E. V. HARTFORD.

ELECTRICAL STARTER.

APPLICATION FILED JUNE 28, 1913. RENEWED NOV. 22, 1919.

1,364,854. **Patented Jan. 4, 1921.**

3 SHEETS—SHEET 1.

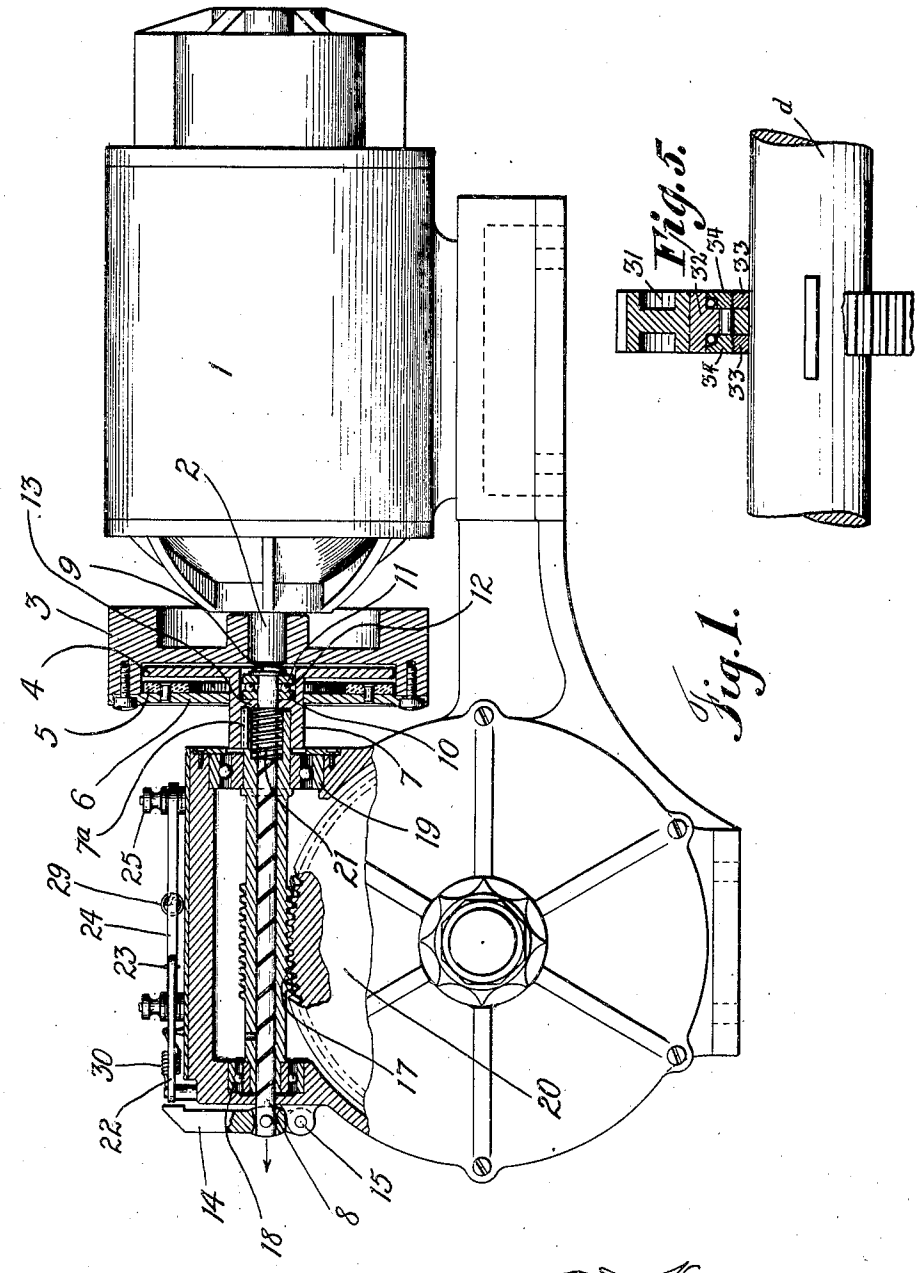


Fig. 1.

Fig. 5.

