No. 814,083. PATENTED MAR. 6, 1906.

M. P. RYDER.

GENERATOR OF INTERMITTENT ELECTRIC CURRENTS.

APPLICATION FILED AUG. 12, 1904.

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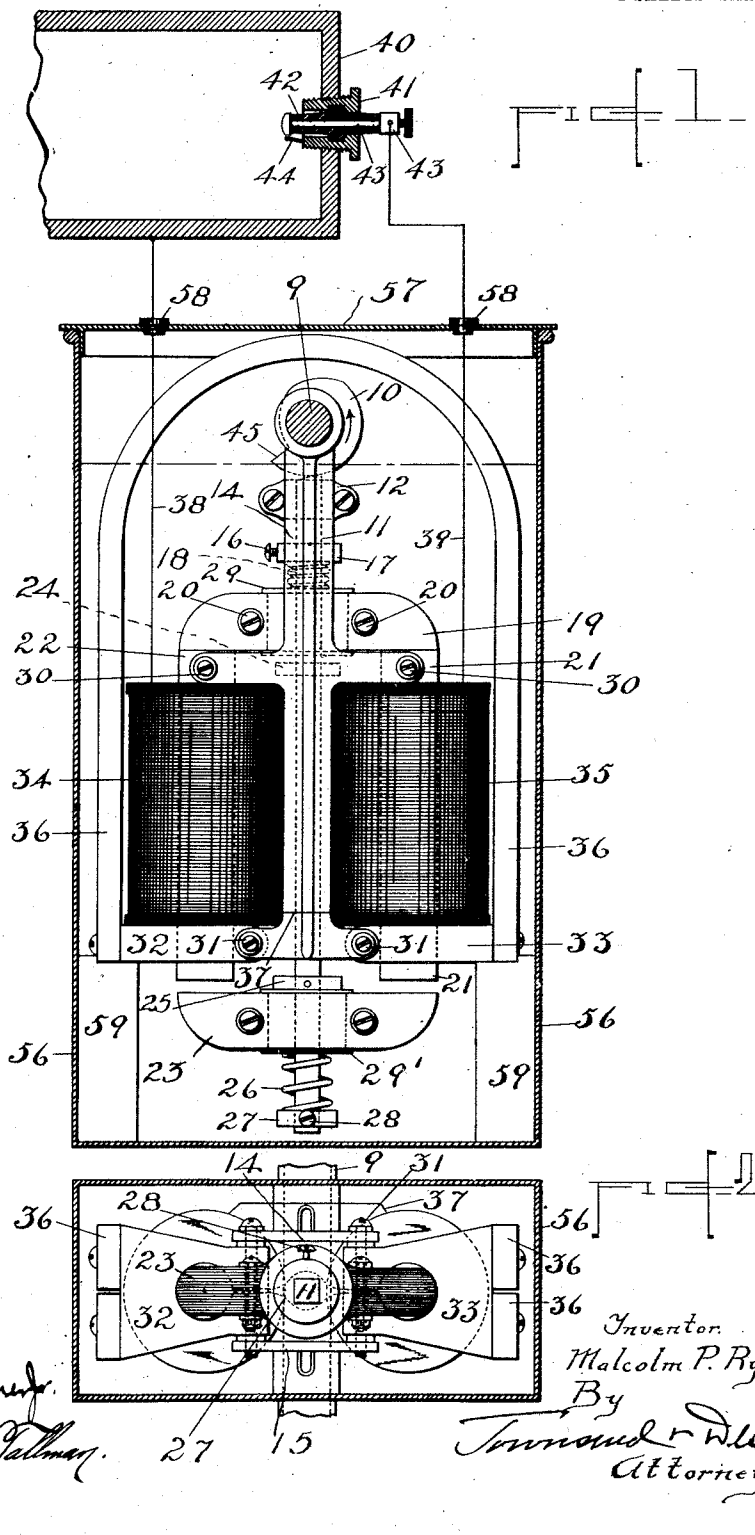

