No. 794,117. PATENTED JULY 4, 1905.

F. I. & B. P. REMY.

ELECTRIC SPARK SYSTEM.

APPLICATION FILED NOV. 4, 1904.

Fig. 1.

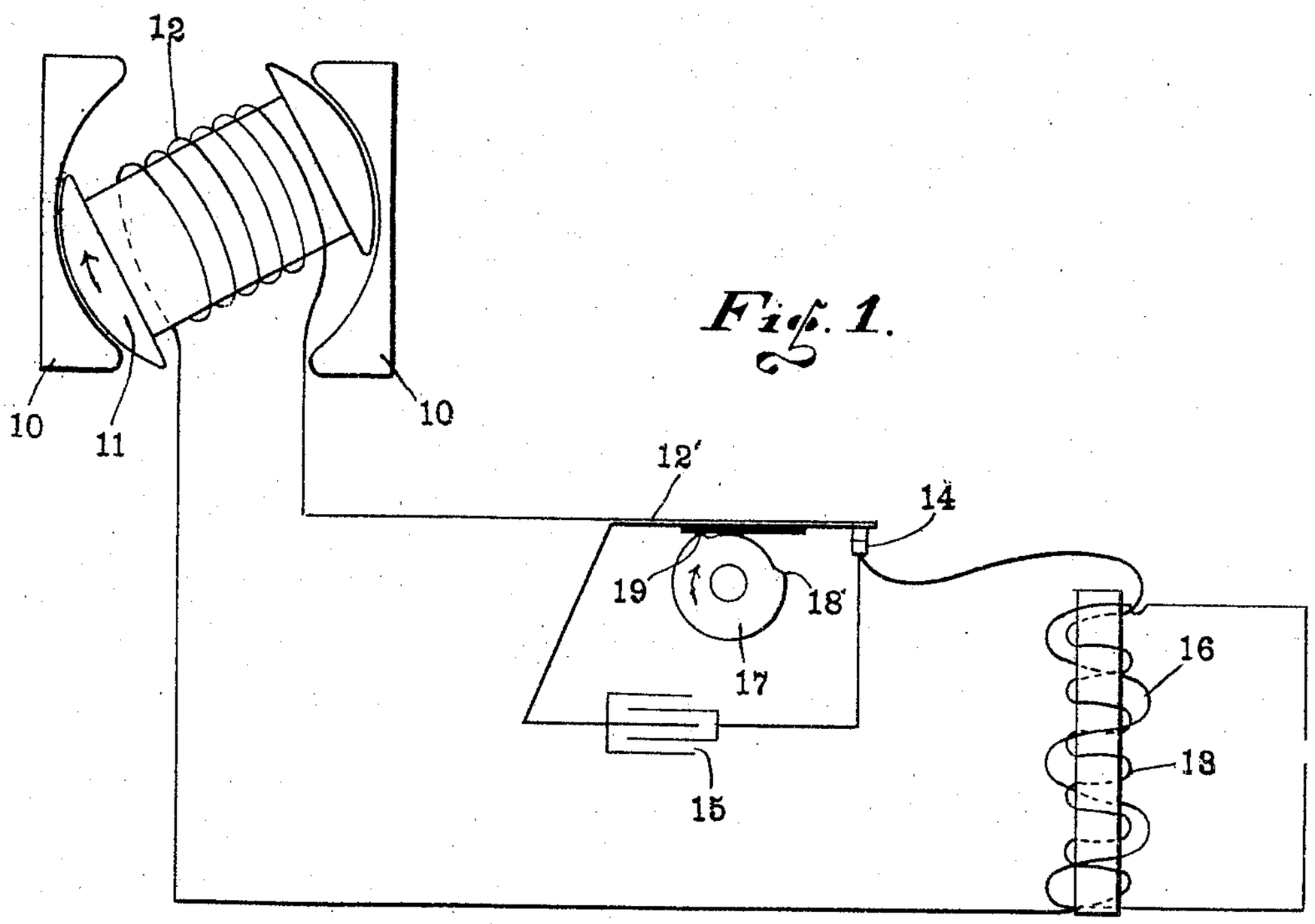
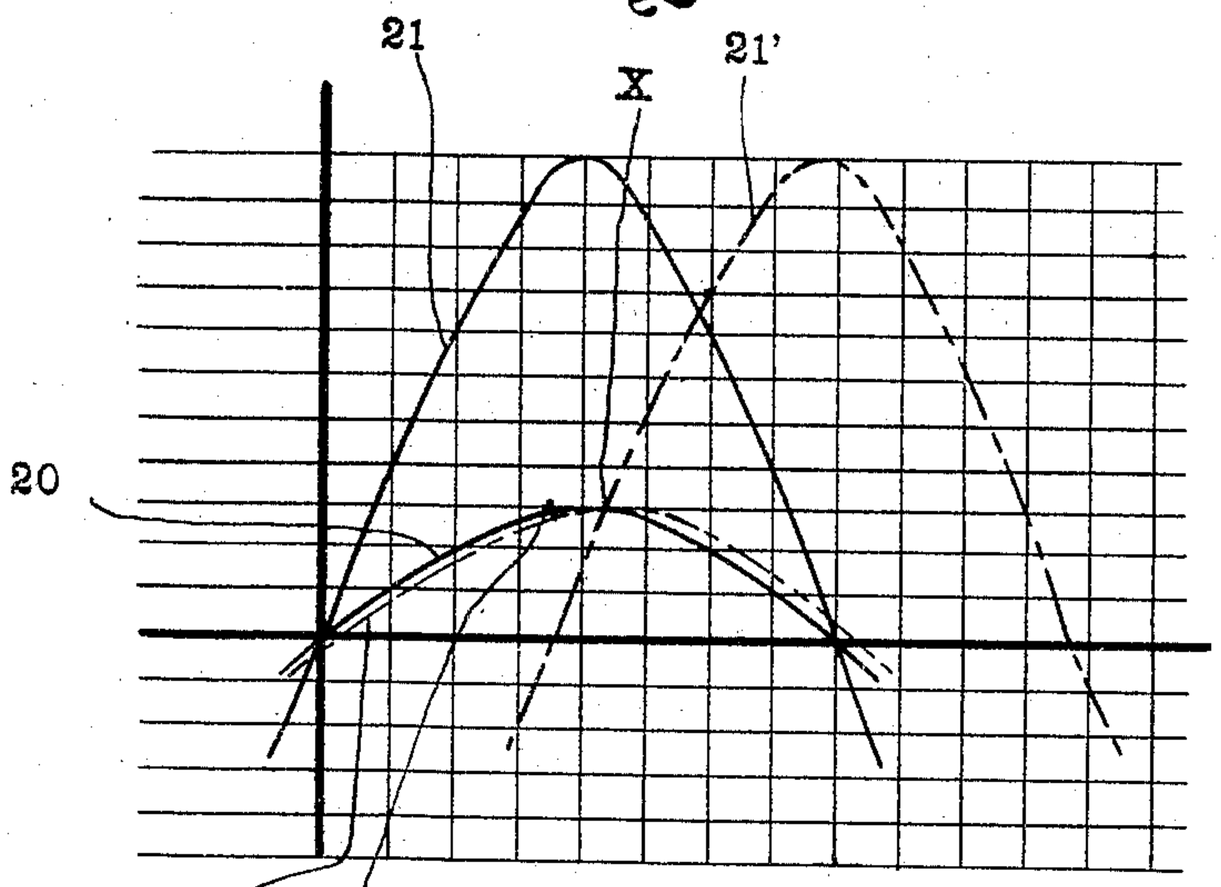