Witnesses:
Arthur Chaquet
Jos. P. Hammond

Edward Russell Hartford Inventor
By his Attorney
Clifford E. Dann

E. V. HARTFORD.

ELECTRICAL STARTER.

APPLICATION FILED JUNE 28, 1913. RENEWED NOV. 22, 1919.

1,364,854.

Patented Jan. 4, 1921.

3 SHEETS—SHEET 2.

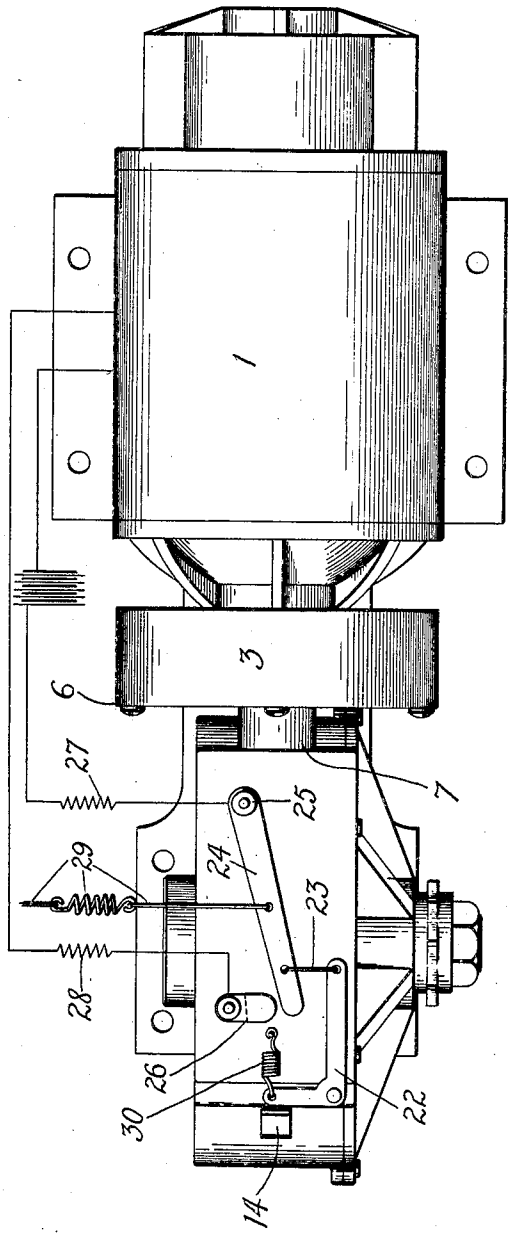


Fig. 2.

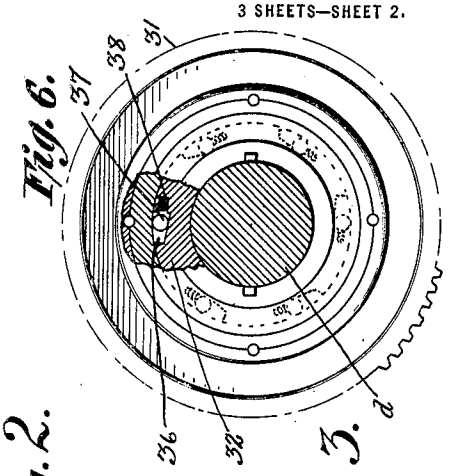
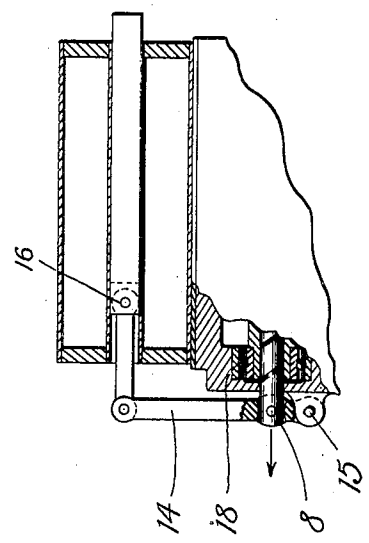


Fig. 6.

Fig. 3.



Witnesses:

Arthur Choquet.

Edward Vassallo Hartford
Inventor

By his Attorney
Clifford E. Dann

E. V. HARTFORD.

ELECTRICAL STARTER.

