Feb. 14, 1933. W. J. BAUMAN 1,897,786

STARTER FOR INTERNAL COMBUSTION ENGINES

Original Filed Sept. 25, 1931

Fig. 1.

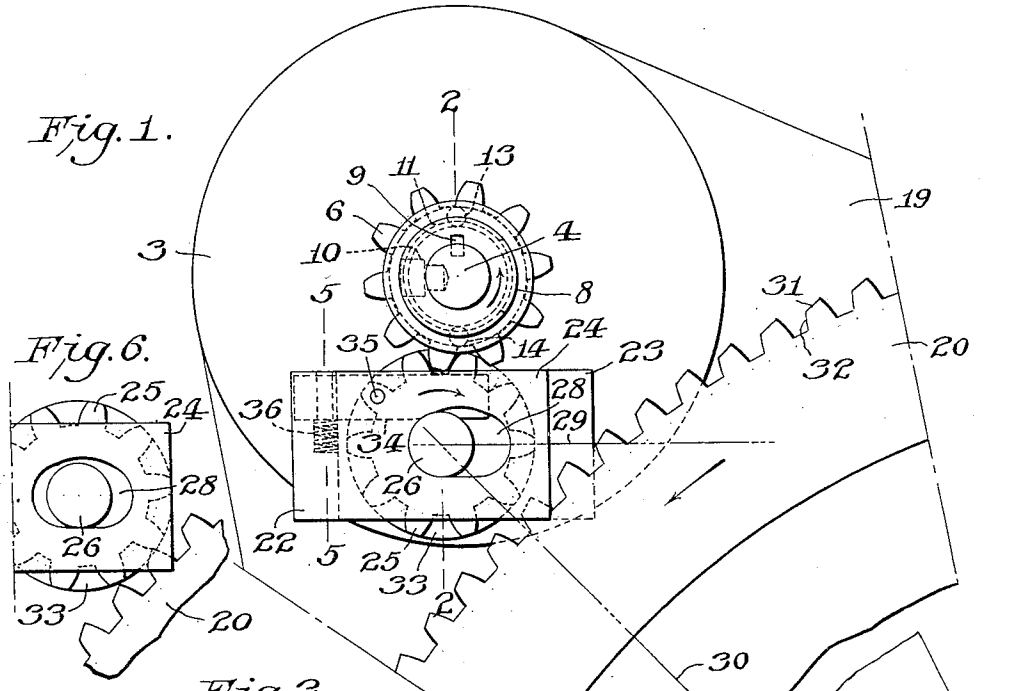


Fig. 6.

Fig. 3.

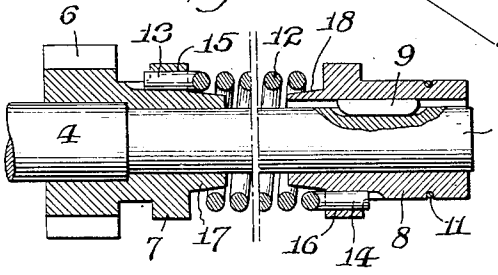


Fig. 4.

Fig. 2.

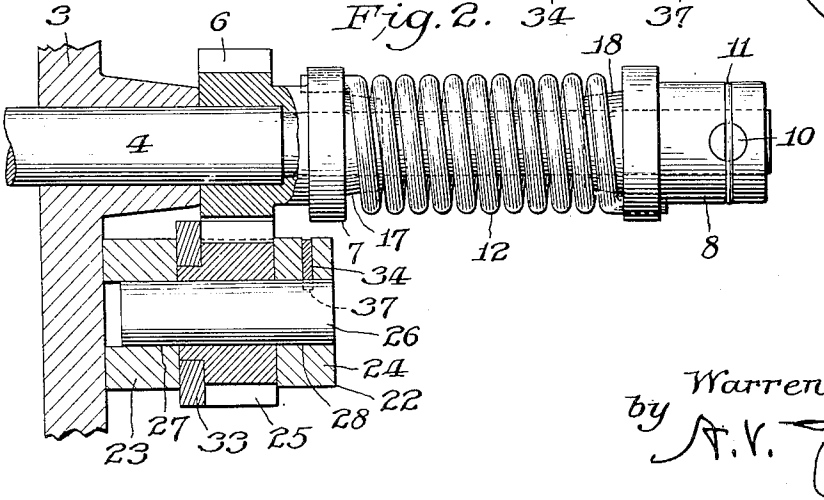
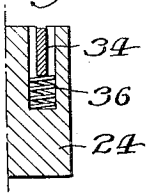


Fig. 5.