Fig. 2.



Witnesses
Adelaide Kearns.
J. A. Walsh.

Inventors.
Benjamin P. Remy
Frank I. Remy
By Bradford & Hood
Attorneys

No. 794,117. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

FRANK I. REMY AND BENJAMIN P. REMY, OF ANDERSON, INDIANA, ASSIGNORS TO REMY ELECTRIC COMPANY, OF ANDERSON, INDIANA, A CORPORATION OF INDIANA.

ELECTRIC SPARK SYSTEM.

SPECIFICATION forming part of Letters Patent No. 794,117, dated July 4, 1905.

Application filed November 4, 1904. Serial No. 231,457.

To all whom it may concern:

Be it known that we, FRANK I. REMY and BENJAMIN P. REMY, citizens of the United States, residing at Anderson, in the county of Madison and State of Indiana, have invented certain new and useful Improvements in Electric Spark Systems, of which the following is a specification.

In the production of jump-sparks for gas-engines and other purposes it has been common heretofore to provide a battery arranged in a breakable primary circuit, which circuit consists in part of the primary coil of a transformer. Mechanical means are provided for making and breaking this circuit, and in many cases the make-and-break apparatus is bridged by a condenser to take the "kick" of the transformer. The spark is produced in such an apparatus in the secondary circuit of the transformer. A continuous-current generator is a natural substitute for the battery in such an arrangement. It has heretofore been found impractical, however, to substitute for the battery or continuous-current generator an alternating generator, for the reason that if the arrrangements are such that the desired spark will be obtained with the generator rotating at a given speed and consequent voltage the spark will probably be either too great or too little when the speed is increased.

We have discovered an arrangement by means of which an alternating-current generator may be used, the speed of rotating of said generator being variable through a wide range, yet producing substantially a uniform spark throughout such range, the discovery being especially adapted for use in the production of a jump-spark required for igniting the charge in gas-engines.

The accompanying drawings illustrate our invention diagrammatically.

Figure 1 is a diagram showing the desired form of circuits, &c. Fig. 2 is a diagrammatic view of portions of the voltage and current curves resulting from different speeds of the generator.

In the drawings, 10 10 indicate the pole-pieces of an alternating-current generator, 11 the armature, and 12 the winding thereof. One end of the armature-winding is connected to a spring or other movable terminal 12′, while the other end of said armature-winding is connected to one end of the primary coil 13, the opposite end of said coil passing to a terminal 14, arranged to coact with the terminal 12′. The portion 12 to 14 of the circuit thus defined is preferably bridged by a condenser 15. The secondary coil 16 is arranged for the sparking circuit. Arranged in conjunction with the movable terminal 12′ is a making-and-breaking device, which consists, preferably, of a rotating cam 17, which is rotated by the generator in order that the angular relation of the cam and armature will remain fixed. This cam 17 in the present case, where a single spark is desired for each revolution of the armature, is provided with a making-point 18 and a breaking-point 19.

Turning now to the diagram shown in Fig. 2. Suppose the abscissa to indicate equal angular advancements of the armature with relation to the pole-pieces and the ordinates to indicate either equal voltage increments or equal current increments. The curve 20 will then indicate one-half of the voltage curve when the armature is rotating at, say, sixty revolutions per minute. The corresponding current curve 20′ will be substantially the same, but will lag behind the voltage-curve, the amount of lag being dependent upon the inductance and capacity of the primary circuit. Suppose (arbitrarily for the purpose of illustration) that the current curve cross the voltage curve at the point X, say twenty degrees beyond the crest of the voltage-wave and that the current at this point in the angular advancement of the armature is sufficient to produce the desired spark in the arrangement of circuits shown. The inductance of the circuit serves as an increasing impedance to the current as the speed of the armature increases. If the speed of the armature be increased until the voltage-wave 21 is produced, the lag of the corresponding current-wave 21′ will depend

