

July 3, 1934.

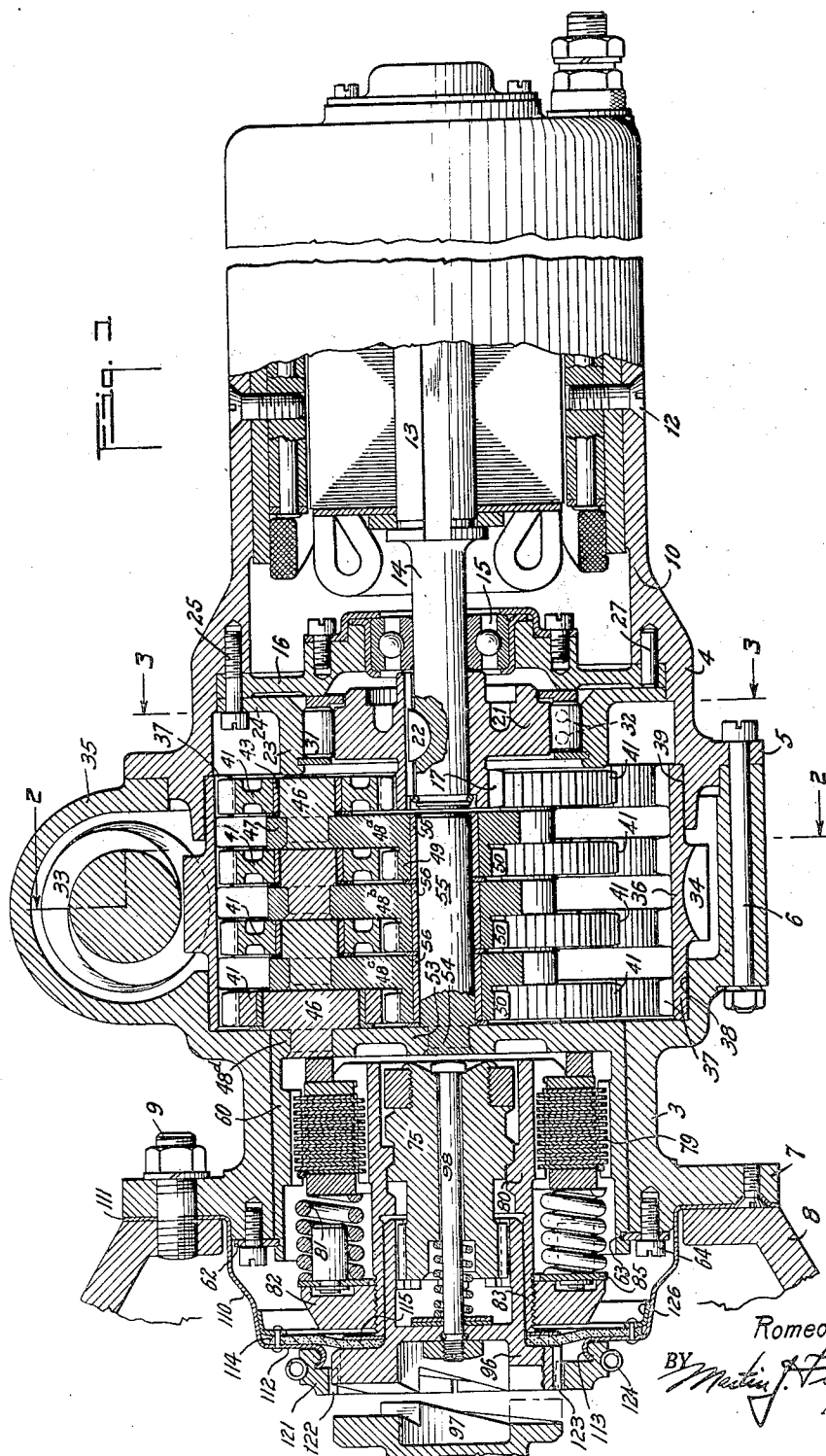
R. M. NARDONE

1,965,050

ENGINE STARTING MECHANISM