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UNITED STATES PATENT OFFICE

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STARTER FOR INTERNAL COMBUSTION ENGINES

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This invention relates to improvements in starting mechanism for internal combustion engines wherein are employed a motor actuated starting shaft, an engine gear wheel for actuating and starting the engine, a primary driving pinion on the starting shaft, a secondary driving pinion actuated by the primary pinion and movable transversely of its axis of rotation into and out of mesh with the engine gear wheel and a yieldable driving connection between the starting shaft and the primary pinion.

The object of my present invention is to improve this type of starting mechanism by reducing the number of parts thereof, simplifying the construction thereof, reducing the cost of the manufacture thereof and increasing the efficiency thereof.

With the aforesaid object in view the invention consists in the novel construction, combination and arrangement of elements hereinafter described and particularly claimed.

In the accompanying drawing, illustrating my invention,

Figure 1 is a front view, partly broken away, of a starting mechanism showing one form of embodiment of my invention.

Figure 2 is a side view thereof, partly in section, on line 2—2 of Fig. 1.

Figure 3 is a longitudinal sectional detail showing the starting shaft and parts carried thereby.

Figure 4 is a side view of the spring pressed lever.

Figure 5 is a sectional detail, on line 5—5 of Fig. 1.

Figure 6 is a detail in front view, showing the secondary driving pinion and adjuncts, after the pinion has been moved a short distance from its normal position toward the engine gear.

Referring to the drawing, 3 designates a suitable frame or support in which the starting shaft 4 is journaled. This shaft 4 is constructed to be actuated by a suitable prime mover, usually an electric motor, the shaft 4 forming an outwardly projecting extension of the armature or power shaft thereof.

The starting shaft 4 carries a primary driving pinion 6 which is mounted to rotate thereon adjacent to the frame 3 and which is provided with an outwardly extending hub or collar 7 formed integral therewith.

The outer or free end portion of the shaft 4 is provided with a collar 8 which is spaced from the pinion collar 7, and which is prevented from turning relatively to the shaft 4 by a suitable key 9 interposed between the shaft and the collar, as clearly shown in the drawing. Longitudinal movement of the collar 8 on the shaft 4 is prevented by a screw 10 which is screwed into the collar 8 and which is provided with a reduced inner end portion which extends into a bore in the shaft 4. Accidental unscrewing of the screw 10 is prevented by a split ring retainer 11 which is formed of spring wire and sprung into an annular groove in the collar and into the slot in the outer end of the screw.

A helical spring 12 encircles the shaft 4 and extends between the collars 7 and 8. The respective ends of the spring 12 terminate in oppositely directed end portions 13 and 14 which extend parallel to the shaft 4 and which are located within bores 15 and 16 formed in the collars 7 and 8, respectively, and extending parallel to the shaft 4.

The spring 12 and collars 7 and 8 provide a yieldable driving connection between the starting shaft 4 and the pinion 6, said connection causing the pinion to be turned in either direction by and with the shaft 4 as a unit when there is insufficient load upon the pinion 6 to affect the spring 12, and said connection permitting a limited amount of relative rotary movement between the shaft 4 and the pinion 6, cushioned by the spring 12, when the load is sufficient to overcome the resistance of the spring to relative rotary movement between the shaft and the pinion.

The collars 7 and 8 are provided with sleeves 17 and 18, respectively, which extend toward each other and into the end portions of the spring 12 and support the central portion or main body of the spring in concentric spaced relation to the shaft. This construction permits the free action of the helices of the spring as it winds and unwinds

about the shaft 4 in performing its function as a yieldable driving connection.

