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ENGINE STARTING MECHANISM

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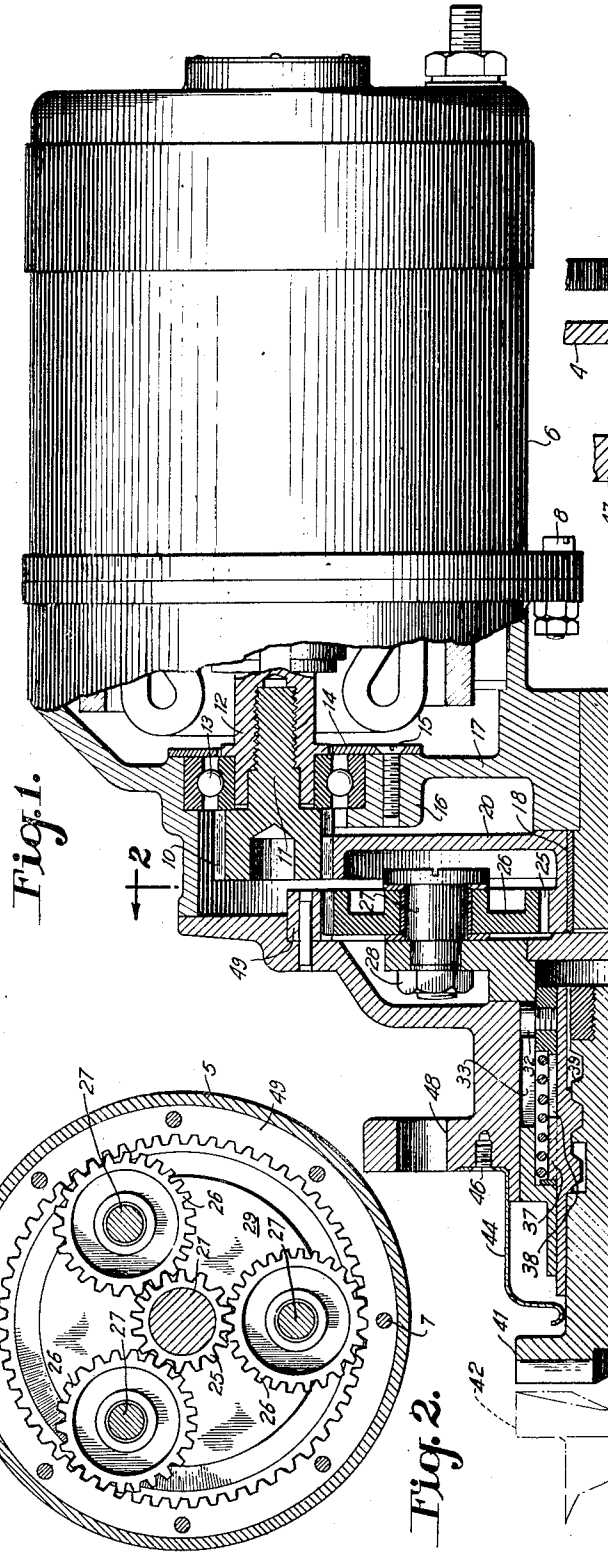


Fig. 1.

Fig. 2.

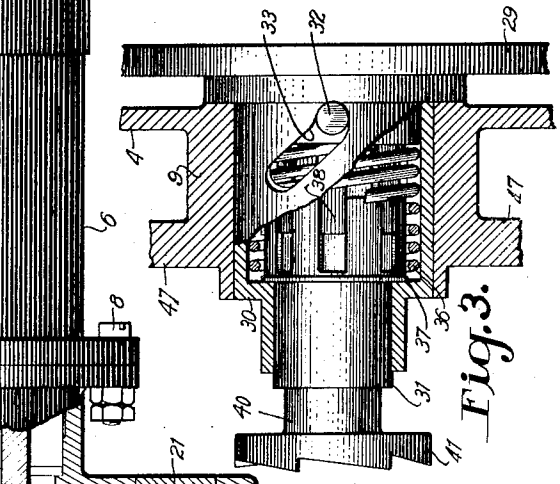


Fig. 3.

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ENGINE STARTING MECHANISM

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10 Claims. (Cl. 74—7)

This invention relates to engine starting mechanisms and particularly to those adapted to impart the initial turning force to a member, such as the crankshaft, of an engine having other means for maintaining itself in operation after such initial turning or cranking.

An object of the invention is to provide a starter for the foregoing purpose embodying novel means for establishing driving connection between a rotatable element of the starter and a rotatable member of the engine, which means includes yieldable means normally adapted to maintain positive driving connection between the driving member of the starter and the aforesaid rotatable member, but adapted to yield temporarily to absorb the sudden reverse torque resulting in the event of a backfire of the engine to be started.

