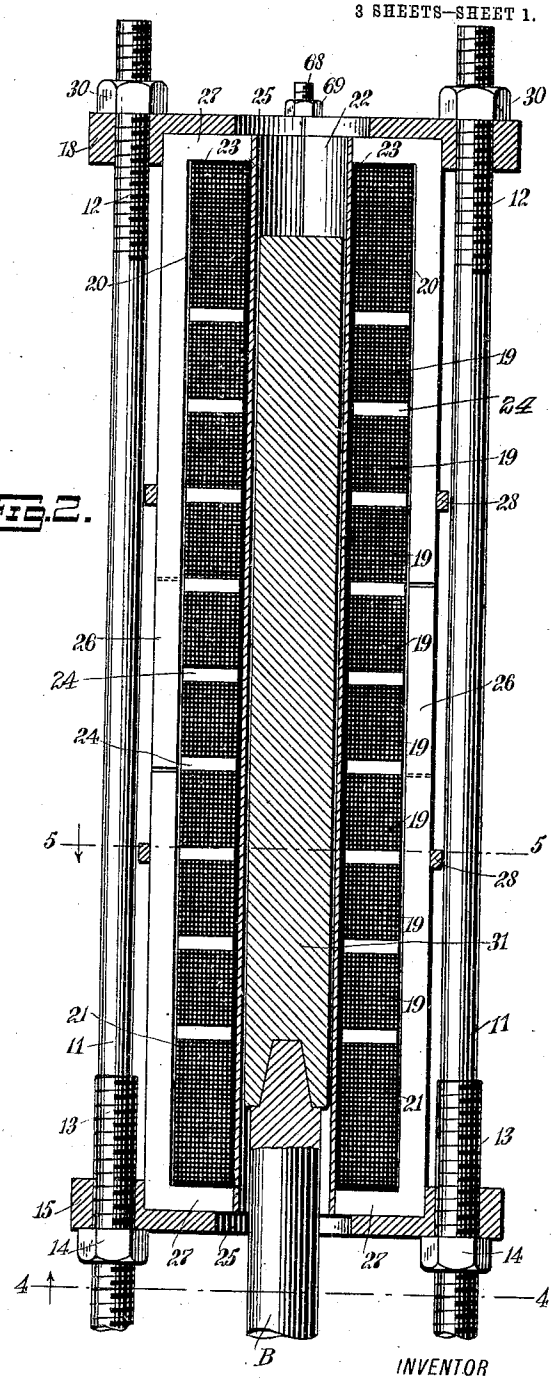


Fig. 2.



WITNESSES

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FIG. 3.

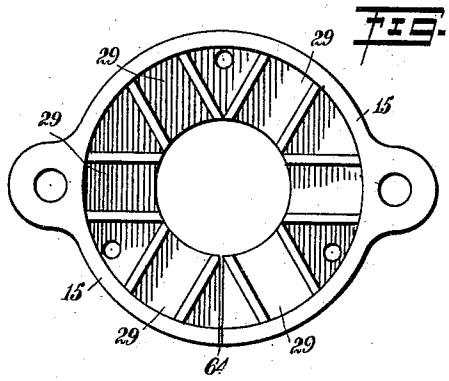


FIG. 6.

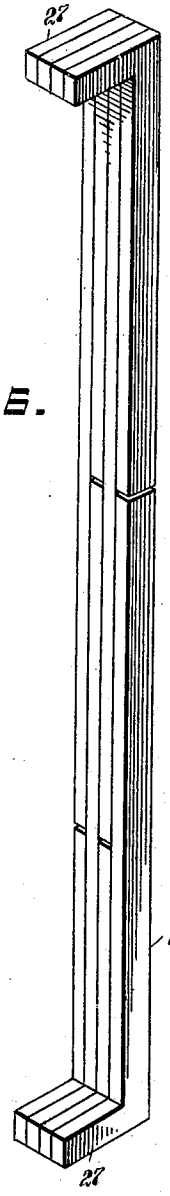


FIG. 4.

