L. A. CASGRAIN.

STARTING DEVICE FOR INTERNAL COMBUSTION MOTORS.

APPLICATION FILED JUNE 26, 1912.

**1,132,160.**

Patented Mar. 16, 1915.

2 SHEETS—SHEET 1.

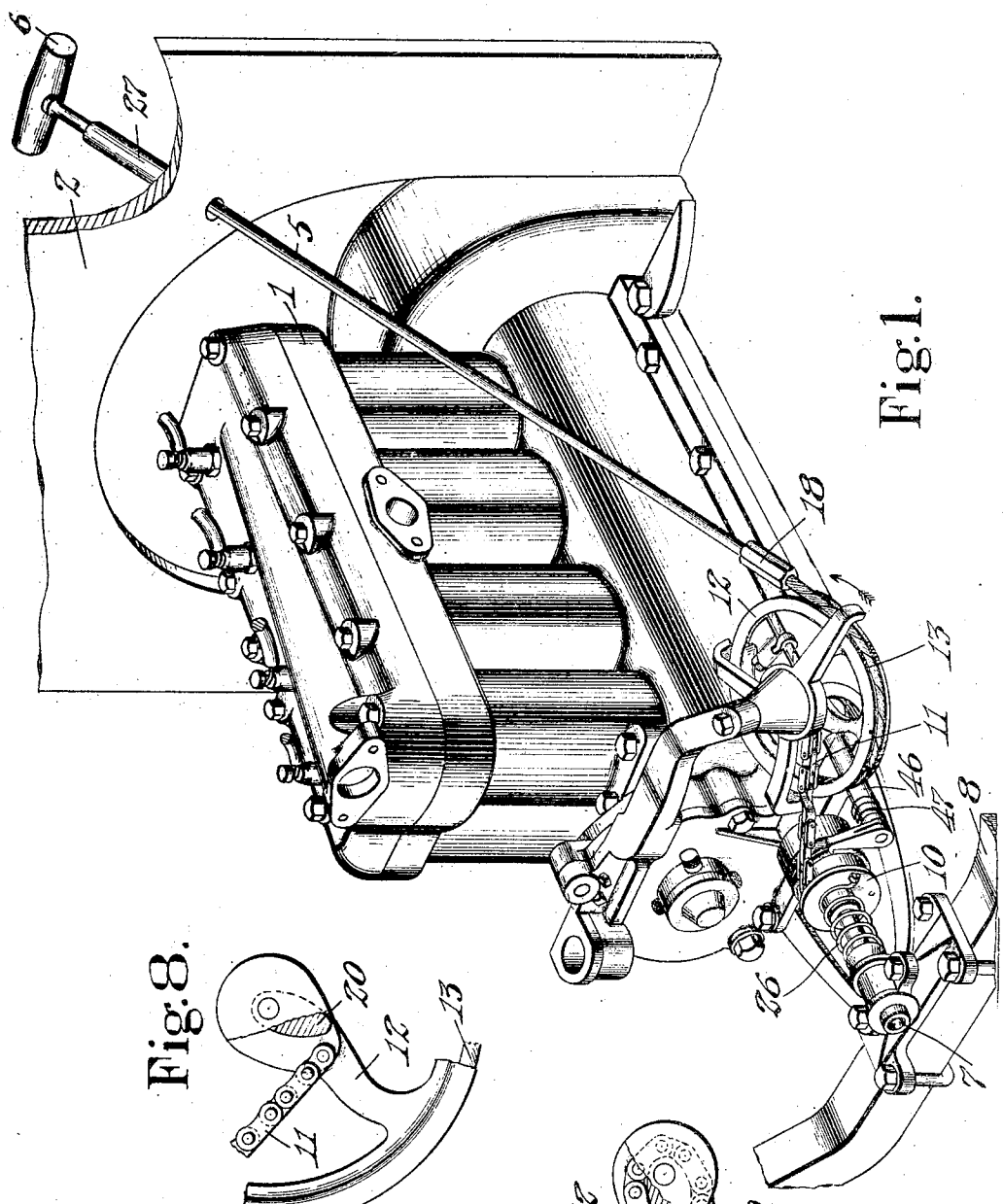


Fig. 1.