upon the inductance and capacity of the primary circuit. If now the inductance and capacity of this primary circuit be so proportioned that the lag of the current at the higher speeds will be such that the current produced at the same point X is substantially the same as the current produced at the same point at the lower speeds, the character of the spark will be the same if the break in the primary circuit is made at the point X in the angular advancement of the armature. Herein lies our discovery—*i. e.*, that the inductance of the primary circuit can be so proportioned with relation to the capacity of the circuit and the power of the generator by computation thoroughly well-known to all persons skilled in electrical computation that as the speed of the generator increases the lag will increase, so as to produce substantially uniform current at the point of angular advancement of the armature at which the break takes place. The break-point 19 of the cam 17 is therefore arranged to engage the terminal 12′, so as to separate said terminal from the terminal 14 at this desirable point of advancement of the armature. It will be readily understood that the point of break may be at the crest of the voltage-wave if the inductance of the primary circuit is properly proportioned. Our experiments, however, have shown that in order to obtain a wide range of variation of speed it is desirable that the point of break take place somewhat beyond the crest of the voltage-wave. Where the range of speeds desired is not great, the point of making or closing of the primary circuit with relation to the point of break is not very material; but if the point of make is more than ninety degrees before the crest of voltage-wave in the arrangement shown in diagrams, where only one side of the voltage-wave is used, the lag will be materially increased at the higher speeds, because there is the necessity of reversing the magnetization of the core of the transformer. The point of make, therefore, in the arrangement shown should be not more than ninety degrees before crest of voltage-wave. There should also be enough time of contact to obtain the desired current lag, and this of course will depend upon the amount of inductance and the range of speed desired.

In view of the fact that in the use of a system of this kind it is desirable that the generator be capable of being run in either direction we find it advisable to arrange the the point of make, as Y, and the point of break, as X, symmetrically with relation to the crest of the voltage-wave.

We claim as our discovery—

1. A sparking system consisting of, a transformer having in its primary circuit an alternating-current generator, inductance in said primary circuit of such proportion that the increase in current lag due to increase of speed of the generator will cause at different speeds the production of substantially the same current value in the primary circuit at a given point in the angular advancement of the generator, and means for breaking said primary circuit substantially at that point in the angular advancement of the generator where such substantially uniform value of current is produced.

2. A sparking system consisting of, a transformer having in its primary circuit an alternating-current generator, means for making and breaking the primary circuit, a condenser arranged to bridge the point of make and break in the primary circuit, the combined inductance and capacity of the primary circuit being such that the increase in current lag due to increase of speed of the generator will cause at different speeds the production of substantially the same current value in the primary circuit at a given point in the angular advancement of the generator, and means for breaking said primary circuit substantially at that point in the angular advancement of the generator when such substantially uniform value of current is produced.

3. A sparking system consisting of, a transformer, having in its primary circuit an alternating-current generator, inductance in said primary circuit of such proportion that the increase in lag due to increase of speed of the generator will cause at different speeds the production of substantially the same current value in the primary circuit at a given point in the angular advancement of the generator, and means for making and breaking the primary circuit substantially symmetrically with relation to the crest of the voltage-wave, the break being substantially at that point in the angular advancement of the generator when the substantially uniform value of current is produced.

4. A sparking system consisting of, a transformer having in its primary circuit an alternating-current generator, a condenser arranged to bridge the point of make and break in the primary circuit, the combined inductance and capacity of the primary circuit being such that the increase in current lag due to increase of speed of the generator will cause at different speeds the production of substantially the same current value in the primary circuit at a given point in the angular advancement of the generator, and means for making and breaking the primary circuit substantially symmetrically with relation to the crest of the voltage-wave, the break being substantially at that point in the angular advancement of the generator when the substantially uniform value of current is produced.

5. A sparking system consisting of, a transformer having in its primary circuit an alternating-current generator, inductance in said

primary circuit, and means for breaking said primary circuit, the inductance and the point of break bearing such relation to the angular advancement of the generator that increase of speed will produce an increase of lag of the current of such character that less than a maximum current value is utilized at high speeds.

In witness whereof we have hereunto set our hands and seals, at Anderson, Indiana, this 17th day of October, A. D. 1904.

FRANK I. REMY. [L. S.]
BENJAMIN P. REMY. [L. S.]

Witnesses:
FOREST LARMORE,
LEROY WERTZ.