B. VOLKMAR.

STARTER FOR INTERNAL COMBUSTION ENGINES.

APPLICATION FILED SEPT. 22, 1911.

1,097,899.

Patented May 26. 1914.

Fig. 2.

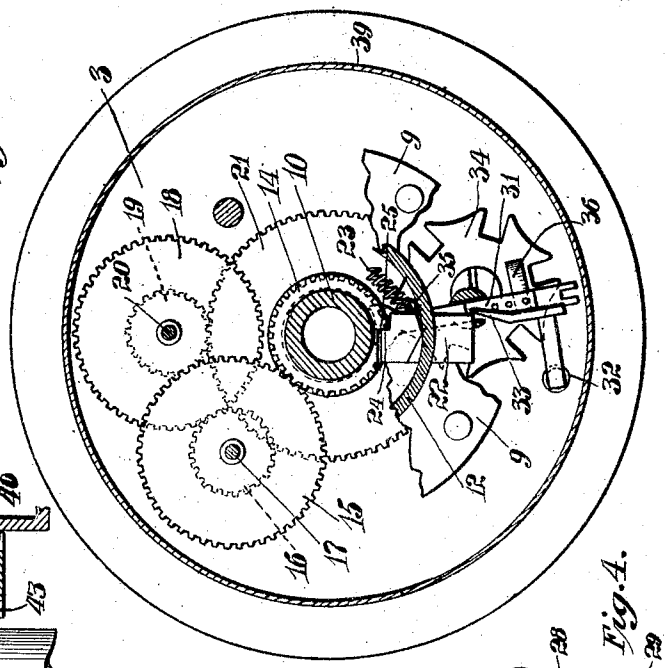


Fig. 3.

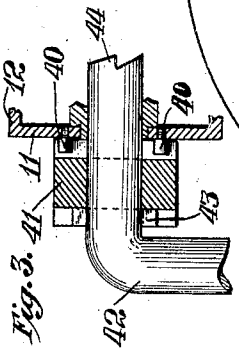


Fig. 4.

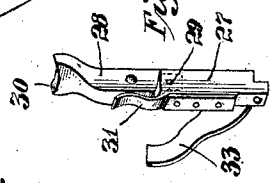
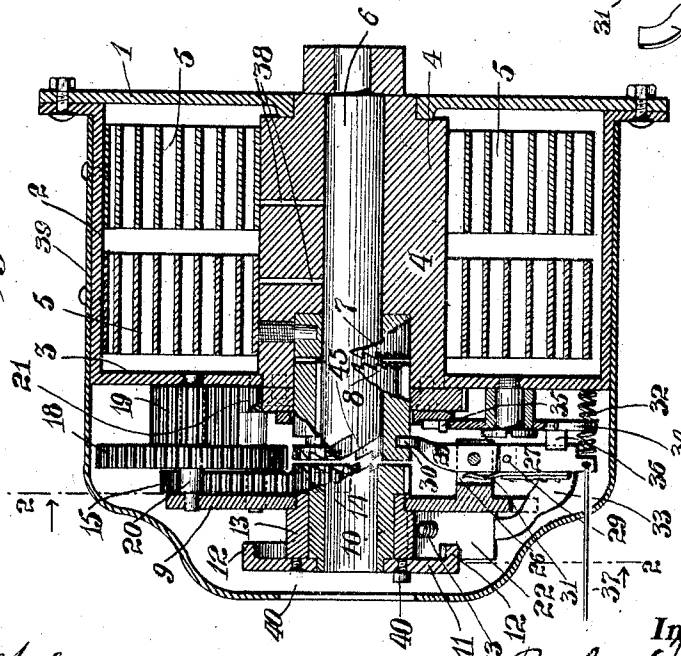


Fig. 1.



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UNITED STATES PATENT OFFICE.

BERNHARD VOLKMAR, OF NEW YORK, N. Y., ASSIGNOR TO VOLKMAR AUTO STARTER COMPANY, A CORPORATION OF NEW YORK.

STARTER FOR INTERNAL-COMBUSTION ENGINES.

1,097,899. Specification of Letters Patent. Patented May 26, 1914.

Application filed September 22, 1911. Serial No. 650,797.

To all whom it may concern:

Be it known that I, BERNHARD VOLKMAR, a citizen of the United States, residing in the borough of Bronx, in the city, county, and State of New York, have invented certain new and useful Improvements in Starters for Internal-Combustion Engines, of which the following is a specification, reference being had therein to the accompanying drawings, which form a part thereof.