The arrangement of the end portions 13 and 14 of the spring 12 and the bores 15 and 16 in which they are located parallel to the shaft 4 provides a very simple and inexpensive construction, the parts of which may be easily and quickly assembled and disassembled by sliding the pinion 6, the spring 12 and the collar 8 longitudinally onto or off from the shaft 4 when the screw 10 is removed from the collar 8. The screw 10 forms the sole means for holding the parts in place when they are assembled on the shaft 4 and the screw 10 is prevented from accidentally leaving its applied position by the removable split retaining ring 11 previously described.

When the parts are assembled on the shaft 4, the spring 12 is slightly compressed longitudinally and holds the pinion 6 firmly against a shoulder on the shaft 4, the spring and shoulder preventing displacement of the pinion 6 longitudinally of the shaft 4 and permitting the free rotation thereof.

The frame or support 3 occupies a fixed relation to the frame of the engine to be started thereby and it is secured to or it may form a part of the engine frame which is indicated at 19 in Fig. 1. The engine is provided with a gear wheel 20 carried by its crank shaft 21 which is journaled in bearings in the engine frame, so that the gear wheel 20 will be rotated by the crank shaft when the engine is running and may be rotated to start the engine when it is idle.

The frame or support 3 has a bracket 22 formed on or secured thereto providing two spaced parts 23 and 24 between which is located a secondary driving pinion 25 in mesh with the primary pinion 6. The secondary pinion 25 is carried by a shaft 26, the respective end portions of which project from the sides of the pinion and into slots 27 and 28 in the parts 23 and 24 to support the pinion 25 and permit it to be rotated and moved transversely of its axis of rotation toward and from the engine gear wheel 20 and into and out of mesh with the teeth thereof. When the pinion 25 is out of mesh with the gear wheel 20 its shaft 26 rests against one end of the slots 27 and 28, and when the pinion 25 is in full mesh with the gear wheel 20, its shaft 26 bears against the opposite end of the slots 27 and 28. The length of the slots 27 and 28 and the relation thereof to the axis of the pinion 6 are such that the movement of the pinion 25, occasioned by the movement of its shaft 26 from end to end of the slots 27 and 28, will not disturb the practical meshing engagement of the two driving pinions 6 and 25 with each other.

In operating the mechanism, the starting shaft 4 is rotated in the direction of the arrow in Fig. 1 and it thereby rotates the pinions 6 and 25 in the directions of the arrows in Fig. 1, and, when the pinion 25 is in mesh with the gear wheel 20, it rotates the same in the direction of the arrow thereon in Fig. 1 to start the engine.

To enable the secondary pinion and its shaft 26 to move toward primary pinion 6 and the starting shaft 4 and thereby permit the primary pinion 6 to continue to advance the secondary pinion into engagement with the engine gear 20 without interruption if the forward surface of a tooth of the secondary pinion 25 should strike against the rearward surface of a tooth of the engine gear 20, as shown in Fig. 6, I make the central portions of the slots 27 and 28 wider than the end portions thereof and wider than the diameter of the secondary pinion shaft 26, as shown in Figs. 1 and 6. When the primary pinion 6 advances the secondary pinion 25 into mesh with the engine gear 20, the action of the pinion 6 and the weight of the pinion 25 tends to keep the pinion shaft 26 in contact with the bottom of the slots 27 and 28. If, however, the forward surface of a tooth of the pinion 25 should strike against the rearward surface of a tooth of the engine gear 20, before the pinion has been moved into full mesh with the engine gear, as shown in Fig. 6, the pressure of the primary pinion 6 tending to rotate the secondary pinion 25, and the opposition of the tooth of the engine gear 20 to such tendency, will cause the secondary pinion 25 to raise the shaft 26 within the widened portions of the slots 27 and 28 and move toward the primary pinion 6 and thereby cause the teeth of the pinion 25 to easily move on into full mesh with the teeth of the engine gear 20, there being sufficient clearance provided in the spaces between the teeth of the pinions 6 and 25 to permit this limited movement of the pinion 25 toward and from the pinion 6.

