July 15, 1941. R. M. NARDONE 2,249,393

ENGINE STARTER

Original Filed June 11, 1937 3 Sheets-Sheet 1

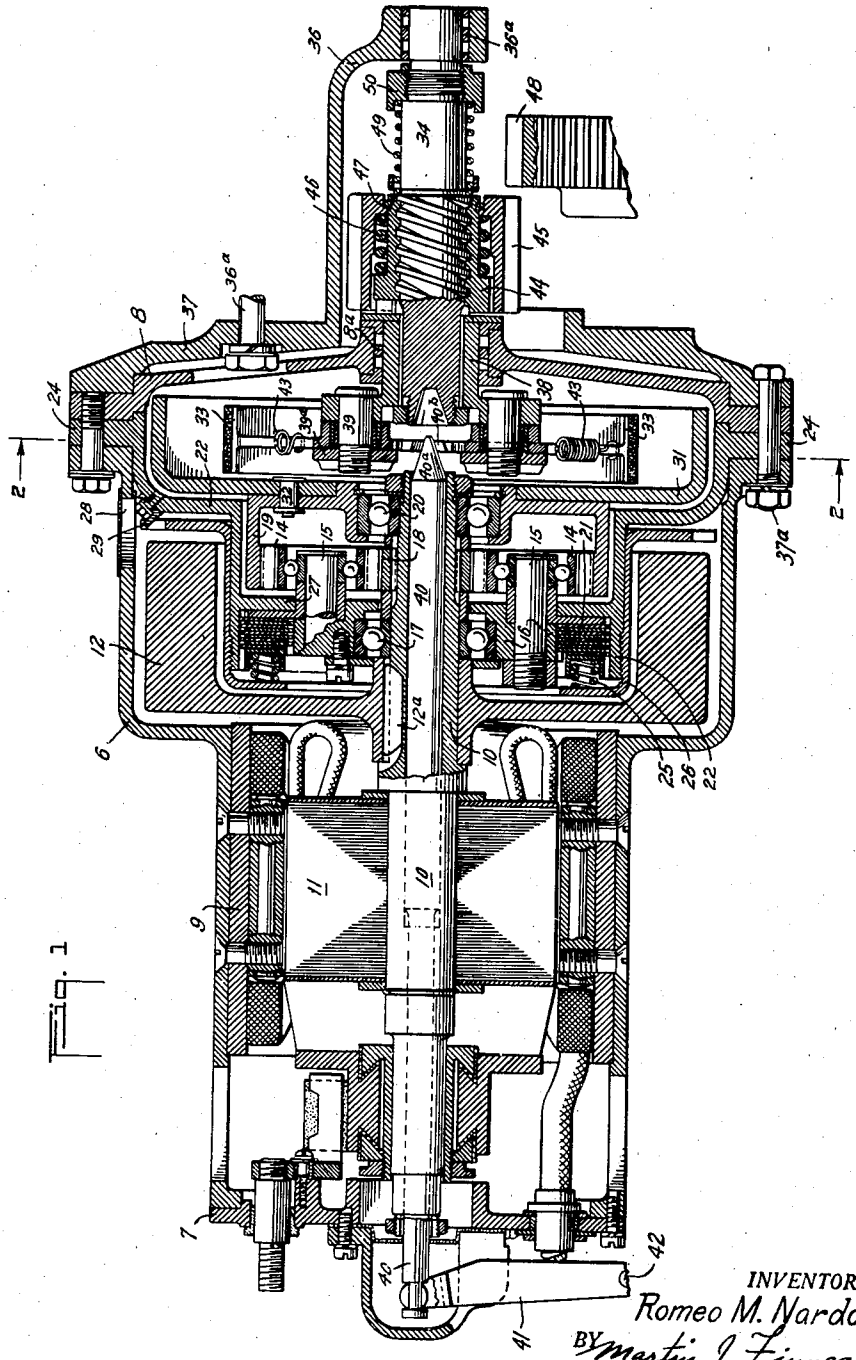

Fig. 1

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Fig. 2