My invention relates to starters for internal combustion engines, and more particularly to a type thereof adapted to turn the engine over a sufficient number of times to insure the firing of the initial charge, and to be reset by the subsequent operation of the engine.

The main object of the invention is to provide a starter for internal combustion engines, wherein the driven member will be normally uncoupled from the driving member, and wherein controlling means will be provided which may be manually actuated to simultaneously couple said driven member to said driving member and release the holding means acting upon said driving member, means being provided whereby when the speed of the driven member exceeds that of the driving member, said coupling means will be automatically actuated to disconnect said members one from the other and connect said driven member with the rewinding mechanism acting upon said driving member in a manner to cause the engine power to rewind said spring.

A further object is to provide a starter wherein the holding means for the driving member will be held totally inoperative during the interval when the spring power is being applied to the driven member so as to relieve said holding member from the violent impacts which would result from the setting of said holding member before the spring energy has become exhausted.

A still further object is to provide a starter wherein the holding member will act solely through friction and will be automatically released during the direct movement of the driving member in rewinding and will be automatically set, through the reaction upon said driving member when power has ceased to be applied to said member for rewinding purposes, thus eliminating the development of any impetus in said driving member prior to the actuation of said holding means.

A still further object is to provide a starter wherein the power stored in the spring will be applied through the driving member directly to the driven member and the power for rewinding said spring will be applied by the driven member in a reverse direction, automatically acting means being provided whereby with the exhaustion of the spring energy, the coupling means connecting the driving member and the driven member will be automatically shifted to couple said driven member with the rewinding mechanism; and supplemental means being provided whereby when sufficient energy has been developed in the spring said coupling member will be disconnected from said rewinding mechanism and positioned in a neutral position.

A still further object is to provide in connection with a clutch mechanism of the character described, a construction whereby the proper clearance between the coöperating members of the clutch mechanism will be afforded to avoid noise from the starter when the engine is running.

A still further object is to provide a starter wherein the coupling means above referred to will be normally disconnected from the driven member and from the rewinding mechanism in order that manual power may be applied to said rewinding mechanism to tension the spring or springs independently of the driven member or engine power.

A still further object is to provide a starter wherein all of the operative parts thereof will be readily accessible without disconnecting the starter from the engine, thus facilitating inspection and repairs.

A still further object is to provide a starter wherein the spring or springs may be readily removed without taking apart the operative mechanisms.

A still further object is to provide a starter wherein the driving member will be mounted upon the driven member, and will be so constructed as to constantly supply lubricant to said driven member in a manner to minimize friction between these two members. And a still further object is to provide a starter which will be composed of few parts so associated and combined as to control the spring energy without like-

lihood of breakage or displacement of parts, and wherein the rewinding mechanism will be operative only upon the exhaustion of the spring energy.

The invention consists in the novel features of construction and combination of parts, hereinafter set forth and described and more particularly pointed out in the claims hereto appended.

Referring to the drawings:—Figure 1 is a vertical section through a starter embodying my invention; Fig. 2 is a front elevation thereof, with the cap removed; Fig. 3 is a detailed view showing the manner of developing spring energy manually; and Fig. 4 is a detailed view of the coupling member actuating means.

Like letters refer to like parts, throughout the several views.