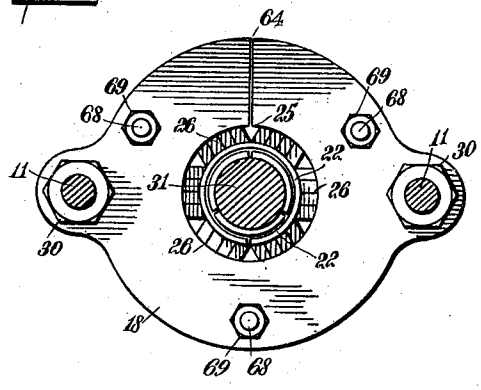
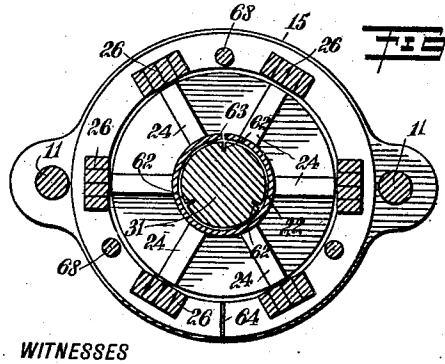


FIG. 5.



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3 SHEETS—SHEET 3.

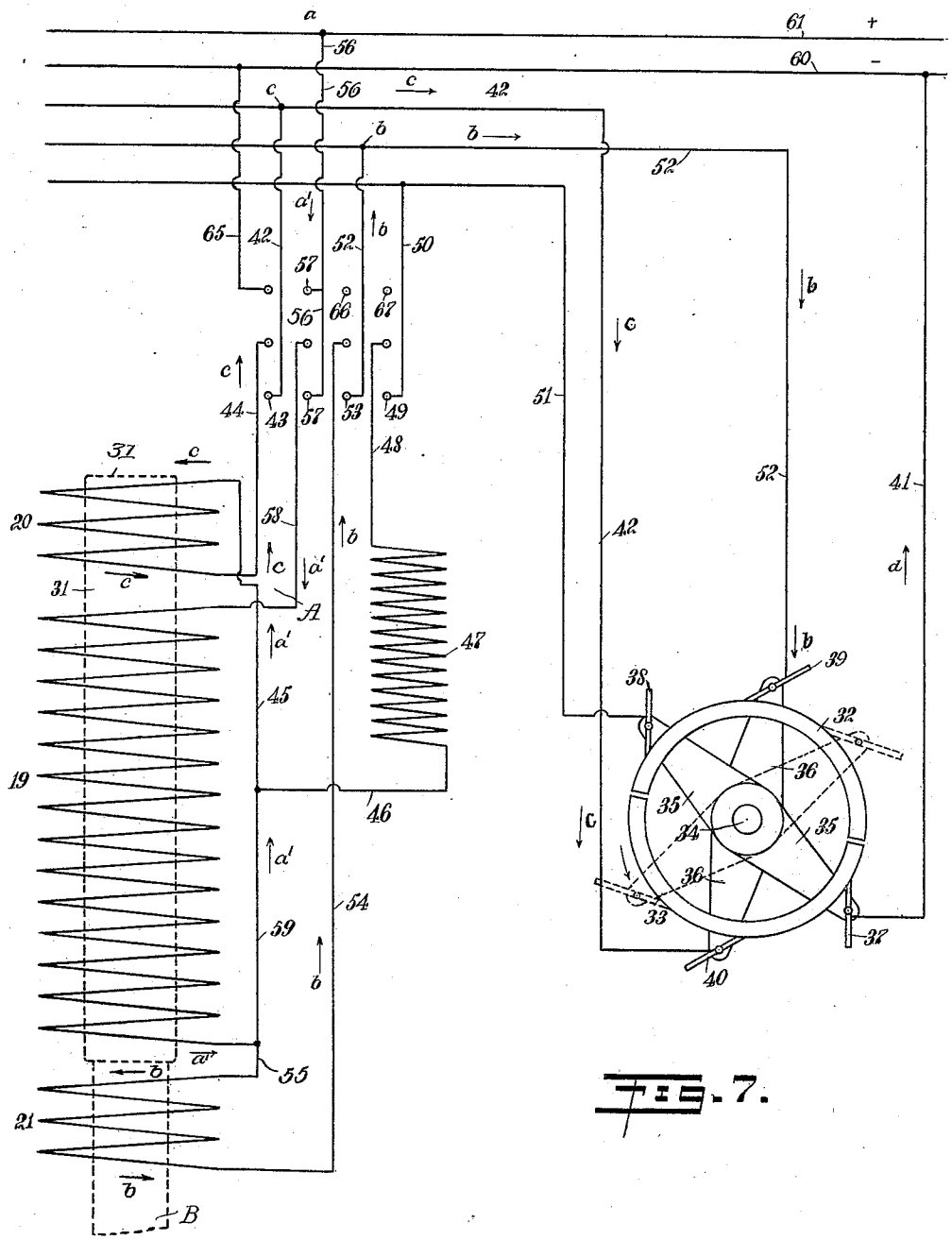

FIG. 7.

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ELECTRIC RECIPROCATING ENGINE.

991,384. Specification of Letters Patent. Patented May 2, 1911.

Application filed April 25, 1910. Serial No. 557,423.

To all whom it may concern:

Be it known that I, WILLIAM A. STEDMAN, a citizen of the United States, and a resident of Millers, in the county of Esmeralda and State of Nevada, have invented a new and Improved Electric Reciprocating Engine, of which the following is a clear, full, and exact description.

Among the principal objects which the present invention has in view are: to provide means for operating the tamp bars of a stamp mill in fixed serial relation without frictional loss; to provide means whereby individual tamp bars may be independently operated, repaired or replaced; to provide electric engines for the operation of the tamp bars constructed to facilitate ventilation and heat radiation; and to simplify and economize the construction of stamp mills.

One embodiment of the present invention is disclosed in the structure illustrated in the accompanying drawings, in which like characters of reference denote corresponding parts in all the views, and in which—