Filed Nov. 14, 1932

2 Sheets-Sheet 1



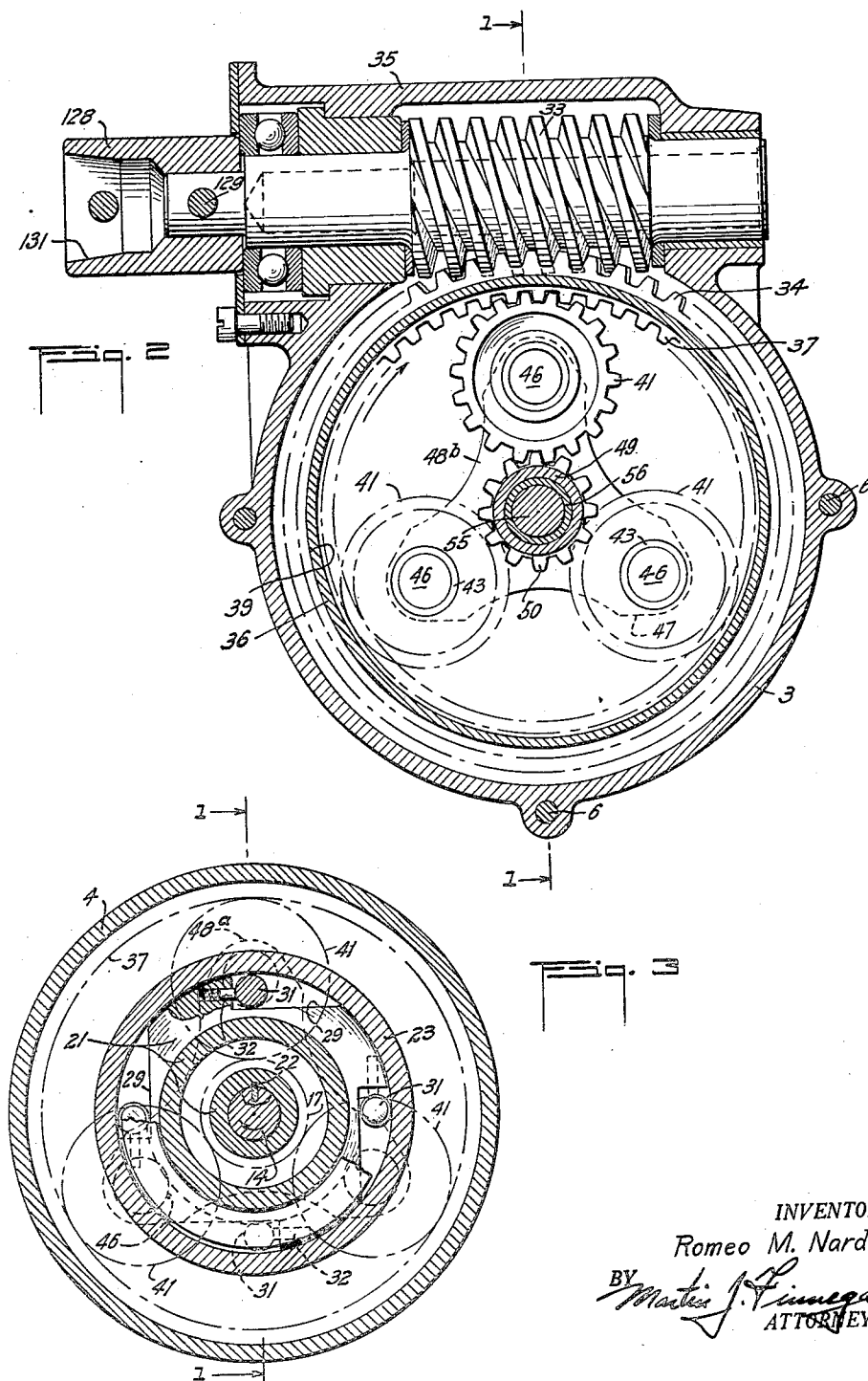
July 3, 1934.