Fig. 8.

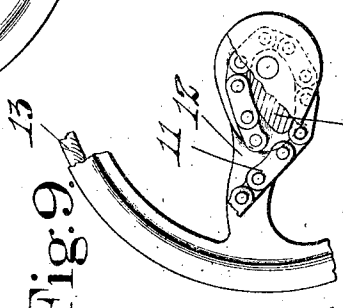


Fig. 9.

WITNESSES.

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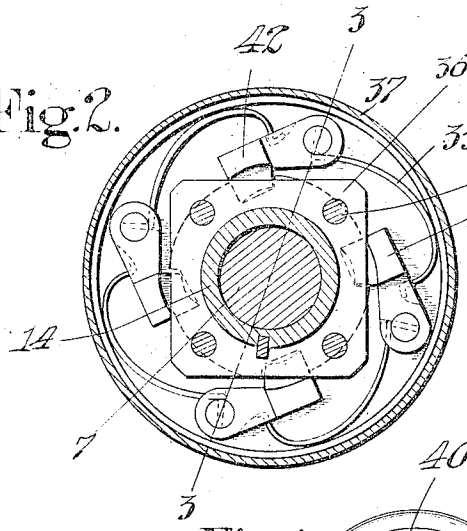
2 SHEETS—SHEET 2.

Fig. 2.



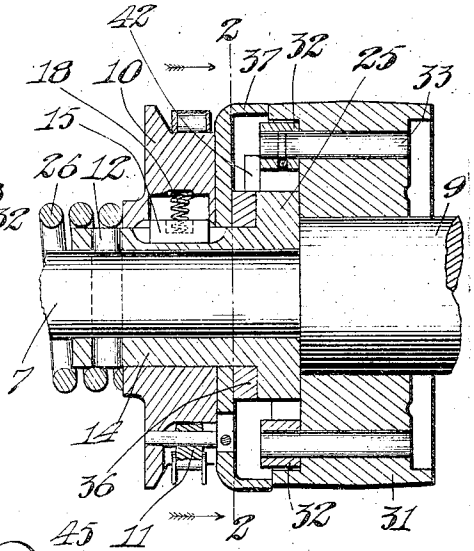




Fig. 3.

Fig. 4.

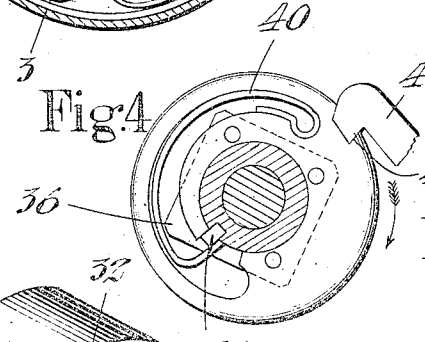
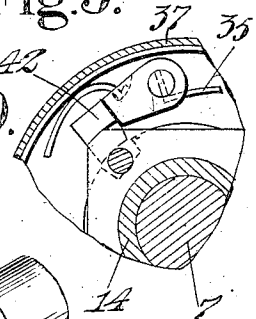



Fig. 10.



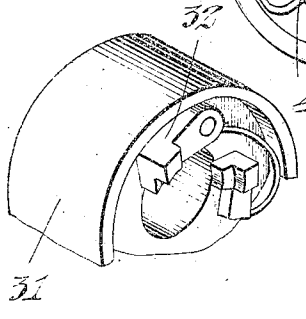




Fig. 5.

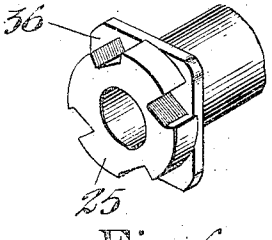



Fig. 6.

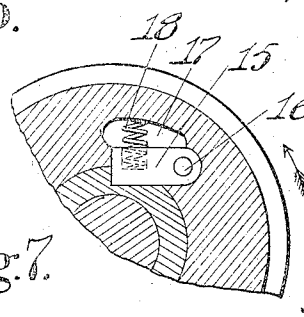



Fig. 7.

