Oct. 20, 1931. W. A. CHRYST 1,828,359

ENGINE STARTING APPARATUS

Original Filed March 21, 1929

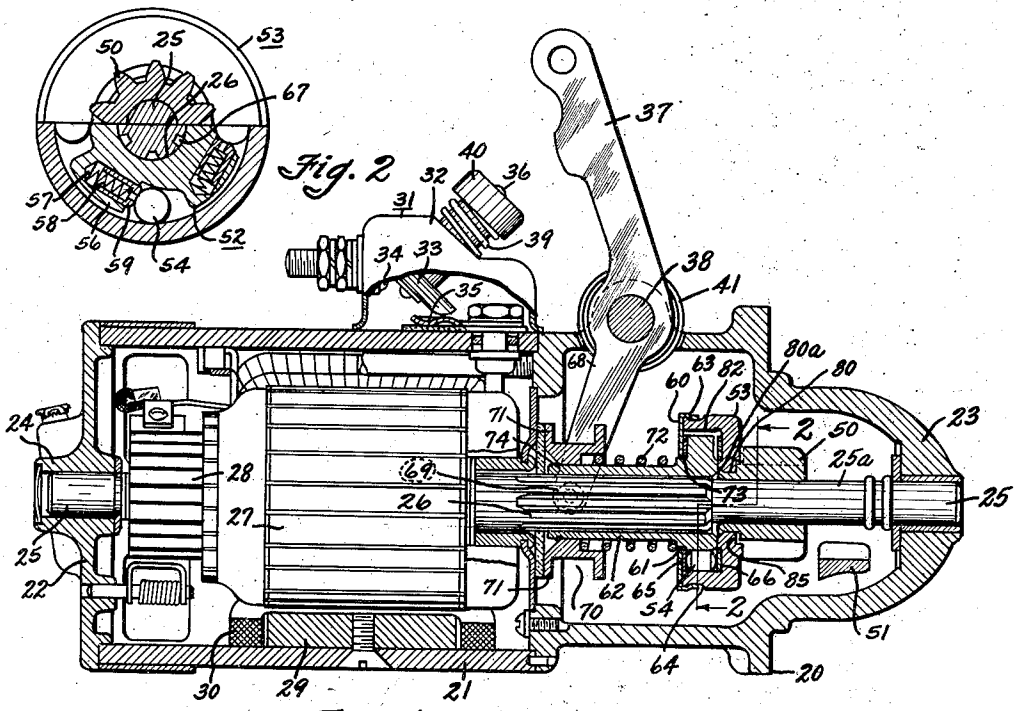



Fig. 1

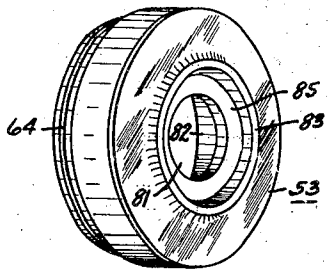



Fig. 3

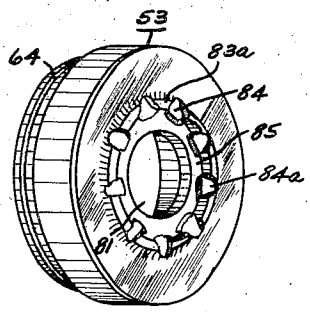



Fig. 4

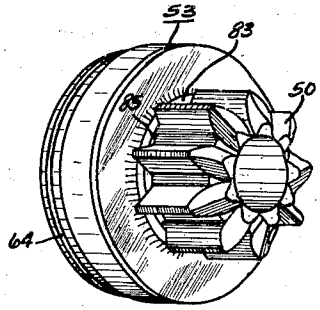



Fig. 5

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# UNITED STATES PATENT OFFICE

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## ENGINE STARTING APPARATUS

Original application filed March 21, 1929, Serial No. 348,969. Divided and this application filed January 2, 1930. Serial No. 418,039.

This invention relates to engine starting apparatus and particularly to the type of apparatus which comprises a motor, a pinion driven by the motor and movable axially into mesh with a gear of an engine to be started, and an overrunning clutch for drivingly connecting the motor with the pinion and for permitting the pinion to overrun the motor while the pinion remains in mesh with the engine gear after the engine becomes self operative.

In certain engine starters which have been in use, the overrunning clutch comprises a clutch cam or driving member which rotates within a clutch shell or driven member and cooperates with balls or rollers, which, while the motor is driving the pinion, are wedged by the cam against the inner cylindrical surface of the clutch shell. The cam is preferably splined to the motor shaft and the shell drivingly connected with the pinion by making the shell integral with the pinion. Means are provided for preventing withdrawal of the cam axially from the shell so that when the clutch is moved axially in either direction, the pinion will move with it.

It has been stated that it has been the practice heretofore to make the clutch shell and pinion in one piece, but the present invention contemplates manufacturing the pinion and clutch shell assembly in two pieces, since it has been discovered that the manufacture of this part of the starting apparatus can be carried on more economically and, that a better and more uniform product is insured by first manufacturing the pinion and clutch shell separately.