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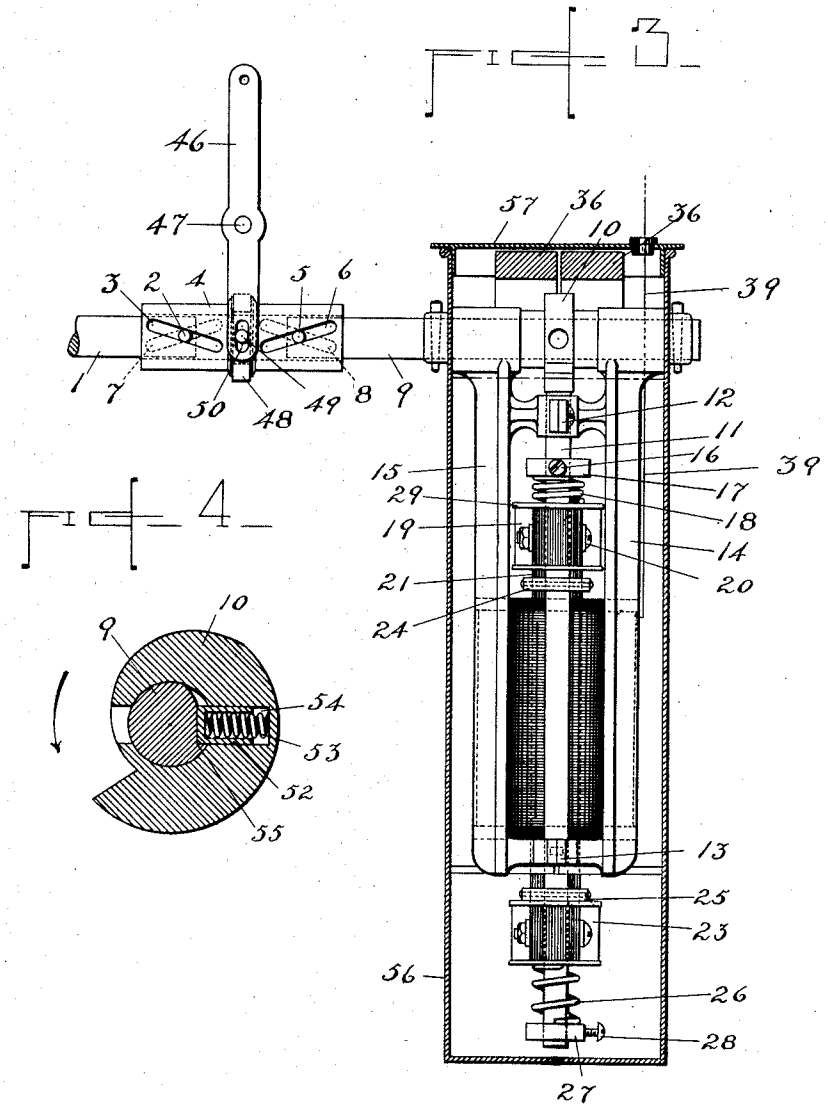

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GENERATOR OF INTERMITTENT ELECTRIC CURRENTS.

No. 814,083. Specification of Letters Patent. Patented March 6, 1906.

Application filed August 12, 1904. Serial No. 220,467.

To all whom it may concern:

Be it known that I, MALCOLM P. RYDER, a citizen of the United States, and a resident of White Plains, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Generators of Intermittent Electric Currents, of which the following is a specification.

My invention relates to an improved means for generating intermittent electric currents, and is especially adapted for use in connection with the igniters of oil or gas engines.

The general object of my invention is to provide an apparatus of simple construction and small dimensions capable of generating a current of high tension.

With the electrical apparatus used for the "jump-spark" system of electrical ignition, largely used for exploding the charge in internal-combustion engines, considerable difficulty has been experienced, due to the delicacy and unreliability of some of the parts, such as circuit-breakers, tremblers, and induction-coils. When the current is taken from dry batteries, the batteries need to be renewed at frequent and uncertain intervals. Wet batteries give considerable trouble when used on automobiles or launches, owing to slopping over of the exciting fluid. Dynamo-generators of the usual type when driven by the engine for which they furnish the igniting-current have the disadvantage of requiring to be driven at a comparatively high speed in order to furnish a sufficiently strong spark to ignite the explosive charge, which makes the engine difficult to start by hand.

I aim by my present invention to overcome the above disadvantages by so constructing and operating the generator that its working parts shall be few and of simple and substantial construction, rendering it unlikely to get out of order, while being at the same time capable of generating directly in the windings of a coil the high voltage necessary to cause the current to jump the spark gap, thus doing away with the necessity for using an induction-coil. In my improved apparatus the current is not generated continuously, but in sudden impulses, which occur just at the instant when they are required to ignite the explosive charge. This allows of keeping the sparking circuit closed at all times and avoids the use of a circuit-breaker. The electromotive force generated is entirely independent of the speed, which allows of easy starting of the engine by hand, because a spark of the same strength is produced whether the engine is revolving very slowly, as when being started by hand, or very rapidly, as when running at full speed under its own power.