APPLICATION FILED JUNE 28, 1913. RENEWED NOV. 22, 1919.

1,364,854. **Patented Jan. 4, 1921.**

3 SHEETS—SHEET 3.

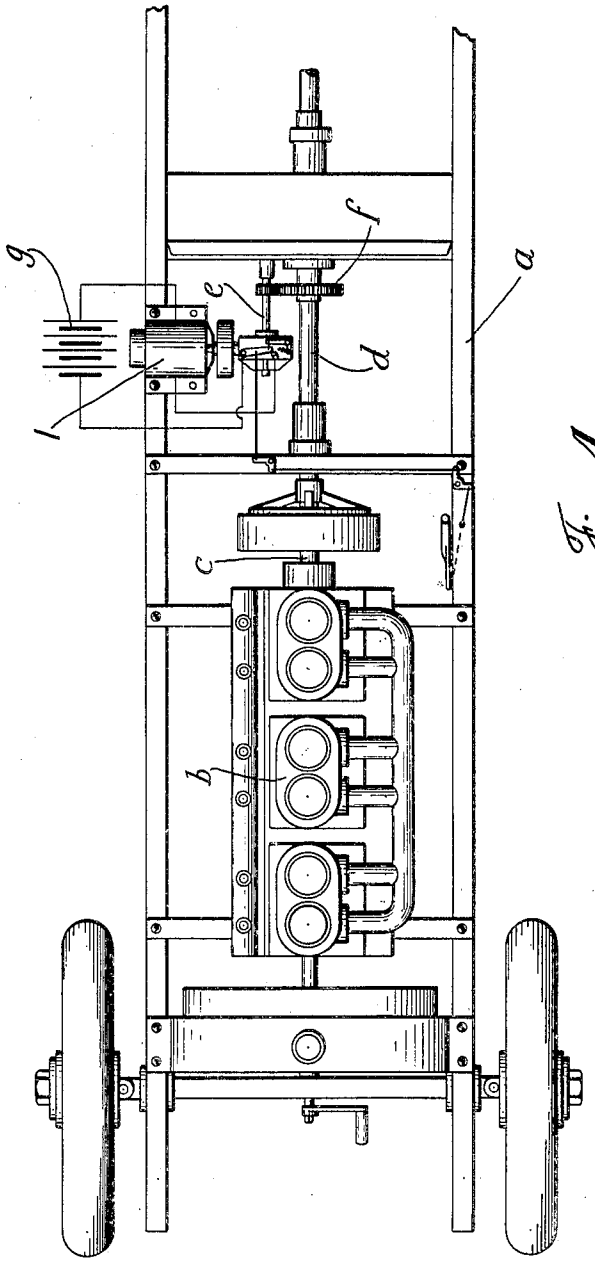


Fig. 4.

Witnesses:
Arthur Chaquet
William P. Hamilton

Edward V. Hartford INVENTOR.
BY
Clifford E. Dunn
ATTORNEYS.

UNITED STATES PATENT OFFICE.

EDWARD VASSALLO HARTFORD, OF DEAL, NEW JERSEY.

ELECTRICAL STARTER.

1,364,854. Specification of Letters Patent. Patented Jan. 4, 1921.

Application filed June 28, 1913, Serial No. 776,233. Renewed November 22, 1919. Serial No. 339,966.

To all whom it may concern:

Be it known that I, EDWARD VASSALLO HARTFORD, a citizen of the United States, residing at Deal, in the county of Monmouth and State of New Jersey, have invented certain new and useful Improvements in Electrical Starters for Motor-Vehicles and the like, of which the following, taken in connection with the accompanying sheet of drawings, is a full, clear, and concise description thereof.

This invention relates to certain improvements in electrical starter devices for internal combustion engines employing a high-speed low-voltage motor of relatively small dimensions, the power of which is small compared with the amount of work required of it. In order to utilize a small high speed motor for this purpose, it has been suggested to supplement its electro-motive force with kinetic energy derived by its operation through a weight or fly wheel mounted on its armature. The function of a fly wheel so mounted is to store up kinetic energy to supplement the electrical energy of the motor in order to carry the engine piston over its highest point of compression. As the resistance against the engine piston is gradually increased during its compression cycle, a greater amount of energy is required to move it when it approaches the limit of its travel than at any other stage in the cycle, therefore, the greatest drain on the motor energy takes place at this point and if a motor is used, which in itself is incapable of supplying the necessary or required energy to complete the cycle, it would be useless, unless it be assisted by other means such as the fly wheel mentioned, which stores up kinetic energy to augment the energy of the motor sufficiently to carry the piston past its highest point of compression to inaugurate the power cycle.