In the embodiment of my invention shown in the drawings, 1 indicates a head plate adapted to be attached to the chassis or engine frame of an automobile, which plate has mounted thereon a spring drum 2, having a fixed head 3. Rotatably mounted within the head 3, and head plate 1, is a driving member or spring arbor 4, acting upon which and the casing 2 is a plurality of heavy coiled springs 5. The drum 2 is non-rotatable, the spring energy being applied through the driving member or spring arbor 4, in starting the engine, and the power of said engine being applied to said member by means of the rewinding mechanism which will be described hereinafter, to rewind said springs or restore the energy thereto. Mounted within the driving member or spring arbor 4 is a driven member 6, which is provided with any suitable means whereby it may be coupled to the engine crank shaft. The driving member or spring arbor 4 has rigidly attached thereto a crown gear or clutch member 7, adapted to coöperate with a coupling member 8 alined to, and rotatable with, the driven member 6. Normally said coupling member 8 is disconnected from the coöperating clutch member 7, so as to permit the driven member to run absolutely free of the driving member under normal conditions. Parallel with the head 3 is a fixed plate 9, within which is mounted a hollow rotary shaft 10, carrying a plate 11 having a circular rim 12 thereon. The shaft 10 rotates within an elongated bearing 13 carried by the plate 9, which bearing serves the twofold purpose of preserving the alinement of the shaft 10, and coöperating with the holding mechanism by means of which the spring energy is held in the springs as, and after they are rewound, and is released when it is desired to apply same to the driven member for starting the engine. The shaft 10 carries thereon a spur gear 14, by means of which said shaft is geared to the driving member so that the driving member is placed under the control of the holding and controlling mechanism through the shaft 10. Enmeshed with the gear 14 is a gear 15, carrying a pinion 16, said gear and said pinion being mounted upon the stud 17 carried by the plate 9. The pinion 16 in turn meshes with a gear 18 carrying a pinion 19, said gear and pinion being mounted upon the shaft 20 extending between the head 3 and the plate 9. The gear 19 in turn meshes with a gear 21 upon the driving member or spring arbor 4, thus forming a reducing gear train between said driving member or spring arbor 4, and the shaft 10 through which the said driving member is held inert or is reversely rotated to restore energy to the springs 5, thus utilizing one and the same mechanism for the twofold purpose of holding the spring energy, as and after it is developed, and for transmitting the power necessary to develop such energy.

Hung upon and adapted to act upon the rim 12, is a friction clutch member 22, having a side recess therein which straddles said rim. Acting upon said clutch member is a spring 23 which normally draws the member 22 in the direction of rotation of the rim 12, under the control of the driving member. The function of this spring is to normally draw the shoulder 24 at the top of the clutch 22 against the coöperating shoulder 25 upon the bearing 13. When the clutch member 22 is set against the shoulder or stop 25, the said clutch will be set through the power exerted by the springs 5, or in other words, said clutch will hold the reaction of said spring. At the same time said clutch may be rocked freely away from the shoulder 25 to prevent such clamping action upon the rim 12 and permit the said rim and the driving member which are connected by a train of gears, to rotate freely as the spring energy is applied to the driven member. Furthermore, if the rim 12 be rotated in a direction away from the spring 23, the said spring will allow the clutch to move away from the shoulder 25, thus permitting the rim to be freely rotated in one direction while being held against rotation in the other direction through the automatic action of the clutch 22.

This construction is desirable in that as the clutch is set, it does not permit the rim 12 to gather impetus or momentum under the action of the springs, and thus permits a clutch of comparatively small dimensions to control the great energy stored in said springs.

It will be observed that the gear system between the driving member and the holding clutch is always in mesh so that when these gears are used as a rewinding mechanism, the power will be applied continuously to rewind the springs, although the

arrangement of gears is such as to relieve the engine from too great a load during this rewinding interval, the driving member being geared down from the driven member during this interval.

Pivotally mounted in the bracket 26, carried by the plate 9, is a controlling lever 27—28 by means of which the driving member is coupled to the driven member and simultaneously with this coupling action, the clutch member 22 is automatically released to permit the free rotation of the driving member with the driven member. Means are also provided in conjunction with said controlling lever whereby, after the exhaustion of the spring energy, the driven member will be automatically uncoupled from the driving member and coupled to the rewinding mechanism, the holding clutch being reset simultaneously with the coupling of the driven member to the rewinding mechanism to cause said clutch mechanism to be automatically actuated through the rewinding mechanism. Thus it will be observed that the driving member, when transmitting power to the driven member, is coupled directly thereto, and when rewinding the springs is coupled thereto through a reducing gear system.

To accomplish the coupling of the member 8 with the shaft 10, I provide said shaft and said coupling, upon the adjacent faces thereof, with crown gears or other equivalent impact coupling means.

The controlling lever is preferably a bi-part lever, the two parts 27 and 28 of which are pivotally connected at 29 to allow an independent movement of the part 27, after being uncoupled from the shaft 10 to insure the proper clearance between the coupling surfaces upon these two parts. This independent movement of the part 27, I secure by allowing clearance about the pivotal point 29, as shown in Fig. 4. The upper part of the part 28 is forked at 30 to form a feather entering an annular slot in the member 8. A flat spring 31 is carried by one of the parts as 28 of the controlling lever and acts upon the other in a manner to normally hold the parts 27—28 in alinement, and at the same time to accomplish a slight movement of the coupling member 8 after it has been disengaged from the shaft 10.