My present invention makes use of the principle that if the magnetic flux through the core or axis of an electric coil be suddenly varied or changed by withdrawing an armature from said core a current will be generated in the coil.

My invention relates in part to a means for operating said armature and also to a means for heightening the rate of variation of the magnetic flux.

The first part of my invention consists in the combination, with the armature, of a hammer acting on the same to displace it and cause it to violently interrupt the magnetic circuit of the coil and mechanism for reciprocating said hammer, comprising, essentially, a rotating cam acting on the hammer and cooperating spring in a manner to alternately gradually retract the hammer and store power in the spring and then to abruptly release the spring and hammer.

Another part of my invention consists, broadly, in generating the electric current by interrupting the magnetic flux through the coils and simultaneously providing a shunt for the lines of magnetic force furnished from any suitable generator of said magnetic flux. The generator of magnetic flux is preferably a permanent magnet whose poles are applied to soft-iron cores upon which the generator-coils are wound, although, as will be obvious to an electrician, such flux may be furnished by an electromagnet.

In the preferred manner of carrying out my invention the interruption of the magnetic flux is produced by withdrawing an armature from the poles of a pair of soft-iron cores magnetically charged, respectively, from opposite poles of the source of magnetic flux, and the shunting of the magnetic flux is produced, preferably, by means of a second armature adapted to form a bridge for the source independently of the bridge furnished by the cores and first-named armature. It will be understood, however, that in these particulars my invention admits of many variations, since the principle thereof, broadly stated, consists in providing a suitable source of magnetic flux for the field of the coil and in interrupting the flow of magnetism through such field and simultaneously affording a

shunt-path for the magnetic lines of force emanating from the source.

My invention consists, further, in the improved mechanical construction hereinafter described for reciprocating the armatures employed for interrupting and shunting the magnetic flux and in details of construction and improved apparatus hereinafter more particularly set forth in connection with the accompanying drawings and then specified in the claims.

In the drawings, Figure 1 is a front elevation of a form of apparatus embodying my invention and shows the same connected to an igniter. Fig. 2 is an end view of the same apparatus looking from below. Fig. 3 is a side elevation of the apparatus, the casing for the same being shown in section and the core, coil, and block of one side being removed. Fig. 4 is a cross-section through the operating-cam and its shaft.

1 is a driving-shaft for the operating mechanism of the device. This shaft 1 may be a shaft positively driven from a gas or oil engine, so that its speed is always proportional to that of the engine, this proportion being determined by the number of strokes per cycle of the engine-piston and the number of cylinders for which the generator furnishes igniting-current. In other words, shaft 1 makes one complete revolution for each explosion taking place in the engine cylinder or cylinders.

Motion is imparted from the shaft 1 to shaft 9 through a coupling device consisting of a sleeve 4, one end of which has inclined slots 3 and 7, engaged by a pin 2, fixed in shaft 1, while the other end has inclined slots 6 and 8, engaged by pin 5, fixed on shaft 9. By reciprocating the sleeve 4 axially, as will be described later on, the angular relation of the shafts 1 9, or rather of the pin members 2 5 of the coupling, can be changed.

Shaft 9 carries a cam 10, which acts in conjunction with a suitable spring or other device as a means for reciprocating the hammer and armature or armatures. As here shown, said cam operates upon a rod 11, which may be square in cross-section and loosely supported in bearings 12 and 13, formed in frame members 14 and 15. The said frame members may also form the bearing for the shaft 9 and rigidly support all the stationary parts of the generator. Connected with the rod 11, as will be presently described, are the hammer and other attachments for operating the armature or armatures. The generating coils or conductors 34 and 35 consist of coils of insulated wire connected together in series by wire 37 and wound upon suitable soft-iron cores 21 22, each composed, preferably, of a number of plates of thin sheet-iron. The upper ends of the plates are held in place by screws 30, which pass through them and through frame members 14 and 15, while their lower ends are rigidly clamped in holes through the solid-iron blocks 32 and 33. Blocks 32 and 33 are slotted from their inner ends to the holes through which cores 21 and 22 pass, so as to allow them to be slightly sprung together by the pressure exerted by screws 31, so as to rigidly clamp cores 21 and 22. Screws 31 pass through frame members 14 and 15 and also through blocks 32 and 33.