A further object of the invention is to provide yieldable means of the foregoing character, constructed and disposed in respect to the driving and driven elements of the starter, in such manner as to be effective to maintain positive driving relation between the said elements even during the assimilation of the reverse torque above referred to.

Another object of the invention is to provide in a starter of the type employing a member movable longitudinally into engagement with a member of the engine to be started and thereafter rotatable to crank the engine, novel means for rotating said first named member at relatively high speed following completion of its longitudinal movement.

Another object of the invention is to provide a simple but efficient starter for the foregoing purposes, which is further characterized by a novel arrangement of the torque transmitting mechanism rendering the starter suitable for installation in engines where space is restricted and economy in size and weight is essential.

These and other objects and advantages to be derived from the use of the invention disclosed herein will become evident on an inspection of the following description when read with reference to the accompanying drawing illustrating one embodiment of the invention. It is to be expressly understood, however, that the drawing is for the purpose of illustration only, and is not to be construed as a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing,

Fig. 1 is a view in elevation with parts shown in longitudinal section of the device embodying the invention.

Fig. 2 is a transverse section view along the line 2—2 of Fig. 1; and

Fig. 3 is a view in elevation with parts broken away and others in section of a portion of the assembly shown in Fig. 1.

Referring to the drawing and particularly to Fig. 1, the invention is shown embodied in a starter having a casing composed of three sections, 4, 5, and 6, the latter constituting the casing for the prime mover, herein shown as an electric motor adapted to actuate an engine-engaging member supported within the first section 4 of the casing and drivably connected to the prime mover through reduction mechanisms mounted within the casing section 5, the three sections being joined by suitable means as indicated at 7 and 8.

In the present embodiment, the reduction mechanism is constituted by a two-stage spur gear reduction including a driving pinion 10 formed on the outer end of the threaded member 11 which engages a threaded socket formed in the armature shaft 12 of the motor, the said armature shaft being rotatably supported by suitable bearings 13 retained in place by the disc 14 and screws 15 secured to the hub 16 formed on the transverse wall 17 of the casing section 5. The pinion 10 is adapted to mesh with a gear 20 of considerably larger diameter and rotatable on a sleeve bearing 18 about a shaft 21 whose axis preferably is in alignment with that of the rotatable member of the engine with which the starter is adapted to be drivably connected. As shown, the casing section 5 is provided with a suitable thickened portion or hub 23 forming a support in which the shaft 21 is held against endwise movement in either direction by provision of a shoulder 19 and a retaining disc 22, while the gear 20 is provided with a forwardly extended hub 24 on which are formed teeth 25 constituting a pinion adapted to drive the planetary gears 26, each of which meshes with a stationary annulus gear 49 and is rotatable about a pin 27 on the forward end of each of which is threaded a nut 28 adapted to retain the pins in operative relation with a flange 29 formed on a hollow driving member or barrel 30 rotatably supported within the hub 9 of the casing section 4, the annulus gear 49 being held against rotation by bolts 7. The barrel 30 is in turn drivably connected to an internally threaded sleeve 31 by novel means constituting one of the major features of the invention now to be described.

The novel means for effecting a normally positive drive from the barrel 30 to the sleeve 31, while at the same time absorbing shock incident

to a sudden application of torque in the reverse direction, preferably takes the form of a pin and slot connection between these members, such a pin being indicated at 32 as having a head portion movable along a diagonally directed slot or opening 33 in the wall of the barrel 30, while the shank portion of the pin 32 is threaded or otherwise permanently secured to an intermediate sleeve member 34 interposed between the barrel 30 and threaded sleeve 31 and preferably provided with a portion 35 of smaller external diameter but of the same internal diameter, such construction providing an annular recess between the members 35 and 30 in which is placed a coil spring 36 normally stressed sufficiently to maintain the pin 32 in the position indicated in Fig. 3 in which position the drive, under normal torque conditions, from the barrel 30 to the member 34 is positive and direct. Similar direct connection is provided between the member 34 and the sleeve 31 by forming external splines 37 on the latter member, adapted to register with corresponding longitudinal extensions 38 on the member 34, the length of such extension 38 being such as to allow a predetermined longitudinal movement thereof in the event of suddenly applied torque tending to rotate the parts in a reverse direction, the amount of permissible longitudinal movement being preferably equal to the length of the slot 33 as projected along the axis of the members. The internally formed threads on the sleeve 31 are adapted to register loosely with corresponding externally formed threads 39 on the engine-engaging member 40 which is provided at its outer end with radially disposed teeth 41 adapted to engage the corresponding teeth of a jaw 42 secured to or as shown, integral with a rotatable member of the engine. In order to enforce longitudinal movement of the member 40 to mesh jaws 41 and 42, and in order to insure proper mesh of these members, detent fingers 44 are provided to engage the smooth cylindrical surface of the member 40 with a frictional pressure sufficient to prevent rotation of the member 40 during the period of its longitudinal advance into engagement with the engine member, such longitudinal advance being produced in response to the first rotation of the sleeve 31 following energization of the prime mover. Suitable means, such as indicated at 46, may be employed for retaining the friction elements 44 in friction-exerting relation to the member 40. In the drawing, only one of the friction elements is shown, but it will be understood that others may be provided at suitable intervals about the flange 47, the latter also being provided with apertures 48 for the reception of means for attachment of the starter to the crankcase, or other supporting structure of the engine to be started.