It, furthermore, has been suggested in order that the high speed of the motor may impart or be transformed into a relatively slow crank shaft movement, to interpose between the starter motor and the crank shaft of the engine a suitable reduction gearing. It will be understood that when it is desired to start the engine, the motor is first energized and the fly wheel is put in motion. As soon as the motor is speeded up to the desired degree and sufficient kinetic energy is developed in the fly wheel, a clutch between the reduction gearing and the crank shaft of the engine is operated to apply the force or power toward inaugurating the self-actuation of the engine. In speeding up the motor, an unnecessary drain of battery energy is made owing to the loss of power encountered or consumed in the reduction gearing, which is operating constantly with the starter motor.

Another object of the invention is to provide a starter for internal combustion engines wherein the motor is permitted to accelerate appreciably before it may transmit torque to the engine and wherein the engine is automatically disconnected when it becomes self-operating.

One of the principal objects of my present invention is to avoid this needles consumption of current. To accomplish this I releasably connect the reduction gearing and the motor by the interposition of a clutch, which may work automatically or manually as desired, so that in starting, the current is used for energizing the motor and rotating the weighted armature only, and thereafter, the reduction gearing, which is connected with the engine shaft is brought into operation after the motor and fly wheel have attained the desired speed or velocity, by means of the clutch mentioned.

Another feature of my invention resides in the means for successively and coöperatively energizing the motor and actuating the clutch mechanism by the movement of common operating means. Other novel features and details of construction are involved which will be readily appreciated and understood from a reading of the following specification.

Referring to the accompanying drawings,

Figure 1 is a view partly in section of the starter showing the motor, fly wheel, reduction gearing and interposed friction clutch.

Fig. 2 is a top plan view thereof.

Fig. 3 is a view partly in section of a modified form of clutch operating means.

Fig. 4 is a view in top plan of so much of an automobile chassis and running gear as is thought to be necessary to illustrate an embodiment of my invention.

Figs. 5 and 6 are views showing the one-way driving mechanism associated with the reducing gears shown in Fig. 4.

Referring particularly to Fig. 4 of the drawings, *a* indicates the automobile's chassis, *b* the internal combustion engine, *c* the crank shaft thereof, *d* the transmission

shaft, *e* the counter shaft, *f* the gearing between the transmission shaft and the counter shaft, and *g* the storage battery which supplies the energizing current. The motor 1 is provided with an armature or shaft 2, having fixedly mounted thereon a weight in the form of a fly wheel 3 so that when the current is applied to the motor 1, the armature and fly wheel will rotate as one. The fly wheel 3 is recessed for the reception of a friction plate or disk 4 which coöperates with a friction ring 5 mounted upon a supporting plate 6 fast to the fly wheel 3, the friction plate 4 and friction ring 5 coöperating to form a friction clutch, the operation of which will presently be described. 7 indicates a bearing or sleeve fast with the friction plate 4 and adapted to move longitudinally a sufficient distance to bring the friction faces of the elements of the clutch in engagement one with the other. This is accomplished by means of a sliding rod 8 formed with a headed end 9, which engages a bearing consisting of a pair of disks 10 and 11 with interposed anti-friction balls 12, the disk 10 resting upon an internal flange 13 of sleeve 7. The sleeve 7 is keyed at 7^a to the worm gear shaft 17, which is journaled within suitable bearings 18 and 19 mounted in the frame or casing. The worm gear is in mesh with a worm wheel 20, which in turn meshes with other gears constituting a reduction gearing which transmits the reduced motion to the engine shaft.