As before stated, the source of magnetic flux may be of any desired kind. It is here shown as consisting of a compound permanent magnet 36, made up of two pieces of steel properly hardened and magnetized. One end of each piece is secured by a screw to block 32, while the other end of each piece is secured in like manner to block 33. As will be understood, these blocks are also of iron, and hence afford a medium for magnetization of the cores from the permanent magnet. An armature which is used to establish and disestablish the magnetic flux through the cores is shown at 19. Said armature may consist of a number of plates of thin sheet-iron mounted upon a metal sleeve or spool 29, through which the rod 11 passes loosely. The plates are bound together and to the spools by bolts 20, which pass through the iron plates.

23 is an armature which may be of similar construction and which is located at the opposite end of the cores and serves to shunt the magnetic flux of the source from said cores when the interruption of the magnetic flux through the cores takes place through removal of the armature 19.

The hammer which operates on armature 19 to disestablish the magnetic flux consists, preferably, of a collar 24, rigidly secured to rod 11 and adapted to engage the armature, or the spool 29 from beneath. Interposed between the top of said armature and a collar 17, adjustably fastened to the rod by set-screw 16, is a spring 18, held under compression between said armature and collar. The rod also passes loosely through armature 23. On the rod is a collar 25 for limiting the upward movement of the armature 23 on said rod. Between the under side of the armature 23 and a collar 27, adjustably secured on the rod by set-screw 28, is a spring 26, held under compression. Armature 23 is similar in construction to armature 19 and has a spool 29′, through which the rod passes loosely.

A portion of the cylinder of the engine is represented by 40. Into this cylinder is screwed a spark-plug of a form commonly used with other jump-spark ignition systems heretofore in use. The spark plug consists of an outer metal shell 41, which screws through the cylinder-wall 40 and serves to support the insulating-sleeve 42, which in turn supports and insulates the metal core 43, which is provided with a hole and binding-screw for making electrical connection to wire 39, leading from coil 35. Inside of

the cylinder is a wire 44 in electrical connection with shell 41 and in close proximity to an enlarged head or flange on the end of core 43, the space between said wire and said flange forming the spark-gap across which the spark jumps for the purpose of igniting the explosive charge.

With the parts in the position shown rod 11 is in contact with the part of cam 10 which is farthest from the center around which it revolves, Thus rod 11 is held at its lowermost position. Armature 19 is held in contact with the ends of cores 21 and 22 by the pressure of spring 18, which is strongly compressed between said armature and collar 17. Armature 23 is held out of contact with cores 21 and 22 by collar 25, being held against collar 25 by the pressure of spring 26. Under these conditions the lines of magnetic force emanating from the north pole of magnet 36 pass into iron block 33, then into core 21, then into armature 19, then into core 22, then into iron block 32, and then into the south pole of magnet 36. A very small part of the magnetic lines also flows from core 21 to core 22 through armature 23 and across the intervening gaps; but as this path has a much greater magnetic resistance (owing to the gaps) than that through armature 19, which forms a closed magnetic circuit, the greater part of the magnetic lines take the path through armature 19. The coils 34 and 35, which surround cores 21 and 22, then have a strong magnetic flux passing through them, any change in the strength of which will cause an electromotive force or electrical pressure to be generated in said coils. Now if cam 10 be revolved in the direction of the arrow until point 45 of said cam has passed under and out of contact with rod 11 rod 11 will no longer be restrained by said cam and will be violently forced upward by the action of spring 18. (Collar 24 being out of contact with armature 19, the reaction of spring 18 comes against cores 21 and 22.) Armature 23 being free to move with rod 11 and being pressed upward by spring 26, moves upward until it comes in contact with cores 21 and 22, which restrain its farther movement in an upward direction. Slightly before armature 23 comes in contact with cores 21 and 22 collar 24 strikes armature 19 and prevents rod 11 from rising any farther without taking armature 19 with it. As rod 11 and armature 23 possess considerable inertia and are in very rapid motion at the time collar 24 strikes armature 19, the said armature is violently torn away from poles 21 and 22 and carried upward to a considerable distance before the momentum of rod 11 is exhausted and its motion checked. The magnetic attraction between cores 21 and 22 and armature 23 assists in overcoming the magnetic attraction which helps to hold armature 19 in contact with cores 21 and 22, because armature 23 is still a slight distance from these cores at the instant that collar 24 comes in contact with armature 19, and rod 11, collar 25, and collar 24 then transmit the force due to the attraction acting upon armature 23 to armature 19. After armature 23 comes in contact with cores 21 and 22 spring 26 acts as a buffer to arrest the motion of rod 11, which it does before rod 11 again comes in contact with came 10, thus doing away with any hammering action on the end of said rod, which might cause crystallization and breakage of said rod.