WITNESSES.

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# UNITED STATES PATENT OFFICE.

LOUIS A. CASGRAIN, OF BEVERLY, MASSACHUSETTS.

## STARTING DEVICE FOR INTERNAL-COMBUSTION MOTORS.

1,132,160. Specification of Letters Patent. Patented Mar. 16, 1915.

Application filed June 26, 1912. Serial No. 705,823.

*To all whom it may concern:*

Be it known that I, LOUIS A. CASGRAIN, a citizen of the United States, residing at Beverly, in the county of Essex and State of Massachusetts, have invented certain new and useful Improvements in Starting Devices for Internal-Combustion Motors; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The present invention relates to starting devices for internal combustion motors, and more particularly to devices of this character which are employed for starting automobile motors. It is desirable in starting engines of this type to employ some means which will enable the operator from his position in the seat to turn the motor over preliminary to the starting of the same under its own power. The starting devices at present employed may be divided into two classes, namely, those in which the preliminary turn is imparted to the motor either mechanically or by introducing an explosive charge into the cylinder, which is ignited in the usual manner, and those in which the first turn is manually imparted to the crank shaft through a suitable control mechanism. The first class of devices are not certain and positive in their operation and are apt to fail when most needed, in addition to being expensive and having a more or less complicated construction, whereas the second class of devices, though comparatively inexpensive and free from complications, require so great a manual effort upon the part of the operator when starting that they have few, if any practical advantages over the ordinary form of starting crank.

The object of the present invention is to provide a manually operated starting device for motors of this type which is simple in construction and which may be operated with facility to start the motor while the driver remains seated.

With this object in view, one feature of the invention consists in the provision in a device of this character having a manually operated control of a one direction clutch connected to the crank shaft of the motor and connections between the control and clutch for multiplying the force applied to the control and for exerting an increasing torque upon the crank shaft with the application of a constant force upon the control.

Still further features of the invention consist in certain novel features of construction, combinations and arrangements of parts hereinafter described and claimed, the advantages of which will be obvious to those skilled in the art from the following description.

In the accompanying drawings illustrating the preferred form of the invention; Figure 1 is a perspective view representing an elevation of a motor embodying the several features of the invention in their preferred form; Fig. 2 is a cross section upon the line 2—2 of Fig. 3, showing the one direction clutch for operatively connecting the starting device and crank shaft of the motor; Fig. 3 is a longitudinal section upon the line 3—3 of Fig. 2 and illustrates the clutch mechanism forming a part of the starting device; Fig. 4 is a detail illustrating the mechanism for preventing a reverse rotation of the starting device by the motor; Fig. 5 is a detail illustrating the construction of the driving pawls carried by the motor crank shaft; Fig. 6 is a detail illustrating the driving ratchet and cam carried thereby; Fig. 7 is a cross section showing one of the clutch mechanisms; Figs. 8 and 9 are details illustrating the mechanism for varying the leverage in different relative positions; and Fig. 10 is a detail illustrating the normal positions of the cam, driving ratchet and pawls.

The illustrated embodiment of the invention is employed in connection with an automobile motor of the usual type, indicated at 1, and consisting of four cylinders cast *en bloc* and having the usual timing devices and other appurtenances connected therewith.

In the present invention, any desired number of turns may be imparted to the motor preliminary to starting under its own power by actuating a manual control which is supported in a conveniently accessible position, enabling the motor to be started while the operator remains in the seat. The dash of the machine is indicated at 2 and a starting rod 5 extends through the dash and is provided with a control handle 6 which is so positioned that it may be readily grasped and manipulated by the operator. The motor 1 is provided with the