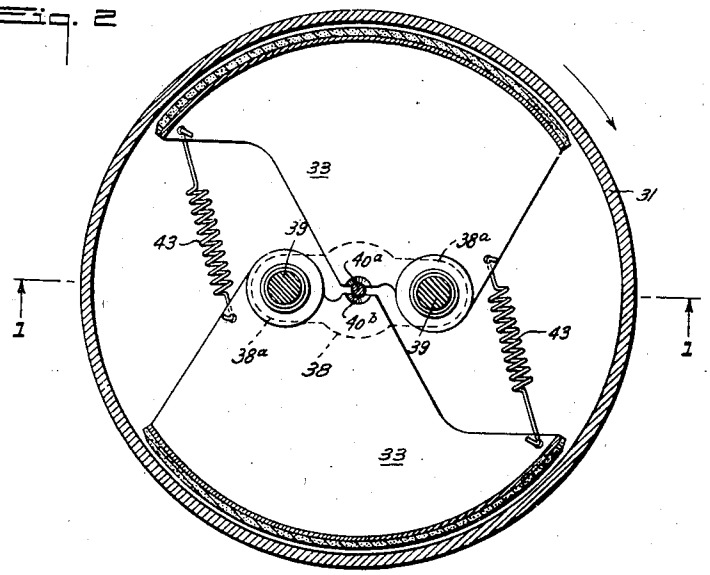

Fig. 3

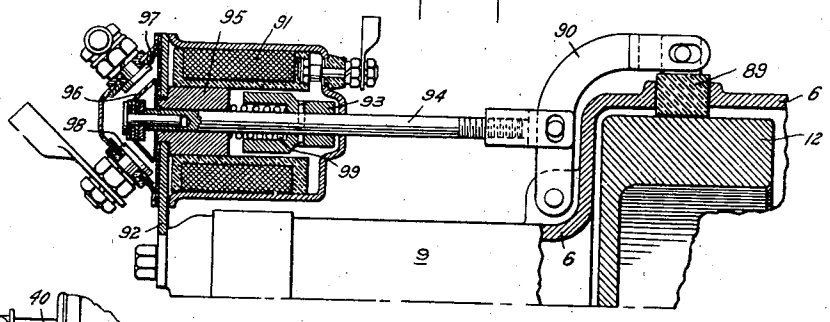

Fig. 4

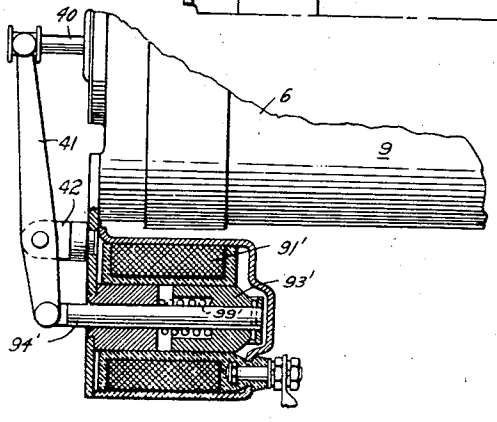

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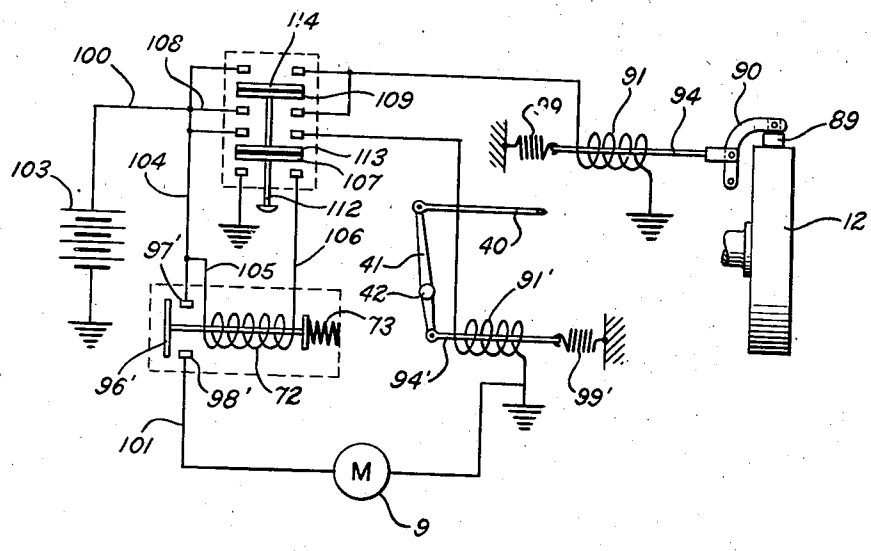
Fig. 5