Figure 1 is a side elevation of the electric reciprocating motor shown in conjunction with a stamp mill of the usual construction, the stamp mill being shown in vertical section; Fig. 2 is an enlarged detail view in vertical section, of the reciprocating motor constructed and arranged in accordance with this invention; Fig. 3 is a plan view of one of the clamping plates, showing the grooved face for holding the structural members of the solenoid in position; Fig. 4 is a view of the clamping plate, shown from the reverse side of that illustrated in the previous figure, the tamp bar and supporting rods being shown in section taken on the line 4—4 in Fig. 2; Fig. 5 is a cross section of the solenoid, taken on the line 5—5 in Fig. 2; Fig. 6 is a perspective view of the laminated side structural framing member; and Fig. 7 is a diagrammatic view, showing the lay out of the operating circuits for one of the said motors and a rotary commutator for energizing said circuits.

The form of stamp mill to which this invention is peculiarly adapted is that in which a series of mortars and tamps are used, arranged to form a battery. The tamp bars are lifted in serial order by tappet cams arranged upon a shaft. The shaft carrying the tappet cams is driven by a motor of any usual and well known construction. The tappet cam shaft is mounted in bearings carried in an overhead frame, which is necessarily cumbersome and heavy, due to the need for resistance to the rapid vibration of the mill when operating. The vibration is increased by the fact that the impact of the cams upon the heads of the tamp bars is sharp and unyielding.