To prevent the pinion 25 from being thrown backward in its line of travel if its teeth should contact with the teeth of the gear wheel 20, and to prevent the teeth of the pinion and the teeth of the engine gear from jamming and thus prevent the damage resulting therefrom when the pinion is moved into mesh with the gear wheel, I arrange the supporting and guiding slots 27 and 28 for the pinion shaft 26 in such relation to the gear wheel 20 that, when the pinion is moved from the normal position shown in Fig. 1 into mesh with the gear wheel 20, it will be moved on a line 29 which intersects a radial line 30 projecting from the center of the gear wheel 20 and which extends from the line 29 at an acute angle thereto and toward the teeth of the gear wheel 20 which approach the pinion 25 when the gear wheel is driven thereby; and, in addition to this, I bevel the free end 31 of each tooth of the gear wheel 20 in a direction which recedes from the center of the gear wheel and from the forward

surface 32 of the tooth. This beveling of the free ends of the teeth of the gear wheel 20 causes them to coincide with the lines of travel of the free ends of the teeth of the pinion 25 and thus permits the pinion to continue to rotate and prevents it from being thrown backward on its line of travel toward the gear wheel 20 if the end surface of a tooth of the pinion 25 should come into contact with the beveled end surface 31 of a tooth of the gear wheel 20, while the pinion is moving into mesh with the gear wheel.

To increase the weight of the secondary pinion 25 near the periphery thereof for the purpose of accelerating its movement into and out of mesh with the engine gear wheel, I provide the same with a ring 33 having an exterior diameter the full diameter of the pinion 25 and being suitably secured thereto adjacent to the ends of its teeth.

To prevent the secondary pinion 25 from being accidentally moved from its normal position, as shown in Fig. 1 when the starting shaft 4 is idle, and while the starting motor comes to rest after the pinion 25 has been returned to the normal position by the engine gear following an engine starting operation, I provide a plate-like lever 34 fitted within a slot in the top of the bracket part 24 and fulcrumed therein on a transversely extending pin 35. One end portion of the lever 34 is pressed yieldingly against the top of the shaft 26 by a spring 36 housed within a bore in the part 24 and acting against the bottom of the other end portion of the lever. The lever 34 bears upon the shaft 26 in all positions thereof and it is provided with a shoulder 37 which prevents accidental movement of the shaft 26 and pinion 25 from its normal position, and which permits movement thereof toward the engine gear wheel 20 when the starting shaft 4 is rotated, as will be presently described.

The operation of the starting mechanism is as follows:

When it is desired to start the engine, power is applied to the starting shaft 4 to rotate it rapidly in the direction of the arrow in Fig. 1. The rapid rotation of the shaft 4 and the primary driving pinion 6 thereon transmits to the secondary driving pinion 25 a driving force, the first impulse of which not only rotates the pinion 25 in the direction of the arrow in Fig. 1, but also moves it toward the engine gear wheel 20, guided by its shaft 26 moving in the slots 27 and 28. When the shaft 26 reaches the end of the slots 27 and 28 nearest the gear wheel 20, the pinion 26 is in full mesh with the gear wheel 20 and it is held there by the power applied thereto. As the pinion 25 comes into mesh with the gear wheel 20, the latter, which is at rest, opposes and retards the rotary movements of the pinions 6 and 25 while the driving force of the starting shaft 4 causes the spring 12 to yield and to be twisted or wound about the shaft to cushion the shock of the engagement of the rotating pinion 25 with the idle gear wheel 20, and, thereafter, the pinion 25 starts and continues to rotate the gear wheel 20 until the firing within the engine begins. Thus the spring 12 provides a yielding driving connection between the shaft 4 and pinions 6 and 25.

When the firing within the engine begins the speed of the gear wheel 20 is suddenly and greatly accelerated and the speed of the pinion 25 is correspondingly accelerated and thereby caused to act against the teeth of primary pinion 6 in a manner to permit the acceleration of the gear wheel 20 to move the pinion 25 out of mesh therewith and back to the normal position, shown in Fig. 1, where it is retained by the shouldered portions 37 of the lever 34 engaging the pinion shaft 26.