At the instant when rod 11 is at its uppermost position armature 23 is in contact with the lower ends of cores 21 and 22, while armature 19 is out of contact with them. Under these conditions the path of lowest magnetic resistance between cores 21 and 22 is through armature 23. Therefore the greater part of the magnetic lines flow through the lower ends of cores 21 and 22 and through armature 23. Very little of the flux then passes through the portions of said cores which are surrounded by coils 34 and 35. The change in the magnetic condition of the cores which takes place during the shifting of the position of the two armatures from that position in which the armature 19 is in contact and armature 23 out of contact to that in which armature 19 is out of contact and armature 23 is in contact is a quick or violent change, which is due to the coöperating action of said armatures as they change their position, and results from the interruption of the lines of force flowing through the core and armature 19 coincidently with a shunting of the lines of force from the core through the armature 23.

While, as will be seen, there is a sudden change of magnetic condition of the cores, the total flow of the lines of force from the permanent magnet does not change, and hence the permanent magnet is not liable to deteriorate from fluctuations in its magnetic condition. As this change of magnetic condition of the cores takes place in an extremely short time and coils 34 and 35 are composed of a great number of turns of wire, the electromotive force generated is sufficient to cause a current to flow through wires 38 and 39 through core 43 of the spark-plug and across the gap between the head of said core and wire 44, the resulting arc or spark in said gap being sufficiently hot to ignite the combustible charge which surrounds said spark, thus producing an explosion in the engine-cylinder.

After the explosion has taken place the further movement of cam 10 returns rod 11 and armatures 19 and 23 to the positions first described, where they are held until the proper time for the next spark to be generated.

In an internal-combustion engine running

at various speeds it is advisable to vary the time of ignition of the charge with respect to the cycle of motion of the engine-piston. This is accomplished by means of lever 46, which is pivoted on pin 47 and may be moved and held in various angular positions by any suitable attachment to the upper end of said lever. Sleeve 4 is provided with a circumferential groove in which is loosely fitted a collar or band 48, provided with projections at diametrically opposite points, one of these projections being shown at 49. The lower end of lever 46 is bifurcated, so as to pass on either side of collar 48, and provided near its lower end with slots or elongated holes 50, which engage with pins 49. If lever 46 be rotated around its pivot 47, collar 48 and sleeve 4 will be carried in a direction parallel to the axis of shafts 1 and 9, slots 3, 7, 6, and 8 allowing of a limited motion with respect to pins 2 and 5. Pins 2 and 5 being rigidly attached to their respective shafts, which shafts are restrained from moving in a direction parallel to their axes, the action of inclined slots 3, 7, 6, and 8 upon pins 2 and 5 causes a slight relative rotary motion between shafts 1 and 9 when sleeve 4 is moved lengthwise of said shafts. Shaft 1 being positively driven by the engine and at a fixed speed relative to same, any variation in the angular relations of shafts 1 and 9 will cause a corresponding variation in the angular relation of cam 10 to the engine, thus varying the relative time at which the spark occurs.

If cam 10 were rigidly attached to shaft 9 and this shaft should be turned backward—that is, contrary to the direction of arrow on cam 10—the shoulder 45 of said cam would come in contact with the side of rod 11, thus preventing further motion of said cam. Any further motion of shaft 9 would result in breakage of one or more of the parts. To prevent the possibility of such an accident, cam 10 is driven from shaft 9 by a suitable slip connection adapted to allow slip if the motion of the shaft is reversed. Preferably such connection is a ratchet-and-pawl device which insures a positive coupling of the shaft and cam when the shaft revolves in the proper direction. A form of such a coupling is shown in detail in Fig. 4.