In the present invention I have substituted for the frame above mentioned upright supporting rods 11, 11. The upper end section of the rods 11, 11 is reduced in diameter, and the extreme upper end of the reduced portion is provided with screw threads 12, 12, as shown. At the lower end of the said rods are provided screw threads 13, 13. Screw nuts 14, 14 are provided and mounted upon the rods 11, 11 to receive and support a clamp plate 15, the nuts 14, 14 being adjusted to support the same. The rods 11, 11, are threaded as at 16, 16, and held in tapped sockets formed in the frame of a mortar A, as shown in Fig. 1 of the drawings. The threaded lower ends of the rods 11, 11 are provided with screw nuts 17, 17, that may be adjusted to raise and lower the one or the other of the rods 11, 11 to correct the vertical position of the said rods and the tamp bars operated by the electric engine supported on the said rods 11, 11.

Between the plate 15 and a plate 18 is mounted a reciprocating electric engine. The engine in the present invention is composed of a plurality of electric coils connected in series, and wound in the same rotary direction. The coils, in the form approved by me, are wound and bound in spools 19, 19, as shown in cross section in Fig. 2 of the drawings. The said spools are connected in series. By using the spool form of winding, the needed repairs are readily made by removing a damaged spool and substituting a perfect spool.

The spools 19, 19 are interposed between enlarged end coils 20 and 21, each of which has an independent electric circuit. The spools 19, 19 and coils 20 and 21 are threaded over a cylinder 22. The cylinder 22 is constructed from non-magnetic material, such as brass, and is provided on the outer surface with a suitable insulating material 23 adapted to electrically insulate the said

cylinder 22 from the said spools and coils. The covered cylinder 22 is forced through central perforations of the spools 19, 19 and coils 20 and 21. Between each of the said spools 19, 19 and coils 20 and 21 are interposed separating strips 24, 24. The strips 24, 24 are constructed of any suitable material, preferably non-metallic and non-magnetic, and are arranged in radial order, as shown in Fig. 5 of the drawings. The strips 24 serve to separate the said coils and said spools, to provide for a free circulation of air.

The clamp plates 15 and 18 are each provided with a central perforation 25, 25, sufficiently large to pass the cylinder 22. The spools 19, 19 and coils 20 and 21, when mounted firmly upon the cylinder 22, holding the interposed strips 24 between, are surrounded by a plurality of separated laminated casing loops 26, 26. The loops 26, 26 are formed from hook-like sections having short end extensions 27, 27, which extend from the outer surface of the coils 20 and 21, to contact with the cylinder 22, as shown in Fig. 2 of the drawings. The hook-like extensions are formed in two lengths, a short and long length, the combined lengths of which are slightly less than the combined length of the spools 19, 19 and coils 20 and 21. In vertical arrangement of the said extensions, a long length and a short length are alined. In the laminated disposition, a short length is held between two long lengths. When the desired number of extensions have been compiled, the middle section of the loops will be found to provide for an endwise contraction, while the sides of the adjacent extensions are in rubbing or metallic contact. In the present construction I provide a series of six of the loops 26. They are held in position upon the said spools and coils by rings 28, 28, which are forced over the loops after the same have been disposed in the desired position upon the said coils and spools. When the rings 28 are thus forced into position, the body of the solenoid may be said to be completed. It is then placed in position on the lower plate 15, the short extensions 27 of the loops 26 fitting within the grooves 29, 29 formed in the plate 15. When the solenoid is in position, the plate 18 is threaded over the rods 11, 11 and forced down upon the top of the solenoid, adjusting the grooves 29, 29 formed in the said plate over the ends of the short extensions 27 of the loops 26, as shown substantially in Figs. 1 and 2 of the drawings. Screw nuts 30, 30 are engaged with the threaded ends of the rods 11, 11 and driven down upon the plate 18. The nuts 30, 30 are forced upon the loops 26, 26, driving the overlapped ends of the long and short sections thereof in closer juxtaposition, and forcing in compact and fixed relation all of the spools 19, 19 and coils 20 and 21. By means of this construction the separate parts of the solenoid are held rigidly in position, being bound more firmly by rods 68, 68 and nuts 69, 69.