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2,249,393

ENGINE STARTER

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Original application June 11, 1937, Serial No. 147,768. Divided and this application November 21, 1939, Serial No. 305,543

6 Claims. (Cl. 123—179)

This invention relates to starters for internal combustion engines, and more particularly to starters of the electric inertia type.

This application is a division of my application No. 147,768 filed June 11, 1937.

One of the objects of the present invention is to provide a novel engine starter which is particularly adapted for use in cranking large high-compression engines such as are in present use on high-powered trucks and buses.

Another object is to provide an engine starter employing novel means for transmitting the energy stored in a high speed flywheel to a member of an engine to be started.

Another object is to provide a novel method of operation of an engine starter of the type including a flywheel, which novel method involves the concept of nullifying, or at least reducing, the "drift" tendency of the engine engaging member by applying a retarding force to the flywheel and thereby consuming the unexpended portion of the energy previously stored therein.

A further object is to provide a novel driving unit for drivably connecting an engine starter to a member of an engine to be started.

Other objects include the provision of novel means for interrupting or preventing the transmission of torque during the energy storing interval, and novel means for quickly stopping the high speed flywheel after the engine has been started.

The above and further objects and novel features of this invention will more fully appear from the following detailed description when taken in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not designed as a definition of the limits of the invention, reference being had primarily for this purpose to the appended claims.

In the drawings wherein like reference characters refer to like parts throughout the several views:

Fig. 1 is a longitudinal section of a starter embodying the present invention;

Fig. 2 is a transverse sectional view taken substantially on line 2—2 of Fig. 1;

Fig. 3 is a view of the brake and brake applying solenoid;

Fig. 4 is a view of the friction clutch actuating solenoid; and

Fig. 5 is a diagrammatic view of the electrical control of the driving motor and the solenoids just referred to.

The embodiment of the invention illustrated in Figs. 1 and 2 comprises a housing 6 having a pair of end cover plates 7 and 8. An electric motor 9 is mounted in the outer end of housing 6 and is provided with a hollow shaft 10 upon which are mounted the motor armature 11 and an inertia flywheel 12, the latter being drivably connected thereto by any suitable means such as a key 12a.

In order to reduce the overall length of the starter, reduction gearing and overload resisting means for such gearing are mounted within the overhanging rim of flywheel 12. As shown, the reduction gearing is constituted by a plurality of planetary gear members 14, preferably three, spaced at 120 degree intervals, rotatably mounted on stub shafts 15 that are supported by a ring 16 which is rotatably mounted on shaft 10 by means such as a ball bearing 17. Gears 14 mesh with a pinion 18 splined to shaft 10, and with an internal gear 19 which is rotatably mounted on the inner end of shaft 10 by means such as ball bearing 20.

Preferably, overload releasing means in the form of a friction disc clutch are provided to protect the above gearing and other elements of the starter from damage due to sudden shocks and overloads imparted thereto. As shown, this clutch comprises a plurality of friction discs 21, one-half of which are splined to the outer periphery of ring 16 and alternate with the other half of said discs which are splined to the inner periphery of cylindrical member 22 that is held in operative position by means of an outwardly extending flange 24 secured as by means of bolts between housing 6 and cover plate 8.