R. M. NARDONE
ENGINE STARTING MECHANISM

1,965,050

Filed Nov. 14, 1932

2 Sheets-Sheet 2



INVENTOR.
Romeo M. Nardone
BY *Martin J. Finnegan*
ATTORNEY.

UNITED STATES PATENT OFFICE

1,965,050

ENGINE STARTING MECHANISM

Romeo M. Nardone, East Orange, N. J., assignor,
by mesne assignments, to Eclipse Aviation Corporation,
East Orange, N. J., a corporation of New Jersey

Application November 14, 1932, Serial No. 642,667

10 Claims. (Cl. 74—7)

This invention relates to engine starting mechanism and more particularly to means for starting an internal combustion engine by the application of a turning or cranking effort to the crankshaft, or some member connected therewith.

An object of the invention is to provide a novel engine starter of the foregoing character in which the cranking effort may be developed manually, or in a motor energizable from an external source, such as a battery. In this connection a feature of the invention is the provision of novel interlocking means associated with both the motor and manual cranking means, said novel interlocking means being so adapted as to lock the manual means against movement while the motor is functioning, and conversely when manual cranking is employed.

In Patent No. 1,753,830 granted April 8, 1930, to Raymond P. Lansing there is disclosed and claimed, in connection with an engine starting mechanism of a character similar to that of the present invention, and involving alternative power and manual operating means, a construction wherein the power means and its operating connections may be automatically disengaged when the starter is operated through the manual means. The present invention, while directed in part to the attainment of the same ultimate result, to wit, prevention of a drive back to the power means during manual operation, achieves the same ultimate result by different means, namely, the substitution of an interlocking connection between the manual and power means, rather than a disengaging connection as shown in the above identified Lansing patent.

Another object of the invention is to provide in a combined motor and manually operated starter of the foregoing character, novel transmission means including a gear train having a plurality of constantly meshed parts, certain of which remain locked during manual cranking to absorb the reaction of the other parts in mesh therewith, while during the motor operation certain other gear elements remain locked to absorb the reaction of the first mentioned parts.

In the preferred embodiment as shown, the novel transmission and interlocking mechanism includes a plurality of planetary gear sets connected in series, and having a common annular or orbit gear which is interlocked with the manual means during motor operation, and a central or sun gear which is interlocked with the motor frame during manual operation. During both motor and manual operation the crank-

ing effort is transmitted to the engine engaging member through the idler elements, or planets, of the gear train, the planet pinions of the last stage of the gear train being drivably connected with said engine engaging member, preferably through the instrumentality of an adjustable torque limiting clutch.

Other objects and features of the invention will become apparent from the following description when read with reference to the accompanying drawings. It is to be 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 for such purpose to the appended claims.

In the drawings,

Fig. 1 is a central longitudinal section of the device embodying the invention;

Figs. 2 and 3 are transverse sectional views taken along the lines 2—2 and 3—3 respectively of Fig. 1.

Referring to the drawings and particularly to Fig. 1, the invention is shown embodied in a housing constituted by an inner section 3 and an outer section 4 having a suitable flange 5 to receive bolts 6 for detachably connecting said sections. The inner section 3 is provided with a flange 7 for engagement with a mounting flange 8 formed on the engine casing, and through which the fastening means 9 are inserted. Secured within section 4 is an electric motor provided with a casing 10 integral with section 4 and having openings to receive screws 12 which may be employed for detachably securing the field yoke of the motor to the housing 4. The armature shaft 13 is preferably provided with a laterally projecting reduced portion 14 that is rotatably mounted as by means of a suitable bearing 15, in the dividing wall 16 interposed between the casing sections 3 and 4. Drivably connected to the reduced portion 14 of the armature shaft is a pinion 17 constituting the sun gear of the first set of the planetary gear train above referred to, the said sun gear 17 having associated therewith a portion of the novel interlocking means now to be described.