As before stated, an electric engine, of which the above described solenoid comprises an element, may be provided for each of the tamp bars B of a stamp mill. Connected to the upper end of the tamp bar B is a soft metal core 31, fitted within the cylinder 22 to loosely move therein without unnecessary vibration. The core 31 is formed to a length equaling the length of the compiled spools 19, 19 plus one of the coils 20 or 21. The cylinder 22 thus serves to guide the tamp bar B to hold the same in vertical disposition above the anvil C of the mortar A. With the engine arranged as thus described, by alternately energizing the coils 20 and 21, the core 31 is raised and lowered, operating the tamp D to crush the ore caught between the said tamp and anvil C.

The electric circuits whereby the spools 19, 19 and the coils 20 and 21 are energized, are shown in diagram in Fig. 7 of the drawings, together with the commutator and accessories to the circuits. The commutator illustrated in said figure consists of two sectors of metal, 32 and 33. The sectors 32 and 33 are suitably mounted on a wheel or drum rotated by a shaft 34. Loosely mounted upon the shaft 34 are radially disposed arms 35 and 36. On the outer ends of said arms 35 and 36 are suitably mounted brushes 37, 38, 39 and 40. Each of the said brushes is insulated from the arm 35 or 36 in which it is mounted, and forms the terminal of an electric circuit. The arms and brushes are adjustable, as shown in dotted lines in Fig. 7. The circuits extending from these terminals, operate to constantly energize the spools 19, 19, and to alternately energize the coils 20 and 21.

The circuit arrangement is as follows: The brush 37 is connected by means of a branch wire 41 to the main 60 of the electric supply. The brush 40 is connected with the switch terminal 43 by a wire 42. The switch terminal 43 is disposed in contact relation with the terminal of a branch wire 44, a continuation of the coil 20. The coil 20, is connected by a wire 45 to a common branch wire 46. The branch wire 46 is connected with a resistance coil 47, from which leads a wire 48 which contacts with the fixed post of a switch, which, in its lower position, contacts with a switch terminal 49. The switch terminal 49 is, by means of wires 50 and 51, connected with the brush 38. The fixed terminal of the switch operating upon the terminal 53 is connected by means of a wire 54 to the coil 21. The opposite terminal of the coil 21 is by means of a wire 55, 59 connected to the common branch 46. The connection between

the branch 46 and the resistance coil 47 with the brush 38 has been above outlined in tracing the circuit energizing the coil 20.

As above described, the energizing of the coils 20 and 21 is alternative. At all times during the operation of the engine the spools 19, 19 are energized. The said spools are connected by means of a wire 58 with both of the switch terminals 57, 57, hence in both thrown positions of the double throw switch employed in this invention the wires 56 and 58 are in circuit with the main supply. The wire 58 is connected with one of the terminals of the spools 19, 19. The opposite end of the spools 19, 19 is connected to a wire 59, 45, 55, which is in turn connected with the coils 20 and 21, and also with the common branch 46.

The operation of the circuits above described is as follows: The shaft 34 is constantly rotated in the direction indicated by the arrow in Fig. 7. This rotation presents the sectors 32 and 33 alternately to the brushes 37, 39 and 37, 40, and also alternately bridges between the brushes 38, 40 and 38, 39. In the drawings, the sectors are shown in the disposition wherein the brush 37 is connected with the brush 40 through the sector 33. In this arrangement of the commutator the acting circuit is as follows: The wire 56 is connected at *a* with the main 61. The wire 56, through the switch 57, is connected with the wire 58. The circuit follows the arrows marked *a'*. From the wire 58 the circuit passes, as shown by the arrows, through the spools 19. At the opposite end of the spools the terminal connects with the wire 59, 45, which is connected with the coil 20. The circuit passes through the coil 20 in the direction of the arrows marked *c* and leaves the same by the wire 44. The wire 44 is connected through the switch terminal 43, when the switch is so disposed, to the wire 42 which wire 42 is connected with the brush 40. The brush 40 being in contact with the brush 37 through the sector 33, the current passes from the said brush 37 through the wire 41 to the main 60 of the supply, thus completing the circuit through the spools 19 and the coil 20.