When the rod 8 is drawn outwardly, the head 9 moves or pushes the sleeve 7 and clutch plate 4 outwardly, the latter into engagement with the frictional clutch ring 5. To accomplish this movement a lever 14 is pivotally mounted at 15 to the frame or casing and to the slide rod 8, the free end being positioned to be engaged by a bell crank 22 mounted upon the housing. This bell-crank lever is linked at 23 to a switch lever 24, which is pivoted at 25 to the casing. 26 indicates a switch, the jaws of which are adapted to receive the free end of the switch blade 24. The switch blade 24 and contact 26 are in electrical circuit with suitable battery and the starter motor 1, through leads or wires 27 and 28. The switch arm 24 is operated by means of a somewhat yielding connection 29, which may be located at any convenient place. It will be understood that by pulling upon the connection 29, the switch arm 24 is moved toward the contact 26 and this movement through link 23 causes the arm of the bell crank 22 to engage the lever 14 and move it longitudinally or outwardly. As soon as the free end of the switch arm 24 engages the end of the jaws of the contact 26, the battery circuit is closed and current is sent to the motor 1 to energize the same. The switch jaws 26 and the contact end of the arm 24 are so proportioned as to present a close fit between the parts in order that additional force will be required to move the end of the switch arm inwardly between the jaws to the limit of its intended movement. Thus an interval of time is obtained within which the starter motor 1 may assume speed and get the fly wheel under way preparatory to the engagement of the bell-crank lever 22 and the slide rod actuating lever 14 which coöperate to throw the clutch mechanism into engagement and cause the transmission of the motor power to the crank shaft of the engine. It will be noticed that the lever 14 and bell-crank lever 22 are separated so that when the end of the switch arm 24 engages the contact 26 the motor immediately starts, but no movement of the slide rod 8 takes place until further movement of the switch arm 24 within the jaws of the contact 26 occurs which movement causes the bell crank 22 to move the lever 24 and slide rod 8 to operate the clutch mechanism. As soon as the engine has become self-actuated by releasing the connection 29 the switch arm 24 and bell crank 22 assume their original inactive position under the power of the spring 30, the motor circuit is thus broken and the latter stopped.

In order to disengage the clutch members 4 and 5, I interpose between the internal flange 13 of the sleeve member 7 and one end of the worm gear shaft 17 and within the latter a spiral spring 21, surrounding the sliding rod 8 so that as soon as the applied force draws the rod 8 outwardly to bring the clutch faces into engagement, the spring 21 is put under tension. The stored energy of the spring is expended in separating the clutch members as soon as the rod 8 is released from the power which caused it to slide and operate the clutch.

The reducing gearing *f*, shown more in detail in Figs. 5 and 6, includes a one-way driving mechanism by which the gears may drive the engine, but which permit the engine to become disconnected when the engine operates under its own power. Gear 31 of train *f* is fastened to a ring 32. The shaft *d* carries a pair of rings 33 on which are mounted a pair of ball-cups 34 which coöperate with ring 32 to form ball-races. A ring 35 carried by the shaft *d* intermediate the rings 33 is provided with a series of pockets 36 which open toward the inner face of ring 32. The bottoms of these pockets are all inclined in one direction. A roller 37 is mounted in each pocket and is lightly pressed up the incline toward the inner face of ring 32 by means of a small spring 38.

The operation of the mechanism, it is thought will be readily understood. As soon as the current is applied to the motor by the closing of contacts 24 and 26 the armature 2 and fly wheel 3 will immediately rotate.

When sufficient speed has been obtained, the sliding rod 8 may be moved longitudinally in the direction of the arrow, causing the friction plate 4 and ring 5 to engage one with the other, the clutch thus being closed, rotary movement is imparted through the sleeve 7 to the worm shaft 17 and via reduction gearing *f*, including the one-way driving mechanism, to the shaft *d*. This will turn the engine over. Upon an explosion in the engine cylinders, the shaft *d* will race away from the reduction gearing. Then the connection 29 is released, the contact being broken between the switch arm 24 and contact jaws 29 by reason of the spring 30 acting upon the bell crank 22. When these parts have returned to normal, the slide rod 8 is returned under the tension of the spring 7, the clutch members being disengaged thereby. The sliding movement of the rod 8 may be accomplished by means of a lever 14 pivotally mounted at 15 to the frame or casing of the starter at one end and at its opposite end to an actuator 16 (see Fig. 3), which is here shown as taking the form of a solenoid.