Should the surface of the outer end of a tooth of the pinion 25 encounter the surface of the beveled free end of a tooth of the engine gear wheel 20 while the pinion 25 is moving into mesh with the gear wheel, the forward bodily movement of the pinion will be momentarily retarded thereby until the rotation of the pinion causes the said tooth thereof to clear the beveled end of the said tooth of the gear 20, whereupon the pinion will continue its forward movement on the line 29 as the next succeeding tooth thereof enters a space between two teeth of the gear wheel 20 and the pinion moves into full mesh with the gear wheel.

During the operation of the mechanism to start the engine, the first impulse of the starting shaft 4 easily moves the pinion shaft 26 from engagement with the shouldered portions 37 of the lever 34 which bears lightly against the shaft, and, after the pinion 25 has moved into mesh with the gear wheel 20, the free end portion of the lever 34 bears lightly upon the shaft 26 and permits the easy return of the pinion 25 to its normal position.

The extent to which the spring 12 is twisted or distorted from its normal condition in cushioning the engagement of the pinion 25 with the gear wheel 20, during an engine starting operation is governed and controlled by the load or the strength of the resistance offered by the engine through the gear wheel 20 to the turning power of the pinion 25, and the spring is constructed with sufficient strength to enable it to perform its function with the desired yielding or cushioning action as described herein.

I claim as my invention.

1. In a starting mechanism for internal combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support, a primary driving pinion carried by the shaft, a sec-

ondary driving pinion in mesh with the primary pinion and movable under the influence of the starting shaft into mesh with the engine gear, and movable under the influence of the engine gear out of mesh therewith, a shaft carrying the secondary pinion, said support having two spaced parts located on the respective sides of the secondary pinion and having slots therein into which the last named shaft extends to be supported thereby and to guide the secondary pinion toward and from the engine gear wheel, one of said parts having a bore and an additional slot therein, a lever located within the last named slot and pivoted to said support and adapted to bear against the last named shaft in all positions thereof, and a spring within said bore pressing the lever against the last named shaft, said lever having a shoulder for engaging the last named shaft to prevent accidental movement thereof toward the engine gear when the starting shaft is idle.

2. In a starting mechanism for internal combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support, a primary driving pinion rotatable on the shaft, a yieldable driving connection between said shaft and said pinion a secondary driving pinion in mesh with the primary pinion and movable thereby into mesh with the engine gear when the starting shaft is rotated, a shaft carrying the secondary pinion, and means for supporting the secondary pinion shaft, the axis of rotation of the primary pinion being above the axis of rotation of the secondary pinion, and said means having parts provided with elongated, substantially horizontal uninterrupted surfaces extending beneath the secondary pinion shaft and over which it is rolled in supporting contact therewith by the action of the primary pinion when it moves the secondary pinion into mesh with the engine gear.

3. In a starting mechanism for internal combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support, a primary driving pinion rotatable on the shaft, a yielding driving connection between said shaft and said pinion, a secondary pinion in mesh with the primary pinion and movable thereby into mesh with the engine gear when the starting shaft is rotated, a shaft carrying the secondary pinion, and means for supporting and guiding the secondary pinion shaft, the axis of rotation of the primary pinion being above the axis of rotation of the secondary pinion, said means having parts provided with elongated, substantially horizontal, uninterrupted surfaces over which the secondary pinion shaft is rolled by the action of the primary pinion when it moves the secondary pinion into mesh with the engine gear, said secondary pinion shaft being free at all times to be rolled on said parts with uninterrupted contact therewith and being movable therefrom toward the axis of the primary pinion.

4. In a starting mechanism for internal combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support, a primary driving pinion rotatable on the shaft, a part fixed to the shaft, a torsional spring encircling the shaft and having one end portion thereof engaged with said pinion and the other end portion thereof engaged with said part, a secondary driving pinion in mesh with the primary pinion and movable thereby from an inoperative position into mesh with the engine gear when the starting shaft is rotated, a shaft carrying the secondary pinion, means for supporting and guiding the secondary pinion shaft, and means for releasably maintaining the secondary pinion shaft in said inoperative position, the axis of rotation of the primary pinion being above the axis of rotation of the secondary pinion, and said means having parts provided with elongated, substantially horizontal, uninterrupted surfaces extending beneath the secondary pinion shaft and over which it is rolled in supporting contact therewith by the action of the primary pinion when it moves the secondary pinion into mesh with the engine gear.