The portion of the novel interlocking means which is associated with the sun gear 17 preferably includes an overrunning clutch mechanism, the inner race 21 of which is shown as integral with the sun gear 17, the combined sun gear and inner race being suitably secured to the shaft 14 as indicated at 22.

As shown in Figs. 1 and 3, the outer race 23 of the clutch is flanged as indicated at 24 and through this flange suitable fastening means 25

pass to firmly secure said outer race to the motor casing 4, the fastening means 25 also serving in the present embodiment as the means for retaining the transverse plate 16 in position after it has been properly located by means of the locating pin 27. As shown best in Fig. 3 the inner race 21 has a plurality of cut out portions forming pockets 29 in each of which is received a roller 31 constantly urged by the spring pressed plungers 32 into rolling contact with the surfaces of both the pockets 29 and the inner periphery of the outer race 23. It is to be understood however that this specific form of clutch is not essential and any other form of one way clutch may be substituted therefor so long as it permits free rotation of the inner race 21 with the motor-shaft 14 when the latter is energized to cause rotation in the direction of the arrow in Fig. 3. When, however, the starter is manually energized it is desirable to lock the motor-shaft 14 against rotation so that the sun gear 17 may take the reaction necessary for the proper operation of the planetary gear train. During motor operation this reaction is taken through the self locking mechanism associated with the remainder of the gear train and now to be described.

The manual operating means preferably includes a worm 33 mounted transversely in a housing 35 of the casing section 3, and having threads which mesh with the teeth 34 formed on the outer circumferential surface of the central portion 36 of an annular member 37 fitting within bearing surfaces 38 and 39 respectively of the aligned casing sections 3 and 4 and constituting the orbit member of the planetary gear train. On the inner surface of the member 37 a plurality of (herein shown as 4) sets of gear teeth are provided, each set being engaged by a plurality of pinions 41, constituting the planets of the gear train. As shown best in Fig. 2, there are preferably three planets 41 in each set, each planet containing a sleeve bearing 43 facilitating free rotation about the corresponding one of the stub shafts 46 by which each is secured to an arm 47 of the respective mounting cages 48^a, 48^b and 48^c, the hubs 49 of which have toothed extensions 50 constituting sun gears adapted to mesh with the succeeding set of planet pinions 41. The cage 48^d in which the last set of planet pinions 41 is mounted however has no sun gear extension on its hub 53, but the said hub is apertured to receive the upset end 54 of a shaft 55 which extends centrally through and supports the cages 48, and is adapted to receive a series of spacer sleeves 56 which facilitate free rotation of the gear sets about the said shaft 55. The last of the cages, indicated by numeral 48^d, also differs from the others in that it has a cylindrical rim 60 extending laterally therefrom and is secured against axial displacement by the provision of an annular ring 62 extending into a groove 63 formed near the outer end of the rim or barrel 60 and apertured for reception of screws 64 which hold the ring to the housing. This portion of the housing has an inner cylindrical surface supporting the barrel 60 for free rotation therein.

A multiple disc clutch is preferably provided in association with the barrel 60 to insure relative rotary movement between the engine engaging member and the train of gearing above described whereby the latter is protected from damage due to an excessive shock or load. As shown, the disc clutch comprises a plurality of interleaving discs 79, alternately splined to the inner

surface of the barrel 60 and the outer surface of a shell 80, internally threaded to engage a correspondingly threaded screw shaft 75, to be further described. Resilient means, such as a plurality of coiled compression springs 81, the pressure of which is adjustable by a nut 82 threadably engaging the end 83 of the shell 80, are provided to press upon a ring 85 surrounding member 80, and thus maintain the discs 79 in frictional engagement with a pressure sufficient to insure transmission of torque from barrel 60 to shell 80, up to a predetermined capacity.