This application is a division of my Patent 1,761,518 issued June 3, 1930.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of one form of the present invention is clearly shown.

In the drawings:

Fig. 1 is a longitudinal sectional view of engine starting apparatus embodying the present invention.

Fig. 2 is a sectional view on line 2—2 of Fig. 1.

Figs. 3 and 4 are perspective views of the clutch shell in two stages of manufacture.

Fig. 5 is a perspective view of the clutch shell and pinion assembly.

Referring to Figs. 1 and 2, 20 designates a supporting frame and gear housing by which the apparatus is mounted upon the frame of the engine, which is not shown. The frame 20 supports the motor field frame 21 which in turn supports an end frame 22. The frames 20 and 22 provide bearings 23 and 24 for the motor armature shaft 25, which is provided with longitudinal splines 26. The armature shaft 25 supports an armature core 27 carrying windings connected with a commutator 28, and the core rotates between pole pieces 29 surrounded by field windings 30. The motor circuit is controlled by switch 31, housed by a case 32, mounted on the frame 21. The case 32 supports a movable switch contact 33 engageable with a stationary contact 34 carried by the case 32 and a stationary contact 35 insulatingly supported by the frame 21. The movable contact 33 is operated by a rod 36 located in the path of movement of a lever 37 pivoted upon a stub shaft 38 supported by the frame 20. The switch is normally maintained open by a spring 39 located between the case 32 and the cap 40 attached to the rod 36. The lever 37 is normally maintained in the position shown in Fig. 1 by a helical coil spring 41. The shaft 25 includes a smooth portion of reduced diameter 25*a* along which a motor pinion 50 is slidable into mesh with an engine gear 51. The pinion 50 is connected with the motor shaft 25 by a one-way or overrunning clutch 49, which comprises a clutch cam or driving member 52, a clutch shell or driven member 53, and rollers 54, each located in a notch 55 provided by the cam 52. Each arm 56 of the cam 52 provides a recess 57 for receiving a spring 58 and a plunger 59 urged by the spring 58 against a roller 54. The clutch shell 53 and the clutch cam 52 are maintained in assembled relation by a circular plate 60, having a central opening 61 through which the hub 62

of the clutch cam 52 extends and having a flange 63 which is spun into a knurled groove 64 of the shell 53. 65 is a washer located between the ends of rollers 54 and plate 60, and 66 is a washer located between the ends of rollers 54 and the inside wall of the clutch shell 53. The hub 62 of the cam 52 is internally broached to provide internal splines 67 cooperating with the shaft splines 26. The lever 37 is provided with a bifurcated extension 68 carrying studs 69 received by groove 70 in a collar 71 which is slidable along the hub 62 of the cam 52. A compression spring 72 is located between the collar 71 and a shoulder 73, provided by the cam 52, and is normally maintained in a state of compression. Removal of the collar 71 from the hub 62 is prevented by a wire split ring 74 received by a suitable annular groove in the hub 62. By a method and construction to be described, the shell 63 is drivingly connected with the pinion 50.

The engine is started by moving the lever 37 counter-clockwise in order to move the pinion into mesh with the engine gear 51, and to close the motor switch 31. In case of gear tooth abutment prior to meshing the pinion with the engine gear, the spring 72 will yield to permit closing the motor switch whereupon the motor shaft will rotate in order to turn the pinion 50 into meshing registration with the engine gear 51. When this occurs the pinion 50 will be moved quickly into mesh with the gear 51 due to the sudden release of the compressed spring 72.

In the present disclosure the clutch 49 is constructed so that the pinion 50 will be rotated by the motor when the shaft 25 turns in a clockwise direction, as viewed in Fig. 2. When the engine becomes self operative, the pinion 50 will be driven in the same direction but at a speed greater than the speed of the shaft 25, hence the shell 53 will overrun the cam 52.

The clutch shell, cam and pinion members are constructed preferably of high grade nickle steel alloy manufactured in an electric furnace. The pinion 50 is manufactured separate from the shell and includes a tubular extension 80. Before the pinion is carbonized, the surfaces of the extension 80 and a portion of the pinion teeth about $\frac{1}{16}$ of an inch from extension 80 are copper-plated to prevent the penetration of carbon into the steel material of the pinion. The pinions are packed with carbonizing material such as bone charcoal in a carbonizing box and are heated for four hours at from 1675° to 1725° F. The pinions are permitted to cool while remaining packed with the carbonizing material in the carbonizing boxes after the lids of the boxes have been removed.