5. In a starting mechanism for internal combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support, a primary driving pinion rotatable on the shaft and having a bore therein substantially parallel to the axis of the shaft, a collar fixed on the shaft and having a bore therein substantially parallel to the axis of the shaft, a torsional spring encircling the shaft between said collar and said pinion and having one end portion thereof extending into the bore in said pinion and the other end portion thereof extending into the bore in said collar, a secondary driving pinion in mesh with the primary pinion and movable thereby from an inoperative position into mesh with the engine gear when the starting shaft is rotated, a shaft carrying the secondary pinion, means for supporting and guiding the secondary pinion shaft, said means having parts provided with elongated, substantially horizontal, uninterrupted surfaces extending beneath the secondary pinion shaft and over which it is rolled in supporting contact therewith by the action of the primary pinion when it moves the secondary pinion into mesh with the engine gear and means for releasably maintaining the secondary pinion shaft in said normal position, the axis of rotation of the primary pinion being above the axis of rotation of the secondary pinion.

6. In a starting mechanism for internal

combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support, a primary driving pinion rotatable on the shaft, a yielding driving connection between said shaft and said pinion, a secondary driving pinion in mesh with the primary pinion and movable thereby from an inoperative position into mesh with the engine gear when the starting shaft is rotated, means for supporting and guiding the secondary pinion shaft, the axis of rotation of the primary pinion being above the axis of rotation of the secondary pinion, said means comprising parts on the respective sides of the secondary pinion and provided with substantially horizontally extending slots into which the secondary pinion shaft extends and over the bottom walls of which it is adapted to be rolled in supporting contact therewith by the action of the primary pinion when it moves the secondary pinion into mesh with the engine gear, the walls of said slots at one end thereof forming stops to limit the movement of the secondary pinion shaft to the inoperative position, and the walls of said slots at the other end thereof forming bearings for the secondary pinion shaft in the operative position thereof.

7. In a starting mechanism for internal combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support and having a free end portion projecting therefrom and provided with a shoulder, a primary driving pinion rotatable on said end portion and being prevented from inward displacement by said shoulder, a collar on said end portion outwardly of said pinion, a helical spring encircling said end portion between said collar and said pinion and having one end portion thereof engaged with the collar and the other end portion thereof engaged with said pinion, said spring opposing relative rotary movement between the collar and the pinion, a secondary pinion in mesh with the primary pinion and movable transversely of its axis of rotation and under the influence of the starting shaft into mesh with the engine gear, means for supporting and guiding the secondary pinion, said primary pinion and said spring and said collar being axially movable onto and off from said end portion, and said primary pinion being axially movable on said end portion into and out of mesh with said secondary pinion, and means for detachably securing said collar to said end portion.

8. In a starting mechanism for internal combustion engines, the combination with an engine gear wheel, of a support, a starting shaft rotatable in the support and having a free end portion projecting therefrom and provided with a shoulder, a primary driving pinion rotatable on said end portion and being prevented from inward displacement by said shoulder and having a bore therein substantially parallel to the axis of the shaft, a collar on said end portion outwardly of said pinion and having a bore therein substantially parallel to the axis of the shaft, a helical spring encircling said end portion between said collar and said pinion and having one end portion thereof extending into the bore in said pinion and the other end portion thereof extending into the bore in the collar, said spring opposing relative rotary movement between the collar and the pinion, a secondary pinion in mesh with the primary pinion and movable transversely of its axis of rotation and under the influence of the starting shaft into mesh with the engine gear, means for supporting and guiding the secondary pinion, said primary pinion and said spring and said collar being axially movable onto and off from said end portion, and said primary pinion being axially movable on said end portion into and out of mesh with said secondary pinion, and means for detachably securing said collar to said end portion.

In testimony whereof I affix my signature.

WARREN J. BAUMAN.