Shaft 9 is provided with a notch or depression the driving side of which has a square shoulder 55, which is normally in contact with driving-pin 52. Pin 52 fits loosely in cavity 54 inside of cam 10 and is constantly pressed toward shaft 9 by spiral spring 53. In normal operation shaft 9 revolves in the direction of the arrow, which causes shoulder 55 to drive pin 52, which in turn drives cam 10. If the direction of rotation of shaft 9 is reversed, cam 10 remains stationary, shoulder 55 recedes from pin 52, and pin 52 recedes farther into the cavity 54 against the pressure of spring 53, sliding out of notch across the slanting surface of same. When shaft 9 returns to its normal position, pin 52 snaps back into notch ready to be driven when the direction of rotation is reversed.

All the working parts of the generator are inclosed in a tank or case 56, provided with a cover 57, through which wires 38 and 39 pass through insulating-bushings 58. The working parts are supported in this tank by shaft 9, which passes through the sides of the tank, and also by blocks 59. The tank is filled with a light fluid oil to about the level of the horizontal dash-and-dot line. This oil is of such a nature as to reinforce and preserve the insulation of the coils 34 and 35 and also to lubricate the various bearing-surfaces. Cam 10 dips in this oil at each revolution, picking up a quantity of oil each time. Part of the oil so picked up finds its way to shaft 9 and thoroughly lubricates it where it passes through the bearings in frame members 14 and 15 and also where it passes through the sides of tank 56. It is not essential that the tank should be filled with oil, as described, or even that a tank should be used; but the use of oil as described adds greatly to the life and usefulness of the apparatus by lubricating the sliding parts thoroughly and protecting them from dust, by keeping moisture away from the insulating material of coils 34 and 35 and by adding to the electrical efficiency of the insulation.

What I claim as my invention is—

1. A generator of electric currents comprising in combination an electric conductor, a source of magnetic flux by whose variations currents are produced or generated in said conductor, an armature and core, means for detaching the armature from the core to suddenly interrupt the magnetic flux and means for simultaneously shunting the magnetic flux of the source around the conductor, as and for the purpose described.

2. In a generator of intermittent electric currents, the combination of a generating coil or conductor, a reciprocatory armature, means for reciprocating the same to and from position where it will close the magnetic circuit of a magnetic flux in whose field the coil or conductor lies, and means for simultaneously opening or closing a magnetic shunt for the source of magnetic flux external to said coil or conductor.

3. The combination substantially as described of a coil, a core and an armature, a sliding rod passing loosely through the armature and provided with a collar, a rotary cam acting on the rod, a hammer carried by the rod and a spring compressed between the armature and a collar on the rod.

4. In an electric-spark generator, the combination with the generator-coil and core therefor, of a means for producing a magnetic flux through said core, an armature adapted to reciprocate to and from position for clos-

ing the magnetic circuit through said core and a coöperating armature reciprocating synchronously to and from position for shunting the magnetism from the core.

5. In a generator of intermittent or pulsatory currents, the combination of a pair of cores and generator-coils wound thereon, a permanent magnet or other continuous source of magnetic flux having its opposite poles connected respectively to one end of said cores, a reciprocatory armature adapted to interrupt and close the magnetic circuit across the opposite ends of said cores and a coöperating reciprocatory armature adapted to close and open the magnetic circuit directly across the poles of the source of magnetic flux.

6. In a generator of intermittent or pulsatory electric currents, the combination of a reciprocating armature adapted to close the magnetic flux through a generating-coil, a reciprocating hammer for displacing the armature, a source of magnetic flux and a coöperating armature acting synchronously with said hammer and affording at each interruption of the magnetic circuit a shunt for the magnetic lines of force emanating from said source.

7. In a generator of intermittent or pulsatory electric currents, the combination of a permanent magnet, a pair of coil-wound cores connected respectively to the opposite poles of said permanent magnet, a reciprocating armature adapted to close the magnetic circuit of said cores to establish the magnetic flux through the same, a hammer acting on said armature to violently disengage it, an armature adapted to bridge the poles of the permanent magnet and means connected with the hammer for moving the latter armature into and out of bridging position.

8. The combination with an electric generating-coil of an armature for the magnetic flux through said coil, a power-actuated hammer adapted to engage the armature to cause it to interrupt the magnetic circuit and a cam for alternately releasing the hammer and restoring it to position for a new blow.

9. In an electric generator of intermittent currents, the combination of a coil, a core, a generator of magnetic flux connected to one end of the core; a reciprocating armature applied to the other end of the core, a rod bearing a hammer adapted to act on said armature, a cam and spring for reciprocating said rod, an armature at the opposite end of the core adapted to shunt the magnetic flux of the source away from the core and means interposed between said rod and said armature for reciprocating the same.