Acting upon the member 8, in a manner to normally draw it toward the shaft 10 is a spring 32, the tension of which is lighter than that of the spring 31, the action of said spring 32 accomplishing the automatic coupling of the driven member to the rewinding mechanism through the clutch member 8.

Carried by the controlling lever is an arm 33, projecting into close juxtaposition to, and adapted to engage and displace, the clutch member 22, to simultaneously release said clutch member with the oscillation of the controlling lever, to throw the member 8 into engagement with the driving member, to couple these two parts together, and apply power to the engine. The outer end of the arm 33 is beveled as shown to secure a camming action in displacing said member and thus contribute toward ease in the tripping of the starter.

The controlling lever and the clutch member 8 are normally held in a neutral position wherein said member 8 will be connected with neither the driving member nor the rewinding mechanism, and the clutch member 22 will be set upon the rim 12. This condition is brought about when the desired energy has been developed in the springs 5; the mechanism accomplishing the restoration of the parts to normal being automatically actuated from the driving member so as to be set through the actuation of said driving member in a manner to cause a reversal of the direction of rotation of said driving member in restoring the energy to the spring to impart a timely actuation to said controlling lever. This mechanism preferably comprises a Geneva gear 34, mounted upon the head 3 and actuated by a stud 35 carried by the driving member or spring arbor 4. The face of said arbor is cut away adjacent to the pin 35 in the manner usual in connection with Geneva gears, the coöperation between said gear and said arbor preventing the over-running of this mechanism through the impetus or momentum due to the violence of the impact between the pin 35 and the said gear. Carried by the gear 34 is a bevel 36, adapted to engage the controlling lever 27—28 adjacent to the bottom thereof, which bevel imparts that movement to the lever necessary to disengage it from the rewinding mechanism and after such disengagement hold said gear against movement under the spring 32, and position the parts in the manner above referred to, which is the normal inoperative position of all parts of the starter, excepting the holding clutch 22, which, when the other parts are normally inoperative, as well as during the rewinding interval, is in its normal operative position.

Acting upon the longest leverage of the controlling lever is a pull cord or other equivalent means 37 by means of which said lever may be manually oscillated to couple the driving member and the driven member together and release the holding clutch to initiate the operative moment of the starter.

The spring arbor 4 is provided with a plurality of radially extending openings 38, through which oil may flow from the spring chamber about said arbor to the driven member or shaft 6, so as to constantly lubricate this shaft, the springs being always supplied with lubricating oil.

Secured to the casing or drum 2, is an in-

closing hood 39 which covers the entire mechanism of the starter for the three-fold purpose of excluding dust and dirt from the parts, giving a finished appearance to the structure, and permitting ready access to the rewinding mechanism to facilitate the inspection and repair thereof.

It will be observed that all of the moving parts of the starter excepting the driving and driven members are positioned forwardly of the head 3, so as to be readily accessible both while assembling the starter and after the application thereof to an automobile. This manner of associating the parts is very desirable, as it permits the inspection of that portion of the mechanism most subject to disarrangement and wear, and also permits the removal and replacement of parts without disconnecting the starter from the engine.

Owing to the frequent failure of engines to start, due to improper sparking or other reasons, it sometimes follows that the spring energy in the starter is exhausted without starting the engine. Under such conditions, it is desirable to provide means whereby the engine may be manually started or whereby the rewinding mechanism may be actuated manually to develop the desired energy in the springs so as to permit the subsequent actuation of the starter to turn over the engine. To permit such manual development of energy in the springs, I provide the plate 11 with a plurality of studs 40 adapted to be engaged by a removable collar 41 upon the crank shaft 42, said shaft being provided with studs 43 adapted to engage openings in said collar so as to rotate said collar with the actuation of said crank. The crank 42 I also provide with an impact coupling face 44 adapted to coöperate with a similar coupling face 45 upon the driven member 6.