In operation, energization of the motor 6 will be transmitted at reduced speed to the barrel 30 through the reduction mechanism above described, and from the barrel 30 through pins 32 to the intermediate sleeve 34 and from the latter to the threaded sleeve 31 by means of the splined connections 37 and 38. Threaded shaft 40 being somewhat loosely threaded within the sleeve 31 will, in view of its inertia, fail to turn immediately with said sleeve, and will therefore be constrained by the turning of said sleeve and by the frictional pressure of the detent fingers 44, to move forward without any rotary movement until the teeth 41 have meshed with those of the engine member. As the shaft is thus advanced, stop nut 50 is carried along, and after meshing begins, will contact with the shoulder 51 in which the threaded portion of the sleeve 31 terminates. Thereafter further longitudinal movement of the shaft 40 being impossible the latter member will rotate with the sleeve 31 and thus impart sufficient torque to the engine-member to allow the engine to develop sufficient compression for starting under its own power.

In the event the engine backfires during the cranking operation, a reverse torque is transmitted from the jaw teeth through the threaded connection to the sleeve 34, causing the pin 32 to slide along the inclined slot 33, thus moving the sleeve 34 to the left as viewed in Figs. 1 and 3 and compressing the spring 36. During this compressing action, limited and predetermined torque is transmitted through the gears to the armature of the motor, thereby first retarding it and finally bringing it to a stop. At the same time, a greater degree of torque is applied to the engine to stop further backward rotation thereof. If equilibrium is not established before the pin reaches the end of the slot 33, the engine drives the armature shaft in a reverse direction until the energy caused by the backfire has been dissipated. On the other hand, if equilibrium is established before the pin reaches the end of the slot 33, spring 36 will be effective to return pin 32 and member 34 to the normal position as shown in Figs. 1 and 3, thereby re-establishing direct cranking operation between the prime mover and the engine. In either of these events, it will be seen that the shock produced by the engine backfire has been assimilated by the yielding connection and without any possibility of serious injury to the parts of the starter, such as the gearing or motor.

After the engine has started under its own power, the inclination of the jaw teeth will cause the return of the shaft 40 back to the disconnected position, in which position it will remain until the next operation of the starter.

There is thus disclosed a novel engine starter of the inertia type which is simple and rugged in structure, inexpensive to manufacture and efficient in operation. It is especially adapted for use with small engines because of its compactness and light weight, but since it is a self-contained unit, it may be easily attached to any engine, and requires no external supporting means other than a mounting flange or bracket provided on the engine housing.

While the embodiment above described possesses considerable practical merit, the invention is not limited to such embodiment since the novel principles may be incorporated in structures varying considerably from that above described. Thus, for example, a cam and follower construction may be substituted for the pin and slot connection shown at 32 and 33 in the accompanying drawing, and other types of yielding means may be employed in place of the coil springs 36. Moreover, in cases where the requirements permit, the motor may be mounted in coaxial alignment with the engine-engaging member and other types of gearing substituted for that shown.

It is to be understood that various other changes may be made in the form, details of construction and arrangement of the parts and the uses to which they are applied, without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of a radially disposed normally positive driving connection between said driving means and driven member, means for causing said normally positive driving connection to be displaced angularly only to a predetermined extent relatively to said driving means in the event of a sudden reversal of the direction of rotation of the engine member during its engagement with said driven member, and means distinct from said angularly displaceable driving connection for shifting said driven member into engine engaging position and maintaining it in said position regardless of any angular displacement of said driving connection.

2. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of a means for yieldably retarding the rotary speed of said driving means and thereafter reversing the direction of rotation of said driving means in the event of a sudden reversal of the direction of rotation of the engine member during its engagement with said driven member, said means comprising a pair of concentrically disposed sleeves, one of which is slotted obliquely of their common axis of rotation, and means projecting from the other of said sleeves for engagement with the slotted portion of said first named sleeve to be driven thereby, and means distinct from both said sleeves for shifting said driven member into engine engaging position.

3. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of a sleeve drivably connected to said driven member, a second sleeve slotted obliquely of its common axis and drivably connected to said driving means, and means projecting from said first named sleeve for engagement with the slotted portion of said second sleeve to be driven thereby, and means for yieldably preventing relative rotation between said projecting means and said second sleeve, and means distinct from both said sleeves for shifting said driven member into engine engaging position.

4. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of means comprising a pair of concentrically disposed sleeves normally rotatable in unison but capable of limited relative rotation in the event of reversal of the direction of torque transmission, and a third sleeve splined to one of said first named sleeves and threadedly engaging said ribbon member.

5. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of a sleeve interposed between said driving means and driven member, said sleeve having a screw threaded driving connection with said driven member and means for yieldably retarding the rotary speed of said driving means and thereafter reversing the direction of rotation of said driving means in the event of a sudden reversal of the direction of rotation of the engine member during its engagement with said driven member, said means comprising a pair of concentrically disposed members surrounding said threaded sleeve and normally rotatable in unison but capable of limited relative rotation in the event of reversal of the direction of torque transmission, said screw threaded driving connection being effective to maintain said driven member in engagement with said engine member during the entire cranking process regardless of any change in the relative positions of said concentrically disposed units.

6. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of a sleeve threadedly engaging said driven member, and means for causing a reversal of the direction of rotation of said driving means in the event of a sudden reversal of the direction of rotation of the engine member during its engagement with said driven member, and means for delaying such reversal of rotation until absorption of a predetermined amount of torque generated in said engine member, said means comprising a pair of concentrically disposed members one of which is in splined engagement with said sleeve and the other of which is normally rotatable in unison therewith but capable of limited relative rotation in the event of reversal of the direction of torque transmission, and means constituted by said threaded sleeve for maintaining said driven member in engagement with the engine member during the entire cranking process regardless of any relative rotation which might occur between said concentrically disposed members.

7. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of a sleeve threadedly engaging said driven member, a normally positive driving connection between said driving means and sleeve, and means for causing said normally positive driving connection to yield only to a predetermined extent in the event of a sudden reversal of the direction of rotation of the engine member during its engagement with said driven member and without producing any corresponding disengaging movement on the part of said driven member, said means comprising a pair of concentrically disposed sleeves, one of which has splined engagement with said first named sleeve and the other of which is provided with inclined surfaces, and a member engageable with one portion of said inclined surfaces during transmission of torque in one direction and with another portion of said surfaces during transmission of torque in the opposite direction.

8. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, the combination with said driving means, driven member and engine member of a sleeve threadedly engaging said driven member, and means for yieldably retarding the rotary speed of said driving means and thereafter reversing the direction of rotation of

said driving means in the event of a sudden reversal of the direction of rotation of the engine member and without producing any corresponding disengaging movement on the part of said driven member during its engagement with said driven member, said means comprising a pair of concentrically disposed sleeves, one of which has driving engagement with said first named sleeve and the other of which is provided with inclined surfaces and a member engageable with one portion of said inclined surfaces during transmission of torque in one direction and with another portion of said surfaces during torque transmission in the opposite direction.

9. In an engine starting mechanism of the type employing power operated driving means and a driven member engageable with a member of the engine to be started, said driven member having a threaded portion, the combination with said driving means, driven member and engine member of a means for causing a reversal of the direction of rotation of said driving means in the event of a sudden reversal of the direction of rotation of the engine member during its engagement with said driven member, and means for delaying such reversal of rotation until absorption of a predetermined amount of torque generated in said engine member, said means comprising a pair of concentrically disposed sleeves one of which is threaded internally to engage the correspondingly threaded portion of said engine engaging member and the other of which is provided with inclined surfaces, and a radially disposed pin engageable with one portion of said inclined surfaces during transmission of torque in one direction and with another portion of said surfaces during torque transmission in the opposite direction, said radially disposed pin constituting the torque transmitting connection between said driving means and threaded sleeve, said threaded sleeve and driven member remaining axially fixed during the entire cranking period regardless of any movement of said pin along said inclined surfaces.

10. In a device of the class described, a driving member, a driven member, and a two-way driving connection between said members, said connection comprising a radially disposed pin positively connecting said driving and driven members and also adapted to positively connect said members for reverse torque transmission after a limited degree of relative rotation between said pin and driving member, said driven member remaining in fixed axial position during the entire cranking period regardless of any relative rotation between said pin and driving member.

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