usual crank shaft 9 and a starting shaft 7 which ordinarily carries the starting crank is journaled in the frame 8 of the machine and connected with the crank shaft by the mechanism hereinafter described. In order to facilitate the actuation of the device and minimize the danger of a backward rotation of the motor, the starting handle 6 is pulled toward the operator when starting and if the motor fires prematurely and rotates in the reverse direction the starting handle is merely pulled out of the hand of the operator without doing other damage. The starting shaft 7 is actuated by a drive pulley 10 connected with the starting handle through a chain 11 fastened at one end to the periphery of the drive pulley and at its opposite end to the hub of an idler pulley 12. The starting rod 5 is connected to the rim of the idler pulley through a flexible cable 13, thus multiplying the force applied to the pulley 10. To enable the shaft 7 to be rotated either by the drive pulley 10 of the starting device or by the usual crank independently of one another, the drive pulley is connected to the shaft 7 by a one direction clutch mechanism. The pulley 10 is loosely journaled upon a sleeve 14 secured to the shaft and is connected therewith by a spring pressed pawl 15 pivoted at 16 in a recessed portion of the drive pulley and engaging with a coöperating ratchet tooth formed in the sleeve 14, as shown clearly in Fig. 7. In order to return the starting device to its initial position after the handle 6 has reached its limit of movement, a coiled spring 26 surrounds the shaft 7 and is respectively connected at its opposite ends to the frame and the drive pulley 10. Although the drive pulley is connected to the sleeve 14 through a pawl 15 the spring 26 serves to return the sleeve as well as the drive pulley to its initial position. It will be obvious that no great force is required to return these parts and the spring 18 is of sufficient strength to retain the pawl in engagement with the coöperating ratchet tooth upon the reverse movement of the pulley tending to throw it out. The starting rod 5 is guided by a sleeve 27 secured to the dash 2 and inclosing the rod and the initial position of the handle may be varied lengthening or shortening the cable 13 which is secured at one end to the rim of the pulley 12 and at its opposite end to the starting rod through a threaded sleeve 18.

When starting engines of this type, and more particularly those having four cylinders, it is only necessary to impart one quarter of a revolution to the crank shaft to ignite the charge in the cylinder which is primed. The cylinder in which the explosion occurs is on the compression stroke and as the engine is rotated the charge in this cylinder is compressed, making it necessary to exert a constantly greater pull upon the crank shaft until the highest point of compression is reached and the charge is fired. Thus when employing any device in which the operator rotates the motor manually, the most difficult part of the cranking operation is at the end of the stroke just prior to the explosion and when the starting handle is in the most inconvenient position to exert a strong pull thereon. In the present invention, mechanism is provided for exerting a uniformly increasing turning torque upon the crank shaft with the application of a constant pull upon the starting handle. In the illustrated embodiment of the invention, one complete pull of the operating handle imparts one quarter to one half a revolution to the crank shaft, which is ordinarily sufficient to explode the charge in one of the cylinders. In order to uniformly increase the torque which is exerted upon the crank shaft, an approximately elliptical cam 20 is secured to the hub of the pulley 12 and is positioned in such a manner that as the pulley is revolved the end of the chain 11 winds about the periphery of the cam 20. It will be noted from an inspection of Figs. 8 and 9 that the end of the chain is secured to the pulley at some distance from its center and that as the motor is gradually turned over, the chain winds about the cam and the point of application of the pull upon the chain approaches the axis of the pulley, thus shortening the moment arm and causing the constant force which is applied to the rim of the pulley to exert a uniformly increasing pull upon the chain which reaches its maximum at a time when the piston in the firing cylinder is at the top of the compression stroke. After the highest point of compression has been reached in the cylinder the cam causes the point of application of the pull to recede from the axis of the pulley, lengthening the moment arm and increasing the speed of rotation of the crank shaft during the last portion of the turn and just prior to firing the charge which occurs with a retarded spark on the downward stroke of the piston.

The starting shaft 7 is connected to the crank shaft 9 of the motor by a one direction clutch mechanism which actuates the crank shaft when the shaft 7 is turned in the proper direction to start the motor and which is released automatically when the crank shaft is rotated in the same direction by the motor. As stated previously, the shaft 7 has a sleeve 14 secured thereon and this sleeve is provided with a ratchet 25 which forms the driving member of the clutch. In this type of motor, a fan pulley 31 is secured to the end of the crank shaft 9 and this fan pulley constitutes the driven