The operation of the herein described apparatus is substantially as follows:—The plate 1 having been attached adjacent to the engine in any desired manner, the driven member 6 is coupled to the engine in any desired or well known manner, thus positioning the starter and holding it in the desired relation to the engine so as to avoid a loss of alinement in the engine shaft and the driven member. If the springs have been so rewound as to have the desired energy stored therein, the relation of parts will be as shown in Fig. 1 of the drawings, and the engine may be started at any time by means of the pull cord 37 under the control of a treadle, lever or any other desired means, not shown. When power is applied to the cord 37, it oscillates the bi-part lever 27—28, the forked end of which through its engagement with the coupling member 8 will reciprocate said member upon the driven member 6 so as to bring the right hand clutch surfaces upon said member 8 into engagement with the coöperating clutch member 7 carried by the driving member or spring arbor 4, thus coupling the driving member and the driven member together so as to cause them to rotate in unison under the power of the springs 5. As the controlling lever 27—28 is thus oscillated, the arm 33 thereon will engage the bottom of the friction clutch member 22, and force it, against the tension of its spring, away from the shoulder 25 sufficiently to remove it from frictional engagement with the rim 12 and permit the plate 11 and the driving member 4 to turn frecly. With the rotation of the driving member 4, the engine will be turned over and the gear train between the shaft 10 and said driving member will run idly. With each rotation of the driving member 4, the stud 35 thereon will impart a partial rotation to the Geneva gear 34 which will displace the cam surface 36 thereon so as to permit the bi-part lever 27—28 to oscillate in the opposite direction in a manner which will be hereinafter referred to. The quantity of movement of the cam surface 36 will be determined by the number of rotations of the driving member 4, thus necessitating a reverse rotation of said driving member and said Geneva gear before said cam surface will be restored to its former position. While power is being applied to the driven member by the driving member, through the clutch members 7 and 8, the friction between the coöperating clutch surfaces upon said clutch members will maintain the coupling in the closed position, but when the driven member 6 rotates under the engine power, independently of the driving member 4, this friction will be decreased to an extent to permit the spring 32 to disengage the member 8 from the member 7 and throw it toward and into engagement with the shaft 10.

The energy stored in the springs 5 will ordinarily be sufficient to turn the engine over only two or three times, so that before the members 7 and 8 will be disengaged in the manner described, the spring energy will be exhausted or substantially exhausted. With the return reciprocation of the controlling lever 27—28, the arm 33 thereon will be withdrawn from engagement with the friction clutch member 22, whereupon the spring 23 will immediately reset said member upon the rim 12 so as to properly position it preparatory to the rewinding operation. Upon the limit of the movement of said controlling lever under the said spring, the clutch surface upon the left hand side of the clutch member 8 will be forced into engagement with the coöperating clutch surface upon the shaft 10, thus applying power to said shaft 10 and through the gears 14, 15, 16, 18, 19, and 21 to the driving mem-

ber 4, to rotate same in the reverse direction to that during which power is applied to the engine shaft, and thus rewind the springs 5, the rim 12 being free to rotate in the direction necessary to rewind said springs, but being held against any return movement by the friction clutch member 22 which operates automatically under its spring 23. The movement of the lever 27—28 to accomplish the connection of the coupling member 8 and the shaft 10 is made possible by the clearance afforded by the displacement of the cam surface 36 upon the Geneva gear 34. With the reverse rotation of the member 4, however, the stud 35 rotates the Geneva gear 34 in the reverse direction and brings this cam 36 back to its former position, during which movement through its engagement with the arm 28 of the controlling lever, it will restore the controlling lever to its former position and uncouple or disconnect it from the shaft 10.

Inasmuch as the friction clutch member 22 acts constantly to hold the rim plate 11 against a return movement, immediately upon the disconnection of the clutch member 8 from the shaft 10, the power or the reaction of the springs 5 will be applied directly to said clutch member 22 which will hold all of the energy developed in said springs until such time as the operator may desire to again actuate the starter.

Inasmuch as movement of the cam surface 36 will cease instantly upon the disengagement of the clutch member 8 from the shaft 10, there would arise a condition under which wear would occur between the coöperating clutch surfaces upon the said clutch members with an accompanying objectionable noise. To avoid this difficulty, I employ the bi-part controlling lever. With this lever, as the member 8 is forced toward the member 7, the part 28 will oscillate in a manner to tend to take up the lost motion or clearance at the point of pivotal connection between it and the part 27, and the member 8 being forced against the tension of the spring 32, by the higher tension of the spring 31, will prevent the taking up of this lost motion until the members 7 and 8 are in actual engagement. Upon the oscillation of the said controlling lever, under the control of the spring 32, the parts 27 and 28 will move in unison, but as the lever is reciprocated by the cam 36, the frictional engagement between the clutch surfaces upon the member 8 and the shaft 10, will result in the tensioning of the spring 31 prior to and during any movement of the member 8, so that after the disengagement of said members 8 and 10, the spring 31 will impart to the part 27 a slight movement in excess of that under the cam 36 thus affording slight clearance between the clutch surfaces and avoiding the noise and wear above referred to.