Fitted over the inner end of the starter is a cup-shaped member 110 that is preferably formed of metal and is provided with a flange 111 adapted to be clamped between flange 7 of the starter housing and the engine flange 8. The inner portion of member 110 is bent inwardly toward jaw member 96 as at 112 and is provided with a central opening which is slightly larger in diameter than the outer diameter of the jaw member 96. Preferably member 110 is strengthened adjacent said opening by being bent or curved, as at 113, the lip thus formed serving to receive a split ring 121 composed of a plurality of segments each of which has an inwardly extending tooth or lug 122 engageable with correspondingly spaced grooves 123 cut along the peripheral surface of clutch member 96. A toroidal spring 124 surrounds the split ring 121, resting in an annular groove formed in the periphery thereof. This spring 124 serves to yieldingly restrain the ring 121, and hence the clutch element 96, against immediate rotation in response to the initial rotary movement of the member 80, and thus cooperates with the members 80 and 75 in converting the initial rotary movement into an axial movement of the member 75 which axial movement is effective to move the clutch element 96 into mesh with the engine member 97.

In order to prevent seepage of oil through the central openings in member 110, the latter preferably carries a washer 114 which may be formed of leather or equivalent material. Normally the inner portion of washer 114 is held in engagement with the adjacent surface of the head of jaw member 96 by means of a washer 115 which slidably surrounds the outer cylindrical surface of the member 96. If desired, a metal ring 126 may be provided to clamp the washer 114 to the cap member 110.

From the foregoing it will be apparent that when manual operation is desired, rotation of the worm 33 through the instrumentality of the cranking shaft 128 pinned to the worm shaft 33 as indicated at 129 in Fig. 2 and having a socketed end 131 for the reception of a removable hand-crank. Upon application of the handcrank, the worm 33 may be rotated to cause rotation of the annular gear 37 at a much reduced speed and in a clockwise direction, as indicated in Fig. 2, with a corresponding rotation of all four sets of planetary pinions 41 in a direction tending to rotate the sun gear 17 in a counter-clockwise direction as viewed in Fig. 3. Such rotation of sun gear 17 is impossible, however, due to the jamming action of the rollers 31 and the result is that the sun gear 17 and the elements of the one way clutch take the torque reaction due to the load which the planetary gears are driving, such torque reaction being ultimately absorbed by the stationary frame 4 to which the outer race of the clutch is rigidly secured. As a result, the successive sets of planetary pinions 41 rotate in a clockwise direction about their individual axes

and in so rotating carry the corresponding cages 48 about the shaft 55 in a clockwise direction and produce corresponding clockwise rotation of friction clutch 79 and shell 80, the initial rotation of the shell being effective to mesh the starter jaw 96 with the engine member 97 with the assistance of the frictional retarding means above described. When the cranking action is completed and the engine starts under its own power, the resulting excess in torque on the part of the driven member 97 will cause a reverse threading action and as a result thereof the shaft 75 will move in an axial direction back to the normal position as indicated in Fig. 1, the clutch jaw 96 being simultaneously returned through the action of the coupling pin 98.

When the motor drive is employed the motor leads are connected in a manner to cause rotation of the armature shaft 14 in a clockwise direction as viewed in Fig. 3, in which direction the rollers 31 run freely in the pockets 29, and do not oppose rotation of the inner race 21 within the stationary outer race 23, due to the pitch and direction of lead of the threads of the worm 33 and the torque reaction is accordingly taken in the elements 34 and 33, planetary pinions 41 and cages 48, which accordingly rotate in the same clockwise direction as during manual operation.

There is thus disclosed a novel engine starting mechanism embodying the above described features of the present invention and capable of obtaining the above expressed objects. While the embodiment herein shown is of considerable practical merit, it is to be understood that various changes may be made in the construction, arrangement and inter-relation of the parts entering into the invention without departing from the spirit thereof, the extent of the included variations being ascertainable by reference to the appended claims.

What is claimed is:

1. An engine starter including a drive having a member adapted to engage and crank a member of the engine to be started, a housing for said drive, a hand operated cranking shaft journaled in said housing and operatively connected with said drive, power means also operatively connected with said drive, and means including a one-way clutch responsive to rotation of said hand-cranking shaft for locking said power means against rotation.