I do not wish to be understood as limiting myself to the specific details of construction shown and described, but on the contrary I wish to reserve to myself a fair range of equivalents commensurate with the scope of the appended claims and state of the art.

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

1. In combination with an internal combustion engine, a starter motor adapted to cooperate with the crank shaft of said engine, a reducing gearing between the starter motor and the crank shaft of the engine, a fly wheel mounted upon the shaft of the motor and a clutch mechanism interposed between the fly wheel and crank shaft of the engine, and means for operating the clutch after the motor has been speeded up, whereby the kinetic energy stored up in the fly wheel may be utilized in assisting the motor in propelling the engine pistons past their highest points of compression.

2. In apparatus of the character described, in combination, an internal combustion engine having a crank shaft, an electric starting motor having its armature shaft disposed in a direction transverse of said crank shaft, power transmitting devices between said shafts including a worm and worm wheel connection and a friction clutch, said clutch being intermediate the armature shaft and the worm, and having means whereby the transmission may be broken when the engine operates under its own power.

3. In apparatus of the character described, in combination, an internal combustion engine having a crank shaft, an electric starting motor having its armature shaft disposed in a direction transverse of said crank shaft, power transmitting devices between said shafts including a worm and worm wheel connection, means comprising a friction clutch whereby the transmission may be broken when the engine operates under its own power, and a single means for controlling said motor and clutch.

4. In combination with an internal combustion engine, a starter therefor comprising a motor having an armature shaft, an intermediate element, driving means inter-connecting the intermediate element and the engine including means for disconnecting the intermediate element from the engine when the engine operates under its own power, a spring, and means under the control of the spring and responsive to the yielding thereof to delay the transmission of torque from the armature shaft to the intermediate element for an appreciable time after energization of the motor.

5. In combination with an internal combustion engine, a starter therefor comprising a motor having an armature shaft, an intermediate element, driving means interconnecting the intermediate element and the engine including means for disconnecting the intermediate element from the engine when the engine operates under its own power, a spring, and means under the control of the spring and responsive to the yielding thereof to delay the transmission of torque from the armature shaft to the intermediate element for an appreciable time after energization of the motor, said last mentioned means further including a movable switch contact in the motor circuit.

6. In combination with an internal combustion engine, a starter therefor comprising a motor having an armature shaft, an intermediate element, reduction gearing interconnecting the intermediate element and the engine including means for disconnecting the intermediate element from the engine when the engine operates under its own power, a spring, and means under the control of the spring and responsive to the yielding thereof to delay the transmission of torque from the armature shaft to the intermediate element for an appreciable time after energization of the motor.

7. In combination with an internal combustion engine, a starter therefor comprising a motor having an armature shaft an intermediate element, driving means interconnecting the intermediate element and the engine including means for disconnecting the intermediate element from the engine when the engine operates under its own power, a spring, and means under the control of the spring and responsive to the yielding thereof to delay the transmission of torque from the armature shaft to the inter-

mediate element for an appreciable time after energization of the motor, said last mentioned means including a shaft on which the intermediate element is mounted.

8. In combination with an internal combustion engine, a starter therefor comprising a motor having an armature shaft, an intermediate element, reduction gearing inter-connecting the intermediate element and the engine including means for disconnecting the intermediate element from the engine when the engine operates under its own power, a spring, and means under the control of the spring and responsive to the yielding thereof to delay the transmission of torque from the armature shaft to the intermediate element for an appreciable time after energization of the motor, said last mentioned means including a shaft in alinement with the armature shaft on which the intermediate element is mounted.

9. In combination with an internal combustion engine, a starter therefor comprising a motor having an armature shaft, an intermediate element normally idle relative to the armature shaft, driving means interconnecting the intermediate element and the engine including means for disconnecting the intermediate element from the engine when the engine operates under its own power, a spring, means under the control of the spring and responsive to the yielding thereof to delay the transmission of torque from the armature shaft to the intermediate element for an appreciable time after energization of the motor, and means to restore the intermediate element to its normal position after the engine has started.

In witness whereof I have hereunto set my hand in the presence of two subscribing witnesses.

EDWARD VASSALLO HARTFORD.

Witnesses:
ALFRED REEVES,
W. P. MONTGOMERY.