From the foregoing it will be observed that the clutch block 8 is normally held by the cam 36 in a neutral position between the clutch surfaces 7 and 10, and disengaged from both of these surfaces. When the starter is actuated through the cord 37, the lever 27—28 is rocked against the tension of the spring 32 and away from the cam 36, thus throwing the clutch block 8 into mesh with the clutch surface 7 to the right of Fig. 1, as heretofore described. The tension of the spring 32 is increased by this movement, this spring always having a normal tendency to force the block 8 away from the surface 7 into a neutral position, which tendency is overcome by the friction between these two clutch surfaces engendered by the energy of the springs 5 when the starter is in operation. Instantly upon the release of this friction, as by the exhaustion of spring energy, or a speed of the clutch 7 in excess of that of the block, the spring 32 will act upon the lever 27—28 to an extent to throw said clutch block 8 into engagement with the surface 10, the cam 36 being at this moment out of the path of the arm 27, thus placing no limitation upon the oscillatory movement of this arm. The spring 31 during this process is not in tension, so that it exerts no influence in disengaging the block from the clutch 10. When, however, the cam 36 is restored to its normal position through the continued rotation of the stud 35, in applying power to the driven member 6, it will, during the first portion of its engagement with the arm 27, tension the spring 31 so as to develop a tendency of this spring to throw the arm 28, and with it the clutch block 8, out of engagement with the clutch surface 10. This tendency, however, is resisted by the friction between the members 8 and 10, thus preserving the tension of this spring until the cam 36, through the arms 27—28, has fully disengaged the clutch surfaces 8 and 10 and the member 10 has ceased to rotate. Thereupon, the cam 36 will become idle so that the clutch surface upon the block 8 will have a tendency to ride upon the similar surfaces upon the shaft 10, thus causing wear and noise. Under these conditions, however, the spring 31 is free to act so that its tension will impart a very slight movement to the block 8, thus moving this block sufficiently to avoid the wear and noise above referred to. This movement under the spring 31, occurring after the cam 36 has ceased to impart movement to the lever 27—28, is a movement of said lever in excess of that imparted by said cam.

If the engine should not start under the spring energy, the engine may be started by hand by using the crank 42, without the collar 41 thereon, in the usual manner, the pull cord 37 being used to hold the member 8 out of engagement with the shaft 10. If it be

preferred to restore the energy to the springs, however, the collar 41 may be slipped over the stem of the crank 42 and into engagement with the studs 43 thereon and brought into engagement with the studs 40 upon the plate 11, the member 8 being disconnected as before. The rewinding mechanism alone will then be actuated to rotate the driving member or spring arbor 4 and develop the desired energy in the springs. When the desired spring energy has been developed, all of the parts will be positioned as shown in Fig. 1, preparatory to the next actuation of the starter. When rewinding in the manner described, the friction clutch member 22 would prevent any kick-back upon the crank.

Through the removal of the casing 39, the entire rewinding, holding, and controlling mechanisms will be exposed at the front of the starter, so that by merely removing said casing at any time, the condition of these mechanisms may be readily ascertained, or if repairs or renewal of parts are necessary, the same may be quickly and readily accomplished.

The arrangement of parts is not only compact, but all parts may be inexpensively produced, and are few in number.

It is not my intention to limit the invention to the precise details of construction shown in the accompanying drawings, it being apparent that such may be modified without departing from the spirit or scope of the invention.

Having described my invention, what I claim as new and desire to have protected by Letters Patent, is:—

1. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be acutated by said energy, a driven member, a rewinding mechanism, including therein a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction, while said rewinding mechanism is permitted to be freely actuated to restore said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, means whereby said coupling member may be connected with said driving member, automatically acting means whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said friction clutch may be released to apply said spring energy to said driving member.

2. A starter for internal combustion engines embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, including therein a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction, while said rewinding mechanism is permitted to be freely actuated to restore said spring energy, a coupling member rotatable with said driven member and adapted to be alternately connected with said driving member and with said rewinding mechanism, means adapted to simultaneously connect said coupling member with said driving member and release said friction clutch, automatically acting means whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said friction clutch may be released to apply said spring energy to said driving member.

3. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, including therein a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction, while said rewinding mechanism is permitted to be freely actuated to restore said spring energy, a coupling member rotatable with said driven member and adapted to be alternately connected with said driving member and with said rewinding mechanism, means adapted to simultaneously connect said coupling member with said driving member and release said friction clutch, automatically acting means whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, and said holding member will be simultaneously set to hold said rewinding mechanism against return movement, means for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said friction clutch may be released to apply said spring energy to said driving member.