The clutch shell 53 is provided with a central opening 81, concentric with its inner cylindrical surface 82, and with an annular boss 83, concentric with the opening 81. The shell 53 is placed between coining dies which deform portions of the boss 83 so as to provide interrupted boss portions 83*a* separated by recesses or depressions 84. The depressions 84 are shaped and spaced so as to each receive an end portion of a tooth 50*a* of the pinion 50, as shown particularly in Fig. 5. The shell 53 is provided with a counter-bored portion 85, which receives the material 84*a* which has been deformed from the boss 83 to provide the gear-tooth receiving recess 84. After making the shell in the manner described, it is carburized for about 5½ hours at 1700° F., following the method used in carburizing the pinion. After the shell is cooled, it is secured to the pinion by passing the pinion tubular extension 80 through the opening 81, fitting the ends of the pinion teeth into the recesses 84 and then riveting over the pinion extension as at 80*a* against the inside wall of the shell 53. The next step is to heat treat the pinion and shell assembly in order to harden the wearing surfaces thereof. This is done preferably by immersing the pinion and shell assembly in a bath of molten potassium cyanide for 30 minutes, the bath being approximately at 1350 to 1375 degrees F. After heating the assembly it is quenched in oil, and the pinion is re-riveted to the shell to overcome any looseness between the tubular extension 80 and the shell which may have taken place by reason of heat treatment.

The heat treatment provides a clutch shell wearing surface 82 which is harder than the wearing surface of the pinion teeth 50*a*, due to the fact that a greater amount of carbon has penetrated the clutch shell than the pinion teeth as a result of the greater carburizing time and temperature of the clutch shell. It is desirable that the clutch shell be harder than the pinion teeth, since this surface is subjected to the action of the hardened steel rollers 54, whereas the pinion cooperates with the relatively soft metal flywheel gear 51. On the other hand, the pinion teeth are heat treated so that they will be relatively strong and tough to withstand strains incident to driving the gear 51. The tubular extension 80, which functions as a rivet for attaching the pinion to the shell, remains soft during the heat treatment so that it may be easily swedged without breaking. Those portions of the pinion teeth which are received by the recesses 84 provided by the shell 53 also remain soft during the heat treatment and hence, provide relatively strong members for transmitting torque from the clutch shell to the portions of the pinion teeth which engage the flywheel gear.

From the aforegoing description of the construction and method of assembling and heat treating the pinion and clutch shell assembly, it is apparent that certain advan-

tages result from making the pinion and clutch shell separately, and afterwards, joining them together. In the first place, there is a saving of material since the pinion may be made of a round bar of stock considerably less in diameter than a round bar required for making the clutch shell. Since it is desirable to have the clutch shell provided with a harder wearing surface than the pinion, the heat treatment can be readily carried out by carburizing the clutch shell separate from the carburizing of the pinion. If these members were integral, it would be difficult to carborize the wearing surfaces of the clutch shell to a greater degree than the wearing surfaces of the pinion, but by making the shell and pinion in separate pieces, these pieces may be carburized separately, one to a greater extent than the other. As explained before, the heat treatment of the assembly produces greater hardness of the shell than of the pinion. Where the pinion and shell have been first made integral, it has been the practice to harden all portions of the piece to the same degree, therefore, the pinion teeth would be rendered more hard than necessary for durability and would at the same time be rendered more brittle, and hence, more apt to break. To overcome this, it was necessary to add more material to the pinion in order to obtain the required strength. Since the manufacture of the pinion separate from the shell permits giving the pinion a heat treatment differing from the heat treatment of the shell, it is possible to give the pinion the proper heat treatment required for hardness and strength, hence it is possible to make the pinion of the minimum amount of material. The reduction in the amount of material is not only desirable, but also the reduction in the weight of the pinion so as to reduce the amount of mass to be moved by the spring 72 when "jumping" the pinion into mesh with the engine gear after the switch 32 has been closed. It is obvious that the less mass the spring 72 has to move, the more rapid will be its action in moving the pinion into mesh with the engine gear after the motor starts, hence the less damage to the entering portions of the pinion and gear teeth when this occurs. Since each part of the pinion and clutch shell assembly may receive its own individual carburizing treatment, it is possible to manufacture the clutch shell also with the minimum amount of material, resulting in reduction in cost and the amount of mass to be moved by the spring 72.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. An engine starter drive comprising a drive shaft, a pinion slidable along said shaft into mesh with a gear connected with an engine to be started, and a one way roller clutch slidable along the shaft and comprising a cam member splined to the shaft and a shell member attached to the pinion, the shell member having depressions each receiving a portion of a pinion tooth whereby the shell member and pinion are drivingly connected, and means for securing the pinion axially to the shell.

2. An engine starter drive comprising a drive shaft, a pinion slidable along said shaft and into mesh with a gear connected with an engine to be started, and a one way roller clutch slidable along the shaft and comprising a cam member splined to the shaft and a shell member attached to the pinion, the shell member having a central opening and an annular boss concentric with the opening and facing the pinion and having depressions therein each receiving a portion of a pinion tooth, and the pinion having a tubular extension extending through the central opening in the shell and riveted over on the inside of the shell.

In testimony whereof I hereto affix my signature.

WILLIAM A. CHRYST.