The circuit above described is established through the spools 19 and the coil 20 simultaneously. In this position of the sectors the lower coil 21 is not energized, therefore the active solenoid is constituted within the length occupied by the spools 19 and the coil 20. The core 31 is lifted to the position shown in dotted lines in Fig. 7, centrally disposed with reference to the spools 19 and coil 20, and above the coil 21.

When the commutator is rotated so that the sector 33 passes out of contact with the brush 40, it passes under the brush 39, connecting the latter brush with the brush 37. This disposition of the sectors operates to change the circuits as follows: The circuit now is from the wire 56 through the terminals 57, the wire 58, through the spools 19 to the wire 55. From the wire 55 the current is through the coil 21. The coil 21 is connected by means of the wire 54 to the switch 53. The current in the coil 21 and wires connected therewith is indicated by the arrows marked *b*. From the wire 53 the circuit is through the wire 52 to the brush 39, from the brush 39 over the sector, to the brush 37, and thence by the wire 41 to the main 60.

With the current established as above described, the coil 20 is deënergized, while the coil 21 is excited. This changes the active area of the solenoid to include the spools 19 and the coil 21. The core 31 is then dropped by the downward pull, until it rests in the relation to the lower coil 21 that it formerly bore to the upper coil 20, causing thereby a downward thrust or drop of the core 31, tamp bar B and parts connected therewith.

The above described alternations of the circuits are produced in rapid succession. It is, however, desirable that the circuit established in the coil 20 should be for an increased period of time over that in which the current is established in the coil 21. This is for the reason that, attached to the core 31 is the weight of the tamp bar B and tamp D, requiring a greater length of time for the current flow to produce the necessary magnetic lift. This is accomplished by shifting the arm 36 to dispose the brushes 37 and 40 and 38 and 39 in closer relation each to the other than are the brushes 37 and 39 and 38 and 40. This arrangement produces disproportioned periods of time during which the brushes 37 and 40 and 37 and 39 are in contact with the same sectors, the brushes 37 and 40 being considerably longer in contact with the sectors than the brushes 37 and 39. As above described, the wire 45, 55, 59, which forms the connection between the spools 19 and the coils 20 and 21, is connected to the common branch 46. The circuit formed by the branch 46, the resistance coil 47, the wires 48, 50 and 51, the brush 38 and the wires connecting the brushes 39 and 40 with the coils 21 and 20, is provided to form a relief circuit to dissipate or dissolve the induced or static current produced by the induction in the coils 20 and 21. The circuit through each of the coils and the resistance coil 47, is established whenever either of the sectors 32 or 33 bridges the space between the brushes 38 and 39 or 38 and 40. By bridging the said brushes it will be noticed that a completed circuit is formed, including the coil 20, and the resistance coil 47 or the coil 21 and the resistance coil 47. This circuit through the resistance coil 47 and one of the coils 20 or 21 is simultaneous with the establishment of the active circuit in the

other coil. For instance, as shown in Fig. 7, the active current is established by the sector 33 bridging the brushes 37 and 40. This disposition of the parts has established an active current in the coil 20. The sector 32 coincidently bridges the space between the brushes 38 and 39, thereby establishing a circuit including the resistance coil 47 and the coil 21. With the rotation of the sectors, and simultaneously with the passage of the sector 33 under the brush 39, the sector 32 will pass under the brush 40. In this arrangement an active circuit is established in the coil 21, while the circuit through the brushes 38 and 40 is completed through the coil 20 and resistance coil 47. By means of this arrangement the inductive tension established in the coils 20 and 21 is dissipated through the coil 47, thus avoiding arcing due to the rapidly changing electro-magnetic currents.