10. In a generator of intermittent electric currents, the combination of a coil, a core, a magnetic circuit-breaking armature for said core, a reciprocating rod passing loosely through said armature, means for reciprocating the armature from the rod, in the one direction by a hammer action, and in the other by a spring, a second armature applied to the opposite end of said core for shunting magnetism therefrom and mounted loosely on said rod and means for operating said armature by the rod through a spring or cushioning connection, as and for the purpose described.

11. A generator of electric currents, comprising in combination an electric conductor, a source of magnetic flux by whose variations currents are generated in said conductor, an armature adapted to abruptly open the circuit of the magnetic flux through the field of the conductor, an independent armature adapted to shunt the magnetic flux from said field, and means for actuating said armatures to cause them to coöperate in producing a change in the magnetic flux through the field of the conductor, the one by interrupting said flux and the other by providing a shunt-path for the flux from the source.

12. A generator of electric currents comprising in combination an electric conductor, a source of magnetic flux by whose variations currents are generated in said conductor, an armature adapted to abruptly open the circuit of the magnetic flux through the field of the conductor, an independent armature adapted to shunt the magnetic flux from said field and means for simultaneously operating said armatures to cause the latter to effectively shunt the flux at the instant when, but not before, the former interrupts the flux.

13. In an electric-spark generator, the combination of an armature and actuating-cam positively driven from an operating-shaft and a ratchet-and-pawl connection between said shaft and cam.

14. The combination with the reciprocating armature of a reciprocating hammer and an actuating-cam for the latter connected with its operating-shaft by a pawl or slip connection.

15. The combination in a generator of pulsatory or intermittent electric currents, of two coils and soft-iron cores therefor, a permanent magnet, a rod adapted to reciprocate in a line parallel to the axis of said core, a spring and cam acting on said rod in opposite directions, an armature at one end of said cores, a hammer connected to the rod and adapted to act on said armature, an armature at the opposite end of said core and a spring and collar on the rod for actuating the latter armature.

16. In a generator of pulsatory or intermittent electric currents, the combination with a pair of coils and cores therefor of means connected to one end of said cores for furnishing continuously a source of magnetic flux, an armature adapted to bridge said cores at their opposite ends, a reciprocating rod having two collars one of which engages the ar-

mature positively, a spring interposed between the armature and the other collar, an armature at the opposite end of said core, a collar on the rod adapted to withdraw said armature and a spring interposed between the armature and a collar by which said armature is caused to engage the cores.

17. In an apparatus for generating electric currents, the combination of a coil a core, an armature adapted to be moved into and out of contact with the core, a hammer for detaching the armature from the core and means connected with said hammer for shunting the magnetism from the core at or about the time that the hammer operates to detach the armature.

18. In an apparatus for generating electric currents, the combination of an armature adapted to close the magnetic circuit by direct contact, means for detaching the armature to suddenly interrupt the magnetic circuit and means for simultaneously shunting the magnetism, as and for the purpose described.

19. The combination of a coil, a core, an armature forming a path for a magnetic flux through the core, a hammer for actuating said armature and a second armature coöperating with the first to vary the flux through the core by shunting the magnetism therefrom, as and for the purpose described.

20. In an electric generator of intermittent currents, a reciprocating armature, a rod bearing a hammer adapted to act on said armature, a cam and spring for reciprocating said rod, a second armature coöperating with the first to vary a magnetic flux and means interposed between said rod and said armature for reciprocating the same.

21. In a generator of intermittent electric currents, the combination of an armature, a reciprocating rod passing loosely through said armature, means for reciprocating the armature from the rod, in the one direction by a hammer action, and in the other by a spring action, a second armature coöperating with the first to vary a magnetic flux and mounted loosely on said rod, and a spring or cushioning connection between the armature and the rod.

22. As a means for securing the coöperating action of two armatures in disturbing the magnetic flux through a coil, a reciprocating rod, an actuating-cam for moving the same in one direction and a spring acting on the rod in the opposite direction and released by the cam, two armatures, means carried by said rod for operating on one of said armatures by a hammer action and means connecting the rod with the other armature to cause the latter to move into coöperative or effective position when the first-named armature is operated by a hammer action.

Signed at New York, in the county of New York and State of New York, this 8th day of August, A. D. 1904.

MALCOLM P. RYDER.

Witnesses:

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