The discs 21 are positioned between an internal flange 27 on member 22 and an annular series of coil springs 25 which bear at their outer ends against the bottom of a flanged cup-shaped adjusting member 26 threaded onto the cylindrical portion of member 22, thereby the slippage load of the clutch discs 21 may be adjusted. For adjusting cylinder 26 and hence the tension of springs 25, said cylinder is provided on its inner end with a notched flange accessible through a hand hole 28 in housing 6. A clip 29 removably secured to cylinder 22 is provided for engagement with a suitable notch in the flange of member 26 whereby the latter may be locked in adjusted position.

In cranking engines of the character referred to above, it is desirable to establish the engagement of the starter with the flywheel gear of the engine. If such a drive be permanently connect-

ed to the reduction gearing and flywheel, the engagement with the engine flywheel gear would be automatically effected as soon as the motor is energized and before sufficient energy was stored in flywheel 12 to overcome the inertia of the parts of the engine to be started.

Means are provided for interrupting the transmission of torque from the reduction gearing to the driving unit until flywheel 12 has been brought up to speed. In the form shown, such means are constituted by a self-energizing friction clutch comprising a drum 31 fixed to internal gear 19 by means of bolts or rivets 32 and adapted to be frictionally engaged on its inner periphery by a pair of arcuate shoes 33 (Fig. 2).

The friction shoes 33 are drivably connected to a shaft 34 which is rotatably supported at its outer end by a bearing 8a mounted centrally of cover plate 8 and at its inner end by a bearing 36a mounted in a bracket 36 formed integral with a supporting spider 37. The latter is adapted to be attached to the crankcase of an engine as by bolts 36b and the starter is in turn secured to the spider as by means of bolts 37a. As illustrated, shoes 33 are mounted on a sleeve 38 splined, or otherwise drivably connected, to a shaft 34 in the plane of bearing 8a. Sleeve 38 is provided with a pair of laterally extending, diametrically disposed ears 38a which carry bolts 39 on which shoes 33 are pivotally mounted and retained as by means of nuts 39a. The pivots of shoes 33 are thus offset from the center of rotation of drum 31.

Novel means are provided for moving shoes 33 into engagement with drum 31 and such means, as illustrated, comprise a rod 40 slidably mounted within hollow armature shaft 10. Said rod is adapted to be actuated by a lever 41 which operatively engages the outer end thereof and is pivoted on a bracket 42 suitably attached to cover plate 7. The inner end of rod 40 has a conical portion 40a adapted to engage beveled portions 40b of the webs of shoes 33 at a point midway between pivots 39 and is effective, when moved to the right as viewed in Fig. 1, to impart to said shoes a camming action whereby the latter are moved into engagement with drum 31. Suitable springs 43 are attached to a portion of the web near the pivot of each shoe and to the free end of the other shoe thereby tending to hold said shoes out of engagement with drum 31. It will be noted that the above-described clutch is of the self-energizing type and during clockwise rotation of drum 31 and after shoes 33 have been moved by means of rod 40 into engagement with the drum, the latter tends to move shoes 33 into closer frictional relationship.

A novel drive unit is provided for automatically connecting the mechanism described above to a member of an engine on which said starter is mounted and, as shown, such unit consists of an internally threaded sleeve 44 adapted to be mounted on a threaded portion of shaft 34 for rotary and longitudinal movement thereon. Splined to sleeve 44 for longitudinal movement relative thereto and rotary movement therewith is a pinion 45. For yieldingly resisting relative longitudinal movement between said sleeve and pinion, a coil spring 46 is interposed between an outwardly extending shoulder on the former and an inwardly extending shoulder on the latter. A split ring 47 is received within a peripheral groove in sleeve 44 for engagement with a suitable shoulder on the pinion to limit the relative longitudinal movement of said pinion to the right. When shaft 34 is rotated, sleeve 44 and pinion 45 resist rotation, due to their inertia, and are thereby caused to move longitudinally to the right on shaft 34, and into driving engagement with the engine flywheel gear 48. To prevent movement of sleeve 44 and pinion 45 along shaft 34 into engagement with gear 48 when the starter is not in use, a light anti-drift spring 49 is interposed between said sleeve and a stop nut 50 secured to shaft 34 adjacent the outer bearing 36a therefor.