member of the clutch and is conveniently utilized to carry a series of pawls 32. These pawls 32 are loosely journaled upon transverse pins 33 secured in the fan pulley adjacent its periphery and are normally held in yielding engagement with the ratchet 25 by a plurality of springs 35, each spring having one end passed through a hole in the pin 33 and having its opposite free end bearing upon the adjacent pawl 32. Each pawl 32 is slotted transversely where it is journaled upon the pin 33 and the end of the spring 35 which is fastened to the pin is received in the slot. Thus the springs serve the double function of pressing one pawl into engagement with the ratchet wheel and retaining the adjacent pawl upon its supporting pin 33. The illustrated embodiment of the invention is applied to a four cylinder motor and the one direction clutch is provided with four pawls and an equal number of coöperating recesses formed in the ratchet 25, the recesses being positioned in such a manner that whenever the starting device is actuated the highest point of compression will come at a time when the chain 11 is positioned at the proper point upon the cam 20. This portion of the operation will be clearly understood when it is explained that the ratchet 25 is always returned to the same initial position by the spring 26 and that the crank shaft 9 and pawls 32 carried thereby always stop in approximately the same relation to the ratchet. If by any chance the pawls 32 should not engage at the proper time with the coöperating recesses in the ratchet, the starting device will serve simply upon its first actuation to bring the parts into their proper relative position and the next actuation of the starting device after the crank shaft is positioned properly will turn the motor over until the charge is fired, the highest point of compression coming at the proper time automatically.

In order to prevent a back kick of the engine being communicated to the starting device, mechanism is provided for automatically disconnecting the starting device from the crank shaft if the normal direction of rotation of the motor is reversed. The cam plate 36 is loosely journaled upon the hub of the ratchet 25 and is rigidly secured to a cup-shaped ring 37 by a plurality of rivets 38. The ring 37 is yieldingly connected to the ratchet 25 by a spring 40 received in an annular slot formed in the ring and having its free end engaging with the key 41 secured in the sleeve 14 and projecting into a recessed portion of the slot. The cam plate 36 is rectangular in form having straight faces and beveled or rounded corners which are arranged to engage with a laterally extending shoulder 42 formed upon each of the pawls 32. The initial position of the starting device is determined by a pawl 45 pivotally mounted upon a fixed shaft 46 and held in engagement with a ratchet tooth 48 formed in the periphery of the ring 37 by a spring 47. When a charge in one of the cylinders is fired prematurely or before the piston has reached the top of the compression stroke, the motor is rotated in the wrong direction, causing a rotation of the ring 37 counter to the direction of the arrow, Fig. 4, until the pawl 45 engages with the ratchet tooth 48, when further movement of the ring in this direction is prevented. The continuing rotation of the crank shaft then causes a relative movement of the ratchet 25 and cam 36, forcing the pawls 32 out of engagement with the coöperating ratchet teeth and causing the cam and ratchet to assume the relative position shown in Fig. 10. Thus with the present construction, the starting device is automatically disconnected from the crank shaft when the direction of rotation of the latter is reversed without breaking or otherwise injuring the starting device.

Although at the normal speed of rotation of the crank shaft the pawls are held out of engagement with the periphery of the ratchet owing to the action of centrifugal force, yet at a low speed this force may not be sufficient to retain the pawls entirely out of engagement. To this end the ratchet 25 and cam 36 are normally positioned so that a substantially unbroken cylindrical surface is presented to the pawls when the starting device is in its normal position. It will be noted that when the starting handle 6 is released, the spring 26 rotates the pulley 10 and sleeve 14 counter to the direction of the arrow, Fig. 2, and through the spring 40 the member 37 is rotated in a like direction. When the pawl 45 engages with the coöperating tooth 48, rotation of the member 37 and cam 36 is stopped and as the spring 26 is of greater strength than the spring 40, the rotation of the sleeve 14 continues until the end of the spring 40 engages with the side of the recessed portion of the slot opposite to that shown in Fig. 4, in which position the parts are normally retained. This position of the member 37 and ratchet 25 is that shown in Fig. 10, in which the beveled corners of the cam 36 are positioned opposite each of the recesses in the driving ratchet 25 to hold the pawls 32 out of engagement therewith. If the crank shaft is now rotated at a low speed so that the pawls are not held entirely out of engagement with the driving ratchet, the shoulders 42 will engage with the rounded corners of the cam and ride thereover, and before the shoulders have become disengaged from the cam the faces of the pawls engage with the periphery of the ratchet 25 between the recesses, thus causing the pawls to ride upon a substan-

tially unbroken cylindrical surface without clicking or other noise which would result from the dragging of the pawls over the ratchet teeth.