4. A starter for internal combustion engines, embodying therein means for storing

spring energy, a driving member adapted to be actuated by said energy, an impact coupling carried thereby, a rewinding mechanism embodying therein an impact coupling oppositely disposed to said first named coupling, and a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction while said rewinding mechanism is permitted to be freely actuated to restore said spring energy, a driven member, an impact coupling member mounted thereon and rotatable therewith, means normally holding said coupling member out of engagement with the impact couplings of both said driving member and said rewinding mechanism, means adapted to act simultaneously with said last named means whereby when said coupling member is connected to said driving member, said friction clutch will be released, and when said coupling member is connected to said rewinding mechanism said friction clutch will be set, means whereby said coupling member may be connected to said driving member, automatically acting means disconnecting said coupling from said driving member and connecting it to said rewinding mechanism, and automatically acting means for disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed.

5. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, said rewinding mechanism including therein a friction clutch adapted to be automatically set by said spring energy whereby said driving member is normally held against movement in one direction, while being permitted to be freely rotated to restore said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, an oscillatory lever adapted to engage said coupling member, automatically acting means acting upon said lever whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means acting upon said lever for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said friction clutch may be released to apply said spring energy to said driving member.

6. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, a holding member adapted to control said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, an oscillatory lever adapted to engage said coupling member, a spring acting upon said lever whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means acting upon said lever for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said holding member may be released to apply said spring energy to said driving member.

7. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, said rewinding mechanism including therein a friction clutch adapted to be automatically set by said spring energy whereby said driving member is normally held against movement in one direction, while being permitted to be freely rotated to restore said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, an oscillatory lever adapted to engage said coupling member, automatically acting means acting upon said lever whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, a cam receiving a timely movement from said driving member acting upon said lever for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said friction clutch may be released to apply said spring energy to said driving member.

8. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, a holding member adapted to control said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, an oscillatory lever adapted to engage said coupling member, comprising two pivotally connected parts having a limited movement relative to each other and a spring carried by one of said parts and acting upon the other to force said coupling away from said rewinding mechanism, a spring acting upon said lever whereby, with the exhaustion of the spring energy,

said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means acting upon said lever for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said holding member may be released to apply said spring energy to said driving member.

9. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, holding means comprising a rotary plate having a rim thereon and forming a part of said rewinding mechanism, a clamping member acting solely through friction acting upon said rim, and a spring normally setting said clamping member upon said rim, adapted to control said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, an oscillatory lever adapted to engage said coupling member, automatically acting means acting upon said lever whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, a cam receiving a timely movement from said driving member acting upon said lever for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, means carried by said lever whereby said clamping member is automatically released as said coupling member is connected to said driving member and is permitted to automatically set as said coupling member is disconnected from said driving member, and means whereby said holding member may be released to apply said spring energy to said driving member.

10. A starter for internal combustion engines embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, holding means adapted to control said spring energy comprising a rotary plate having a rim thereon and forming a part of said rewinding mechanism, a clamping member acting solely through friction acting upon said rim, and a spring normally setting said clamping member upon said rim, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, an oscillatory lever adapted to engage said coupling member, automatically acting means acting upon said lever, whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means acting upon said lever for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, an arm having a beveled surface adapted to engage said clamping member whereby said clamping member is automatically released as said coupling member is connected to said driving member and is permitted to automatically set as said coupling member is disconnected from said driving member, and means whereby said holding member may be released to apply said spring energy to said driving member.

11. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy having a coupling surface at one end thereof, a driven member mounted within and concentric with said driving member, a rewinding mechanism, a coupling surface thereon parallel with the coupling surface upon said driving member and spaced away therefrom, said rewinding mechanism including therein a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction, while being permitted to be freely actuated to restore said spring energy; a coupling member, splined upon, so as to be rotatable with, said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, said coupling member having upon both ends thereof clutch surfaces, means whereby said coupling member may be connected with said driving member, automatically acting means whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, and means whereby said friction clutch may be released to apply said spring energy to said driving member.

12. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, including therein a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction, while said rewinding mechanism is permitted to be freely actuated to restore said spring energy, a coupling member rotatable with said driven member adapted to be alter-

nately connected with said driving member and with said rewinding mechanism, an oscillatory lever adapted to engage said coupling member, automatically acting means acting upon said lever, whereby with the exhaustion of the spring energy, said coupling member will be disconnected from said driving member and connected with said rewinding mechanism, means acting upon said lever for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, comprising a Geneva gear, a pin carried by said driving member, and a cam carried by said gear, whereby said gear will be alternately rotated in opposite directions from said driving member, and means whereby said friction clutch may be released to apply said spring energy to said driving member.

13. A starter for internal combustion engines, embodying therein a driving member, a driven member, a rewinding mechanism comprising a gear train, the last gear of which is normally in mesh with the driving member and the first gear of which is adapted to be coupled directly to the driven member, a friction clutch included in said rewinding mechanism, means whereby said friction clutch may be made inoperative with the actuation of the starter, and a coupling member whereby said driving member is coupled directly to said driven member and said driven member is coupled through said rewinding mechanism to said driving member to apply the spring energy directly to said driven member and indirectly from said driven member to said driving member.

14. A starter for internal combustion engines, embodying therein a driving member, a driven member, a rewinding mechanism comprising a gear train, the last gear of which is normally in mesh with the driving member and the first gear of which is adapted to be coupled directly to the driven member, holding means acting solely through friction, acting upon said rewinding mechanism, means whereby said holding means are made inoperative with the actuation of the starter and are rendered operative during the rewinding interval, and a coupling member whereby said driving member may be alternately coupled directly to said driven member and said driven member is coupled through said rewinding mechanism to said driving member to apply the spring energy directly to said driven member and indirectly from said driven member to said driving member.

15. A starter for internal combustion engines, embodying therein a spring casing having mounted therein a spring and a rotatable arbor therefor, said casing having a head upon its forward face, a plate parallel with and spaced away from said head, a coupling member, and a rewinding mechanism mounted between said head and said plate and upon said plate, whereby all the operative parts of the starter are exposed and accessible, and a cover inclosing said mechanism.

16. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, including therein a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction, while said rewinding mechanism is permitted to be freely actuated to restore said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, means whereby said coupling member may be connected with said driven member, automatically acting means whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driven member and connected with said rewinding mechanism, means for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, means whereby said friction clutch may be released to apply said spring energy to said driving member, and means carried by said rewinding mechanism whereby said mechanism may be actuated manually.

17. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, including therein a friction clutch adapted to be automatically set by said spring energy, whereby said driving member is normally held against movement in one direction, while said rewinding mechanism is permitted to be freely actuated to restore said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, means whereby said coupling member may be connected with said driven member, automatically acting means whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driven member and connected with said rewinding mechanism, means for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, means whereby said friction clutch may be released to apply said spring energy to said driving member, and means comprising a clutch member

carried by said rewinding mechanism, and a crank member adapted to coöperate with said clutch member, whereby said mechanism may be actuated manually.

18. A starter for internal combustion engines, embodying therein means for storing spring energy, a driving member adapted to be actuated by said energy, a driven member, a rewinding mechanism, a holding member adapted to control said spring energy, a coupling member rotatable with said driven member adapted to be alternately connected with said driving member and with said rewinding mechanism, means whereby said coupling member may be connected with said driven member, automatically acting means whereby, with the exhaustion of the spring energy, said coupling member will be disconnected from said driven member and connected with said rewinding mechanism, means for automatically disconnecting said coupling member from said rewinding mechanism when the desired spring energy has been developed, means whereby said holding member may be released to apply said spring energy to said driving member, and means comprising a clutch member and a crank member carrying a removable member adapted to coöperate with said clutch member, whereby said mechanism may be actuated manually, and said crank member may be used to actuate said driven member directly.

19. A starter for internal combustion engines embodying therein a spring actuated driving member, a rewinding mechanism, including therein an automatically acting friction clutch whereby said driving member is controlled through said rewinding mechanism, a driven member, a clutch member carried thereby adapted to be normally held in a neutral position and to be alternately connected with said driving member and with said rewinding mechanism, a lever controlling said clutch member, and respective means acting upon said lever whereby said lever may be oscillated in one direction to connect said driving member and said driven member and in the opposite direction to connect said driven member and said rewinding mechanism and return to its normal inoperative position, whereby all of the functions of the starter are under the control of one lever.

In witness whereof, I have hereunto affixed my signature in the presence of two subscribing witnesses, this 18th day of September, 1911.

BERNHARD VOLKMAR.

Attest:

CLAUSIA FRANCK,
EUGENE WENING.