As a supplement to the anti-drift spring 49 I provide an energy dissipating means for positively eliminating the condition which tends to reduce the objectional "drift" of the pinion 45 toward a re-meshing position, after it has once been retracted by the over-running action hereinafter referred to. As shown in Fig. 3, this energy dissipating means comprises a brake shoe 89 adapted to frictionally engage the periphery of flywheel 12 or 12a through a suitable opening in housing 6. The outer end of shoe 89 is operatively attached to the forked end of a right angle lever 90 pivoted at its lower end to housing 6.

Electro-magnetic means are preferably provided for rocking lever 90 about its pivot, whereby shoe 89 may be lifted out of engagement with flywheel 12 or 12a. A magnet 91 is shown mounted on housing 6 by means of bracket 92 and is provided with a plunger or core 93. The latter is fastened to, and adapted to actuate, a rod 94 which is suitably attached at one end to lever 90 for operating brake shoe 89. Coil 91 is also provided with a stationary soft iron core 95 which extends substantially one-half the length of the coil and is effective to attract plunger 93 when said coil is energized. The other end of rod 94 slidably extends through core 95 and may have mounted thereon a contact arm 96 adapted to bridge a pair of contacts 97, 98 for closing a circuit to motor 9 or 9a; but the preferred method is to employ a separate solenoid, as shown at 72 in Fig. 5, to control closure of the motor circuit, as will be more fully described.

Electromagnetic means are also provided for effecting the driving engagement of the members of the self-energizing clutch shown in Fig. 2. One form of such means is shown in Fig. 4 and comprises an electromagnetic unit substantially the same as those described above for actuating the brake shoe 89 and the motor control switch 96'. Lever 41, above referred to, connects at its lower end with a plunger 94' of a solenoid 91'. Thus, when coil 91' is energized, plunger 94', attached to core 93', moves to the left to swing lever 41 in a clockwise direction, thereby moving rod 40 to the right. The movement of the latter to the right is effective, as explained above, to complete the line of torque transmission from the starter motor and flywheel to the driving unit 44, 45.

As shown best in Fig. 5, a common electrical control is provided for all four electromagnetic units—motor 9, coil 72, coil 91 and coil 91'. A cycle of operation is as follows: Beginning with the parts in their normal positions as shown in Figs. 1 and 5, the common control switch 112 is moved downwardly from the neutral position shown in Fig. 5 whereupon two conditions are brought about. First, there is an energization of solenoid 72 by current taken from the battery 103 by way of conductors 100, 104 and 105, the return circuit being by way of conductors 106

and contact plate 107 of the control switch 112. The resulting bridging of contacts 97' establishes a circuit to energize the motor 9 by current drawn from the same source 103, as shown.

Simultaneously with this action, there is the closure of a circuit to the brake releasing solenoid 91 by way of conductors 100 and 108 and the conducting plate 109 of the control switch 112, the plates 109 and 107 moving in unison to the circuit closing positions. The brake 89 being thus released, and the motor 9 being energized, shaft 10 and flywheel 12 are rotated.

When sufficient energy has been built up in flywheel 12, the control switch 112 is shifted to its upper position, thereby bringing conducting plate 113 into position to close a circuit to the solenoid 91' while at the same time bringing conducting plate 114 into position to maintain the brake releasing solenoid 91 energized. Energization of solenoid 91' causes the lower end of lever 41 to be moved to the left, thus moving rod 40 to the right and shoes 33 radially into driving engagement with drum 31 whereby shaft 34 is rotated. Upon the initial rotation of shaft 34, the inertia of driving unit 44, 45 causes said unit to move longitudinally on shaft 34, compressing spring 49, whereby pinion 45 meshes with flywheel gear 48 and engages stop nut 50. The driving unit now rotates with shaft 34 and the engine is cranked.