The operation of the improved starting device is as follows: The operator first grasps the handle 6 and then with a constant pull moves the handle toward him in a linear direction. The movement of the handle serves initially to turn the sleeve 14 and ratchet 25 without turning the cam 36, thus bringing the parts into the position shown in Fig. 4, after which a further movement of the handle turns the sleeve 14, ratchet 25 and cam 36 as one. This force is multiplied through the idler pulley 12 and exerts a turning torque upon the crank shaft through the drive pulley 10 and one direction clutch, connecting the drive pulley with the crank shaft, this turning torque constantly increasing as the pull upon the handle continues, until the highest point of compression is reached, when the explosion occurs, after which the torque decreases and the speed of rotation of the crank shaft increases until the charge is fired. When the explosion occurs, the crank shaft rotates in the same direction at a much higher speed and the pawls 32 are automatically thrown out of engagement with the ratchet owing to the action of centrifugal force, the springs 35 being only of sufficient strength to press the pawls inwardly when the parts are at rest or rotating at a low speed. With this construction, after the motor is started, the pawls are held entirely out of engagement with the ratchet, avoiding the ensuing noise and wear which would result if the pawls were caused to drag over the teeth of the ratchet. If the charge is fired prematurely when starting and the motor is caused to rotate in the opposite direction, the ring 37 is locked and the pawls are forced out by the cam 36, disengaging the starting device from the crank shaft.

While it is preferred to employ the specific construction and arrangement of parts shown and described, it will be understood that this construction and arrangement is not essential except so far as specified in the claims, and may be changed or modified without departing from the broader features of the invention.

The invention having been described, what is claimed is:—

1. A starting device for internal combustion motors having, in combination, a manually operated control, a one direction clutch adapted to be connected to the crank shaft of the motor, an idler pulley, connections between the rim of the pulley and the control, a cam, and connections between the cam and clutch whereby the constant force applied to the control is multiplied and an increasing torque is exerted upon the crank shaft.

2. A starting device for internal combustion motors having, in combination, a starting handle, a one direction clutch adapted to be connected to the crank shaft of the motor, a cam, a flexible connection between the cam and clutch, and connections between the cam and starting handle to rotate the cam as the starting handle is actuated and wind the flexible connection about the periphery of the cam.

3. A starting device for internal combustion motors comprising a driving ratchet, a plurality of pawls coöperating therewith, a cam engaging with the pawls and freely movable in the normal direction of rotation of the ratchet, and means for securing a relative rotation of the cam and driving ratchet when the ratchet is turned reversely to its normal direction of rotation to cause the cam to remove the pawls from engagement with the ratchet.

4. A starting device for internal combustion motors comprising a driving ratchet, a pawl engaging therewith, a cam plate engaging with the pawl and arranged to disengage the pawl from the ratchet when moved relative to the ratchet, means for yieldingly connecting the cam plate to the ratchet, and means for locking the cam plate against movement when the ratchet is rotated in one direction.

5. A starting device for internal combustion motors comprising a handle which is conveniently accessible to the operator, a starting shaft, a one direction clutch adapted to connect the starting shaft and crank shaft of the motor, a drive pulley mounted upon the starting shaft, an idler pulley, a cam secured to the hub of the idler pulley, a flexible connection between the periphery of the drive pulley and the periphery of the cam and a connection between the handle and the rim of the idler pulley.

6. A starting device for internal combustion motors comprising a driving ratchet, a plurality of pawls coöperating therewith, a cam supported adjacent to the driving ratchet and normally coöperating with the driving ratchet to present a substantially unbroken cylindrical surface to the pawls when the engine is rotating, and means for securing a relative movement of the cam and driving ratchet to allow the pawls to enter the recesses in the ratchet.

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