In the employment of the loops 26, 26, disposed and constructed in the manner as above described, I provide for the establishment of increased magnetic effects, presenting alternately active field flows, which assist in the lift of the core 31. The magnetic currents are, by reason of the laminated and lapped end constructions, unimpaired and unbroken.

The core 31 is provided with a series of vertically disposed slots 62, 62; the cylinder 22 with a vertically disposed slot 63; and the clamping plates 15 and 18 with vertically disposed slots 64, 64; all for the purpose of preventing the establishment of counter-currents in the cylindrical or ring-like members of the construction, during the operation of the invention.

Between the engine and commutator is disposed the four pole double throw switch, indicated in Fig. 7 of the drawings. When this switch is lifted out of contact with the terminals at both ends of the throw, the engine is electrically disconnected. When the switch is thrown to the upper position, wherein the blades are connected with the upper switch terminals, then the wire 44 is electrically connected with the wire 65, which is connected to the main 60. The wire 42 is thereby thrown out of commission. As above described, the terminals 57, 57 are bridged by the wire 56, which is connected with the main 61. By this arrangement, the wire 56 is not thrown out of commission. The switch blades, which in the lowered position contact with the terminals 53 and 49 in the upper position, contact with the posts 66, 67, which form no part of the electric circuit. This throws the wires 50, 51 and 52 out of commission. In this position the rotation of the sectors does not affect the coils 20 and 21 and spools 19. The current thus established constantly flows through the spools 19 and the coil 20, thereby lifting, and maintaining lifted, the core 31 and parts connected therewith.

By this arrangement a simple device is provided for holding the tamps suspended during necessary repair or inspection. With the dropping of the switch the tamps are permitted to fall into lowered position.

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

1. An electric reciprocating engine comprising a solenoid having a series of distinct superposed section windings, the middle winding being connected in series with each of the end windings; an operating electric circuit suitably connected with an electric source embodying said middle winding and one of said end windings of said solenoid; an independent electric circuit embodying a resistance coil and connected with the inactive end coil of said solenoid; a supporting frame for said solenoid; a rotary switch having a plurality of curved metal sectors cylindrically arranged and adapted to be rotated; a plurality of brushes adapted to electrically contact with said sectors, said brushes forming the terminals of the said operating and independent circuits; and means for adjusting the said terminals to vary the relative distances between the said terminals to effect a prolongation of the circuit closure in one of the said end windings.

2. An electric reciprocating engine comprising a solenoid having a series of distinct superposed section windings, the middle winding being connected in series with each of the end windings; an operating electric circuit suitably connected with an electric source embodying said middle winding and one of said end windings of said solenoid; an independent electric circuit embodying a resistance coil and connected with the inactive end coil of said solenoid; a supporting frame for said solenoid; a rotary switch having a plurality of curved metal sectors cylindrically arranged and adapted to be rotated; a plurality of brushes adapted to electrically contact with said sectors, said brushes forming the terminals of the said operating and independent circuits; and means for adjusting the said terminals to vary the relative distances between the said terminals to effect a prolongation of the circuit closure in the uppermost of the said end windings.

3. An electric reciprocating engine comprising a solenoid having a series of distinct superposed section windings, the middle winding being connected in series with each of the end windings; an operating electric circuit suitably connected with an electric source embodying said middle winding and one of said end windings of said solenoid; an independent electric circuit embodying a resistance coil and connected with the inactive end coil of said solenoid; a supporting

frame for said solenoid; a rotary switch embodying a plurality of curved metal sectors cylindrically arranged and adapted to be rotated; a plurality of brush arms revolubly mounted concentric with the said sectors; and electric contact brushes mounted on said arms and forming the terminals of the said operating and independent circuits.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM ARMOR STEDMAN.

Witnesses:
JOSEPH H. DALE,
F. F. DUPREY.