When the engine starts, flywheel gear 48 will drive pinion 45 and this overrunning action will return the driving unit to the demeshed position shown in Fig. 1. Thereupon the operator allows switch 112 to return to the neutral position indicated in Fig. 5, thereby deenergizing the solenoid 91 and permitting the brake shoe 89 to take hold upon the flywheel 12 under the urge of spring 99. The resultant stoppage of the flywheel and the gears and other parts rotated thereby, including the screw shaft 34, eliminates any tendency which the thread of the screw shaft might otherwise have to induce a re-drift of the pinion 45 into objectionable contact with the now rapidly rotating teeth of the gear 48. Thus the application of the brake 89 serves as a supplement to the spring 49 in reducing any such re-drifting tendency on the part of the pinion 45.

The self-energizing clutch 33, 34 tends to form a positive driving connection between the flywheel and the pinion 45, but the various elements of the starter are protected from overload by the preset clutch 21, 22, 26, which may be accurately adjusted to transmit a desired amount of torque.

What I claim is:

1. In a device of the character described, in combination, a driving drum, a driven shaft, said driven shaft having a flange located within said driving drum, means including friction shoes pivotally mounted on said flange for radial movement into engagement with the inner surface of said drum, electromagnetic means for producing radial movement of said shoes into engagement with said drum, means for producing rotation of said drum independently of energization of said shoe moving means, said last named means including an electric motor, and means for producing successive feeding of current to said motor and said electromagnetic means.

2. In a device of the character described, in combination, a driving drum, a driven member, means including friction shoes pivotally mounted on said driven member for radial movement into engagement with said drum, electromagnetic means for producing radial movement of said shoes into engagement with said drum, means for producing rotation of said drum independently of energization of said shoe moving means, said last named means including an electric motor, and means for producing successive feeding of current to said motor and said electromagnetic means.

3. In an electric starter wherein a flywheel is energizable by acceleration thereof to a relatively high speed and wherein the energy of said flywheel is adapted to be transmitted through an engine engaging member to a member of an engine to be started, the combination with said engine engaging member and flywheel of means for engaging and disengaging said engine engaging member, said means tending to produce a re-drift of said member into the engine engaging position, braking means engageable with said flywheel to reduce said re-drift tendency, electromagnetic means for holding said braking means out of contact with said flywheel during acceleration of the flywheel and application of cranking energy to said engine member, an electric motor for accelerating said flywheel, a clutch interposed between said flywheel and engine engaging member, electromagnetic means for controlling said motor, electromagnetic means for controlling said clutch, and a common control for all three electromagnetic means above recited.

4. In an electric starter wherein a flywheel is energizable by acceleration thereof to a relatively high speed and wherein the energy of said flywheel is adapted to be transmitted through an engine engaging member to a member of an engine to be started, the combination with said engine engaging member and flywheel of means for engaging and disengaging said engine engaging member, said means tending to produce a re-drift of said member into the engine engaging position, means to reduce said re-drift tendency, electromagnetic means for preventing operation of said last named means during acceleration of the flywheel and application of cranking energy to said engine member, an electric motor for accelerating said flywheel, a clutch interposed between said flywheel and engine engaging member, electromagnetic means for controlling said motor, electromagnetic means for controlling said clutch, and a common control for all three electromagnetic means above recited.

5. In an electric starter wherein a flywheel is energizable by acceleration thereof to a relatively high speed and wherein the energy of said flywheel is adapted to be transmitted through an engine engaging member to a member of an engine to be started, the combination with said engine engaging member and flywheel of means for engaging and disengaging said engine engaging member, said means tending to produce a re-drift of said member into the engine engaging position, braking means engageable with said flywheel to reduce said re-drift tendency, means for accelerating said flywheel, and electromagnetic means for holding said braking means out of contact with said flywheel during operation of said accelerating means.

6. In an electric starter wherein a flywheel is energizable by acceleration thereof to a relatively high speed and wherein the energy of said flywheel is adapted to be transmitted through an engine engaging member to a member of an engine to be started, the combination with said engine engaging member and flywheel of means

for engaging and disengaging said engine engaging member, said means tending to produce a re-drift of said member into the engine engaging position, braking means engageable with said flywheel to reduce said re-drift tendency, means including an electric motor for accelerating said flywheel, electromagnetic means for controlling said motor, electro-magnetic means for holding said braking means out of contact with said flywheel during energization of said motor, and common control means for both said electromagnetic means.

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