2. In a device of the class described, in combination with separate power and manually operated shafts, a motor connected to said power operated shaft to drive the latter, a common housing for said shafts, an overrunning clutch having an inner race keyed to said power operated shaft and an outer race rigidly held to said housing, and means interposed between said races to prevent rotation of said power operated shaft in response to rotation of said manually operated shaft, said means being ineffective to restrain rotation of said power operated shaft upon energization of said motor.

3. In a device of the class described, in combination with a gear train and a motor connected to said gear train to drive the latter, a common housing for said motor and gear train, an overrunning clutch having an inner race rotatable with one element of said gear train, and an outer race rigidly held to said housing, and means interposed between said races to prevent rotation of said motor in response to rotation of other elements of said gear train, said means being

ineffective to restrain rotation of said first named gear upon energization of said motor.

4. In a device of the class described, in combination with separate power and manually operated shafts, a gear train connecting said shafts, a motor connected to said power operated shaft to drive the latter, a common housing for both said shafts, an overrunning clutch having an inner race rotatable with said power operated shaft and an outer race rigidly held to said housing, means interposed between said races to prevent rotation of said power operated shaft in one direction, and means engageable with one element of said gear train and rotatable with said manually operated shaft, to lock said gear element against rotation upon energization of said motor.

5. An engine starter including a drive having a member adapted to engage and crank a member of the engine to be started, a housing for said drive, a worm and gear journaled in said housing and operatively connected with said drive, power means also operatively connected with said drive, and means including a one-way clutch responsive to rotation of said worm and gear for locking said power means against rotation.

6. In a device of the class described, in combination with a power operated shaft and a gear train drivably connected therewith, a motor connected to said power operated shaft to drive the gear train, a housing common to both said motor and gear train, an overrunning clutch having an inner race rotatable with said power operated shaft and an outer race rigidly held to said housing, means interposed between said races to prevent rotation of said power operated shaft in one direction, and means engageable with one element of said gear train to lock said gear element against rotation upon energization of said motor.

7. In a device of the class described, in combination with separate power and manually operated shafts, a motor connected to said power operated shaft to drive the latter, a common housing for both said shafts, an overrunning clutch having an inner race rotatable with said power operated shaft and an outer race rigidly held to said housing, means interposed between said races to prevent rotation of said power operated shaft in one direction, and means rotatable with said manually operated shaft for preventing rotation thereof upon energization of said motor and notwithstanding the mechanical connection between said power and manually operated shafts.

8. In a device of the class described, in combination with separate power and manually operated shafts, a motor connected to said power operated shaft to drive the latter, a common housing for both said shafts, an overrunning clutch having one race rotatable with said power operated shaft and another race rigidly held to said housing, means interposed between said races to prevent rotation of said power operated shaft in one direction, means rotatable with said manually operated shaft for preventing rotation thereof upon energization of said motor and notwithstanding the mechanical connection between said power and manually operated shafts, said last named means including a gear train one element of which cooperates with said manually operated shaft to be rotated thereby when the motor is de-energized but interlocked therewith when said motor is energized.

9. In an engine starting mechanism, in combination with a power operated shaft and a power transmitting element drivably connected there-

with, a housing common to both said shaft and power transmitting element, an overrunning clutch having an inner race rotatable with said power operated shaft and an outer race rigidly held to said housing, means interposed between said races to prevent rotation of said power operated shaft in one direction, and means responsive to rotation of said shaft to establish driving connection between said power transmitting element and the engine to be started.

10. In an engine starting mechanism, in combination with separate power and manually operated shafts, a common housing for both said shafts, an overrunning clutch having an inner race rotatable with said power operated shaft and an outer race rigidly held to said housing, means interposed between said races to prevent rotation of said power operated shaft in one direction, and means responsive to rotation of either of said shafts to establish driving connection between said shaft and the engine to be started.

ROMEO M. NARDONE.

15	90
20	95
25	100
30	105
35	110
40	115
45	120
50	125
55	130
60	135
65	140
70	145
75	150